Assam down town University

Curriculum and Syllabus

Bachelor of Science
in
Forensic Science

OUTCOME BASED EDUCATION FRAMEWORK
CHOICE BASED CREDIT SYSTEM
Version: 1.2

FACULTY OF SCIENCE

July, 2024

PREAMBLE

Assam down town University is a premier higher educational institution which offers Bachelor, Master, and Ph.D. degree programmes across various faculties. These programmes, collectively embodies the vision and mission of the university. In keeping with the vision of evolutionary changes taking place in the educational landscape of the country, the university has restructured the course curriculum as per the guidelines of National Education Policy 2020. This document contains outline of teaching and learning framework and complete detailing of the courses. This document is a guidebook for the students to choose desired courses for completing the programme and to be eligible for the degree. This volume also includes the prescribed literature, study materials, texts, and reference books under different courses as guidance for the students to follow.

Recommended by the Board of Studies (BOS) meeting of the Faculty of Science held on dated 16th & 17th July, 2024 and approved by the 51st Academic Council (AC) meeting held on dated 26/07/2024

Chairperson, Board of Studies

Member Secretary, Academic Council

Vision

To become a Globally Recognized University from North Eastern Region of India, Dedicated to the Holistic Development of Students and Making Society Better

Missions

1. Creation of curricula that address the local, regional, national, and international needs of graduates, providing them with diverse and well- rounded education.

2. Build a diverse student body from various socio-economic backgrounds, provide exceptional value-based education, and foster holistic personal development, strong academic careers, and confidence.

3. Achieve high placement success by offering students skill-based, innovative education and strong industry connections.

4. Become the premier destination of young people, desirous of becoming future professional leaders through multidisciplinary learning and serving societybetter.

5. Create a highly inspiring intellectual environment for exceptional learners, empowering them to aspire to join internationally acclaimed institutions and contribute to global efforts in addressing critical issues, such as sustainable development, Climate mitigation and fostering a conflict-free global society.

6. To be renowned for creating new knowledge through high quality interdisciplinary research for betterment of society.

7. Become a key hub for the growth and excellence of AdtU's stakeholders including educators, researchers and innovators

8. Adapt to the evolving needs and changing realities of our students and community by incorporating national and global perspectives, while ensuring our actions are in harmony with our foundational values and objectives of serving the community.

Programme Details

Programme Overview

B.Sc. in Forensic Science is a 3-year undergraduate programme under Faculty of Science of Assam downtown University, Guwahati, Assam. The main aim of the Programme is to create experts in the field of forensic science with the application of advanced scientific techniques This course targets to develop a platform where students can get to learn and practice about the scientific methodology and techniques that can be used to the field of crime investigation so that justice can be serve to the right person in less time which is the need of the hour for society. A graduate in forensic science course may avail jobs in the Forensic science laboratories, Research and Development, Education, Armed forces and Private sector also.

I. Specific Features of the Curriculum

The curriculum integrates multidisciplinary concepts of forensic science, fostering an in-depth understanding necessary for solving complex forensic problems. It emphasizes holistic development through activities that enhance interpersonal skills, adaptability, and teamwork in diverse socio-cultural settings. Additionally, the curriculum promotes global competency by incorporating international standards and offering global certification courses, enabling students to address forensic issues on a worldwide scale. This comprehensive approach ensures that graduates are well-equipped with both technical expertise and soft skills essential for thriving in the forensic science profession.

II. Eligibility Criteria:

Minimum 45% in 10+2 with English, Biology & Chemistry

III. Program Educational Objectives (PEOs):

PEO-1: AdtU forensic science graduates will be well-prepared for successful careers in industry, corporate, research organizations and/or government sectors in one or more of the disciplines/sub-disciplines of forensic science.

PEO-2: The forensic graduates will be academically prepared to apply advanced technologies for analyzing forensic evidence, leading diverse teams and delivering impartial scientific opinions.

PEO-3: AdtU forensic graduates will play a vital role in fostering a safe and vibrant society by serving as forensic experts for crime awareness, with the potential for successful pursuits in higher education in forensic science if pursued.

IV. Program Specific Outcomes (PSOs):

PSO1: Techno-Professional Ability: Apply the comprehensive understanding of multidisciplinary concepts of forensic science with interdisciplinary approaches to address complex forensic problems.

PSO2: Holistic Development: Foster interpersonal ability and adaptability in diverse socio-cultural teams and efficient working in the profession through co-curricular and extra-curricular activities.

PSO3: Global Competency: Ability to address forensic issues and understand international scenarios through global certification courses.

V. Program Outcome:

PO1: Forensic Knowledge: Apply fundamental concepts of basic and applied sciences, criminal laws aspects, forensic science principles and analytical processes with psycho-social aspects in investigation to support the agencies and the criminal justice system.

PO2: **Crimes Scene Reconstruction:** Examine physical evidence, witness statements, and forensic findings to understand the sequence of evidence, addressing intricate forensic challenges and formulating logical procedural approaches.

PO3: Analysis and Interpretation: Identify and analyze complex forensic problems using standard analytical protocols and methods.

PO4: **Practice-In-Research:** Identify, formulate and analyze forensic problems utilizing evidence-based research to draw logical conclusions.

PO5: Communication: Communicate efficiently with individuals, peers, investigating agencies and other stakeholders, and prepare quality reports to convey findings.

PO6: Code of Conduct: Adhere to the code of conduct and ethical values in the profession.

PO7: Teamwork: Perform efficiently as a member or leader in collaboration with multidisciplinary teams and diverse settings.

PO8: Modern Tool Practice: Recognize and apply appropriate techniques, resources and modern scientific theories with an understanding of scientific principles.

PO9: Lifelong Learning: Engage in lifelong learning staying abreast of advancements in forensic technology and practices.

VI. Total Credits to be Earned: 140

VII. Career Prospects:

Graduates with a B.Sc. in Forensic Science have excellent career prospects in laboratories and research, criminal justice agencies, armed forces, academics etc. They can become Crime Scene Expert, Document Examiner in banks and different sectors, Forensic Scientist, Advisor and Guide to insurance agencies and banks, Academic Profession, Research & development scientist in respective industries, Research (Food & Beverage, medicine and disease research), Food safety department, Narcotics department and Defence sector.

EVALUATION METHODS

The student performance shall be evaluated through In-semester (Sessional) and semester-end examinations. A weightage of 40% or as prescribed by the programme shall be added to the score of the end-semester examination.

A. INTERNAL ASSESSMENT:

The teacher who offers the course shall be responsible for internal assessment by conducting in-semester (sessional) examination and evaluating the performance of the students pursuing that course. The components for internal assessment are illustrated in the table given below.

SN	Components/ Examinations	Marks Allotted
1.	In-Sem Exam – I (ISE-I) (Written Examination)*	30
2.	In-Sem Exam – II (ISE-II) (Written Examination)*	30
3.	Assignment	10
4.	Presentation (SP)	10
5.	Quiz	5
6.	Class Performance based score*	5

are compulsory

Note: *Total Internal assessment should be out of 40*

INSTRUCTION

1. If a student fails to appear in the any of the component without any valid reason he/she shall be marked zero in that component. However, the course teacher at his discretion may arrange for the missed test on an alternate date for the absentee students after determining ground with genuine/valid reasons for the absent.

2. The report of evaluation of an activity towards the in-semester (sessional) component of a course shall be duly notified by the concerned course teacher within a week of completion.

3. The program coordinators should upload the in-semester marks to the ERP and forward acknowledgement of all the courses of the program to the Controller of Examinations before the start of the End-semester examination.

B. SEMESTER END EXAMINATION:

Time table for end semester examination is published at least 25 days prior to the start of Examination.

I. Pre-Examination:

Eligibility Criteria for a student to appear in University Examinations:

The student shall only be allowed to appear in a University Examination, if:

i) He/ She is a registered student of the University;

ii) He/ She is of good conduct and character;

iii) He/ She has completed the prescribed Programme of study with minimum percentage of attendance as laid down in the Regulations of the Programme concerned.

Under special cases, a student may be allowed to appear for an examination without being registered in the University but the result of the said student will be kept on hold till the registration of the concerned student is completed.

II. Admit Card:

Admit card for the examination may be downloaded through ERP where the system will generate a Unique ID Cards through online.

The University shall have the right to cancel admission for examination of any candidate on valid grounds.

III. Pattern of Question Papers:

The question paper shall follow the principles of Bloom's Taxonomy.
Table

S. N.	Level	Questions /verbs for test
1	Remember	List, Define, tell, describe, recite, recall, identify, show who, when, where, etc.
2	Understand	Describe, explain, contrast, summarize, differentiate, discuss, etc.
3	Apply	Predict, apply, solve, illustrate, determine, examine, modify
4	Analyze	Classify, outline, categorize, analyze, diagrams, illustrate, infer, etc.
5	Evaluate	Assess, summarize, choose, evaluate, recommend, justify, compare etc.
6	Create	Design, Formulate, Modify, Develop, integrate, etc.

Note: No course is to be evaluated on basis of **all 6 knowledge levels.**

The format of the question paper across all the program follow a unique pattern and the total marks is 60

Table 1: Question paper pattern for End semester examination

Sl no	Question pattern	Total marks
1	MCQs (10 Questions)	10
2	2 Marks questions (10 Questions)	20
3	4 Marks questions (5 Questions)	20
4	10 Marks questions (1 Question)	10

IV. Examination Duration:

Each paper of 60 marks shall ordinarily be of two hours duration.

V. Practical Examinations, Viva-Voce etc.:

i) Practical examination shall be conducted in the presence of one external expert and one or more internal examiners.

ii) Viva-Voce, Oral examinations of the Project report, Dissertation etc. shall be undertaken by a Board of Examiners constituted by the respective Dean of Program with the advice of Supervisor(s).

VI. Procedure of Expulsion:

If any candidate is found to be using any unfair-means during the examination, the invigilator may cease his/her answer sheet and report it directly to the Officer-in-Charge. The Office-in-Charge of the center may take appropriate decisions as per the rules and procedure of the examination. The Officer-in-Charge may allow the students to write the exam with new answer sheet or may expel the student from appearing the paper depending on the nature of unfair-means. In case of Computer based test, the students may be directed to write an apology letter and sign in the prescribe expulsion form. The student may not be allowed to write that examination.

VII. Instruction to the Students:

(i) The students shall not bring to the Examination Hall, any electronic gadget used as a means of communication or record except electronic calculator, if required.

(ii) The students shall not receive any book or printed or hand written or photo copy (Xerox) or blank-paper from any other person while he/she is in the examination-room or in laboratory or in any other place to which he/she is allowed to have access during course of examination.

(iii) The students shall not communicate with any other candidate in the examination room or with any other person in and outside the examination-room.

(iv) The students shall not see, read or copy anything written by any other candidate, nor shall he/she knowingly or negligently permit any other candidate to see, read or copy anything written by him/her or conveyed by him/her.

(v) The students shall not write anything on the Question Paper or in other paper or materials during the examination, or pass any kind of paper to any other candidate in the examination-room, or to any person outside the room.

(vi) The students shall not disclose his/her identity to the examiner by writing his/her name or putting any sign / symbol in any part of his answer-script.

(vii) The students shall not use any abusive language or write any objectionable remark or make any appeal to examiner by writing in any part of his answer-script.

(viii) The students shall not detach any page from the answer-script or insert any authorized or unauthorized loose sheet into it. He /she shall also not insert any other answer-script / loose sheet by removing the pins of the origin answer-scripts and re-fixing it.

(ix) The students shall not resort to any disorderly conduct inside the examination-room or misbehave with the invigilator or any other examination official.

VIII. Provision for an Amanuensis (writer):

(i) A candidate may be provided with an Amanuensis (writer) to write down on dictation on his / her behalf on ground of his / her physical disability to write down by himself / herself due to accident or any other reason. The amanuensis may be provided till he / she recovers from the physical disability. The physical disability to write down by himself / herself must be supported by Medical Certificate from a competent Medical Officer.

(ii) The qualifications of the amanuensis so provided must not be equal or higher than that of the candidate. This is also to be supported by Certificate from the Faculty of Study where the Amanuensis is provided.

(iii) Such candidates are to be accommodated in a separate room under the supervision of an invigilator so that the fellow candidates are not disturbed in the process.

C. Credit Point:

It is the product of grade point and number of credits for a course, thus, CP = GP x CR

i. Credit:

A unit by which the course work is measured. It determines the number of hours of instructions required per week. 'Credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. Credits assigned for a single course always pay attention to how many hours it would take for an average learner to complete a single course successfully.

ii. Grade Point:

Grade Point is a numerical weight allotted to each Grade Letter on a 10-point scale.

iii. Letter Grade:

Letter Grade is an index of the performance of students in a said paper of a particular course. Grades are denoted by letters O, A+, A, B+, B, C, P, F and Abs. Student obtaining Grade F / Grade Abs shall be considered failed/ absent and, will be required to appear in the subsequent ESE. The UGC recommends a 10-point grading system with the following (Table: 1) Letter Grades:

(i) A Letter Grade shall signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point shall indicate the numerical weight of the Letter Grade on a 10-point scale.

(ii) There shall be 08 (eight) Letter Grades bearing specific Grade Points as listed in Table 1, where the Letter Grades 'O' to 'P' shall indicate successful completion of a course.

(iii) Apart from the 08 (eight) regular Letter Grades listed in Table 1, there shall be 03 (three) additional Letter Grades, which shall be awarded if a Course is withdrawn or spanned over the next Semester or remains incomplete as stated in Table 2.

Table 2: Letter Grades and Grade Points

Letter Grade	Grade Points	Description
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Abs	0	Absent
UFM	0	Unfair Means

iv. Grade Point Average:

a. SGPA (Semester Grade Point Average)

The SGPA of a student in a Semester shall be the weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered in that Semester, irrespective of whether he/she could or could not complete the Courses. More specifically, the calculation of SGPA shall take into account the Courses graded with Letter Grades 'O' to 'F' as given in Table 1.

$$\text{SGPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad (1.1)$$

The SGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.1) up to two decimal places, where n is the total number of Credit Courses registered by the student in that Semester, Gi is the Grade Point secured in the i^{th} registered Course and Ci is the Credit (weight) of that Course.

b. CGPA (Cumulative Grade Point Average)

(i) The CGPA of a student in a Semester of a Programme shall be the accumulated weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered and successfully completed so far starting from the enrollment in the Programme. In other words, taking into account all the Courses graded with 'O' to 'P' as given in Table 1.1, generally the CGPA of a student shall be calculated starting from the first Semester of his/her enrolled Programme, while the CGPA of a lateral-entry student shall be calculated starting from the Semester of his/her enrollment.

(ii) The CGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.2) up to two decimal places, where N is the total number of Credit Courses registered and successfully completed so far by the student, Gi is the Grade Point secured in the ith completed Course and Ci is the Credit (weight)of that Course.

$$\text{CGPA} = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i} \qquad (1.2)$$

(iii) The CGPA shall be convertible into equivalent percentage of marks using Equation Conversion of CGPA to percentage marks: = CGPA*10

D. Post-Examination

i. Transcript or Grade Card or Certificate:

A marking certificate shall be issued to all the registered students after every Semester. The Semester mark sheet will display the course details (code, title, number of credits, grade secured) along with total credit earned in that Semester.

ii. Grievance Readdress Mechanism:

Students with any dissatisfaction or grievance regarding the marks awarded in any of the Papers / Courses may appeal to the Controller of Examinations for remedial action such as Re-evaluation within 10 days of the declaration of result.

(i) A student has options to appeal for re-evaluation of his /her answer script to the Controller of Examination.

(ii) Application for re-evaluation / re-scrutiny of answer scripts shall be made in the definite proforma available with the Examination Office through the head of the respective departments within 10 days of declaration of the results of the respective examinations.

(iii) The Controller of Examination may appoint an examiner for re-evaluation and will consider and recognize the evaluation done by a University appointed examiner.

(iv) There shall be no provision for re-evaluation of the Practical Papers, Project Work, and Dissertation etc. However, the students fail in practical examination or viva voce and wish to appear again may apply to be evaluated can do so with the next schedule.

(v) After screening the application for re-evaluation, the CoE may send the answer scripts of the student to the examiners appointed by the CoE with the approval of Vice Chancellor.

(vi) The marks/grades achieved by the students after the re-evaluation shall be final and binding.

(vii) Fresh Marks – sheets / Grade Card shall be issued only if the candidate secures pass marks / passing grade in the re-evaluated paper.

(viii) Revaluation of answer scripts shall be deemed to be an additional facility provided to the students with a view to improving upon their results at the preceding examination result for any reason whatsoever shall not confer any right upon them for admission to next higher class which matters always be regulated in accordance with the relevant rules or regulations framed by the University.

(ix) If as a result of revaluation of the candidate attracts the provision of condonation of deficiency, the same may be applied to his/her only for fresh attempt.

INSTRUCTION TO TEACHERS AND STUDENTS

(Teaching and Learning Methods)

In all the courses the teacher has to select topics for teacher-method which should not be less than 20 percent. The approach will be direct classroom teaching through a series of lectures delivering concepts using ITC facilities, white or blackboard. Notes may also be circulated to the students; however, the students are to be involved in the preparation of the notes. The teacher will be responsible for selecting the best note for circulation. The teacher-centric methodology has recently fallen out of favour because this strategy for teaching is seen to favour passive students.

1. Student- centric / Constructivist Approach:

The topics of the courses may be selected at the start of the class and assigned one topic to each of the students for studying by themselves, prepare presentations, notes, etc., and present at respective class time after consultation and discussion with the course teachers. The teacher facilitates the learning of the students by guiding and providing input and explaining concepts. 60 percent of the course contents may be selected for this purpose. To avoid behaviour problems, teachers must lay a lot of groundwork in student-centric classrooms. Typically, it involves instilling a sense of responsibility in students. In addition, students must learn internal motivation.

a. Project-Based Learning: The teacher may select 5 percent of topics for the purpose and may conduct visits to the laboratory for experiments or field surveys. The selection of the topic may be done considering the available facility for the purpose. However, in the final semester of each of the programme the student has to undergo project-based learning at least 4 months duration. This approach will help the student to think critically, evaluate, analyze, make decisions, collaborate, and more.

b. Inquiry-Based Learning: The teacher/ students are supposed to list at least five questions in each contact hour and student solve these question or search for answer which becomes the home work for the students "question-driven" learning approach. The teacher may look for the correctness of the solution or the best possible answer and discuss in the successive class. This will help in the preparation for various competitive examination and develop a habit for search for solutions.

c. Flipped Classroom: About 10 percent of the course content has to be completed by this method. In this approach the students are asked to watch video or lecture prepared by the teacher or any video available (relevant to the course). A set of questions may be given to the students for searching answers by the students. The idea is that students should have more time in-classroom focusing on achieving these higher levels of thinking and learning. The Flipped classroom is also an acronym. The letters FLIP represent the four pillars included in this type of learning: Flexible environment, Learning culture shift, Intentional content, and Professional educator. As you can see, the second pillar refers to a culture shift from the traditional approach where students are more passive to an approach where students are active participants. As a result, this approach is also a student- centric teaching method.

d. Cooperative Learning: The remaining five percent has to be completed by cooperative learning approach. In this approach, the students are allotted problems. During library hours the students along with the teacher visit the library and search for probable solutions for the assigned problem. The same has to be done in groups so that the students discuss among themselves for the appropriate answers. Essentially, cooperative learning believes that social interactions can improve learning. In addition, the approach recreates real-world work situations in which collaboration and cooperation are required.

The percentage categorization for the completion of a theory course

Teacher-centric or Direct Classroom Teaching: Delivery by series of lectures	20%
Student-centric Approach, Students present and deliver lectures in the presence of teacher and supervised by teacher	60%
Students visit fields or perform experiments or teachers perform demonstration	05%
Flipped Classroom approach	10%
Cooperative learning approach	05%

Inquiry-based approach has to be followed in all of the classes

The teacher has to distribute the topics to be considered for teaching by the above-mentioned approaches and prepare a lesson plan for execution and maintain a file.

SEMESTER WISE COURSE DISTRIBUTION

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester I	1	24BSFS1101R	Crime Scene Management	DSC Major	4	0	2	0	0	0	5	40	60	100	200
	2	24BSFS1102R	Crime and Society	MDC	3	0	2	0	0	0	4	40	60	100	200
	3	24BSFS1103R	Indian Constitution & Legal system	VAC	3	0	2	0	0	0	4	40	60	100	200
	4	24UBPD1102R	Elementary English	AEC	0	0	4	0	0	0	2	0	0	100	100
	5	24UBEC1101R	Extra-curricular	Co and extra-Curricular	0	0	0	4	0	0	1	0	0	100	100
	DSC Minor (Sub-disciplinary) (Any two to be selected)														
	6	24FSCH1104R	Chemistry- I	DSC Minor	2	0	0	0	0	0	2	40	60	0	100
	7	24FSPH1105R	Physics-I	DSC Minor	2	0	0	0	0	0	2	40	60	0	100
	8	24FSBO1106R	Biology- I	DSC Minor	2	0	0	0	0	0	2	40	60	0	100
	Total				**14**	**0**	**10**	**4**	**0**	**0**	**20**	**200**	**300**	**500**	**1000**

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester II	1	24BSFS1201R	Forensic Physics	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	2	24BSFS1202R	Fingerprints & other impressions	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	3	24BSFS1203R	Forensic Engineering	MDC	1	0	0	0	0	0	1	40	60	0	100
	4	24BAPS1206R	Psychology of Happiness	MDC	2	0	0	0	0	0	2	40	60	0	100
	5	24UBPD1202R	Implicit English	AEC	0	0	4	0	0	0	2	0	0	100	100
	6	24UBES1201R	Environmental Education (Online)	VAC	2	0	0	0	0	0	2	40	60	0	100
	7	24UCDT1201R	Ideation and Design Thinking	SEC	1	0	0	0	0	0	1	40	60	0	100
	8	24UBEC1201R	Extra-Curricular	Co and extra-Curricular	0	0	0	4	0	0	1	0	0	100	100
	DSC Minor (Sub-disciplinary) (Any two to be selected)														
	9	24FSCH1203R	Chemistry- II	DSC Minor	2	0	0	0	0	0	2	40	60	0	100
	10	24FSPH1204R	Physics- II	DSC Minor	2	0	0	0	0	0	2	40	60	0	100
	11	24FSBO1205R	Biology- II	DSC Minor	2	0	0	0	0	0	2	40	60	0	100
	Total				**16**	**0**	**8**	**4**	**0**	**0**	**21**	**320**	**480**	**400**	**1200**

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester III	1.	24BSFS2101R	Forensic Ballistics	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	2	24BSFS2102R	Instrumental techniques	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	3		Agriculture Course	MDC	2	0	0	0	0	0	2	40	60	0	100
	4	24UBPD2102R	English Language for excellence	AEC	0	0	4	0	0	0	2	0	0	100	100
	5	24BSFS2104R	Techno Professional Course	SEC	0	0	4	0	0	0	2	0	0	100	100
	6	24BSFS2105R	Field Training	Field Training	0	0	0	4	0	0	1	0	0	100	100
	DSC Minor (Sub-disciplinary) (Any two to be selected)														
	7	24FSCH2106R	Chemistry- III	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	8	24FSPH2107R	Physics- III	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	9	24FSBO2108R	Biology- III	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	Total				**12**	**0**	**16**	**4**	**0**	**0**	**21**	**200**	**300**	**700**	**1200**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester IV	1	24BSFS2201R	Forensic Anthropology	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	2	24BSFS2202R	Questioned Document Examination	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	3	24BSFS2203R	Forensic Chemistry	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	4	24BSFS2204R	Cyber & digital Forensics	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	5	24UBPD2202R	English for employability	AEC	0	0	4	0	0	0	2	0	0	100	100
	6		Aptitude course	SEC	0	0	0	8	0	0	2	0	0	100	100
	7	24UUFL2201R	Financial Literacy	MDC	1	0	0	0	0	0	1	40	60	0	100
	8	24UULS2202R	BLSS	VAC	1	0	0	0	0	0	1	40	60	0	100
	9		UHV	VAC	1	0	0	0	0	0	1	40	60	0	100
	DSC Minor (Sub-disciplinary) (Any two to be selected)														
	10	24FSCH2205R	Chemistry- IV	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	11	24FSPH2206R	Physics- IV	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	12	24FSBO2207R	Biology- IV	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	Total				**19**	**0**	**16**	**8**	**0**	**0**	**29**	**360**	**540**	**800**	**1700**

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester V	1.	24BSFS3101R	Forensic Toxicology	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	2	24BSFS3102R	Forensic Medicine	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	3	24BSFS3103R	Forensic Biology & Serology	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	4		Logical Reasoning Course	SEC	0	0	4	0	0	0	2	0	0	100	100
	5	24BSFS3104R	Forensic Photography	SEC	0	0	4	0	0	0	2	0	0	100	100
	6	24BSFS3105R	Summer Internship	DC/PC	0	0	0	0	0	32	4	0	0	100	100
	7	24BSFS3106R	Research Project- I	DC/PC	0	0	0	0	12	0	2	0	0	100	100
	DSC Minor (Sub-disciplinary) (Any two to be selected)														
	8	24FSCH3107R	Chemistry- V	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	9	24FSPH3108R	Physics- V	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	10	24FSBO3109R	Biology- V	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	Total				**13**	**0**	**18**	**0**	**12**	**32**	**28**	**200**	**300**	**900**	**1400**

	S. N.	Course Code	Course Title	Course Category	Engagement						C	Maximum Marks for			
					L	T	P	S	R	O		IA*	SEE*	PE*	Total
Semester VI	1	24BSFS3201R	Forensic Case management and expert witness	DSC Major	3	0	0	0	0	0	3	40	60	0	100
	2	24BSFS3202R	Forensic Audio and video analysis	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	3	24BSFS3203R	DNA Forensic	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	4	24BSFS3204R	Research Project- II	DC/PC	0	0	0	0	24	0	4	0	0	100	100
	DSC Minor (Sub-disciplinary) (Any two to be selected)														
	5	24FSCH3205R	Chemistry- VI	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	6	24FSPH3206R	Physics- VI	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	7	24FSBO3207R	Biology- VI	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	Total				**13**	**0**	**8**	**0**	**24**	**0**	**21**	**200**	**300**	**500**	**1000**

***IA: Internal Assessment, SEE: Semester End Examination, PE: Practical Examination**

SEMESTER – I									
Course Title	**Fundamentals of Forensic science & Criminology**								
Course code	**24BSFS111R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. Understand the definition, history, and scope of forensic science. 2. Learn the basic principles, tools, and techniques used in forensic science. 3. Comprehend the elements, characteristics, and causes of crime, and identify different types of criminal behavior. 4. Explore criminological theories and understand the goals and objectives of criminology. 5. Familiarize with various crime investigation agencies in India and their functions.								
CO1	Describe history, scope and fundamentals of forensic science, including ethics.								
CO2	Explain the forensic principles, lab hierarchy, and utilizing forensic tools.								
CO3	Recognize crime elements, deviant behavior, hate crimes, and societal implications along with their practical aspects in real life criminal cases.								
CO4	Discuss various crime theories, investigative techniques, criminal profiling, and media's impact on criminal cases along with the practical aspects.								
CO5	Explain India's crime investigating agencies, their roles, and contributions to the criminal justice system.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Definition of Forensic Science, History of Forensic science, Scope of Forensic Science, Need of Forensic Science, Basic Principles of Forensic Science, Tools and Techniques of Forensic Science, Tasks performed by Forensic scientists. Code of ethics for forensic scientist in India.	**8**	Understanding history, scope, ethics, principles	1,2
II	Principles of Forensic science: Law of individuality, principle of exchange, law of progressive exchange, principle of comparison, Principle of analysis, law of probability. Set up of Forensic Science Laboratory, Hierarchy of experts in Forensic Science Laboratories.	**7**	Grasp forensic principles, lab hierarchy.	1,2
III	Elements, characteristics, causes and effects of crime. Deviant behaviour. Hate crimes. Organized crime. Public disorder. Domestic abuse and workplace violence. White collar crimes. Juvenile delinquency. Social change and crime. Psychological disorders and criminality. Situation crime prevention. Theories of criminal behaviour.	**10**	Explore crime elements, deviant behavior	1,2

IV	Goals and objectives of criminology. Theories of crime: Classical, Positivist, Sociological, Criminal Anthropological. Understanding Modus Operandi. Investigative Techniques. Criminal Profiling. Role of media**.**	**10**	Study crime theories, investigating techniques	1,2
V	Crime Investigation Agencies: CFSL, SFSL, GEQD, CBI, NIA, NDTL, IB, BPRnD, CDTS, NCRB.	**10**	Familiarize with key investigation agencies	1,2
Practical	1. To study the history of crime cases from standpoint of forensic science. 2. To compile reports on various types of criminal cases. 3. To evaluate the organizational structure of several forensic science organizations and make suggestions for improvement. 4. To compare the standards of conduct established by various organizations for forensic scientists. 5. To examine criminal cases and clarify which hypothesis best explains the accused's illegal behavior 6. To study at criminal situations where criminal profiling helped the police catch the suspect. 7. To evaluate victimology in a heinous crime. 8. To analyze an instance of juvenile misbehavior and recommend corrective action	**30**		1,2,3,4

TEXT BOOKS:

T1: Encyclopedia of Forensic Science by J.A. Saigel, Elsevier.
T2: Encyclopedia of crime, criminology by Casper davis, koros.
T3: Introduction to Forensic Science by Uttam K.S., Jnanada.

REFERENCE BOOKS:

R1: B.B. Nanda and R.K. Tiwari, *Forensic Science in India: A Vision for the Twenty First Century*, Select Publishers, New Delhi.
R2: B. S. Nabar, *Forensic Science in Crime Investigation,* 3rd Edition, Asia Law House.
R3: B. R. Sharma, Forensic Science in Criminal Investigation and Trials, 4th Edition, Universal Law Publishing - An imprint of LexisNexis.
R4: R. Saferstein, *Criminalistics*, 8th Edition, Prentice Hall, New Jersey.
R5: Barak, Gregg : Integrative Criminology.
R6: Adler, Freda : Criminology.
R7: Reid S.T. : Crime and Criminology

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Describe history, scope and fundamentals of forensic science, including ethics.	**1, 6**
2	Explain the forensic principles, lab hierarchy, and utilizing forensic tools.	**1, 2, 6**
3	Recognize crime elements, deviant behavior, hate crimes, and societal implications along with their practical aspects in real life criminal cases	**1, 5, 9**
4	Discuss various crime theories, investigative techniques, criminal profiling, and media's impact on criminal cases along with the practical aspects.	**1, 6**
5	Explain India's crime investigating agencies, their roles, and contributions to the criminal justice system.	**1**

SEMESTER – I									
Course Title	**Crime Scene Management**								
Course code	**24BSFS112R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. Comprehend crime scene definition, importance, management, and reasons for crimes in India. 2. Recognize various crime scene types and roles of police, experts, and judicial officers. 3. Learn barricading, photography, sketching, and search techniques for indoor and outdoor crime scenes. 4. Understand types, collection, preservation, and chain of custody for physical evidence. 5. Grasp principles and stages of crime scene reconstruction, from data collection to theory formulation.								
CO1	Recognize crime scene investigation, and understand the reasons for crime along with their practical aspects.								
CO2	Explain different crime scene types and comprehend the role of investigating agencies in crime scene management along with their practical aspects.								
CO3	Apply techniques for documenting crime scenes, utilizing various search patterns along with their practical aspects.								
CO4	Describe the methods for collecting evidences, package, and preserve, and maintain the chain of custody for crime exhibits along with their practical aspects.								
CO5	Analyze crime scene reconstruction using various principles of data collection, hypothesis formulation, testing, and theory formation.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Defining a crime scene, Importance, problem, location and processing of Crime Scene and Crime scene Management. Reasons for committing crime in India.	**8**	Grasp crime scene definition, importance	1,2
II	Types of crime scenes: Primary, Secondary, Indoor, Outdoor. Role of different agencies involved in crime scene management: Police, Medico legal experts, Judicial officers.	**7**	Recognize crime scene types, roles.	1,2
III	Barricading of crime scene; Documenting crime scene: Crime scene photography and videography, Crime scene notes. Crime scene sketching: Indoor and outdoor, triangulation method, baseline method, polar coordinate method. Search: definition, objectives, search patterns – Strip method, grid method, zone/quadrant method, spiral method (Inward and outward), wheel method.	**10**	Master crime scene documentation techniques	1,2
IV	Definition, types of physical evidences, Collection, packaging, preservation and forwarding of physical evidences, Chain of	**10**	Understand evidence collection preservation procedures	1,2

	custody			
V	Crime scene reconstruction**:** Introduction, importance, nature and principles: recognition, identification, individualization and reconstruction, stages: data collection, conjecture, hypothesis formulation, testing, theory formation.	**10**	Acquire principles of crime reconstruction	1,2
Practical	**1.** Securing the crime scene, clothing, and plan for crime scene management. **2.** Demonstration of photography of scene of crime and evidences. **3.** Searching and Listing of evidences at indoor crime scene. **4.** Searching and Listing of evidences at outdoor crime scene. **5.** Sketching of Crime scene by triangulation method. **6.** Sketching of Crime scene by baseline method. **7.** Sketching of Crime scene by Polar coordinate method. **8.** Evidence collection, preservation, packaging, sealing and labeling of physical evidences. **9.** Evidence collection, preservation, packaging, sealing and labeling of biological evidences. **10.** Demonstration of reconstruction of scene of crime	**30**	Describe, illustrate and explain and apply staining techniques and carry out microscopic examination.	1,2,3,4

TEXT BOOKS:

T1: Saferstein R., **Criminalistics**, Prentice Hall Inc. USA.

REFERENCE BOOKS:

R1: Gilbert N. (3rd Edition), **Criminal Investigation**, Macmillan Publishing company.

R2: Nicharrs J., **Investigative Forensic Hyponsis**. CRC Press LLC.

R3: Sharma B.R.,**Forensic Science in Criminal Investigation and Trials,** Central Law Agency, Allahabad.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Recognize crime scene investigation, and understand the reasons for crime along with their practical aspects.	**1, 2, 6**
2	Explain different crime scene types and comprehend the role of investigating agencies in crime scene management along with their practical aspects.	**1, 2, 3**
3	Apply techniques for documenting crime scenes, utilizing various search patterns along with their practical aspects	**1, 2, 3, 7**
4	Describe the methods for collecting evidences, package, and preserve, and maintain the chain of custody for crime exhibits along with their practical aspects.	**1, 2, 6, 7, 8**
5	Analyze crime scene reconstruction using various principles of data collection, hypothesis formulation, testing, and theory formation.	**1, 2, 3**

SEMESTER – I									
Course Title	**Criminal Law**								
Course code	**24BSFS113R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. Grasp offence forms, case classification, legislation components, judicial hierarchy. 2. Differentiate cognizable and non-cognizable offences, bailable and non-bailable offences. 3. Examine Sections related to offences against individuals and property. 4. Explore constitutional articles and legal acts. 5. Dive into specific legal areas and acts' intricacies.								
CO1	Define offenses and their forms, compare and distinguish civil and criminal classifications along with their practical aspects in real cases.								
CO2	Interpret offenses against persons and property, including sexual offenses under relevant sections along with their practical aspects in real cases.								
CO3	Apply knowledge of evidence and rules of relevancy, including the examination of witnesses and expert testimony.								
CO4	Demonstrate an understanding of constitutional articles and acts, such as the Narcotic Drugs and Psychotropic Substances Act along with their practical aspects in real cases.								
CO5	Interpret various acts, including the Explosive Substances Act, Arms Act, Dowry Prohibition Act, and Wildlife Protection Act along with their practical aspects in real cases.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Definition and forms of offence. Case classification: civil and criminal. The fundamental components of criminal legislation. Constitution and judicial system hierarchy. Cognizable and non-cognizable offences under the Criminal Procedure Code. Bailable and non-bailable offences under the Criminal Procedure Code. Bailable and non-bailable offences, as well as other pertinent laws. Sections 291 through 293.	**5**	Define offences, understand case classification	1,2
II	Offences against person- Sections, 299, 300, 302, 304, 304A, 304B, 306, 307, 319, 320, 325, 359, 362, 363. Section 375 & 376 and their amendments. Offences against property- Sections 378, 383, 390, 391, 395, 415, 420, 441, 463, 489A, 497, 499, 503, 511. POSCO Act.	**7**	Distinguish and analyze specific offences.	1,2

III	Evidence and rules of relevancy in brief. Expert witness. Cross examination and re-examination of witnesses. Examination in chief. Sections 32, 45, 46, 47, 57, 58, 60, 73, 135, 136, 137, 138, 141.	**8**	Grasp evidence rules, witness examination	1,2
IV	Articles 20, 21, 22, 51A of Indian Constitution, Narcotic Drugs and Psychotropic Substances Act. Drugs and Cosmetics Act, Prevention of Corruption	**5**	Understand constitutional articles, rights	1,2
V	Explosive Substances Act. Arms Act. Dowry Prohibition Act. Act. Wildlife Protection Act. I.T. Act. Environment Protection Act	**5**	Explore specialized legal acts	1,2
Practical	**1.** To prepare a schedule of five cognizable and non-cognizable crimes. **2.** To study crime scene in which accused was punished under charges of section 302. **3.** To study crime scene in which accused was punished under charges of section 375. **4.** To cite a case under section 14 of the constitution of India where Right to equality before law was allegedly violated. **5.** To study a case in which Drugs and cosmetic act was invoked. **6.** To study a case in which arms act was invoked	**30**		1,2,3, 4

TEXT BOOKS:

T1: Constitution of India, Bare Act.

REFERENCE BOOKS:

R1: D.A. Bronstein, Law for the Expert Witness, CRC Press, Boca Raton .
R2: Vipa P. Sarthi, Law of Evidence, 6th Edition, Eastern Book Co., Lucknow.
R3: A.S. Pillia, Criminal Law, 6th Edition, N.M. Tripathi Pvt Ltd., Mumbai.
R4: R.C. Nigam, Law of Crimes in India, Volume I, Asia Publishing House, New Delhi.
R5: M. Monir, Law of Evidence, 6th Edition, Universal Law Publishing Co. Pvt. Ltd., New Delhi.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Define offenses and their forms, compare and distinguish civil and criminal classifications along with their practical aspects in real cases.	**1**
2	Interpret offenses against persons and property, including sexual offenses under relevant sections along with their practical aspects in real cases.	**1**
3	Apply knowledge of evidence and rules of relevancy, including the examination of witnesses and expert testimony	**1**
4	Demonstrate an understanding of constitutional articles and acts, such as the Narcotic Drugs and Psychotropic Substances Act along with their practical aspects in real cases.	**1, 2, 5**
5	Interpret various acts, including the Explosive Substances Act, Arms Act, Dowry Prohibition Act, and Wildlife Protection Act along with their practical aspects in real cases.	**1,2, 5**

SEMESTER – I									
Course Title	**Elementary English**								
Course code	**24UBPD112R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/I Semester of First year of the programme**								
Course Objectives	1. To enable students to identify and use parts of speech, articles, auxiliary verbs, and construct affirmative and negative sentences. 2. To master advanced grammar concepts: Enable students to use determiners, construct various types of sentences, and understand degrees of comparison. 3. To develop speaking skills: Enable students to introduce themselves, use correct pronunciation, intonation, and stress, and effectively ask and offer information.								
CO1	Equip students to recognize and apply parts of speech, articles, and auxiliary verbs, and to create both affirmative and negative sentences.								
CO2	Teach students to apply determiners, form different types of sentences, and comprehend degrees of comparison.								
CO3	Prepare students to confidently introduce themselves, use proper pronunciation, intonation, and stress, and effectively ask for and provide information.								
CO4	Help students grasp the communication process, differentiate between communication types, manage both formal and informal communication, and identify barriers to effective communication.								
CO5	Teach students the key components of an effective presentation and how to use visual aids proficiently.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Basics of Grammar (Flipped classroom)** i. Parts of Speech ii. Articles iii. Auxiliary Verbs iv. Affirmative and Negative Sentences	**6**	Students will demonstrate a fundamental understanding of grammar rules.	1,2, 3
II	**Grammar (Flipped classroom)** i. Determiners ii. Sentence Construction iii. Types of Sentences (Assertive, Imperative, etc.) **iv.** Degree of Comparison	**6**	Students will construct grammatically correct and varied sentence types.	1,2, 3,4
III	**Speaking Skills** i. Introduction and Greetings ii. Pronunciation, Intonation, Stress iii. Asking and offering information	**5**	Students will confidently introduce themselves and engage in basic conversations with correct pronunciation.	1,2, 3
IV	**Communication Skills** i. Introduction to Communication ii. Process and Types of Communication, iii. Formal and informal communication **iv.** Understanding Barriers to Communication	**7**	Students will effectively communicate in both formal and informal settings.	1,2, 3

V	**Presentation Skills** i. Introduction ii. Essential characteristics of a good presentation iii. Use of Visual Aids in Presentation	**8**	Students will deliver well-organized and visually supported presentations.	1,2

TEXT BOOKS:

T1: Chaturvedi, P.D., Chaturvedi Mukesh, 2011.Business Communication: Concepts, Casesand Applications, second edition, Pearson, Noida.

T2: Alex K., Chand, S, 2009. Soft Skills: Know Yourself and Know the World, first edition, S. Chand & Company Ltd.: New Delhi.

REFERENCE BOOKS:

R1: Quirk, Randolph. (2010) A Comprehensive Grammar of the English Language Randolph Quirk, Sidney Greenbaum, Pearson Education India.

R2: Marks, Jonathan. (2017) IELTS Advantage Speaking and Listening Skills: A step-by- step guide to a high IELTS speaking and listening score. Book + CD-ROM, Delta Publishing by Kle.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Equip students to recognize and apply parts of speech, articles, and auxiliary verbs, and to create both affirmative and negative sentences.	**5, 7, 9**
2	Teach students to apply determiners, form different types of sentences, and comprehend degrees of comparison.	**5, 7, 9**
3	Prepare students to confidently introduce themselves, use proper pronunciation, intonation, and stress, and effectively ask for and provide information.	**5, 7, 9**
4	Help students grasp the communication process, differentiate between communication types, manage both formal and informal communication, and identify barriers to effective communication.	**5, 7, 9**
5	Teach students the key components of an effective presentation and how to use visual aids proficiently.	**5, 7, 9**

SEMESTER – I									
Course Title	**Chemistry - 1**								
Course code	**24FSCH114R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 1st semester of first year of the program**								
Course Objectives	1. Understand the principles of hybridization, shapes of molecules, and chemical bonds, including van der Waals interactions, hydrogen bonding, and electronic displacements in covalent bonds. 2. Explore isomerism concepts, including optical isomerism, geometric isomerism, and conformational isomerism, and understand the nomenclature and properties associated with different isomers. 3. Grasp the kinetic molecular theory of gases, deviations from ideal behavior, and the van der Waals equation, as well as the principles governing the liquefaction of gases. 4. Comprehend the quantum mechanical aspects of atomic structure, including Bohr's theory, wave mechanics, quantum numbers, and the electronic configuration of atoms. 5. Study periodic properties of elements, focusing on effective nuclear charge, atomic radii, ionization enthalpy, electron gain enthalpy, and electronegativity, along with their variations in the periodic table.								
CO1	Understand the hybridization of carbon, types of bonds, electronic effects, and the shapes of molecules.								
CO2	Identify the kinetic molecular theory of gases, deviations from ideal behavior, and properties of enantiomers.								
CO3	Explain Bohr's theory, wave mechanics, and quantum numbers.								
CO4	Understand the periodic properties of elements, including effective nuclear charge and ionization enthalpy.								
CO5	Describe electron gain enthalpy, trends in electronegativity, and the variation of electronegativity with bond order								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Hybridization of carbon, its types, shapes of molecules, bond lengths and bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, hydrogen bonding. Organic acids & bases, their relative strengths, dipole moment. Homolytic and heterolytic bond breaking. Types of reagents-electrophiles and nucleophiles. Nucleophilicity& basicity. Electronic displacements in a covalent bond (inductive effect, electromeric effect, resonance effect or mesomeric effect, hyperconjugation). Types of organic reactions & their mechanisms. Reactive intermediates-carbocations, carbanions, free radicals, carbenes, and nitrenes (their types, shapes & relative stability).	**7**	Understand organic hybridization, chemical bonds.	1,2

II	Concept of isomerism, Types of isomerism, Optical isomerism - elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, specific rotation, properties of enantiomers, Chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enatiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism - determination of configuration of geometric isomers.Syn-anti & E & Z notations with C.I.P. rules, Conformational isomerism - conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivatives, Fischer and flying wedge formulae Newman projection and Sawhorse formulae & their interconversion.	**5**	Grasp isomerism concepts, stereochemical nomenclature.	1,2
III	The kinetic molecular theory of gases, deviation from ideal behaviour, van der Waals equation of states, kinetic energy & temperature, Maxwell distribution of molecular velocities & energies, types of molecular velocities, collision parameters (diameter, cross section, number frequency), mean free path , the vander Waal's equation of critical state, principal of corresponding states, reduced equation of state, molar masses & density of real gases, liquefaction of gases.	**8**	Master kinetic theory, real gas properties	1,2
IV	Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics:de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ. Radial and angular wave functions for hydrogen atom. Quantum numbers and their significance. Probability diagrams of s and p orbitals. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations.	**5**	Comprehend atomic spectra, wave mechanics	1,2
V	Detailed discussion of the following periodic properties of the elements, with	**5**	Learn periodic properties, electronegativity trend	1,2

	reference to s & p-block. Effective nuclear charge, shielding or screening effect, variation of effective nuclear charge in periodic table. Atomic radii (van der Waals). Ionic and crystal radii. Covalent radii. Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. Electron gain enthalpy, trends of electron gain enthalpy. Electronegativity, Variation of electronegativity with bond order, hybridization, group electronegativity			

TEXT BOOKS:

T1: Inorganic Chemistry, J. D. Lee. Concise, 5th Edition, Oxford.

REFERENCE BOOKS:

R1: Organic Chemsitry, Paula Yurkanis Bruice, 8th Edition, Pearson.
R2: Organic Chemsitry, Jonathan Clayden, Nick Greeves and Stuart Warren, 2nd Edition (South Asia Edition), Oxford.
R3: Stereochemistry of Organic Compounds Principles and Applications, D. Nasipuri, 4th Edition, New Age International Publishers
R4: Physical Chemistry, Gurdeep Raj, Krishna Prakashan Media (P) Ltd.
R5: Physical Chemistry, Puri Sharma Pathania, Vishal Publishing Co.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand the hybridization of carbon, types of bonds, electronic effects, and the shapes of molecules.	**1**
2	Identify the kinetic molecular theory of gases, deviations from ideal behavior, and properties of enantiomers.	**1**
3	Explain Bohr's theory, wave mechanics, and quantum numbers	**1**
4	Understand the periodic properties of elements, including effective nuclear charge and ionization enthalpy.	**1, 8**
5	Describe electron gain enthalpy, trends in electronegativity, and the variation of electronegativity with bond order.	**1**

SEMESTER – I									
Course Title	**Physics - 1**								
Course code	**24FSPH115R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 1nd semester of first year of the program**								
Course Objectives	1. Understand scalar and vector quantities, their properties, and interpretations, including scalar and vector products. 2. Explore coordinate systems, motion concepts, frames of reference, and principles of relativity. 3. Analyze fluid dynamics, elastic properties of matter, and equations like Bernoulli's and continuity. 4. Grasp energy principles, work, conservation, rotational dynamics, and relationships between linear and angular variables. 5. Differentiate wave types, calculate properties, delve into sound waves, and explore ultrasonic applications.								
CO1	Understand scalar and vector properties, coordinate systems, divergence, curl, and the distinction between conservative and non-conservative forces.								
CO2	Identify the concepts of frame of reference, inertial and non-inertial frames, special theory of relativity, Lorentz transformations, and relativistic addition of velocities.								
CO3	Explain the fundamentals of motion, acceleration, projectile motion, pseudo forces, elastic properties of matter, fluid dynamics, and equations like Bernoulli's.								
CO4	Explain the concepts of energy, kinetic energy, work, rotational variables, and the conservation of energy, especially in rotational motion.								
CO5	Describe different types of waves, sound waves, Doppler effect, sound intensity measurement, and the introduction to ultrasonic waves and their applications.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Scalar and Vector, Properties of vectors, scalar and vector product, scalar and their interpretation in terms of area and volume respectively, scalar and vector fields. Concepts of Cartesian and spherical polar co–ordinate systems, area, volume, velocity, and acceleration in these systems. Concepts of divergence and curl. Conservative and non-conservative forces.	**7**	Mastering vectors and coordinate systems	1,2
II	Frame of reference, Inertial and non-inertial frame, Galilean transformation and Invariance, Non-Inertial frames, , Constancy of speed of light, Postulates of Special Theory of Relativity, Lorentz transformations, Length contraction, Time dilation, Relativistic addition of velocities, Mass-energy relation, Relativistic momentum & energy, Transformation of momentum and energy.	**5**	Grasping relativity and reference frames.	1,2

III	Definition of motion, position and displacement, average velocity, average speed, acceleration, acceleration of freely falling body, projectile motion, Pseudo forces, elastic properties of matter, elastic constants and their interrelations Fluid dynamics, equation of continuity, Bernoulli's equation, stream line and turbulent flow, Poiseuille's equation.	**8**	Analyzing motion, forces, and fluids.	1,2
IV	Energy, kinetic energy, work, work done by gravitational force, work done by spring force, power, work and potential energy, work done on system by external force, conservation of energy. The rotational variable, rotation with constant angular acceleration, relating linear and angular variables, kinetic energy of rotation.	**5**	Understanding energy, work, and rotation	1,2
V	Types of waves, transverse and longitudinal waves, wavelength and frequency, speed of travelling wave, the wave equation, sound waves, speed of sound, the Doppler effect. Velocity of sound, noise and sound intensity measurement, echo, Sabine's Formula, Sound distribution in an auditorium, introduction to ultrasonic, production of ultrasonic waves, applications of ultrasonic	**5**	Exploring waves and sound properties	1,2

TEXT BOOKS:

T1: Halliday, Resnick and Walker, Fundamentals of Physics, John Wiley & Sons Publication, sixth edition.

REFERENCE BOOKS:

R1: R. K. Gaur and S. L. Gupta, Engineering Physics, DhanpatRai Publication, 8 th Edition,
R2: A.P. French, Vibrations and waves, CBS Publishers and Distributors, Inc., first Indian edition.
R3: Heat and Thermodynamics: Brij Lal and N. Subramanyam

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand scalar and vector properties, coordinate systems, divergence, curl, and the distinction between conservative and non-conservative forces.	**1**
2	Identify the concepts of frame of reference, inertial and non-inertial frames, special theory of relativity, Lorentz transformations, and relativistic addition of velocities.	**1**
3	Explain the fundamentals of motion, acceleration, projectile motion, pseudo forces, elastic properties of matter, fluid dynamics, and equations like Bernoulli's	**1**
4	Explain the concepts of energy, kinetic energy, work, rotational variables, and the conservation of energy, especially in rotational motion.	**1**
5	Describe different types of waves, sound waves, Doppler effect, sound intensity measurement, and the introduction to ultrasonic waves and their applications.	**1**

SEMESTER – I										
Course Title	**Biology- 1**									
Course code	**24FSBO116R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 1nd semester of first year of the program**								
Course Objectives	1. Develop a comprehensive understanding of Algae, covering general characteristics, classification, reproduction, and economic significance. 2. Study the fundamental aspects of fungi, including their characteristics, classification, and economic importance. 3. Explore lichens, understanding their general features, structure, reproduction, and economic importance. 4. Gain insights into Bryophytes, covering characteristics, classification, reproduction, and economic relevance 5. Examine Pteridophytes, focusing on characteristics, classification, reproduction, and economic importance. Additionally, explore ecological concepts such as ecosystems, energy flow, biogeochemical cycles, and succession.									
CO1	Understand the general characteristics, classification, modes of reproduction, and economic significance of algae.									
CO2	Identify the general features, classification of fungi, and their economic importance.									
CO3	Understand of the general aspects, structure, reproduction, and economic significance of lichens									
CO4	Identify the general characteristics, classification, modes of reproduction, and economic importance of bryophytes									
CO5	Identify the concept of ecosystems, their structure and function, energy flow, biogeochemical cycles, and the process of succession									

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Algae: General account of Algae, Classes of algae. Reproduction, of algae Economic importance of algae.	**7**	Identify classes, understand reproduction, economic importance.	1,2
II	Fungi: General account of fungi, Study of different classes of fungi, Economic importance fungi. LICHEN: General account of lichen, structure and reproduction, Economic importance Lichen.	**5**	Classify fungi, lichen; grasp economic relevance.	1,2
III	Bryophytes: General account of Bryophytes, Study of different classes of Bryophytes, Reproduction, Economic importance bryophytes.	**8**	Differentiate classes, understand reproduction, ecological role	1,2
IV	Pteridophytes: General account of Pteridophytes, Study of different classes of Pteridophytes, Reproduction, Economic importance Pteridophytes.	**5**	Classify pteridophytes, understand reproduction, ecological significance	1,2

V	Ecology: Concept of Ecosystem, Ecosystem structure and function, Energy flow in ecosystem, Biogeochemical cycles in ecosystem, Sucession	**5**	Grasp ecosystem concepts, energy flow, succession	1,2

TEXT BOOKS:

T1: Hand Book of Microalgal culture. Ed by A. Richmond. Blackwell Publishing House.

REFERENCE BOOKS:

R1: Hand Book of Microalgal culture. Ed by A. Richmond. Blackwell Publishing House.

R2: Algae- Anatomy, Biochemistry and Biotechnology-L. Barsanti& P. Gualtieri. Taylor &Francis.

R3: Phycology (4th Edition) R.L. Lee, Cambridge University Press. Nasipuri, 4th Edition, New Age International Publishers

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand the general characteristics, classification, modes of reproduction, and economic significance of algae.	**1**
2	Identify the general features, classification of fungi, and their economic importance.	**1**
3	Understand of the general aspects, structure, reproduction, and economic significance of lichens	**1**
4	Identify the general characteristics, classification, modes of reproduction, and economic importance of bryophytes.	**1**
5	Identify the concept of ecosystems, their structure and function, energy flow, biogeochemical cycles, and the process of succession.	**1**

SEMESTER – II									
Course Title	**Forensic Physics**								
Course code	**24BSFS121R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ II semester of first year of the programme**								
Course Objectives	1. Understand and apply principles of impression evidence analysis, including tyre marks, skid marks, serial number restoration, and vehicular accident assessment. 2. Identify, classify, and analyze tool marks, emphasizing class and individual characteristics, tracing, lifting, and photographic examination. 3. Examine glass properties, including composition, fractures, and direction of impact, and conduct soil examinations based on color, density, size distribution, and chemical analysis. 4. Identify types of paints, conduct microscopic and macroscopic studies, analyze pigment distribution, and perform pyrolysis gas chromatography. 5. Understand hair structure, collection, and evaluation, and classify fibers, conducting microscopic, physical, chemical, and instrumental examinations								
CO1	Identify and analyze various impression evidence types in the context of forensic investigations.								
CO2	Apply techniques for making casts, and obliteration and restoration methods, showcasing competence in tool mark analysis.								
CO3	Demonstrate expertise in glass and soil analysis, contributing to forensic investigations through comprehensive examinations along with their practical aspects.								
CO4	Exhibit proficiency in forensic paint examinations, including physical matching and chemical analyses.								
CO5	Demonstrate competence in hair and fiber analysis, providing valuable contributions to forensic investigations involving these types of physical evidence along with their practical aspects.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Impression evidence: types of impression evidence, tyre marks, skid marks, serial number restoration, vehicular accident	**8**	Understand the Importance of impression marks in vehicular accident cases.	1,2
II	Tool marks evidence: types of tool marks, class and individual characteristics, tracing and lifting of marks, photographic examination of tool marks. method of making-cast, methods of obliteration and restoration	**7**	Elucidate the use of tool marks their restoration and method of recording those restored marks.	1,2
III	Glass: types and their composition. determination of direction of impact, fractures, examination of glass: colour, fluorescence, physical matching, density comparison, refractive index. Soil: examination of colour, density, size distribution of soil particles, mineral analysis and chemical analysis of soil	**10**	Mastery of glass examination	1,2
IV	Paints: types of paint and their composition, forensic examination of	**10**	Competence in paints examination	1,2

	paints: microscopic and macroscopic studies-pigment distribution, micro-chemical analysis, physical matching, solubility test, pyrolysis gas chromatography			
V	Hair: structure of human and animal hair. examination of hair, location, collection, evaluation; Fibers: classification, microscopic, physical and chemical, instrumental examination of fibers.	**10**	Grass fiber, hair morphology, tool marks	1,2
Practical	**1.** To analyze density of glass **2.** To analyze refractive index of glass **3.** To analyze density of soil **4.** To analyze hair **5.** To analyze types of glass their composition, their macroscopic and microscopic properties. **6.** To analyze Hair and fibers, their composition, their macroscopic and microscopic analysis **7.** To identify tool marks, their restoration and method of recording those restored marks.	**30**		1,2,3, 4

TEXT BOOKS:

T1: Sharma, B. R., Forensic Science in Criminal Investigation and Trials (3rd Edn) Universal Law Publishing Co. Ltd. New Delhi

REFERENCE BOOKS:

R1: Morris, E. K., and Braukman,, C. J.(Eds.), Behavioural Approaches to Crime and Delinquency- A Hand book of Application, Research and Concepts, Plennum Press, New York,

R2: Abaadinsky, H., Organised Crime (2nd Edn.), Nelson – Hall, Chicago.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Identify and analyze various impression evidence types in the context of forensic investigations.	**1, 2, 3**
2	Apply techniques for making casts, and obliteration and restoration methods, showcasing competence in tool mark analysis.	**1, 2**
3	Demonstrate expertise in glass and soil analysis, contributing to forensic investigations through comprehensive examinations along with their practical aspects.	**1, 3**
4	Exhibit proficiency in forensic paint examinations, including physical matching and chemical analyses.	**1, 3**
5	Demonstrate competence in hair and fiber analysis, providing valuable contributions to forensic investigations involving these types of physical evidence along with their practical aspects.	**1, 3**

SEMESTER – II									
Course Title	**Forensic Psychology**								
Course code	**24BSFS122R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/ II semester of first year of the programme**								
Course Objectives	1. Explore scope, ethics, and expert witness role. 2. Analyze causes, impact, bystander effect, mental health. 3. Study profiling, testimony, competence, treatment, special populations. 4. Learn tests, detection methods, lie detection, applications. 5. Develop competences, interviewing skills, legal role, psychotherapy practices								
CO1	Understand the nature, history, and scope of forensic psychology, distinguishing its role from traditional psychology and law.								
CO2	Identify the causes and analyze the impact of crime on victims, exploring victimization and factors influencing it, such as the bystander effect.								
CO3	Access crime for criminal profiling, factors, eyewitness testimony, competence to stand trial, and explain the roles of correctional psychologists along with their practical aspects using real life criminal cases.								
CO4	Discuss psychological tests and forensic methods for crime detection, including Brain Electrical Oscillation Signature Profiling (BEOS) and lie detection methods along with their practical aspects using real life criminal cases.								
CO5	Demonstrate forensic consultancy and supervision, emphasizing core competencies, cognitive interviewing techniques, and psychotherapy with criminal offenders								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction to forensic Psychology, Nature, History and its Scope. Fundamental distinctions between Psychology and Law, Police Psychology, Forensic Psychology in India and its sub-fields. Ethical and legal issues in Forensic Practice, Psychologist as Expert Witnesses.	**5**	Understand forensic psychology's scope, ethics.	1,2
II	Crime: Causes, impact of crime on victim, Victimization, Factors affecting victimization: Bystander Effect, Forensic Mental Health. Psychological explanations of specific crime types: Arson, terrorism, homicides, sexual offences, burglary, robbery, theft, white collar crimes.	**7**	Analyze crime causes, victim impact.	1,2
III	Criminal Profiling, Eyewitness Testimony, Competence to stand trial, Roles of correctional psychologist, Treatment and Rehabilitation in Correctional facilities, Risk Assessment, Treatment of Special population: Violent Offenders, Women Prisoners, Juvenile Justice.	**8**	Study profiling, competence, correctional roles	1,2
IV	Psychological Tests used in forensic psychology, Forensic methods in detection of crime: Brain Electrical Oscillation Signature Profiling (BEOS). Lie Detections: Polygraph, Brain Mapping, Narco-analysis.	**5**	Learn tests, detection methods, lie detection	1,2
V	Forensic consultancy and supervision, core competences, Cognitive interviewing	**5**	Develop consultation skills, legal interaction	1,2

	techniques, psychologist as a consultant, Family law issues, custody and adoptions, Psychology and the legal process interaction, Presentation of evidences and providing feedback, Psychotherapy with Criminal Offenders			
Practical	**1.** To review a crime case involving serial murders. Remark on the accused's psychological traits. **2.** To compile a report on the connection between forensic psychology and mental disorders. **3.** To examine a criminal case in which deception was found using hypnosis. **4.** To review a criminal case involving serial murder **5.** To cite a crime case involving a juvenile and argue for and against lowering the age for categorizing an individual as juvenile. **6.** To provide an example of a criminal case where narco analysis was employed to uncover deceit	**30**		1,2, 3,4

TEXT BOOKS:

T1: Arrigo: Introduction to forensic Psychology

REFERENCE BOOKS:

R1: Cooke, G.: The role of Forensic Psychologist. Chanles C. Thomas.

R2: A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, *Scientific Evidence in Civil and Criminal Cases*, 4th Edition, The Foundation Press, Inc., New York.

R3: J.C. DeLadurantey and D.R. Sullivan, *Criminal Investigation Standards*, Harper & Row, New York.

R4: Elaad in *Encyclopedia of Forensic Science, Volume 2*, J.A. Siegel, P.J. Saukko and G.C.

R5: J. Niehaus, *Investigative Forensic Hypnosis*, CRC Press, Boca Raton.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand the nature, history, and scope of forensic psychology, distinguishing its role from traditional psychology and law.	**1, 3**
2	Identify the causes and analyze theimpact of crime on victims, exploring victimization and factors influencing it, such as the bystander effect.	**1, 2**
3	Access crime for criminal profiling, factors, eyewitness testimony, competence to stand trial, and explain the roles of correctional psychologists along with their practical aspects using real life criminal cases.	**1, 2, 3, 6**
4	Discuss psychological tests and forensic methods for crime detection, including Brain Electrical Oscillation Signature Profiling (BEOS) and lie detection methods along with their practical aspects using real life criminal cases.	**1, 3, 8**
5	Demonstrate forensic consultancy and supervision, emphasizing core competencies, cognitive interviewing techniques, and psychotherapy with criminal offenders.	**1, 3**

SEMESTER – II										
Course Title	**Fingerprints & Other Impressions**									
Course code	**24BSFS123R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/ II semester of first year of the programme**								
Course Objectives	1. Understand the historical development and biological foundation of fingerprints. 2. Analyze and interpret fingerprint patterns, ridge characters, and minutiae. 3. Explore the classification and cataloging of fingerprint records, including the use of automated systems. 4. Investigate the constituents of sweat residue and employ various methods for latent fingerprint detection. 5. Investigate the constituents of sweat residue and employ various methods for latent fingerprint detection									
CO1	Understanding the historical facts and basic concepts of fingerprinting.									
CO2	Analyze various fingerprint patterns, including ridge characters/minutiae, and differentiate types fingerprints found at crime scenes along with their practical aspects.									
CO3	Explain classification and cataloging of fingerprint records, including automated systems, and understand the significance of poroscopy and edgeoscopy along with their practical aspects.									
CO4	Analyze and interpret latent fingerprints through physical and chemical methods, preservation, and lifting, including digital imaging techniques along with their practical aspects.									
CO5	Illustrate the importance of footprints casting techniques, electrostatic lifting of latent footprints, and understand the historical significance of palm prints and lip prints along with their practical aspects.									

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Introduction and History. Biological basis of fingerprints. Formation of ridges. Fundamental principles of fingerprinting.	**8**	Understanding fingerprint history and formation.	1,2
II	Fingerprint patterns. Ridge characters/minutiae. Plain and rolled fingerprints. Ridge Tracing and Ridge Counting. Types of Fingerprints found at Crime Scene.	**7**	Recognize fingerprint pattern and minutiiae.	1,2
III	Classification and cataloguing of fingerprint record. Automated Fingerprint Identification System. Significance of poroscopy and edgeoscopy. Ten Digit Classification. Single Digit Classification.	**10**	Classify fingerprints and use identification systems.	1,2
IV	Constituents of sweat residue. Latent fingerprints' detection by physical and chemical methods. Preservation and lifting of developed fingerprints. Digital imaging for fingerprint enhancement. Fingerprinting the deceased	**10**	Detect, preserve, and enhance fingerprints	1,2

V	Importance of footprints. Casting of foot prints, Electrostatic lifting of latent foot prints. Palm prints and their historical importance. Lip prints - Nature, location, collection and examination of lip prints.	**10**	Grasp footprints, palm prints, lip prints.	1,2
Practical	1. To obtain plain fingerprints. 2. To obtain rolled fingerprints. 3. To identify core and delta in the given fingerprint sample 4. To identify pattern types in the given fingerprint sample. 5. To perform ridge counting in the given fingerprint sample 6. To perform ridge tracing in the given fingerprint sample 7. To identify ridge characteristics or minutiae in given fingerprint sample 8. To develop latent fingerprint using powder method 9. To develop and lift latent finger Prints with fuming and chemical methods. 10. To compare two fingerprint samples 11. To prepare cast of foot prints.	**30**		1,2, 3,4

TEXT BOOKS:

T1: Lee and Gaensleen's, Advances in Fingerprint Technology, 3rd Edition, R.S. Ramotowski (Ed.), CRC Press, Boca Raton.

REFERENCE BOOKS:

R1: J.E. Cowger, Friction Ridge Skin, CRC Press, Boca Raton.
R2: D.A. Ashbaugh, Quantitative-Qualitative Friction Ridge Analysis, CRC Press, Boca Raton.
R3: C. Champod, C. Lennard, P. Margot an M. Stoilovic, Fingerprints and other Ridge Skin Impressions, CRC Press, Boca Raton.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understanding the historical facts and basic concepts of fingerprinting.	**1**
2	Analyze various fingerprint patterns, including ridge characters/minutiae, and differentiate types fingerprints found at crime scenes along with their practical aspects.	**1, 3**
3	Explain classification and cataloging of fingerprint records, including automated systems, and understand the significance of poroscopy and edgeoscopy along with their practical aspects.	**1,2, 8**
4	Analyze and interpretlatent fingerprints through physical and chemical methods, preservation, and lifting, including digital imaging techniques along with their practical aspects.	**1, 2, 3, 8**
5	Illustrate the importance of footprints casting techniques, electrostatic lifting of latent footprints, and understand the historical significance of palm prints and lip prints along with their practical aspects.	**1, 3, 8**

SEMESTER – II									
Course Title	**IMPLICIT ENGLISH**								
Course code	**24UBPD122R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/II Semester of First year of the programme**								
Course Objectives	1. To equip students with the skills to interchange sentence types, use various tenses, and correct common grammatical errors. 2. To enable students to effectively use one-word substitutions, understand homonyms and homophones, avoid commonly confused words, and use idioms and phrases. 3. To help students understand the nature and types of listening, and overcome barriers to effective listening.								
CO1	Provide students with the ability to transform sentence types, utilize different tenses, and address common grammatical mistakes.								
CO2	Empower students to proficiently apply one-word substitutions, differentiate between homonyms and homophones, avoid frequently confused words, and incorporate idioms and phrases in their vocabulary.								
CO3	Assist students in comprehending the various aspects and types of listening, and in identifying and overcoming obstacles to effective listening.								
CO4	Facilitate students in employing effective reading strategies, extracting relevant information from texts, and utilizing the SQ3R method.								
CO5	Instruct students on the significance of time management and provide foundational strategies to manage their time efficiently.								
CO6	Lead students in creating a well-rounded and professional LinkedIn profile.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Grammar (flipped classroom)** i. Interchange of Interrogative and Assertive Sentences, Exclamatory and Assertive Sentences ii. Types of Tenses iii. Common Errors	**6**	Students will accurately construct and transform various sentence types and correct grammatical errors.	1,2, 3
II	**Vocabulary Development** One word substitution Homonyms and Homophones Words often confused Idioms and phrases	**6**	Students will enhance their vocabulary and use words accurately in context.	1,2, 3
III	**Listening Skills** i. What is listening? ii. Types of Listening iii. Understanding Listening Barriers	**5**	Students will demonstrate effective listening skills and identify listening barriers.	1,2, 3
IV	**Reading Skills** i. Techniques of Effective Reading ii. Gathering ideas and information from a text iii. The SQ3R Technique	**5**	Students will read efficiently and extract relevant information using the SQ3R technique.	1,2, 3
V	**Time-Management Skills** i. Introduction to Time Management ii. Purpose and Importance of Time Management iii. Basic Tips to Maintain Time	**4**	Students will effectively manage their time using various strategies.	1,2, 3
VI	**Creation of LinkedIn Profile**	**6**	Students will create a professional LinkedIn profile.	2, 3

TEXTBOOKS:

T1: Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.
T2: Reed, James. 2016. 101 Job Interview Questions You'll Never Fear Again, Plume.
T3: Pease, Barbara. 2006. The Definitive Book of Body Language, RHUS.
T4: McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition)

REFERENCE BOOKS:

R1: Zinsser, William. (2006) On Writing Well: The Classic Guide to Writing Nonfiction Harper Perennial
R2: Taylor J. and Wright, J., IELTS Advantage Reading Skills: A step-by-step guide to a high IELTS reading score, Delta Publishing by Klett.
R3: Kelley, Thea. 2021. Get That Job: The Quick and Complete Guide to a Winning Interview, Plovercrest Press.
R4: Murphy, Raymond,.(2012) English Grammar in Use Book with Answers: A Self- Study and Practice Book for Intermediate Learners of English ,Cambridge University Press

OTHER LEARNING RESOURCES:

https://www.ef.com/wwen/english-resources/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Provide students with the ability to transform sentence types, utilize different tenses, and address common grammatical mistakes.	**2,3,4,8**
2	Empower students to proficiently apply one-word substitutions, differentiate between homonyms and homophones, avoid frequently confused words, and incorporate idioms and phrases in their vocabulary.	**2,3,4,8**
3	Assist students in comprehending the various aspects and types of listening, and in identifying and overcoming obstacles to effective listening.	**2,3,4,8**
4	Facilitate students in employing effective reading strategies, extracting relevant information from texts, and utilizing the SQ3R method.	**2,3,4,8**
5	Instruct students on the significance of time management and provide foundational strategies to manage their time efficiently.	**2,3,4,8**

SEMESTER – II									
Course Title	**Environmental Science**								
Course code	**24BSFS127R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/II Semester of First year of the programme**								
Course Objectives	1. To prepare students for careers as leaders in understanding and addressing complex environmental issues from a problem-oriented, interdisciplinary perspective.								
	2. To develop a world population that is aware of and concerned about the environment and its associated problems and which has the knowledge, Skills, attitudes, motivations and commitment to work individually and collectively towards solutions of current problems and prevention of new ones.								
	3. To gain knowledge about the conservation of biodiversity and its importance.								
CO1	The students will be able to appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.								
CO2	Students will learn about natural resource, its importance and environmental impacts of Human activities on natural resource.								
CO3	Gain knowledge about environment and ecosystem, Students will be able to understand the concept of biodiversity and respect them								
CO4	Gain knowledge about the conservation of biodiversity and its importance.								
CO5	Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Multidisciplinary nature of environmental studies:** Definition, scope and importance, Need for public awareness.	**4**	Environmental studies combines sciences to tackle environmental issues. Its multidisciplinary approach is key to solving complex problems. Public awareness and education are vital for promoting sustainability	1,2
II	**Natural Resources: Renewable and non-renewable resources,** Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. Land resources: Land as a resource, land degradation,	**6**	Natural resources, both renewable and non-renewable, face exploitation issues, including deforestation, overuse of water resources, environmental challenges with minerals and food, and land degradation. Individuals play a crucial role in conserving resources and promoting sustainability.	1,2

	man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles			
III	**Ecosystems:** Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the Following ecosystem: - Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	**4**	This module covers ecosystems, including their concept, structure, functioning, and diversity. Students will learn about energy flow, ecological succession, and various ecosystem types like forests, grasslands, deserts, and aquatic ecosystems.	1,2
IV	**Biodiversity and its conservation:** Introduction – Definition: genetic, species and ecosystem diversity. Bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a megadiversity nation• Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.	**5**	This module covers biodiversity, including its definition, value, levels, and threats. Students will learn about India's bio-geographical classification, its status as a megadiversity nation, and key biodiversity hotspots. They'll also explore threats like habitat loss, wildlife poaching, and human-wildlife conflicts, crucial for conservation efforts.	1,2
V	**Environmental Pollution:** Definition Cause, effects and control measures of:- Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste, Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.	**5**	This module covers environmental pollution, including causes, effects, and control measures, alongside waste management and disaster preparedness strategies.	1,2
VI	**Social Issues and the Environment:** From Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case Studies. **Environmental ethics:** Issues and	**6**	This module explores social-environmental dynamics, including urban energy challenges, water conservation, and resettlement issues. It delves into environmental ethics, climate change impacts, and relevant legislation like the Environment Protection Act, emphasizing public awareness and enforcement challenges.	1,2

	possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Waste land reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.			
VII	**Human Population and the Environment:** Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Case Studies.	**4**	This module covers human population dynamics, including growth, impact on the environment and health, along with initiatives like Family Welfare Programs and the role of information technology, illustrated with case studies.	1,2
VIII	**Field work:** Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc. (**Field work Equal to 5 lecture hours**)	**5**	Fieldwork objectives include documenting environmental assets like rivers and forests, assessing pollution in urban or rural sites, and studying local biodiversity and ecosystems such as ponds and hill slopes	1,2

TEXT BOOKS:

T1: Bharucha. Textbook of Environmental Studies for Undergraduate Courses. 2nd edition. Orient Black swan Publishing; 2019.

REFERENCE BOOKS:

R1: Trivedi Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media(R). B.S. Publications; 2010.

R2: Trivedi, Goel. Introduction to air pollution. 1st publication. Techno-Science Publication (TB); 2003.

R3: Brunner. Hazardous Waste Incineration. 2nd edition. McGraw Hill Inc.; 1994

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning PlatformsP[

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	The students will be able to appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.	**1, 4**
2	Students will learn about natural resource, its importance and environmental impacts of Human activities on natural resource	**1, 4**
3	Gain knowledge about environment and ecosystem, Students will be able to understand the concept of biodiversity and respect them	**1, 4**
4	Gain knowledge about the conservation of biodiversity and its importance.	**1, 4**
5	Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures.	**1, 2, 4**

SEMESTER – II									
Course Title	**Chemistry- 2**								
Course code	**24FSCH124R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/ 2nd semester of first year of the program**								
Course Objectives	1. Understand the principles of isomerism, including its sources, methods of formation, and physical and chemical properties of alkanes, alkenes, and alkynes, along with mechanisms involved. 2. Explore the formation and chemical reactions of alkyl halides and aryl halides, emphasizing nucleophilic substitution reactions and their mechanisms. 3. Examine irreversible and reversible reactions, chemical equilibrium, the law of mass action, and the thermodynamic treatment of the law of mass action. 4. Gain insights into various types of chemical bonds, oxidation numbers, and theories such as Lewis theory, Valence Bond theory, and Molecular Orbital theory. 5. Understand acid-base reactions through the Brönsted-Lowry concept, solvated proton, levelling solvents, Lewis acid-base concept, and the application of Hard and Soft Acids and Bases (HSAB) principle.								
CO1	Understand the diverse isomerism and mastering the physical and chemical properties of alkanes, alkenes, alkynes, and aromatic compounds.								
CO2	Interpret in handling the methods of formation, reactions, and mechanisms involved in alkyl and aryl halides.								
CO3	Explain chemical equilibrium principles, Le Chatelier's principle, and their applications.								
CO4	Identify chemical bonding, structure, and hybridization principles in the context of molecular orbitals.								
CO5	Describe application of acid-base concepts, including Brönsted-Lowry, Lewis theories, and the Hard and Soft Acids and Bases (HSAB) principle								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Isomerism, sources, methods of formation, physical properties and chemical reactions of alkanes, alkenes, alkynes along with the mechanism involved. Saytzeff's rule, Hofmann elimination, Markownikoff's rule, Antimarkownikoff's rule. Dienes and their classification: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, Diels-Alder reaction. Aromaticity, Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions & Pheterocyclic compounds with suitable examples, antiaromaticity& nonaromaticity; Preparation, physical and chemical properties of arenes (especially benzene).	**7**	Master hydrocarbon properties, reactions, aromaticity..	1,2
II	Methods of formation, chemical reactions of alkyl halides and aryl halides. Mechanisms of nucleophilic substitution reactions of alkyl halides, SN2and SN1 mechanism. Nucleophilic aromatic substitution, the addition elimination and the elimination-additional mechanisms of nucleophilic aromatic substitution reactions	**5**	Understand halide formation, reactions, mechanisms.	1,2
III	Irreversible & reversible reactions, chemical	**8**	Grasp equilibrium	1,2

	equilibrium, law of mass action, thermodynamic treatment of law of mass action, Van't Hoff reaction isotherm, relation between Kp, Kc &K x, homogenous & heterogenous equilibria, Le Chatelier's principle, applications of Le Chatelier's principle, Clausius-Claperyron equation.		principles, Le Chatelier's principle	
IV	Types of bonds: lonic bond, Covalent bond and Co-ordinate bonds. Oxidation number. Lewis theory, Formal charge, Valence Bond theory, Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Valence shell electron pair repulsion theory (VSEPR), Bent's rule, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, HCl, CO_2. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules.	**5**	Comprehend bond types, hybridization, molecular orbitals.	1,2
V	Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB). Application of HSAB principle	**5**	Master acid-base concepts, Lewis theory.	1,2
Practical	1.Qualitative analysis of inorganic salts. • Cations: Pb^{2+}, Cu^{2+} As^{3+}, $A\ell^{3+}$, Fe^{3+}, Mn^{2+}, Zn^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+} • Anions: $(CO_3)^{2-}$, S^{2-}, $(SO_3)^{2-}$, $(NO_2)^{-}$, $(SO_4)^{2-}$, $C\ell^{-}$, Br^{-}, I^{-}, $(PO_4)^{3-}$, $(C_2O_4)^{2-}$, CH_3COO^{-}, NO_3^{-} 2.Qualitative organic analysis. • Detection of elements (N, S, Halogens) Detection of organic functional groups (-COOH, PhOH, -CHO, =CO, -OH, $-NO_2$, $-NH_2$	**30**		1,2, 3,4

TEXT BOOKS:

T1: Shriver & Atkins Inorganic Chemistry, Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong, Michael Hagerman, Oxford.

REFERENCE BOOKS:

R1: Organic Chemsitry, Robert Thornton Morrison, Robert Neilson Boyd and Saibal Kanti Bhattacharjee, 7th Edition, Pearson IN.

R2: Organic Chemsitry, Jonathan Clayden, Nick Greeves and Stuart Warren, 2nd Edition (South Asia Edition), Oxford.

R3: Physical Chemistry by Gurdeep Raj; Krishna Prakashan Media (P) Ltd

R4: Physical Chemistry by Puri Sharma Pathania; Vishal Publishing Co.

R5: Inorganic Chemistry, J. D. Lee. Concise, 5 th Edition, Oxford.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand the diverse isomerism and mastering the physical and chemical properties of alkanes, alkenes, alkynes, and aromatic compounds.	**1**
2	Interpret in handling the methods of formation, reactions, and mechanisms involved in alkyl and aryl halides.	**1**
3	Explain chemical equilibrium principles, Le Chatelier's principle, and their applications	**1**
4	Identify chemical bonding, structure, and hybridization principles in the context of molecular orbitals.	**1**
5	Describe application of acid-base concepts, including Brönsted-Lowry, Lewis theories, and the Hard and Soft Acids and Bases (HSAB) principle.	**1**

SEMESTER – II										
Course Title	**Physics- 2**									
Course code	**24FSPH125R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/ 2nd semester of first year of the program**								
Course Objectives	1. Grasp electric fields, Gauss' Law, and conservative nature of electrostatics. 2. Understand polarization, dielectric effects, and electric displacement in matter. 3. Define magnetic fields, calculate forces, and explore magnetic interactions. 4. Study magnetization, susceptibility, and ferromagnetism in materials. 5. Investigate electromagnetic induction, Maxwell's Equations, and circuit phenomena like resonance.									
CO1	Classify fundamental electrostatic concepts, including electric field, Gauss' Law, and capacitance, applying them to charge distributions of varying symmetry.									
CO2	Understand electric fields in matter, polarization, and dielectric properties, effectively employing Gauss' Law in dielectrics									
CO3	Understand and apply magnetic forces, Biot-Savart's Law, Ampere's Circuital Law, and properties of the magnetic field to calculate forces and torques in current-carrying systems.									
CO4	Explain magnetization, magnetic intensity, susceptibility, and permeability, exploring ferromagnetism and understanding the B-H curve and hysteresis.									
CO5	Demonstrate proficiency in electromagnetic induction principles, including Faraday's Law, Lenz's Law, and an introduction to Maxwell's Equations, applying them to AC circuits, resonance, and power dissipation									

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Electric field, Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. Potential and Electric Field of a dipole. Force and Torque on a dipole. Capacitance of a system of charged conductors. Parallel-plate capacitor.	**7**	Grasp electrostatics and Gauss' Law.	1,2
II	Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics	**5**	Understand polarization and dielectrics	1,2
III	Magnetic force between current elements and definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Ampere's Circuital Law and its application to Solenoid. Properties of B (magnetic field). Magnetic Force on point charge current carrying wire between current elements, Torque on a current loop in a uniform Magnetic Field.	**8**	Calculate magnetic forces and fields	1,2
IV	Magnetization vector (M), Magnetic		Analyze	1,2

	Intensity(H), Magnetic Susceptibility and permeability. Relation between B, H, M. Ferromagnetism, B-H curve, and hysteresis.	**5**	magnetization and magnetic materials	
V	Electromagnetic Induction: Faraday's Law. Lenz's Law, Self-Inductance and Mutual Inductance, Charge Conservation and Displacement current. Introduction to Maxwell's Equations. Kirchhoff's laws for AC circuits. LCR circuit: Resonance, Power Dissipation and Bandwidth	**5**	Apply electromagnetic induction principles	1,2
Practical	**1.** Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses (f) Resistors and transistors **2.** To determine the internal resistance of a cell by using potentiometer. **3.** To study a series LCR circuit and determine its (a) Resonant Frequency **4.** Place a bar magnet in the magnetic meridian and draw the field lines **5.** To find the value of a given resistance using a meter bridge	**30**		1,2,3,4

TEXT BOOKS:

T1: Elements of Electromagnetics, M.N.O. Sadiku, Oxford University Press.

REFERENCE BOOKS:

R1: Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, Tata McGraw.
R2: Electricity and Magnetism, Edward M. Purcell, McGraw-Hill Education.
R3: Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., Benjamin Cummings.
R4: Feynman Lectures Vol.2, R.P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.
R5: Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol.I, Oxford Univ. Press.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Classify fundamental electrostatic concepts, including electric field, Gauss' Law, and capacitance, applying them to charge distributions of varying symmetry.	**1**
2	Understand electric fields in matter, polarization, and dielectric properties, effectively employing Gauss' Law in dielectrics.	**1**
3	Understand and apply magnetic forces, Biot-Savart's Law, Ampere's Circuital Law, and properties of the magnetic field to calculate forces and torques in current-carrying systems	**1**
4	Explain magnetization, magnetic intensity, susceptibility, and permeability, exploring ferromagnetism and understanding the B-H curve and hysteresis.	**1**
5	Demonstrate proficiency in electromagnetic induction principles, including Faraday's Law, Lenz's Law, and an introduction to Maxwell's Equations, applying them to AC circuits, resonance, and power dissipation.	**1**

SEMESTER – II										
Course Title	**Biology- 2**									
Course code	**24FSBO126R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/ 2nd semester of first year of the program**								
Course Objectives	1. Introduce principles and basis for animal classification. 2. Explore general characters, classification, and life histories of major animal phyla. 3. Introduce protochordates and agnatha, highlighting general features and significance in vertebrate evolution 4. Cover general features and classification of fishes, amphibians, and reptiles 5. Introduce general features and classification of birds and mammals.									
CO1	Enable comprehension of the rationale behind animal kingdom classification in biological sciences									
CO2	Understand the diverse animal phyla, their characteristics, and evolutionary significance									
CO3	Understand protochordates and agnatha characteristics and their role in vertebrate evolution									
CO4	Identify aquatic adaptations, parental care, and classifications in aquatic vertebrates.									
CO5	Demonstration of flight adaptations, adaptive radiation, and locomotory appendages in birds and mammals									

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Basis for Animal Kingdom Classification; Phylum Porifera:** General characters and classification up to classes; Canal System in Sycon **Phylum Cnidaria:** General characters and classification up to classes; Polymorphism in Hydrozoa **Phylum Platyhelminthes**: General characters and classification up to classes; Life history of *Taenia solium* **Phylum Nemathelminthes:** General characters and classification up to classes; Life history of *Ascaris lumbricoides*.	**7**	Understand the criterion on which animal kingdom is classified, knowledge of Phylum Porifera, Cnidaria, Platyhelminthes, Nemathelminthes	1,2
II	**Phylum Annelida:** General characters and classification up to classes; Metamerism in Annelida **Phylum Arthropoda:** General characters and classification up to classes; Metamorphosis in Insects **Phylum Mollusca:** General characters and classification up to classes; Torsion in gastropods **Phylum Echinodermata:** General characters and classification up to classes; Water-vascular system in Asteroidea	**5**	Regarding different characters of Annelida, Arthropoda, Mollusca, Echinodermata.	1,2

III	**Protochordates:** General features **Agnatha:** General features **Pisces:** General features and Classification up to class; aquatic adaptation of fishes.	**8**	Regarding different characters of Protochordates, Agnatha and Pisces	1,2
IV	**Amphibia:** General features and Classification up to class; Parental care in amphibia **Reptiles:** General features and Classification up to Class; Poisonous and non-poisonous snakes.	**5**	Regarding different characters of Amphibia and Reptiles.	1,2
V	**Aves**: General features and Classification up to class; Flight adaptations in birds **Mammals:** General features and Classification up to orders; Adaptive radiation with reference to locomotory appendages	**5**	Regarding different characters of Aves and Mammals.	1,2
Practical	1. Study of invertebrate museum specimen (two specimen from each phylum). 2. Study of vertebrate museum specimen (two specimen from each phylum). 3. Study of various types of social insects (honeybee/ants) and their nests	**30**		1,2,3, 4

TEXT BOOKS:

T1: Ruppert and Barnes, R.D. Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
T2: Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
T3: Pough H. Vertebrate life, VIII Edition, Pearson International

REFERENCE BOOKS:

R1: Ruppert and Barnes, R.D. Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
R2: Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. The Invertebrates: A New Synthesis, III Edition, Blackwell Science.
R3: Barrington, E.J.W. Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Enable comprehension of the rationale behind animal kingdom classification in biological sciences.	**1, 6**
2	Understand the diverse animal phyla, their characteristics, and evolutionary significance.	**1, 2**
3	Understand protochordates and agnatha characteristics and their role in vertebrate evolution	**1**
4	Identify aquatic adaptations, parental care, and classifications in aquatic vertebrates.	**1, 6**
5	Demonstration of flight adaptations, adaptive radiation, and locomotory appendages in birds and mammals.	**1**

SEMESTER – III									
Course Title	**Cyber & Digital Forensics**								
Course code	**24BSFS211R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ III Semester of Second year of the programme**								
Course Objectives	1. Understand the fundamentals of computer hardware, including hard disk development, memory, processors, and operating systems. 2. Explore the definition and various types of computer crimes, distinguishing them from conventional crimes. 3. Examine malware, such as computer viruses, worms, Trojan horses, and their roles in computer crimes. 4. Learn the principles and procedures of computer forensics investigations, including the seizure, preparation, and extraction of information from suspected computers. 5. Address legal and privacy issues related to the collection and seizure of magnetic media, covering topics like file restoration, password cracking, encryption methods, and user tracking.								
CO1	Understand the fundamentals of computer hardware, accessories and network connections along with their practical aspects								
CO2	Describe the various cyber and digital crimes along with their practical aspects.								
CO3	Explain various viruses, adware, malwares and their effect along with their practical aspects.								
CO4	Demonstrate the methods of collection restoration and decryption of data related to cybercrimes along with their practical aspects.								
CO5	Demonstrate analysis of media, files, folder etc. using various computer forensic software and hardware along with their practical aspects.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Fundamentals and Concepts: Fundamentals of computers Hardware and accessories- development of hard disk, physical construction, CHS and LBA addressing, encoding methods and formats. Memory and processor. Methods of storing data. Operating system. Software. Introduction to network, LAN, WAN and MANl	**8**	Fundamentals of computer hardware and accessories and network connections & their uses.	1,2
II	Computer Crimes: Definition and types of computer crimes. Distinction between computer crimes and conventional crimes. Reasons for commission of computer crimes. Breaching security and operation of digital systems	**7**	Definition and types of crime related to computer.	1,2

III	Malware and Other Crimes: Computer virus, and computer worm – Trojan horse, trap door, super zapping, logic bombs. Types of computer crimes – computer stalking, pornography, hacking, crimes related to intellectual property rights, computer terrorism, hate speech, private and national security in cyber space. An overview of hacking, spamming, phishing and stalking	**10**	A brief idea about malwares and their effect, categories of crime involving computer and internet.	1,2
IV	Computer Forensics Investigations: Seizure of suspected computer. Preparation required prior to seizure. Protocol to be taken at the scene. Extraction of information from the hard disk. Treatment of exhibits. Creating bitstream of the original media	**10**	Computer forensic information- preparation, seizure, analysis.	1,2
V	**C**ollection and Seizure of Magnetic Media: Legal and privacy issues. Examining forensically sterile media. Restoration of deleted files. Password cracking and E-mail tracking. Encryption and decryption methods. Tracking users	**10**	Collection restoration and decryption of magnetic media data.	1,2
Practical	1) To identify, seize and preserve digital evidence from crime scenes. 2) To detect deletions, obliterations and modifications of files using cyber forensic software. 3) To identify the IP address of the sender of e-mails. 4) To identify encrypted/hidden files 5) To use digital signatures for securing e-mail and online transactions. 6) To acquire data from PCs/laptops/HDDs/USBs, pen drives, memory cards and SIM cards cyber forensic software/hardware 7) To carry out imaging of hard disks	**30**		1,2,3,4

TEXT BOOKS:

T1: Verma M., Forensic Computer investigation

REFERENCE BOOKS:

R1: R.K. Tiwari, P.K. Sastry and K.V. Ravikumar, *Computer Crimes and Computer Forensics*, Select Publishers, New Delhi.

R2: C.B. Leshin, *Internet Investigations in Criminal Justice*, Prentice Hall, New Jersey.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand the fundamentals of computer hardware, accessories and network connections along with their practical aspects.	**1, 8**
2	Describe the various cyber and digital crimes along with their practical aspects.	**1**
3	Explain various viruses, adware, malwares and their effect along with their practical aspects	**1, 3**
4	Demonstrate the methods of collection restoration and decryption of data related to cybercrimes along with their practical aspects.	**1, 8**
5	Demonstrate analysis of media, files, folder etc. using various computer forensic software and hardware along with their practical aspects.	**1, 3, 8**

SEMESTER – III									
Course Title	**Basic Instrumental Techniques**								
Course code	**24BSFS212R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/III Semester of Second year of the programme**								
Course Objectives	1. Introduce measurement principles and instrumentation, emphasizing accuracy, precision, sensitivity, and stability in forensic analysis. 2. Familiarize students with chromatographic principles, instrumentation, and visualization, emphasizing forensic applications. 3. Introduce spectroscopy principles, electromagnetic spectrum, and sources, focusing on forensic applications. 4. Provide knowledge of light microscopy principles, including image formation, magnification, and types of microscopes, with forensic applications. 5. Introduce general principles of biological and biochemical analysis, emphasizing RIA and ELISA in forensic science.								
CO1	Illustrate various calculation to validate methods, ensuring reliable and precise forensic measurements along with their practical aspects.								
CO2	Apply chromatographic methods for qualitative and quantitative analysis in forensic scenarios along with their practical aspects.								
CO3	Utilize atomic and molecular spectroscopy for forensic analysis and understand energy levels in atomic spectra along with their practical aspects.								
CO4	Develop skills in microscopic analysis for effective interpretation of forensic evidence along with their practical aspects.								
CO5	Utilize biochemical techniques for analyzing of biological evidence in forensic investigations along with their practical aspects.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Basic Concepts of Method Validation** Introduction to measurement and instrumentation, methods of measurement. Performance characteristics of Instruments: -accuracy, precision, sensitivity, linearity, reproducibility, repeatability, resolution, threshold, drift, stability	7	Demonstrate understanding and application of method validation concepts, measurement, and instrumentation, showcasing proficiency in assessing instrument performance characteristics.	1,2
II	**Chromatography**- Introduction, Review of basic principles and types of chromatography, thin layer chromatography, Theory and instrumentation, visualization, Qualitative and Quantitative, Forensic Application.	5	Apply chromatography principles and techniques for qualitative and quantitative analysis in forensic applications, showcasing expertise in analytical methods.	1,2
III	**Atomic & Molecular Spectroscopy: -** Spectroscopy, electromagnetic spectrum, sources of radiation, their utility and limitations, conventional sources for UV, visible and infrared rays, sources for shorter wave length radiations, atomic spectra, energy levels	8	Understand the principles of atomic and molecular spectroscopy, including the electromagnetic spectrum, radiation sources, and their utility in forensic analysis.	1,2
IV	**Microscopy-** Light Microscopy-	5	Analyze and interpret	1,2

	Introduction, Geometrical optics, Image formation, Magnification and Resolution, lens aberrations, Distortion of image and curvature of field, Types of microscopes-Compound, Comparison, their basic principles, working and Forensic Applications		microscopy principles, including geometrical optics, image formation, and magnification, applying these concepts to forensic investigations.	
V	**Biochemical techniques: -**Biological and biochemical techniques: general principles of biological/ bio-chemical analysis, Radio Immune Assay (RIA), ELISA.	5	Apply biochemical techniques, demonstrating knowledge of general principles and practical application, showcasing proficiency in methods like Radio Immune Assay (RIA) and ELISA in forensic	1,2
Practical	1) To prepare sample (various conc., M, %) etc. 2) To understand validation of instrumental methods 3) TO analyze samples using TLC. 4) To analyse sample using UV spectrophotometer 5) To analyse sample using compound microscope 6) To analyse sample using comparison microscope 7) To analyse sample using biochemical techniques	**30**		1,2,3,4

TEXT BOOKS:

T1. D.A. Skoog, D.M. West and F.J. Holler, *Fundamentals of Analytical Chemistry,* 6th Edition, Saunders College Publishing, Fort Worth.

REFERENCE BOOKS:

R1. W. Kemp, *Organic Spectroscopy*, 3rd Edition, Macmillan, Hampshire.
R2. J.W. Robinson, *Undergraduate Instrumental Analysis*, 5th Edition, Marcel Dekker, Inc., New York.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Illustrate various calculation to validate methods, ensuring reliable and precise forensic measurements along with their practical aspects.	**1, 3**
2	Apply chromatographic methods for qualitative and quantitative analysis in forensic scenarios along with their practical aspects.	**1, 3**
3	Utilize atomic and molecular spectroscopy for forensic analysis and understand energy levels in atomic spectra along with their practical aspects	**1, 3**
4	Develop skills in microscopic analysis for effective interpretation of forensic evidence along with their practical aspects.	**1, 3**
5	Utilize biochemical techniques for analyzing of biological evidence in forensic investigations along with their practical aspects.	**1, 3**

SEMESTER – III										
Course Title	**Questioned Document Examination**									
Course code	**24BSFS213R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/III Semester of Second year of the programme**								
Course Objectives	1. Understand the basics of questioned documents, including types, forgery, and procedures for collecting standards for document comparison. 2. Explore the principles of handwriting identification, covering physiology, class and individual characteristics, natural variations, and examination of tampered documents. 3. Examine disputed documents, such as wills, deeds, cheques, and various types of frauds, including ATM and credit card frauds. 4. Learn about the examination of security documents, printed matter, built-up documents, and the identification of typists using forensic stylistics. 5. Familiarize with instrumentation in questioned documents, including document photography, various light sources, magnifying tools, and specialized forensic equipment like Video Spectral Comparator and ESDA.								
CO1	Identify characteristic features and employ proper procedures for document comparison along with their practical aspects								
CO2	Understand individual handwriting characteristics and analyze ink, paper, photocopies, and other document elements along with their practical aspects.								
CO3	Examine diverse disputed documents frequently encountered in forensic scenarios along with their practical aspects.								
CO4	Analyze security documents, employing various techniques to determine authenticity and detect forgeries along with their practical aspects.								
CO5	Apply method solving practical skills in utilizing advanced instrumentation for accurate and detailed examination of questioned documents along with their practical aspects.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction to questioned documents, types, Forgery and its types, characteristic features of genuine handwriting/signatures, characteristic components of forged documents and their examination, procedure for collection of standards for comparison of documents, admitted/ genuine/documents/signature/writing	**8**	Introduction, to qd-definition, types, preliminary examination and basic tools regarding the field.	1,2
II	Principle of Handwriting Identification: introduction of handwriting, physiology, handwriting characteristics: class and individual characteristics, natural variations in handwriting, causes of variations, disguised writings, its examination, tampered documents: addition, alteration, erasure, obliteration, interlineation, page substitution, secret writing. examination of the documents for the ink, paper, photocopies/xerox, printouts and scanned documents.	**7**	Instruments used in questioned documents examination.	1,2
III	Disputed documents - wills, deeds,	**10**	Comparison of documents	1,2

	cheques, suicide letters, anonymous letters, threatening letters, stamps fraud, counterfeit currencies, fake paintings and printing, ATM and Credit card frauds, fake rubber stamps and seals, charred documents, torn documents, typed and photocopied documents.		by the age of ink, variations, divergences and characteristic of handwriting.	
IV	Examination of security documents. examination of printed matter, examination of built-up documents, determination of sequence of strokes, identification of typist: use of forensic stylistics, examination of other mechanical impressions, examination of paper	**10**	Standards of comparison of different types of documents.	1,2
V	Instrumentation in Questioned Documents Document photography using Camera, Color filters, Various light sources/Transmitted light, Oblique light/UV/ IR radiations), apparatus for specialized photographic techniques, magnifying glasses, illuminated torch, measuring equipment, geometrical requirements, compound microscope, Stereo microscope, Video Spectral Comparator, Docu-centre, Projectina, ESDA, TLC	**10**	Different types of forgeries and forged documents.	1,2
Practical	1) Analysis of class and individual characteristics of handwriting 2) Comparison of handwriting exemplars 3) Detection of free hand forgery 4) Detection of forgery by simulation 5) Detection of forgery by tracing 6) Ink identification 7) Examination and photography of security features in Indian rupee notes 8) Examination and photography of security features in Indian passport 9) Determination of sequence of strokes 10) Identification of inkjet printing on a document from laser printing/ photocopy	**30**		1,2,3 ,4

TEXT BOOKS:

T1: E. David, The Scientific Examination of Documents – Methods and Techniques, 2nd Edition, Taylor & Francis, Hants.

REFERENCE BOOKS:

R1. W. Kemp, *Organic Spectroscopy*, 3rd Edition, Macmillan, Hampshire.
R2. J.W. Robinson, *Undergraduate Instrumental Analysis*, 5th Edition, Marcel Dekker, Inc., New York.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Identify characteristic features and employ proper procedures for document comparison along with their practical aspects.	**1, 3**
2	Understand individual handwriting characteristics and analyze ink, paper, photocopies, and other document elements along with their practical aspects.	**1, 3**
3	Examine diverse disputed documents frequently encountered in forensic scenarios along with their practical aspects	**1, 3, 5**
4	Analyze security documents, employing various techniques to determine authenticity and detect forgeries along with their practical aspects.	**1, 3**
5	Apply method solving practical skills in utilizing advanced instrumentation for accurate and detailed examination of questioned documents along with their practical aspects	**1, 3, 8**

SEMESTER – III										
Course Title	**Forensic Ballistics**									
Course code	**24BSFS214R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/III Semester of Second year of the programme**								
Course Objectives	1. Understand the definition, scope, and significance of forensic ballistics, including the history and development of gunpowder and firearms. 2. Explore improvised and country-made firearms, gunshot residues, and methods of analyzing residues on shooting hands and targets. 3. Classify small firearms and ammunition, examining firing mechanisms, types of ammunition, and marks produced during the firing process. 4. Delve into internal ballistics, covering propellant ignition, shape and size of propellants, and factors influencing internal ballistics. 5. Study external ballistics, including vacuum trajectory, air resistance effects, projectile stability, and trajectory computation, as well as terminal ballistics, focusing on the impact of projectiles on targets, ricochet effects, and firearms injuries.									
CO1	Understand the history and development of Gun powder firearms, IED, GSR and need and scope of forensic ballistics along with their practical aspects.									
CO2	Explain types of Firearm and ammunition and its composition along with their practical aspects									
CO3	Explain the type and mechanism of series of events that takes place after firing inside the firearm along with their practical aspects.									
CO4	Explain the series of events takes place after the bullet will leave the muzzle of the firearm and factor affecting its velocity along with their practical aspects.									
CO5	Examine the effect of bullets after terminating and different factors resulting it along with their practical aspects.									

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Definition, Scope, and Significance of Forensic Ballistics; Gun powder – Definition, History and Development. Firearms – Definition according to Indian Arms Act. History and Development; Improvised & country made firearms; Formation of gunshot residues. Methods of analysis of gunshot residues from shooting hands and targets, with special reference to clothing.	**8**	Introduction to ballistic-need & scope. History and development of gun powder, firearms, ied, gsr-its collection and analysis.	1,2
II	Weapon types and their operation. Firing mechanisms of different firearms. Types of ammunition. Constructional features and characteristics of different types of cartridges and bullets. Primers and priming compounds. Projectiles. Different types of marks produced during firing process on cartridge – firing pin marks, breech face marks, chamber marks, extractor and ejector marks	**7**	Classification of firearm as per their type and mechanism. Different parts of bullets and firearms.	1,2

III	Internal Ballistics- Definition, ignition of propellants, shape and size of propellants, manner of burning, and various factors affecting the internal ballistics	**10**	Detailed study of internal ballistics- series of events takes place after firing inside the firearm.	1,2
IV	External Ballistics- Vacuum trajectory, effect of air resistance on trajectory, base drag, drop, drift, yaw, shape of projectile and stability.	**10**	Detailed study of external ballistics- series of events takes place after the bullet will leave the muzzle of the firearm and factor affecting its velocity.	1,2
V	Terminal Ballistics- Terminal Ballistics, Wound ballistics, nature of injury, Effect of projectile on hitting the target, entry wound, exit wound, multiple entry and exit wound, ricochet and its effects.	**10**	Detailed study of terminal ballistics- what happens to the bullet and the target after hitting and different factors resulting it.	1,2
Practical	1. To identify different parts of firearms 2. To identify different parts of firearm ammunition 3. To perform collection of GSR particles. 4. To perform chemical analysis for presence of GSR.	**30**		1,2,3, 4

TEXT BOOKS:

T1: B.J. Heard, *Handbook of Firearms and Ballistics*, Wiley and Sons, Chichester.

REFERENCE BOOKS:

R1: K Kumar, *Forensic Ballistics in Criminal Justice*, Eastern Book Company, Lucknow.
R2: W.F. Rowe, Firearms identification, *Forensic Science Handbook*, Vol. 2, R. Saferstein (Ed.), Prentice Hall, New Jersey.
R3: A.J. Schwoeble and D.L. Exline, *Current Methods in Forensic Gunshot Residue Analysis*, CRC Press, Boca Raton.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand the history and development of Gun powder firearms, IED, GSR and need and scope of forensic ballistics along with their practical aspects.	**1, 2, 3**
2	Explain types of Firearm and ammunition and its composition along with their practical aspects.	**1, 8**
3	Explain the type and mechanism of series of events that takes place after firing inside the firearm along with their practical aspects	**1, 2**
4	Explain the series of events takes place after the bullet will leave the muzzle of the firearm and factor affecting its velocity along with their practical aspects.	**2**
5	Examine the effect of bullets after terminating and different factors resulting it along with their practical aspects	**2**

SEMESTER – III									
Course Title	**Techno Professional Course- I**								
Course code	**24BSFS215R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/III Semester of Second year of the programme**								
Course Objectives	1. Introduce the fundamental concepts of forensic psychology and the psychological explanations for specific crimes. 2. Explore the relationship between criminality and mental illnesses such as necrophilia and schizophrenia, supported by case studies. 3. Provide knowledge on the history, principles, procedures, and scope of narco-analysis,including detailed case studies. 4. Educate students on the principles, instrumentation, procedures, and scope of BEOS, polygraph, and brain mapping, supported by detailed case studies. 5. Discuss the acceptance and application of psychological study evidence in judicial systems.								
CO1	Understand the basic concepts of forensic psychology and the psychological factors contributing to specific crimes.								
CO2	Analyze the relationship between criminality and mental illnesses, and apply this knowledge to case studies.								
CO3	Conduct narco-analysis by understanding its history, principles, procedures, and applications in forensic investigations.								
CO4	Utilize BEOS, polygraph, and brain mapping techniques, understanding their principles, procedures, and scope in forensic contexts.								
CO5	Evaluate the judicial acceptance and application of psychological evidence in court proceedings.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction: Introduction to forensic Psychology, Psychological explanations of specific crime	**6**	Explain fundamental concepts of forensic psychology.	1,2
II	The relationship of criminality to mental illness: Necrophilia,Schizophrenia and their types, case studies:	**6**	The psychological factors behind specific crimes.	1,2
II	Narco- Analysis: History, Principle, Procedure and its Scope. Detailed Case studies.	**6**	Perform narco-analysis, understanding its principlesand applications in forensic investigations.	1,2
III	BEOS, Polygraph, Brain mapping: History, Principle, Instrumentation,Procedure and its Scope. Detailed Case studies	**6**	Utilize BEOS, polygraph, and brain mapping techniques in forensic contexts, supported by understanding their principles and procedures	1,2
IV	Aspects in judicial system: Aspects of acceptance of Psychology study evidences in Courts discussions.	**6**	Evaluate the acceptance anduse of psychological evidencein judicial systems, understanding its impact on court proceedings	1,2

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the basic concepts of forensic psychology and the psychological factors contributing to specific crimes.	**1, 3**
2	Analyze the relationship between criminality and mental illnesses, and apply this knowledge to case studies.	**1, 3**
3	Conduct narco-analysis by understanding its history, principles, procedures, and applications in forensic investigations.	**1,3**
4	Utilize BEOS, polygraph, and brain mapping techniques, understanding their principles, procedures, and scope in forensic contexts.	**1, 8**
5	Evaluate the judicial acceptance and application of psychological evidence in court proceedings.	**1, 5**

SEMESTER – III										
Course Title	**English Language for excellence**									
Course code	**24UBPD212R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/III Semester of First year of the programme**								
Course Objectives	1. To enable students to learn, understand and practice transformation of sentences, uses ofcorrect preposition. 2. To augment the writing skills in different areas including CV and cover letter writing. 3. To boost productivity and performance at work, which assists in the achievement ofprofessional goals. 4. To evaluate the required attributes in a candidate.									
CO1	Enable students to use prepositions, construct simple, complex, and compound sentences, and distinguish between active and passive voice.									
CO2	Teach students the basics of writing, how to avoid ambiguity, write paragraphs and letters, and prepare resumes and cover letters.									
CO3	Help students conduct SWOT analyses, practice self-regulation, and maintain personal hygiene.									
CO4	Equip students with knowledge about non-verbal communication, types of body language, and their impact.									
CO5	Train students in planning and conducting group discussions, effectively disagreeing, and summarizing to attain objectives.									

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Grammar: Use of preposition, tag questions, simple, complex and compound sentences.	**3**	Describe preposition, simple and complex sentences	1,2
II	Grammar: Active and passive voice, direct and indirect speech.	**3**	Describe type of voices and type of speech	1, 2
III	Self-Management Skills: SWOT analysis, self-regulation, personal hygiene.	**3**	Explain self-regulation and personal hygiene.	1, 2, 3
IV	Non- Verbal Communication-Sciences of Body Language: What is Non-Verbal Communication & Body Language, Elements of Communication, Types of Body Language, Importance and Impact of Body Language, Types of Communication through Body Language,Body Language Do's and Don'ts, Doubt Clearing Session.	**3**	Explain nonverbal communication, body language	1, 2, 3,
V	Group Discussion (Theory): Importance, Planning, elements ad skills assessed; effective disagreeing, summarizing and attaining the objective.	**3**	Develop knowledge on group discussion.	1,2,

TEXT BOOKS:

T1: What Employers Want: The Work skills Handbook- Karen Holmes.

T2: English Grammar in Use, Raymond Murphy 4th edition, CUP.

REFERENCE BOOKS:

R1: Professional Communication, by Dr. Prachi Dr. S. K. Singh.

R2: Word Power Made Easy, Norman Lewis, 15 March.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Practice of grammar will strengthen their speaking and writing skills.	**5, 7**
2	Learners will be able to use the skills in their professional communication.	**5, 7**
3	It will enable to deal with thoughts, and emotions in a productive way.	**5, 7**
4	The different attributes will develop the students' ability to cope up in professional environment.	**5, 7, 8**
5	Train students in planning and conducting group discussions, effectively disagreeing, and summarizing to attain objectives.	**3,4,7,8**

SEMESTER – III									
Course Title	**Basic Financial Literacy**								
Course code	**24UUFL211R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours:30P	**0**	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 3rd semester of second year of the program**								
Course Objectives	1. To create awareness among students about the need for possessing financial literacy education. 2. Identification of money as a working asset. 3. Impart the ability to make better financial decisions								
CO1	The students would be able to understand the importance of financial Knowledge and prepare financial plans and budgets and plan and manage personal finances.								
CO2	The students would be able to understand the need and various kind of banking institutions' instrument and their utilities								
CO3	The student would be able to describe the importance of insurance services as social security measures.								
CO4	The student would be able to manage the money and debt more effectively								
CO5	Students will learn how to assess and compare different investment options to make informed financial decisions.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction: • Meaning, need and importance of Financial Literacy; • Different components of Financial Literacy; • Prerequisites of financial literacy; • Savings– Meaning and Difference between savings and investment; • Types of Financial Institutions and the services provided- Banking and Non-Banking; • Different investment avenues.	**6**	Define financial literacy and its importance in personal finance management and Identify components such as savings, investments, financial institutions, and investment avenues.	1,2
II	Financial Planning • Meaning, need and importance for financial planning, • Budgeting and its importance in financial planning; • Steps to involved in Financial Planning Process; • Preparation of personal budgets, budget surplus and budget deficit, avenues for savings from surplus, sources for meeting deficit. • Informal Society funds and crowd funding	**6**	Explain the significance of financial planning in achieving financial goals and understand budgeting as a tool for managing income and expenses	1,2,3

III	Banks & Post Office- As financial service provider: • Meaning and evolution of money, • Banks– meaning, types & functions; types of accounts; • Formalities to open various accounts. • Different types of Post Office saving schemes: Recurring deposit, savings, term deposit; NSC; Kisan Vikas Patra; Monthly Income scheme (MIS) Account, • Public Provident Funds (PPF), Senior citizen savings scheme (SCSS), Sukanya Samriddhi Accounts, • Indian Postal Order; International Money transfer service; Forex Services; • Money remittance services; Jansuraksha Scheme	**6**	Define different types of banks, their functions, and account opening formalities and Understand services like international money transfer, forex, and insurance offered by banks and post offices	**1,2,3**
IV	Insurance-As financial service provider: • Different types of Risks and their Management, Diversification of risk; • Meaning, need and importance of Insurance • Pension and retirement policies; • Post office life insurance schemes, Postal life insurance and rural postal life insurance.	**6**	Identify types of insurance policies such as life insurance and retirement plans and learn about post office insurance schemes like Postal Life Insurance and Rural Postal Life Insurance.	1,2,3, 4
V	Transformations in Digital Money market: • Various functions & innovative services of Banks; Mobile Banking, NEFT, IMPS, RTGS, • Money transfer, Different types of cards-Debits & Credit, E-Banking, Unified payment interface (UPI), • Credit Scoring- CIBIL, Digital Banking, crypto currency and related transactions,	**6**	Explore innovative banking services like mobile banking, NEFT, IMPS, RTGS, and digital wallets and understand digital transactions, security measures, and credit scoring systems like CIBIL.	1,2,3, 4,5

TEXT BOOKS:

T1: The Young Adult's Guide to Financial Success- HowTo Manage Your Money& Live Better On Less By Edward M. Wolpert

T2: Financial Freedom with Financial Control by Jagmohan Singh Pen down Press

REFERENCE BOOKS:

R1: The Richest Man in Babylon (Deluxe Hardbound Edition) by George S. Clason ixia Press Garden City, New York, Ships from and sold by MG BOOKS.

R2: Financial literacy to financial planning by Dr.Purvi Kothari and Mr. Keyur Mehta Nexus Publications Surat Gujarat

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	The students would be able to understand the importance of financial Knowledge and prepare financial plans and budgets and plan and manage personal finances.	**8,9**
2	The students would be able to understand the need and various kind of banking institutions' instrument and their utilities	**8,9**
3	The student would be able to describe the importance of insurance services as social security measures.	**8,9**
4	The student would be able to manage the money and debt more effectively	**8,9**
5	Students will learn how to assess and compare different investment options to make informed financial decisions.	**8,9**

SEMESTER – III									
Course Title	**Basic lifesaving skills**								
Course code	**24UULS212R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 15T	**1**	**0**	**0**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 3rd semester of second year of the program**								
Course Objectives	1. To learn and demonstrate essential Basic Life Support (BLS) techniques for assisting in medical emergencies before professional help arrives. 2. To enhance communication, teamwork, and conflict resolution skills to improve personal and professional interactions. 3. To Understand the Triage system, recognize different levels of triage, and classify common medical emergencies to prioritize patient care effectively.								
CO1	Demonstrate knowledge and skill to perform CPR use an AED, and respond to choking in adults and children.								
CO2	Understand the significance of communication and teamwork in various situations.								
CO3	Apply knowledge and skill about pre-hospital care and management of trauma emergencies.								
CO4	Understand the principles and purpose of the Triage system in healthcare settings.								
CO5	Identify and manage common medical emergency conditions.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Basic Life Support (BLS)** • Introduction of BLS • Chain of survival • ABCs Assessment • CPR and Ventilation Technique • AED - Choking for adult and children	**3**	Introduction about basic life support, about the chain of survival, different assessment techniques.	1,2
II	**Soft skills** • Introduction • Communications Skills • Situational Skills • Team Work • Other Soft Skills	**3**	Illustrates different communication skills, situational awareness including teamwork.	1,2,3
III	**Trauma emergencies** a) Introduction b) Priorities of Initial approach in pre-hospital care c) Scene safety d) Primary assessment e) Bleeding control f) Helmet removal g) Care of amputated body part h) Extrication of victims and safe transfer i) Cervical spine stabilization j) Cervical collar application k) - Splinting of broken Limbs	**3**	Explains about different trauma emergencies and methods of managing trauma emergencies.	1,2,3

IV	**Triage system** • Introduction • Flow chart approach of Triage • Triage of Multiple Casualties in Pre-Hospital setting - Triage of Single casualty	**3**	Illustrates the triage system and explains about multiple causality operations.	1,2,3, 4
V	**Medical emergencies Introduction** • Victim centred approach in medical emergency • Management of :- a) Seizures b) heart attack c) asthma d) diabetic emergencies e) emergency childbirth f) stroke recovery position	**3**	Describes different types of medical emergencies and its management.	1,2,3, 4,5

TEXT BOOKS:

T1: Nancy Caroline'S Emergency Care in the streets Seventh edition by Jones and Bartlett
T2: First Aid book by LC Gupta
T3: Advance Cardiovascular life support and Basic life support provider manual @ American Heart Association(AHA).

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Demonstrate knowledge and skill to perform CPR use an AED, and respond to choking in adults and children.	**4, 5,7,8,9**
2	Understand the significance of communication and teamwork in various situations.	**4, 5,7,8,9**
3	Apply knowledge and skill about pre-hospital care and management of trauma emergencies.	**4, 5,7,8,9**
4	Understand the principles and purpose of the Triage system in healthcare settings.	**4, 5,7,8,9**
5	Identify and manage common medical emergency conditions.	**4, 5,7,8,9**

SEMESTER – III									
Course Title	**Chemistry- 3**								
Course code	**24FSCH216R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 3rd semester of second year of the program**								
Course Objectives	1. Demonstrate a comprehensive knowledge of the formation, reactions, and rearrangement mechanisms of alcohols, phenols, ethers, and epoxides 2. Exhibit proficiency in Werner's coordination theory, isomerism, valence bond theory, crystal field theory, and magnetic behavior in transition metal complexes 3. Apply thermodynamic principles, including internal energy, enthalpy, work, and heat, to analyze gas expansion scenarios and comprehend Joule's law. 4. Understand the fundamental principles and forensic applications of various spectroscopy techniques, including UV-Visible, Infrared, Atomic Absorption, Atomic Emission, Mass, and X-ray spectrometry. 5. Attain proficiency in chemical kinetics, including rate laws, factors influencing reaction rates, order, molecularity, and half-life determination methods.								
CO1	Understand and gain knowledge about synthesis, physical properties and chemical reactions of oxygen containing organic compounds such as alcohols, phenols, ethers and epoxides and their named reactions.								
CO2	Explanation on how to write the nomenclature of co-ordination compounds.								
CO3	Understand the difference between valence bond theory and crystal field theory. The spectroscopic splitting as well as magnetic properties, orgel diagrams related to crystal field theory.								
CO4	Discuss the concepts of thermodynamic fundamentals before studying their application in applied thermodynamics. The understanding of thermodynamic properties and processes will assist them in other related coursework.								
CO5	Understand the concept of rate of change associated with chemical change, recognizing that the rate of change and how it can be measured. Determine rate law of chemical change based on experimental data								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Oxygen containing organic compounds (Alcohols, Phenols, Ethers, Epoxides- Methods of formation and chemical reactions of Monohydric Alcohols, Dihydric Alcohols (vicinal glycols), oxidative cleavage with [Pb(OAc) and HIO4] and Pinacol-Pinacolone rearrangement. methods of formation and chemical reactions of glycerol. Preparation of Phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonanace stabilization of phenoxide ion. Reaction of phcnols-electrophilic aromatic subsititution, acylation and carboxylation Mechanisms of Fries rearrangement. Gatterman synthesis, Hauben. Heesch reaction. Lederer-Mianasse reaction and	**10**	Analyze properties and reactions of alcohols, phenols, ethers, and epoxides.	1,2

	Reimer-Tiemann reaction. Methods of formation, physical properties, Chemical reactions of Ethers (cleavage and autooxidation, Ziesel's Method). Synthesis of epoxide, acid and base catalyzed ring opening of epoxide, orientation of ring opening reactions of Grignard and organolithium reagents with epoxide.			
II	Coordination compounds- Werner's coordination theory, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.	**8**	Understand coordination compounds' theory, nomenclature, and isomerism	1,2
III	Metal ligand bonding in Transition metal complexes- Limitations of valence bond theory, an elementary idea of crystal- field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters. Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, Correlation of μs and μeff values, orbital contribution to magnetic moment, application of magnetic moment data for 3d-metal complexes. Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel-energy level diagram for d1and d9 states, discussion of electronic spectrum of [Ti (H2 O)6]3+ complexion.	**10**	Apply crystal field theory to transition metal complexes.	1,2
IV	Thermodynamics-I: (15 hrs)- Definition of thermodynamics terms: system, surroundings etc. Types of systems, First Law of Thermodynimcs: statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law. Joule Thomson coefficient and inversion temperature, Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.	**10**	Use thermodynamics to calculate energy changes in gases.	1,2

V	Chemical Kinetics:- Rate of a reaction, rate law & rate constant, factors influencing the rate of a reaction, Units of rate constant, order & molecularity of reactions, zero order, first order, second order half life time of a reaction, methods of determining order of a reaction.	**7**	Study reaction rates, orders, and mechanisms.	1,2
Practical	**1.** Preparation and Properties of Organic Compounds **2.** Analysis of Coordination Compounds. **3.** Magnetic and Spectral Properties of Metal Complexes. **4.** Determination of heat capacity and Joule-Thomson coefficient. **5.** Determination of the rate constant for reactions of zero, first, and second order	**30**		1,2,3, 4

TEXT BOOKS:

T1: Organic Chemsitry, Paula Yurkanis Bruice, 8th Edition, Pearson.
T2: Stereochemistry of Organic Compounds Principles and Applications, D. Nasipuri, 4th Edition, New Age International Publishers.
T3: Physical Chemistry, Puri Sharma Pathania, Vishal Publishing Co.
T4: Inorganic Chemistry, J. D. Lee. Concise, 5 th Edition, Oxford.

REFERENCE BOOKS:

R1: Organic Chemsitry, Jonathan Clayden, Nick Greeves and Stuart Warren, 2nd Edition (South Asia Edition), Oxford.
R2: Physical Chemistry, Gurdeep Raj, Krishna Prakashan Media (P) Ltd.
R3: Shriver & Atkins Inorganic Chemistry, Peter Atkins, Tina Overton, Jonathan Rourke,Mark Weller, Fraser Armstrong, Michael Hagerman,Oxford.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand and gain knowledge about synthesis, physical properties and chemical reactions of oxygen containing organic compounds such as alcohols, phenols, ethers and epoxides and their named reactions.	**1**
2	Explanation on how to write the nomenclature of co-ordination compounds.	**1**
3	Understand the difference between valence bond theory and crystal field theory. The spectroscopic splitting as well as magnetic properties, orgel diagrams related to crystal field theory	**1**
4	Discuss the concepts of thermodynamic fundamentals before studying their application in applied thermodynamics. The understanding of thermodynamic properties and processes will assist them in other related coursework.	**1**
5	Understand the concept of rate of change associated with chemical change, recognizing that the rate of change and how it can be measured. Determine rate law of chemical change based on experimental data.	**1**

SEMESTER – III										
Course Title	**Physics- 3**									
Course code	**24FSPH217R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**	
Pre-requisite	**Nil**	**Co-requisite**	**Nil**							
Programme	**Bachelor of Science in Forensic Science**									
Semester	**Fall/ 3rd semester of second year of the program**									
Course Objective	1. Understand wave motion concepts including wave types, velocities, and intensity based on inverse square law. 2. Explore the electromagnetic nature of light and apply principles like Huygens and Fermat's to wave behavior. 3. Analyze interference, diffraction, and polarization phenomena, including Newton's rings and Brewster's law. 4. Utilize matrix algebra to solve physics problems involving Hermitian, unitary, and orthogonal matrices. **5.** Apply differential equations and field concepts to model physical systems, using Dirac delta functions and error analysis.									
CO1	Understand the concept of waves, electromagnetic nature of light.									
CO2	Discuss the concept of vibration like free, damped, force vibrations etc									
CO3	Differentiate between wave optics and ray optics									
CO4	Discuss the concept of interference, diffraction, polarisation									
CO5	Illustration of matrices and their properties, differential equations and their methods of solutions									

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Wave and Oscillations: wave motion: plane and spherical waves, longitudinal and transverse waves, plane progressive (travelling) waves, wave equation, particle and wave velocities, intensity of wave, inverse square law. Electromagnetic nature of light, definition and properties of wave front, Huygens principle, temporal and spatial coherence. Fermat's principle and its application in establishing laws of reflection and refraction.	**6**	Classify and analyze wave types.	1,2
II	Interference of Light, condition of sustained interference by analytical treatment, theory of Newton's rings, determination of wavelength and refractive index using Newton ring apparatus. Diffraction of light: Fresnel and Fraunhofer class of diffraction, diffraction at straight edge, circular aperture, Fraunhofer diffraction at single slit, plane diffraction grating	**6**	Explain light's wave properties	1,2
III	Polarization of light and its mathematical representation, production of polarization of light by reflection, refraction and scattering. Huygen's theory and Nicol prism, Brewster's law, double refraction.	**8**	Study interference, diffraction, polarization	1,2
IV	Properties of matrices, Transpose matrix, complex conjugate matrix, Hermitian matrix, special square matrix, unit matrix, diagonal	**5**	Use matrix theory in physics	1,2

	matrix, co-factor matrix, adjoint of a matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix, rank of a matrix. Eigen value problems.			
V	Concepts of scalar and vector field, concepts of divergent and curl, First Order and Second Order Differential equations, solutions to partial differential equations, using separation of variables, definition and properties of Dirac delta function, Systematic and Random Errors	**5**	Apply fields and differential equations.	1,2
Practical	**1.** Experiment to study the intensity of sound or light and verify the inverse square law **2.** Use of a slinky or ripple tank to demonstrate and analyze longitudinal and transverse wave motion **3.** Measure the velocity of a wave on a string or in a medium using a frequency generator and tension adjustment **4.** Analysis of wave motion using a digital oscilloscope and function generator to simulate plane waves. **5.** Experimental determination of Brewster's angle for glass and calculation of the refractive index. **6.** Demonstration of wavefronts in a ripple tank to validate Huygens' principle	**30**		1,2, 3,4

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand the concept of waves, electromagnetic nature of light.	**1**
2	Discuss the concept of vibration like free, damped, force vibrations etc.	**1**
3	Differentiate between wave optics and ray optics	**1**
4	Discuss the concept of interference, diffraction, polarisation.	**1**
5	Illustration of matrices and their properties, differential equations and their methods of solutions.	**1**

SEMESTER – III										
Course Title	**Biology- 3**									
Course code	**24FSBO218R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**	
Pre-requisite	**Nil**	**Co-requisite**	**Nil**							
Programme	**Bachelor of Science in Forensic Science**									
Semester	**Fall/ 3rd semester of second year of the program**									
Course Objectives	1. This course aims to educate student on concepts of forestry									
	2. Basic knowledge of forest dendrology, forest types									
	3. The course further deals with physiology of forest, forest management and forest pathology									
CO1	Articulate the history and basic concept of Forestry.									
CO2	Importance of Dendrology and knowledge of wood forest									
CO3	Understanding of forest types and forest management									
CO4	Importance of physiology in forestry									
CO5	Understanding the forest pathology, causes of forest diseases									

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction Forestry: History of forestry, Classification of forest, Basic concepts on forest types of India. Important acts and policies related to Indian Forest.		History, types and policies of forest.	1,2
	Forest management: Definition and scope of forest management, principle of forest management and their applications.	**6**		
II	Dendrology: Introduction, importance and scope of dendrology. Role of vegetative morphology in identification of woody forest flora		Importance, scope and morphology of woody forest and Ecotourism.	1,2
	Ecotourism: Definition and elements of ecotourism, Principles and objectives of ecotourism. Potential of ecotourism in India.	**6**		
III	Plant Physiology: Introduction to tree physiology, Photosynthesis. Water relation of forest trees, transpiration from forest canopies, environmental effects on growth and development.	**8**	Importance of tree physiology in relation to forestry	1,2
IV	Forest Ecology and Diversity: Forest types of India, Forest Ecosystem-abiotic and biotic components and their interaction, Nutrient cycling, forest management. Conservation measurement of diversity, diversity hot spots, Principle of conservation.		Importance of forest ecosystem, biotic and abiotic	1,2
		5	Components and forest management and ecotourism.	
V	Forest Pathology: Importance of forest pathology. Principles of forest pathology, causes of forest diseases-Physiological and pathological, general symptoms of forest tree disease, control of	**5**	Principle of forest pathology causes of forest diseases and plant quarantine.	1,2

	forest diseases, plant quarantine			
Practical	1. Study of vegetation of the university campus.	**30**		1,2,3,4
	2. Study of ecological modifications of leaves			
	3. Study of woody flora of: Magnoliaceae and Leguminosae			
	4. Techniques of preparing herbarium specimens.			
	5. Estimation of leaf area of plants			

TEXT BOOKS:

T1: Agarwal, W.P. Forests in India. Oxford and I.B.H

T2: Arvind Kumar. Biodiversity and environment. A.P.M. Publishing Corporation, New Delhi

T3: Kumar and Asija. Biodiversity – Principles and conservation. Updesh Purohit, Agrobios, Jodhpur

REFERENCE BOOKS:

R1: Raghavendra AS. Physiology of Trees.

R2: John Wiley & Sons. Taiz, L. and Zeiger, E. Plant Physiology 4 th Ed. Sinauer Associates Inc. Publishers, Sunderland.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Articulate the history and basic concept of Forestry.	**1**
2	Importance of Dendrology and knowledge of wood forest.	**1**
3	Understanding of forest types and forest management	**1**
4	Importance of physiology in forestry.	**1**
5	Understanding the forest pathology, causes of forest diseases.	**1**

SEMESTER – IV									
Course Title	**Forensic Biology**								
Course code	**24BSFS221R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/IV Semester of Second year of the programme**								
Course Objectives	1. Understand the fundamentals of fibre examination, including classification, transfer, and persistence. 2. Develop proficiency in fibre recovery techniques at crime scenes and in the laboratory, emphasizing contamination prevention. 3. Gain expertise in fibre identification and comparison through microscopical examination and instrumental analysis. 4. Explore hair examination, covering hair structure, growth phases, species identification, and variations among different population groups. 5. Acquire knowledge of wildlife forensic methods, including the identification of protected and endangered species, Pug marks, and DNA techniques								
CO1	Identify various types of fibres.								
CO2	Apply effective fibre recovery methods in crime scenes and laboratories, preventing contamination along with their practical aspects.								
CO3	Examine hair evidence to identify species and understand variations among major population groups along with their practical aspects.								
CO4	Demonstrate proficiency in wildlife forensic techniques, including the identification of protected species and the use of DNA methods along with their practical aspects.								
CO5	Apply forensic entomology principles to assess the time since death, understand insect succession, and use of entomotoxicology in forensic investigations along with their practical aspects.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction, Classification, Fibre transfer and persistence. Fibre Recovery: At the scene, in the laboratory, contamination and its prevention. Fibre Identification and comparison: Microscopical Examination, Determination of optical properties, Refractive Index, Birefringence, Instrumental analysis, dye analysis by TLC, factors affecting the strength of fibre evidence.	**8**	Proficiently analyze fibres, considering classification, transfer, and persistence, utilizing microscopical and instrumental techniques.	1,2
II	Hair structure, growth phases of hair, species Identification, variation in different major population groups, somatic origin	**7**	Understand hair structure, growth phases, and variations in different populations, ensuring accurate species identification.	1,2
III	Introduction, importance, Wildlife (Protection) Act-1972, protected and endangered species of Animals and Plants. Identification of wild life materials such as skin, fur, bones, nails, horn, teeth, plants, plant parts and products by conventional and modern methods, Identification of Pug marks of various animals, DNA techniques in wildlife investigations	**10**	Identify and apply methods for wildlife materials, including protected species, Pug marks, and DNA techniques in forensic investigations.	1,2
IV	Introduction, general entomology and	**10**	Apply entomological	1,2

	arthropod biology, insects of forensic importance, collection of entomological evidence during death investigations, the role of aquatic insects in forensic investigations, Insect succession on carrion and its relationship to determine time since death, factors influencing insect succession on carrion, its application to Forensic Entomology, Entomotoxicology: Insects as toxicological indicators, impact of drugs and toxins on insect development, molecular methods for forensic entomology**.**		principles to determine time since death, assess insect succession, and understand entomotoxicology's role in forensic investigations..	
V	Type of wood, leaves, pollens and their identification and comparison. Diatoms: Nature, location, structure, extraction from various body tissues including bone marrow, preparation of slides, methods of identification and comparison, forensic significance	**10**	Evaluate and apply botanical evidence analysis, including wood identification, leaf anatomy, and pollen structure, for forensic significance.	1,2
Practical	1) To examine hair morphology and determine the species to which the hair belongs. 2) To prepare slides of scale pattern of human hair. 3) To examine human hair for cortex and medulla. 4) To carry out microscopic examination of pollen grains. 5) To carry out microscopic examination of diatoms. 6) To cite a crime case in which diatoms have served as forensic evidence. 7) To prepare a case report on forensic entomology. 8) To prepare a case report on problems of wildlife forensics.	**30**		1,2, 3,4

TEXT BOOKS:

T1: R. Saferstein, *Criminalistics*, 8th Edition, Prentice Hall, New Jersey.

REFERENCE BOOKS:

R1: W.G. Eckert and S.H. James, *Interpretation of Bloodstain Evidence at Crime Scenes*, CRC Press, Boca Raton.
R2: G.T. Duncan and M.I. Tracey in *Introduction to Forensic Sciences*, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton.
R3: T. Bevel and R.M. Gardner, *Bloodstain Pattern Analysis*, 3rd Edition, CRC Press, Boca Raton.
R4: J.M. Butler, *Forensic DNA Typing*, Elsevier, Burlington.
R5: K. Inman and N. Rudin, *An Introduction to Forensic DNA Analysis*, CRC Press, Boca Raton.
R6: H. Coleman and E. Swenson, *DNA in the Courtroom: A Trial Watcher's Guide*, GeneLex Corporation, Washington.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Identify various types of fibres.	**1**
2	Apply effective fibre recovery methods in crime scenes and laboratories, preventing contamination along with their practical aspects.	**1, 3**
3	Examine hair evidence to identify species and understand variations among major population groups along with their practical aspects	**1, 3, 8**
4	Demonstrate proficiency in wildlife forensic techniques, including the identification of protected species and the use of DNA methods along with their practical aspects.	**1, 3, 8**
5	Apply forensic entomology principles to assess the time since death, understand insect succession, and use of entomotoxicology in forensic investigations along with their practical aspects.	**1, 8**

SEMESTER – IV										
Course Title	**Forensic Chemistry**									
Course code	**24BSFS222R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/IV Semester of second year of the programme**								
Course Objectives	1. Introduce students to designer drugs, narcotics, and psychotropic substances, including their effects on driving. 2. Familiarize students with laboratory tests for drugs in blood, urine, and tissues, considering post-mortem changes and drug abuse in sports. 3. Explore types and causes of fires, patterns, thermodynamics, accelerants, incendiary devices, and forensic analysis of fire debris and petroleum products. 4. Provide knowledge on explosives, IEDs, explosion reconstruction, and systematic examination of explosive residues. 5. Cover analysis of alcoholic beverages, country-made liquor, illicit liquor, and medicinal preparations containing alcohol, as well as examination of chemicals in bribe trap cases.									
CO1	Identify and understand various drug categories, their impact, and their relevance in forensic investigations along with their practical aspects.									
CO2	Discuss various laboratory examination for drug detection in forensic contexts along with their practical aspects.									
CO3	Develop expertise in fire-related forensic analysis, allowing students to determine fire origin and causes along with their practical aspects.									
CO4	Analyze and interpret evidence related to explosives, contributing to forensic investigations.									
CO5	Conduct forensic analysis on beverages and identify relevant substances in forensic scenarios along with their practical aspects.									

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Designer drugs, Narcotics, depressants, stimulants, hallucinogens designer drugs, club drugs and date rape drugs, drugs and driving	**8**	Understand the classification, effects, and implications of various substances on driving, fostering a comprehensive understanding of their forensic significance	1,2
II	Drugs detected in blood/urine/biological tissues, post-mortem changes affecting the analysis of clandestine drug laboratories, drug abuse in sports	**7**	Apply laboratory tests for detecting drugs in different biological samples, addressing post-mortem changes and issues related to drug abuse in sports.	1,2
III	Types of Fires, and Causes of fire, Patterns of fire Thermodynamics of fire Accelerants and incendiary devices, Forensic Analysis of Fire Debris by Instrumental methods Forensic Analysis of petroleum products	**10**	Analyze fire incidents, identifying types, causes, and patterns, and conduct forensic analysis of fire debris and petroleum products, showcasing expertise in fire investigations.	1,2
IV	Introduction, classification and chemistry of explosives, Various types of IEDs and their reconstruction Mechanism of explosion and their effects Systematic examination of explosive and explosion residues (organic and inorganic) by chemical and instrumental techniques and interpretation	**10**	Evaluate explosives, their classification, IED types, and conduct systematic examinations of explosive residues through chemical and instrumental techniques, fostering proficiency in explosive investigations.	1,2
V	Analysis of alcoholic beverages, country made liquor, illicit liquor and medicinal	**10**	Demonstrate skills in the analysis of alcoholic beverages,	1,2

	preparations containing alcohol as constituents. Examination of chemicals used in bribe trap cases		country-made liquor, illicit liquor, and chemicals used in bribe trap cases, showcasing expertise in beverage analysis and relevant forensic examinations.	
Practical	1. Analysis of alcoholic liquors. 2. Determination of methanol and ethanol in alcoholic liquors. 3. Analysis of gasoline 4. Analysis of explosion residues 5. Systematic identification of (opiates, cannabis, barbiturates, benzodiazepines, amphetamines etc.) 6. Thin layer chromatographic analysis of drugs 7. UV/Vis spectrophotometric analysis of barbiturates, benzodiazepine and amphetamines.	**30**		1,2,3,4

TEXT BOOKS:

T1: Forensic Chemistry by S bell.

REFERENCE BOOKS:

R1: Criminalistics by R. Safferstein published by Wiley
R2: V.V Pillay, Textbook of forensic medicine and Toxicology, 16th Edition, Paras publications
R3: Pascal Kintz, Toxicological Aspects of Drug-Facilitated Crimes, Academic Press, Elsevier

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms\

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Identify and understand various drug categories, their impact, and their relevance in forensic investigations along with their practical aspects.	**1, 3**
2	Discuss various laboratory examination for drug detection in forensic contexts along with their practical aspects.	**1, 3**
3	Develop expertise in fire-related forensic analysis, allowing students to determine fire origin and causes along with their practical aspects	**1, 2, 3**
4	Analyze and interpret evidence related to explosives, contributing to forensic investigations	**1, 2, 3, 8**
5	Conduct forensic analysis on beverages and identify relevant substances in forensic scenarios along with their practical aspects.	**1, 3, 8**

SEMESTER – IV										
Course Title	**Forensic Anthropology**									
Course code	**24BSFS223R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/IV Semester of Second year of the programme**								
Course Objectives	1. Understand the definition, scope, and application of Forensic Anthropology, with a focus on the study of the human skeleton. 2. Learn the nature, formation, and methods for identification of human bones, with an emphasis on estimating age, race, sex, and stature from skeletal material. 3. Explore the importance and necessity of personal identification in forensic anthropology, particularly in cases requiring personal identification. 4. Master Somatoscopy, focusing on the observation of various anatomical features and marks for personal identification purposes. 5. Acquire knowledge of Somatometry and indices for measurements of different body parts, along with the study of burned bones and bone fragments in mass disasters.								
CO1	Identify human skeleton for estimation of age, race, sex, and stature along with their practical aspects.								
CO2	Apply personal identification techniques, including somatoscopy, for observing and recording anatomical features, scars, occupational marks, and tattoos along with their practical aspects.								
CO3	Illustrate Somatometry measurements and interpret indices for various body parts, contributing to personal identification in forensic scenarios along with their practical aspects.								
CO4	Analyze burned bones and bone fragments in mass disasters.								
CO5	Utilize facial reconstruction techniques.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Definition, scope and application of Forensic Anthropology. Study of Human Skeleton. Nature, formation and identification of human bones. Estimation of age, race, sex and stature from skeletal material – skull, pelvis, long bones.	**8**	Proficiently apply the study of human bones to estimate age, race, sex, and stature, contributing to forensic investigations.	1,2
II	Importance and need for personal identification, cases that will require personal identification. Somatoscopy – observation of hair on head, forehead, eyes, root of nose, nasal bridge, nasal tip, lips, chin, Darwin's tubercle, ear lobes, supra-orbital ridges, physiognomic ear breadth, circumference of head, prognathism. Scar marks, occupational marks and tattoo marks.	**7**	Apply Somatoscopy techniques for the observation and recording of anatomical features, scars, and marks, addressing the need for personal identification	1,2
III	Somatometry – measurements of head, face, nose, cheek, ear, hand and foot, body weight, height. Indices - cephalic index, nasal index, cranial index, upper	**10**	Conduct Somatometry measurements and interpret indices, contributing to personal identification, and	1,2

	facial index. Study of burned bones and bone fragments in mass disasters; Establishment of Partial and Complete identity of skeletal material and dead bodies		study burned bones in mass disasters for identity establishment	
IV	Facial superimposition techniques, Craniofacial superimposition techniques – photographic superimposition. Facial reconstruction and its importance. Importance of tissue depth in facial reconstruction. Use of somatoscopic and craniometric methods in reconstruction.	**10**	Utilize facial reconstruction techniques, including facial and craniofacial superimposition, emphasizing tissue depth for accurate reconstructions	1,2
V	Development, scope and role of forensic odontology in mass disaster and anthropology. Introduction to human dentition, structure of teeth, Types and functions of teeth and their comparative anatomy. Estimation of age from teeth. Bite Marks: Types of bite marks; collection and preservation and photography of bite mark evidence, forensic importance of bite marks**.**	**10**	Understand the role of forensic odontology, estimate age from teeth, and analyze bite marks, including their collection, preservation, and forensic importance...	1,2
Practical	1) To determine of age from skull and teeth. 2) To determine of sex from skull. 3) To determine sex from pelvis. 4) To study identification and description of bones and their measurements. 5) To investigate the differences between animal and human bones. 6) To perform somatometric measurements on living subjects. 7) To carry out craniometric measurements of human skull. 8) To estimate stature from long bone length.	**30**		1,2,3,4

TEXT BOOKS:

T1: Boyd, C.C., Forensic Anthroplogy: Theoretical framework and scientific basis.

REFERENCE BOOKS:

R1: Kapoor, A.K., Anthropology and Forensic science

R2: Sehgal, S. Nath, Forensic Anthropology, Science and medicine

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Identify human skeleton for estimation of age, race, sex, and stature along with their practical aspects.	**1, 3**
2	Apply personal identification techniques, including somatoscopy, for observing and recording anatomical features, scars, occupational marks, and tattoos along with their practical aspects.	**1, 3**
3	Illustrate Somatometry measurements and interpret indices for various body parts, contributing to personal identification in forensic scenarios along with their practical aspects	**1, 8**
4	Analyze burned bones and bone fragments in mass disasters.	**1, 3, 8**
5	Utilize facial reconstruction techniques.	**1, 3, 8**

SEMESTER – IV									
Course Title	**Techno Professional Course- II**								
Course code	**24BSFS224R**	**Total credits:1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/IV Semester of Second year of the programme**								
Course Objectives	1. Introduce students to the fundamental theories of criminology, including classical, positivist, sociological, and criminal anthropology perspectives. 2. Provide knowledge on understanding modus operandi, investigative strategies, and criminal profiling. 3. Explore various types of crimes, including deviant behaviour, hate crimes, organized crimes, domestic violence, white-collar crimes, juvenile delinquency, and their social andpsychological impacts. 4. Analyze different sensational crime case studies to understand real-world applications of criminological concepts. 5. Educate students on the structure and hierarchy of the justice system and Indian investigative agencies.								
CO1	Understand and apply various theories of criminology to analyze criminal behaviour.								
CO2	Develop investigative strategies and criminal profiles based on modus operandi.								
CO3	Analyze different types of crimes and their social and psychological impacts.								
CO4	Evaluate sensational crime case studies to gain practical insights into criminology.								
CO5	Understand the structure and hierarchy of the justice system and Indian investigative agencies.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Basics of Criminology: Theories of Crime-classical, positivist, sociological, Criminal Anthropology, Understanding Modus Operandi, Investigative Strategy, Criminal Profiling, Role of Media.	**6**	Explain the fundamental theories of criminology and their application in analyzing criminal behaviour.	1,2
II	Crime: Deviant Behaviour, Hate Crimes, Organized Crimes, Public Disorder, Domestic Violence and Workplace Violence,	**6**	Analyze the nature and impact of various types of crimes,including deviant behaviour and white-collar crimes.	1,2
III	White Collar Crimes, Juvenile Delinquency, Victimology, SocialChange and Crime, Psychological Disorders and Criminality.	**6**	Analyze the nature and impact of various types of crimes,including juvenile delinquency and white-collar crimes	1,2
III	DIFFERENT SENSATIONAL CRIME CASE STUDIES: Murder & Killings, POSCO, Rape cases, bizarre identity crimes, criminal defamation, Scandal.	**6**	Evaluate and learn from sensational crime case studies	1,2
IV	Justice System & Investigative agency: Types of court, Hierarchy of court & justice, Introduction to Indian investigative agency Hierarchy of Different Investigative agency.	**6**	Understand and describe the hierarchy and functions of the justice system and Indian investigative agencies	1,2

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand and apply various theories of criminology to analyze criminal behaviour.	**1, 2, 6**
2	Develop investigative strategies and criminal profiles based on modus operandi.	**1, 5, 6**
3	Analyze different types of crimes and their social and psychological impacts.	**1, 3,**
4	Evaluate sensational crime case studies to gain practical insights into criminology.	**1, 6**
5	Understand the structure and hierarchy of the justice system and Indian investigative agencies.	**1, 6**

SEMESTER – IV									
Course Title	**English for employability**								
Course code	**24UBPD222R**	**Total credits: 2 Total hours: 60P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**4**	**0**	**0**	**0**	**2**
Pre- requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/IV Semester of First year of the programme**								
Course Objectives	1. To acquaint students with the various tools of effective presentation. 2. To acquire the speaking skill, instruct, influence, engage, educate, or appease thelisteners. 3. To increase proficiency, present ability and quality of resume and provide guidance forself- promotion and self-evaluation in social media. 4. To prepare and train the students for the campus drives & walking interviews.								
CO1	Enable students to prepare scripts, understand nonverbal cues, overcome fear, and practice public speaking strategies.								
CO2	Equip students with skills to prepare, submit, and screen resumes and cover letters.								
CO3	Teach students the different parts of an email and effective email drafting techniques.								
CO4	Prepare students for interviews by practicing commonly asked questions and participating in mock interview sessions.								
CO5	Students will understand the concept of conflict management, identify different types, and analyze its effects.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Public Speaking Skills** i. Preparation of Scripts and understanding Nonverbal cues of Public Speaking ii. Understanding and Overcoming Fear of Public Speaking iii. Practice strategies of Public Speaking	**7**	Students will be able to create effective speaking scripts, interpret nonverbal cues, manage public speaking anxiety, and practice effective speaking techniques.	3, 4
II	**Practical session on Resume and Cover letter** i. Preparation, submission & screening of Resume. ii. Practical session on cover letter screening session	**5**	Students will prepare, submit, and evaluate resumes and cover letters.	3
III	**Email Etiquettes** i. Different Parts of Email and Usage ii. Drafting emails effectively	**5**	Students will understand the structure of emails and draft them effectively.	2, 3
IV	**Interview Skills (Mock sessions)** i. Preparing Commonly asked Interview Questions ii. Mock Interview sessions	**7**	Students will answer common interview questions confidently and perform well in mock interviews.	3, 5
V	**Conflict Management** i. Definition ii. Type of Conflict Management iii. Effects of Conflict Management	**8**	Students will understand the concept of conflict management, identify different types, and analyze its effects.	2, 4

TEXT BOOKS:

T1: Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press**.**
T2: McDowell, Gayle Laakmann.2008.Cracking the Coding Interview (Indian Edition)

REFERENCE BOOKS:

R1: Kannaiyan, S. 2002 Biotechnology of Biofertilizers. Narosa publishing house, New Delhi. Dubey, R.C. 2001

OTHER LEARNING RESOURCES:

https://www.aplustopper.com/active-and-passive- voice-rules/https://www.edudose.com/english/direct-and-indirect-speech-rules/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Enable students to prepare scripts, understand nonverbal cues, overcome fear, and practice public speaking strategies.	**5, 7**
2	Equip students with skills to prepare, submit, and screen resumes and cover letters.	**5, 7**
3	Teach students the different parts of an email and effective email drafting techniques.	**5, 7, 9**
4	Prepare students for interviews by practicing commonly asked questions and participating in mock interview sessions.	**5, 7, 9**
5	Students will understand the concept of conflict management, identify different types, and analyze its effects.	**3,4,7,8**

SEMESTER – IV									
Course Title	**Digital Literacy**								
Course code	**24UCDL222R**	**Total credits:1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/IV Semester of First year of the programme**								
Course Objectives	1. Students will be able to identify and analyze computer hardware, software and their uses. 2. Students will be able to use MS-Office suite for various purposes. 3. Students will be able to use the Internet efficiently for required information as well as for digital financial transactions.								
CO1	Understanding of Computer Hardware, Software and Computer handling.								
CO2	Apply MS-Office to solve basic information Management issues.								
CO3	Operate the Internet, social media and e-commerce sites efficiently and ethically.								
CO4	Analyse the cybercrimes on digital payments application.								
CO5	Explore the functionality and use of credit cards, debit cards, net banking, and UPI.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Fundamentals of Computer Systems Components of a Computer and their functions. Different Types of Computers and their applications.** **Lab Experiment:** • Identify the Components of a Computer and their Functions and different types of Computers and their Applications. • Demonstrate the usage of various storage devices and identify various operating system file management commands	**6**	Explain the fundamental of computer systems.	1,2
II	**Introduction to MS-Office: Components of theMS-Office suite. Creating documents with MS-Word.** Creating Presentations with MS-PowerPoint., Creating Spreadsheets with MS-Excel. **Lab Experiment:** • Demonstrate how a document to be prepared and formatted in MS Word. • Create casual applications for 3 days leave because of family marriage ceremony using Word Processor. • Create a curriculum vitae using MS-Word. 4. Creating a time table with MS – Word. • Design PPT on Computer Components using different effects such as Insert, Design, Record etc., on slides. • Design PPT on Computer Components using different effects such as	**6**	Describe the functions on different tools of Microsoft Office like MS-Excel, MS- Word, etc.	1,2,3

	Transitions, Animations etc., on slides. • Creating the time table with MS-Excel. • Creating the 10 student's Marksheet include total, grade, percentage and results using MS-Excel's formulas			
III	**Introduction to Internet & Cyber World:** Introduction to Computer Networks and Internet. World Wide Web, Websites and Web portals, Web browsing. Web Searching, Search engines, Introduction to Google Search Engine; How to search using Keywords, topics of Interest, etc. Creation and use of Email Accounts. Cyber Crimes. **Lab Experiments:** • Creating a professional Google account and use various products of Google like drive, photos. Study of computer network and internet and demonstrate how to search information using keywords in different search engines.	**6**	Explain the importance and use of internet along with its adverse side.	1,2,3
IV	**Introduction to social media:** The Power of social media, Relevance of social media in present scenario. Creating accounts and using some popular social media portals and Apps like WhatsApp, Facebook, Twitter, Instagram, and LinkedIn. Social Media Etiquettes. **Lab Experiments:** • Creating an account of some popular social media portals and Apps like LinkedIn, Facebook, Twitter, and Instagram. • Creating an accounts of digital payment systems like credit cards, debit cards, net banking	**6**	Explain the power of social media their relevance and adverse effects to over using it.	1,2,3, 4
V	**Introduction to Digital Payment Systems.** Creating accounts and using Digital Payment Systems like Credit Cards, Debit Cards, Net banking, UPI. **Lab Experiments:** • Create online Google form and learn how togive online test. • Creating an account of Online Shopping sites like Amazon, flipkart, eBay etc. Understand the • journey of customer to buy and sell on online shopping sites.	**6**	Illustrate the types of digital payment and their risks.	1,2,3, 4,5

TEXT BOOKS:

T1: Sinha Pradeep K. and Priti Sinha "Computer Fundamentals: Concepts Systems & Applications" 3rd

Edition

T2: Goel A “Computer Fundamentals” 2010

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understanding of Computer Hardware, Software and Computer handling.	**8,9**
2	Apply MS-Office to solve basic information Management issues.	**8,9**
3	Operate the Internet, social media and e-commerce sites efficiently and ethically.	**8,9**
4	Analyse the cybercrimes on digital payments application.	**8,9**
5	Explore the functionality and use of credit cards, debit cards, net banking, and UPI.	**8,9**

SEMESTER – IV									
Course Title	**Basic acclimatizing skills**								
Course code	**24UULS221R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 15T	**1**	**0**	**0**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/ 4th semester of second year of the program**								
Course Objectives	1. To impart knowledge of the fundamentals of Hospitality industry and its applications. 2. Students will be able to familiarize with the cooking equipment's & Utensils. 3. Students will be able to handle different modes of reservations.								
CO1	Students will have basic knowledge of cooking methods.								
CO2	Students will gain the knowledge of organizing & Cleaning of Rooms.								
CO3	Students will be able to gain the travel management concept.								
CO4	Students will be able to acquire the knowledge of basic household's amenities for day-to- day use.								
CO5	Students will develop an understanding of personal financial management and budgeting skills.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction to Accommodation Management** • Telephone handling technique • Organizing of Rooms. • Cleaning agents. • Cleaning equipment's and uses. • Bed making Process.	**3**	Explains the techniques of accommodation management.	1,2
II	**Fundamentals of Cooking** • Definition of cookery–Aim & Objectives of cooking. • Use of basic Cooking equipment's • Personal Hygiene and Safety • Use of Fire & Fuels	**3**	Introduces the fundamentals of cooking including efficient and safety methods.	1,2,3
III	**Methods of Cooking** • Different Cuts. • Use of Herbs and Spices. • Basic Food and Beverage Preparation. • Regional food Habits	**3**	Illustrates different methods of cooking.	1,2,3
IV	**Forms & Format's** • C –form • Reservation form • Registration form • Passport Application form Legal Rent Agreement	**3**	Explains and illustrates various formats of writing forms like reservation, passport, etc.	1,2,3, 4

V	**Introduction to Accommodation Management** • Telephone handling technique • Organizing of Rooms. • Cleaning agents. • Cleaning equipment's and uses. • Bed making Process.	**3**	Explains the techniques of accommodation management.	1,2,3, 4,5

TEXT BOOKS:

T1: Arora K "Theory of cookery" 2011

T2: Bruce H. Axler, Carol A. Litrides "Food and Beverage Service" 2010, Vol-1

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will have basic knowledge of cooking methods.	**9**
2	Students will gain the knowledge of organizing & Cleaning of Rooms.	**9**
3	Students will be able to gain the travel management concept.	**9**
4	Students will be able to acquire the knowledge of basic household's amenities for day- to-day use.	**9**
5	Students will develop an understanding of personal financial management and budgeting skills.	**9**

SEMESTER – IV										
Course Title	**Chemistry- 4**									
Course code	**24FSCH225R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**	
Pre-requisite	**Nil**	**Co-requisite**	**Nil**							
Programme	**Bachelor of Science in Forensic Science**									
Semester	**Winter/ 4th semester of second year of the program**									
Course Objectives	1. Study synthesis and reactions of aldehydes and ketones. 2. Understand properties and reactivity of carboxylic acids and derivatives. 3. Learn thermodynamic principles and entropy calculations. 4. Explore principles of molecular spectroscopy. 5. Analyze Raman and electronic spectral transitions.									
CO1	Understand and gain knowledge about synthesis, physical properties and chemical reactions of carbonyl compounds such as aldehydes and ketones along with their named reactions.									
CO2	Understand and gain knowledge about synthesis, physical properties and chemical reactions of carboxylic acids and their derivatives such as acid chlorides, esters, amides and acid anhydrides.									
CO3	Understand the basic principle of spectroscopy and the various spectroscopic techniques used to study the motion of different molecular systems.									
CO4	Understand the basic principle of spectroscopy and the various spectroscopic techniques used to study the motion of different molecular systems.									
CO5	Understand the molecular techniques associated with Raman and electronic spectroscopy.									

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Aldehydes and Ketones (10 hrs)- Nomenclature and structure of the carbonyl group, Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehyes and ketones using 1,3- dithianes, synthesis of ketones from nitrites and from carboxylic acids. Physical properties and Mechanism of nucleophillic addition to carbonyl group with particular emphasis of Benzoin, Aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives, Wittig reaction, and Mannich reaction. Use of acetals as protecting group.Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, LiAIH4 and NaBH4reductions.Halogenation of enolizable ketones. An Introduction to unsaturated aldehydes and ketones, Michael addition.	**10**	Explain aldehyde and ketone reactions	1,2

II	Carboxylic Acids and derivatives- Nomenclature, structure and bonding. Physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids, Reactions of amides, Reactions of carboxylic acids, Mechanism of decarboxylation. Methods of formition and chemical reactions of halo acids.Hydroxyacids, maleic and tartaric acid, citric acids. (Structural Formula only), Methods of formation and chemical reaction of unsaturated nonocarboxylic acids. Dicaboxylic acids, methods of formation and effect of heat and dehydrating agents. Carboxylic Acid Derivatives Structure and nomenclature of acid chlorides, esters.amides and cid anhydrides. Relative stability and reactivity of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophillic acyl substitution. Preparation of carboxylic derivatives, chemical reactions, Mechanism of esterfication and hydrolysis (acidic and Basic).	**8**	Describe carboxylic acid properties	1,2
III	Theromodynamics-II- Second law of thermodynamics: need for the law, Carnot cycle and its efficiency, Carnot theorem. Concept of entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical changes, Entropy change in ideal gases mixing of gases, Some other state functions: Gibb's Function (G) and Helmholtz function (A).	**10**	Apply thermodynamic laws to reactions	1,2
IV	Spectroscopy: Electromagnetic radiation, regions of spectrum, basic features of different spectrometers, statement of Born-Oppenheimer approximation, degrees of freedom. Rotational Spectrum: Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, determination of bond length, qualitative description of non-rigid rotor, isotope effect. Vibrational Spectrum: Infrared spectrum: Energy levels of simple harmonic	**10**	Interpret rotational and vibrational spectra.	1,2

	oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups.			
V	Raman Spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules. Electronic Spectrum: Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck-Condon principle. Qualitative description of σ, π and n M.O.their energy levels and their respective transitions.	**7**	Analyze Raman and electronic spectra	1,2
Practical	**1.** Perform a nucleophilic addition reaction to synthesize benzoin from benzaldehyde using potassium cyanide as a catalyst. **2.** Study the Cannizzaro reaction by reacting a non-enolizable aldehyde (e.g., formaldehyde) and determine the products. **3.** Study the rotational spectrum of a diatomic molecule like HCl or DCl to determine bond length and verify the rigid rotor model. **4.** Observe Raman spectra of molecules to identify vibrational and rotational transitions., Conduct an experiment using a calorimeter to study heat transfer and efficiency in a Carnot cycle.	**30**		1,2,3,4

TEXT BOOKS:

T1: Fundamentals of Organic Chemistry, Solomons, John Wiley.
T2: Principles of Physical chemistry, Puri ,Sharma, Pathania.

REFERENCE BOOKS:

R1: Organic Chemsitry, Morrison and Boyd, Prentice- Hall.
R2: Organic Chemistry. F.A. Carey, McGraw Hill, Inc.
R3: S.M. Mukherji, S.P. Singh and R.P.Kapoor, Wiley Eastern Ltd (New Age International.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand and gain knowledge about synthesis, physical properties and chemical reactions of carbonyl compounds such as aldehydes and ketones along with their named reactions.	**1**
2	Understand and gain knowledge about synthesis, physical properties and chemical reactions of carboxylic acids and their derivatives such as acid chlorides, esters, amides and acid anhydrides.	**1**
3	Understand the basic principle and laws of thermodynamics	**1**
4	Understand the basic principle of spectroscopy and the various spectroscopic techniques used to study the motion of different molecular systems	**1**
5	Understand the molecular techniques associated with Raman and electronic spectroscopy.	**1**

SEMESTER – IV									
Course Title	**Physics- 4**								
Course code	**24FSPH226R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/ 4th semester of second year of the program**								
Course Objectives	1. Understand the structure and bonding of crystalline materials. 2. Study lattice vibrations, phonons, and magnetic properties of materials. 3. Explore polarization, semiconductor conductivity, and superconductivity principles. 4. Learn thermodynamic laws and their applications. 5. Analyze kinetic theory, blackbody radiation, and statistical mechanics concepts								
CO1	Understand about crystal structure and phonons								
CO2	Discuss about superconductivity								
CO3	Illustrate the knowledge of semiconductor and superconductor								
CO4	Understanding the basics of thermodynamics.								
CO5	Describe about various quantities related to thermodynamics, such as entropy and thermodynamic potentials								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Amorphous and crystalline materials, lattice translation vectors, lattice with a basis, unit cell, atomic packing fraction, reciprocal lattice, types of lattices, Brillouin zones, lattice planes and miller indices, diffraction of x-rays by crystals, Bragg's law types of bonds, ionic bond, covalent bond, Van der Waal's bond.	**7**	Describe crystalline structure and bonding.	1,2
II	Basic idea of lattice vibration and phonon, acoustical and optical phonons, Einstein and Debye theories of specific heat of solids. Dia-, para-, ferri- and ferromagnetic materials, Curie's law, Weiss's theory of ferromagnetism and ferrimagnetisms, magnetic domains, discussion of B-H curve, hysteresis and energy loss.	**5**	Explain lattice vibrations and magnetism	1,2
III	Polarization, polarizability, electric susceptibility, classical theory of electric polarizability, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Meissner effect, Type-I and Type-II superconductors, London's equation and penetration depth, isotope effect, idea of BCS theory (no derivation): cooper pair and coherence length.	**8**	Understand semiconductor and superconducting properties.	1,2
IV	Zeroth Law of thermodynamics and temperature. First law and internal energy, Applications of First Law: General Relation between CP and CV, concept of Isothermal and Adiabatic Processes, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Third law of thermodynamics, Unattainability of absolute zero.	**5**	Apply thermodynamic laws in processes	1,2

V	Derivation of Maxwell's law of distribution of velocities, mean free path (Zeroth Order), Viscosity, Conduction and Diffusion Law of equipartition of energy (no derivation), mono-atomic and diatomic gases. Blackbody radiation, Spectral distribution, Planck's law, Wien's distribution law, Rayleigh, Jeans Law, Stefan Boltzmann Law, concept of Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability	**5**	Analyze kinetic theory and blackbody radiation	1,2
Practical	**1.** Verify Bragg's law by studying the diffraction pattern of X-rays using a crystal (e.g., NaCl). **2.** Measure the Hall voltage and determine the carrier type (P or N), carrier concentration, and mobility in a semiconductor sample. **3.** Trace the B-H curve for a ferromagnetic material and calculate the energy loss due to hysteresis. **4.** Determine the specific heat of a solid using the Debye or Einstein model experimentally. **5.** Determine the viscosity of a gas by measuring its flow through a capillary tube.			1,2, 3,4

TEXT BOOKS:

T1: Charles Kittel, Introduction to Solid State Physics, 7th Edition, John Wiley and Sons, Inc.

REFERENCE BOOKS:

R1: Gupta and Kumar, Solid state Physics, K. Nath and Co., Meerut, 9th Edition.
R2: Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, McGraw-Hill.
R3: Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, Tata McGraw-Hill.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand about crystal structure and phonons.	**1**
2	Discuss about superconductivity.	**1**
3	Illustrate the knowledge of semiconductor and superconductor	**1**
4	Understanding the basics of thermodynamics	**1**
5	Describe about various quantities related to thermodynamics, such as entropy and thermodynamic potentials.	**1**

SEMESTER – IV									
Course Title	**Biology- 4**								
Course code	**24FSBO227R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/ 4th semester of second year of the program**								
Course Objectives	1. To impart the knowledge on different physiological processes. 2. To provide the information regarding role of hormones, enzymes in maintaining physiological homeostasis. 3. To impart knowledge related to various functions of respiratory and endocrine glands.								
CO1	Understand the physiology of Cardiovascular and excretory system of human								
CO2	Discuss the mechanism of gaseous exchange, process of digestion and absorption								
CO3	Illustration of nerve and its impulse propagation and different animal tissues								
CO4	Understand the basics of human reproductive system and endocrine system.								
CO5	Discuss and classification of enzymes, its mechanism and cell biology								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Cardiovascular System: Composition of blood, Basic Structure of Human Heart, Origin and conduction of the heartbeat, Cardiac cycle. Excretory System: Nephron- Structure and Functions, Mechanism of Urine formation, Counter-current Mechanism	**5**	Students will understand the physiology of Cardiovascular and excretory system of human	1,2
II	Respiratory System: Pulmonary ventilation, Mechanism of breathing, Transport of respiratory gases Digestive System: Process of digestion in the alimentary canal; Absorption of carbohydrates, proteins, fats	**7**	Students will be able to explain the mechanism of gaseous exchange, process of digestion and absorption.	1,2
III	Nerve and muscle: Structure of a neuron, Resting membrane potential, Origin and conduction of nerve impulse in myelinated and non-myelinated nerve fibres. Introduction to animal tissue, types of animal tissue, sliding filament theory.	**6**	Students will know regarding nerve and its impulse propagation and different animal tissues	1,2
IV	Reproduction and Endocrine Glands: Physiology of male reproductive and female reproductive system, Structure and function of endocrine glands and their hormones	**5**	Students will have basic understanding of human reproductive system and endocrine system.	1,2

V	Enzymes: Introduction, Types of enzymes, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation Cell Biology: Overview and Cell division	**7**	Students will have understanding on enzymes, its mechanism and cell biology.	1,2
Practical	1. Study of different bones using disarticulated skeleton of fowl/rabbit 2. Study of different developmental stages of frog using permanent slides. 3. Study of developmental stages of Chick embryo using permanent slides. 4. Preparation of human blood smear and study on morphology of blood cells. 5. Preparation of temporary slides of animal tissues: Epithelial, Skeletal and Cardiac	**30**		1,2,3, 4

TEXT BOOKS:

T1: Essentials of Animal Physiology by S. C. Rastogi (Latest Edition) Publisher New Age Internationals.

T2: Textbook of Medical Physiology by Guyton and Hall (Latest Edition). Elsevier.

T3: Animal Physiology Edn.5 Part II, Verma (P.S) Etc, Aul. H Ed.Nch (James) Himalaya.

T4: Chordate Zoology and Animal Physiology, Jordan(El); Verma(P.S), S Chand and Company.

T5: Introduction to Animal Physiology, Kay(Ian), Bios Scientific Publishers.

REFERENCE BOOKS:

R1: Eckert Animal Physiology: Mechanisms and Adaptations by Eckert and Randal (4th Edition). W. H. Freeman.

R2: Animal Physiology by Hill, Wyse and Anderson (3rd Edition). Sinauer Associates, Inc. Publishers • Sunderland, Massachusetts.

R3: Essentials of Medical Physiology by K. Sembulingam and Prema Sembulingam (7th Edition). Jaypee Brothers Medical Pub

R4: Physiology by Linda S. Costanzo (7th Edition.). Wolters Kluwer

R5: Animal physiology: mechanism and adaptations by Eckert R. and Randal D (2nd Edition) CBS publishers and Distributor, New Delhi

R6: General and Comparative physiology by Hoar W. S.(Latest Edition). Prentice Hall of India Pvt. Ltd.

OTHER LEARNING RESOURCES:

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand the physiology of Cardiovascular and excretory system of human.	**1, 6**
2	Discuss the mechanism of gaseous exchange, process of digestion and absorption.	**1, 2**
3	Illustration of nerve and its impulse propagation and different animal tissues	**1**
4	Understand the basics of human reproductive system and endocrine system	**1, 6**
5	Discuss and classification of enzymes, its mechanism and cell biology.	**1**

SEMESTER – V									
Course Title	**Forensic Serology**								
Course code	**24BSFS311R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/V Semester of third year of the programme**								
Course Objectives	1. Understand the immune system, innate and acquired immunity, and the role of antigens, haptenes, and adjuvants in immunology. 2. Explore the types, physio-chemical properties, and functions of immunoglobulins, along with the process of raising antisera. 3. Examine the forensic significance of lectins, serological reagents, and methods of sterilization used in serological work. 4. Investigate antigen-antibody reactions, including precipitation, agglutination, complement, and immunofluorescence. 5. Analyze the applications and potential pitfalls of the HLA system in paternity testing.								
CO1	Explain immune system, innate and acquired immunity, and the role of antigens in forensic contexts.								
CO2	Classify physio-chemical properties, and functions of immunoglobulins, and demonstrate the ability to raise antisera along with their practical aspects.								
CO3	Apply lectins in forensic settings, utilizing serological reagents and explain methods of sterilization for serological work along with their practical aspects.								
CO4	Interpret various antigen-antibody reactions, including precipitation, agglutination, complement, and immunofluorescence.								
CO5	Assess the applications and potential pitfalls of the HLA system in paternity testing scenarios								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Immune system, immune response, innate and acquired immunity and antigens, haptenes and adjuvants. Immunoglobulin: Types, physio-chemical properties and function, raising of antisera. Lectins: Forensic significance, buffers and serological reagents, methods of sterilization employed for serological work. Antigen-Antibody Reactions: Precipitation, agglutination, complement, neutralization, immunofluorescence. HLA system: Its applications in paternity testing, pitfalls of HLA system.	**8**	Understand the immune system, innate and acquired immunity, and apply this knowledge to forensic scenarios	1,2
II	Blood: Identification (Preliminary and confirmatory tests), species of origin (Immunodiffusion and Immunoelectrophoresis), Individualization: Blood grouping, enzyme typing. 2. Semen: Composition, functions and morphology of spermatozoa, Identification (Preliminary and confirmatory tests including Azoospermic semen stains), Individualization (Blood Grouping, seminal fluid isozymes typing. 3. Composition, functions and forensic significance of saliva, sweat, milk, urine,	**7**	Demonstrate proficiency in understanding, classifying, and utilizing immunoglobulins for forensi analysis..	1,2

	faecal matter, vaginal secretions and tests for their identification including the presence of blood group specific ABH substances.			
III	Introduction- History of DNA Typing, human genetics- heredity, alleles, mutations and population genetics, molecular biology of DNA, variations and polymorphism in DNA. DNA typing systems- RFLP analysis, PCR amplifications, sequence polymorphism. Analysis of SNP, Y- STR, Mitochondrial DNA, DNA Barcoding for species identification, evaluation of results, frequency estimate calculations, interpretations, allele frequency determination, match probability- database, quality control, certification and accreditation	**10**	Apply lectins with an understanding of their forensic significance, buffers, and serological reagents in sterilized conditions	1,2
IV	Applications in disputed paternity cases, child swapping, missing person's identity- civil immigration, wildlife and mass disaster victim identification cases**,.**	**10**	Perform and interpret reactions such as precipitation, agglutination, complement, and immunofluorescence in forensic contexts	1,2
V	Legal standards for admissibility of DNA profiling, procedural and ethical concerns, status of development of DNA profiling in India and abroad, new and future technologies: DNA chips, SNPs and limitations of DNA profiling	**10**	Analyze the applications and potential pitfalls of the HLA system in paternity testing, considering its forensic significance..	1,2
Practical	1) To determine blood group from fresh blood samples. 2) To determine blood group from dried blood sample. 3) To carry out the crystal test on a blood sample. 4) To identify blood samples by chemical tests. 5) To identify the given stain as saliva. 6) To identify the given stain as urine. 7) To carry out cross-over electrophoresis. 8) To study the correlation between impact angle and shape of bloodstain. 9) To identify the point of convergence from the bloodstain patterns.	**30**		1,2, 3,4

TEXT BOOKS:

T1: R. Saferstein, *Criminalistics*, 8th Edition, Prentice Hall, New Jersey.

REFERENCE BOOKS:

R1: W.G. Eckert and S.H. James, *Interpretation of Bloodstain Evidence at Crime Scenes*, CRC Press, Boca Raton.

R2: G.T. Duncan and M.I. Tracey in *Introduction to Forensic Sciences*, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton.

R3: T. Bevel and R.M. Gardner, *Bloodstain Pattern Analysis*, 3rd Edition, CRC Press, Boca Raton.

R4: J.M. Butler, *Forensic DNA Typing*, Elsevier, Burlington.

R5: K. Inman and N. Rudin, *An Introduction to Forensic DNA Analysis*, CRC Press, Boca Raton.

R6: H. Coleman and E. Swenson, *DNA in the Courtroom: A Trial Watcher's Guide*, GeneLex Corporation, Washington.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Explain immune system, innate and acquired immunity, and the role of antigens in forensic contexts.	**1**
2	Classify physio-chemical properties, and functions of immunoglobulins, and demonstrate the ability to raise antisera along with their practical aspects.	**1, 3**
3	Apply lectins in forensic settings, utilizing serological reagents and explain methods of sterilization for serological work along with their practical aspects	**1, 3, 8**
4	Interpret various antigen-antibody reactions, including precipitation, agglutination, complement, and immunofluorescence.	**1, 3, 8**
5	Assess the applications and potential pitfalls of the HLA system in paternity testing scenarios.	**1, 8**

SEMESTER – V										
Course Title	**Forensic Toxicology**									
Course code	**24BSFS312R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/V Semester of third year of the programme**								
Course Objectives	1. Introduce students to poison classification, signs of drug addiction, drug toxicity, and methods for extracting poisons from biological specimens. 2. Explore pharmacology and toxicology of psychotropic drugs, including sedatives, stimulants, opiates, and drugs of abuse. 3. Cover the nature, administration, signs, symptoms, and detection of corrosive poisons, arsenic, mercury, and lead. 4. Explore pesticides, their isolation, detection, and estimation, as well as volatile poisons like methyl alcohol and chloroform. 5. Introduce students to animal and plant poisons, blood alcohol analysis, breath test instruments, and asphyxiants like cyanide and carbon monoxide.									
CO1	Understand the foundational knowledge and practical skills to identify and analyze toxic substances in forensic contexts along with their practical aspects.									
CO2	Explain the effects of psychotropic drugs and their implications in forensic investigations along with their practical aspects.									
CO3	Interpret metallic poison analysis and their medico-legal aspects.									
CO4	Analyze non-volatile and volatile poisons, understanding their effects and contributing to forensic investigations along with their practical aspects.									
CO5	Analyze miscellaneous poisons contributing to forensic examination in complex and rare cases									

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**C**lassification of poisons, drug addiction and its signs and symptoms, drug toxicity. Extraction and isolation of poisons from viscera and other biological specimen	**8**	Proficiently identify, classify, and isolate poisons, demonstrating an understanding of drug addiction signs and symptoms	1,2
II	Pharmacology and toxicology of Psychotropic Drugs: Sedatives, Stimulants, Opiates and drugs of abuse**.**	**7**	Apply knowledge of psychotropic drug effects, showcasing expertise in sedatives, stimulants, opiates, and drugs of abuse.	1,2
III	Nature, administration, sign & symptoms, fatal dose, postmortem findings, detection and medicolegal aspects of-Corrosive poisons: acids and alkalis, Arsenic, Mercury, Lead.	**10**	Analyze metallic poisons with expertise in detection methods, postmortem findings, and medico-legal aspects.	1,2
IV	Various pesticides, isolation, detection and estimation, Volatile Poisons: methyl alcohol, chloroform. symptoms, post-mortem findings, isolation, detection and estimation, medico-legal findings.	**10**	Showcase proficiency in identifying, detecting, and estimating non-volatile and volatile poisons, emphasizing toxicological analysis.	1,2

V	Animal poisons, plant poisons, analysis of blood for alcohol, breath test instruments, Asphyxiants Cyanide, Carbon monoxide	**10**	Demonstrate expertise in analyzing various poisons, including animal and plant toxins, breath tests for alcohol, and detecting asphyxiants like cyanide and carbon monoxide, showcasing proficiency in toxicological	1,2
Practical	1) Isolation techniques of different toxic substances. 2) TLC of insecticides, Barbiturates and other drugs. 3) Analysis of volatile and non-volatile poisons. 4) Analysis of vegetable poisons. 5) Spot test of nitrates, nitrites, carbonates, sulphates, sulphites, chlorates. 6) Spot test of mercury, iron, copper, Aluminum and cadmium and zinc and other metallic poisons. 7) Determination of alcohol in blood and urine sample	**30**		1,2, 3,4

TEXT BOOKS:

T1: The Toxicology is all about the studies drugs and poisons, their effect and analysis.

REFERENCE BOOKS:

R1: Gautam Biswas, *Review of Forensic Medicine and Toxicology*, 4th Edition, Jaypee Brothers Medical Publishers

R2: K S Narayan Reddy, *The Essentials of Forensic Medicine and Toxicology,* 34th Edition, Jaypee Brothers Medical Publishers

R3: F.G. Hofmann, A *Handbook on Drug and Alcohol Abuse*, 2nd Edition, Oxford University Press, New York.

R4: S.B. Karch, *The Pathology of Drug Abuse*, CRC Press, Boca Raton.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand the foundational knowledge and practical skills to identify and analyze toxic substances in forensic contexts along with their practical aspects.	**1, 3**
2	Explain the effects of psychotropic drugs and their implications in forensic investigations along with their practical aspects.	**1**
3	Interpret metallic poison analysis and their medico-legal aspects	**1, 3, 8**
4	Analyze non-volatile and volatile poisons, understanding their effects and contributing to forensic investigations along with their practical aspects	**1, 3, 8**
5	Analyze miscellaneous poisons contributing to forensic examination in complex and rare cases.	**1, 3, 8**

SEMESTER – V									
Course Title	**Advanced Instrumental Analysis**								
Course code	**24BSFS313R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/V Semester of third year of the programme**								
Course Objectives	1. Introduce students to gas chromatography (GC) and liquid chromatography (HPLC), emphasizing theoretical principles, instrumentation, and forensic applications.. 2. Explore UV-visible spectrophotometry, infrared spectrophotometry, Raman spectroscopy, AAS, AES, and mass spectrometry. 3. Introduce neutron activation analysis, covering basic theory, instrumentation, and the detection and measurement of gamma-rays for forensic applications. 4. Cover transmission electron microscopy (TEM), scanning electron microscopy (SEM), X-ray techniques, X-ray diffraction (XRD), X-ray fluorescence (XRF), and their forensic applications. 5. Introduce principles of sedimentation, various types of centrifuges, density gradient centrifugation, preparative centrifugation, and analysis of sub-cellular fractions using ultra-centrifuges								
CO1	Describe chromatographic methods, including GC-MS and LC-MS, for forensic analysis along with their practical aspects.								
CO2	Utilize various spectroscopic techniques for qualitative and quantitative forensic analysis along with their practical aspects.								
CO3	Apply knowledge of neutron activation analysis for qualitative and quantitative forensic investigations.								
CO4	Apply knowledge of microscopy and X-ray techniques effectively in forensic examinations for material and evidence analysis along with their practical aspects.								
CO5	Develop skills in applying centrifugation techniques for the separation and analysis of biological and forensic samples.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Gas chromatography, Theoretical principles, instrumentations and technique, columns, stationary phases, detectors, Pyrolysis GC, GC-MS, Forensic applications. Liquid chromatography, HPLC, Review of theory, Instrumentation, Technique, column, detectors, LC-MS, Forensic applications	7	Demonstrate expertise in gas and liquid chromatography, applying theoretical principles and techniques for forensic analysis.	1,2
II	UV Visible spectrophotometry, Infrared spectrophotometry, Raman Spectroscopy, AAS, AES	5	Apply knowledge of various spectroscopic techniques for forensic analysis, including UV-Visible spectrophotometry, infrared spectrophotometry, Raman spectroscopy, AAS, AES, and mass spectrometry.	1,2
III	Introduction, Review, Basic theory and principles, Instrumentation-	8	Apply neutron activation analysis principles for qualitative and	1,2

	Various neutron sources, Detection and measurement of Gamma-rays for qualitative and quantitative analysis, Forensic Applications		quantitative analysis in forensic applications.	
IV	TEM SEM, X-Ray techniques, X-ray Diffraction (XRD), X-ray Fluorescence (XRF and Forensic Applications	5	Analyze and interpret forensic samples using advanced microscopy techniques, X-ray diffraction, and X-ray fluorescence.	1,2
V	Basic principles of sedimentation, Various types of centrifuges, Density gradient centrifugation, Preparative centrifugation, Analysis of sub-cellular fractions, Ultra-centrifuge- Refrigerated Centrifuges**.**	5	Demonstrate proficiency in centrifugation principles, techniques, and applications for sub-cellular fractionation in forensic science.	1,2
Practical	1) To analyse samples using UV-Vis spectrophotometer 2) To analyse sample using FTIR 3) To analyse sample GC/GC-MS 4) To analyse sample using HPLC/LCMS 5) To analyse sample using GC-HS 6) To analyse sample using compound microscope 7) To analyse sample using comparison microscope	**30**		1,2,3, 4

TEXT BOOKS:

T1. D.A. Skoog, D.M. West and F.J. Holler, *Fundamentals of Analytical Chemistry,* 6th Edition, Saunders College Publishing, Fort Worth.

REFERENCE BOOKS:

R1. W. Kemp, *Organic Spectroscopy*, 3rd Edition, Macmillan, Hampshire.

R2. J.W. Robinson, *Undergraduate Instrumental Analysis*, 5th Edition, Marcel Dekker, Inc., New York.

R3: D.R. Redsicker, *The Practical Methodology of Forensic Photography*, 2nd Edition, CRC Press, Boca Raton.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Describe chromatographic methods, including GC-MS and LC-MS, for forensic analysis along with their practical aspects.	**1, 3, 8**
2	Utilize various spectroscopic techniques for qualitative and quantitative forensic analysis along with their practical aspects.	**1, 3, 8**
3	Apply knowledge of neutron activation analysis for qualitative and quantitative forensic investigations	**1, 3, 8**
4	Apply knowledge of microscopy and X-ray techniques effectively in forensic examinations for material and evidence analysis along with their practical aspects	**1, 3, 8**
5	Develop skills in applying centrifugation techniques for the separation and analysis of biological and forensic samples.	**1, 3, 8**

SEMESTER – V									
Course Title	**Techno Professional Course- III**								
Course code	**24BSFS314R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/IV Semester of First year of the programme**								
Course Objectives	1. Introduce students to the instrumentation, principles, working mechanisms, and uses of tools in DNA laboratories. 2. Educate students on the instrumentation and methodologies used in toxicology laboratories, emphasizing principles and applications. 3. Familiarize with the equipment used in ballistics and photography laboratories and understand their applications. 4. Acquire skills in using instrumentation for fingerprint analysis and questioned document examinations. 5. Integrate theoretical knowledge with practical applications in forensic investigations using laboratory instruments.								
CO1	Understand the instrumentation, principles, and applications of tools used in DNA laboratories.								
CO2	Gain comprehensive knowledge of the instruments and techniques employed in toxicology laboratories.								
CO3	Analyze different types of crimes and their social and psychological impacts.								
CO4	Evaluate sensational crime case studies to gain practical insights into criminology.								
CO5	Understand the structure and hierarchy of the justice system and Indian investigative agencies.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Instruments used in DNA Laboratory: Instrumentation, principle, working anduses.	**6**	Master the use of PCR, electrophoresis, and spectrophotometers for DNA analysis	1,2
II	Instruments used in Toxicology Laboratory: Instrumentation, principle,working and uses.	**6**	Learn techniques to detect toxins using GC-MS, HPLC, and immunoassays.	1,2
III	Instruments used in Ballistics and Photography Laboratory: Instrumentation, principle, working anduses.	**6**	Understand ballistic tools and forensic photography methods.	1,2
IV	Instruments used in Fingerprint and Questioned document Laboratory: Instrumentation, principle, working and uses	**6**	Explore tools for fingerprint and document analysis.	1,2
V	Instruments used in Serology Laboratory:Instrumentation, principle, working and uses	**6**	Gain skills in ELISA, centrifuges, and blood grouping techniques.	1,2

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand the instrumentation, principles, and applications of tools used in DNA laboratories.	**1, 8**
2	Gain comprehensive knowledge of the instruments and techniquesemployed in toxicology laboratories.	**1, 3, 8**
3	Analyze different types of crimes and their social and psychologicalimpacts.	**1**
4	Evaluate sensational crime case studies to gain practical insights into criminology.	**1**
5	Understand the structure and hierarchy of the justice system andIndian investigative agencies.	**1, 6**

SEMESTER – V									
Course Title	**Elementary Statistical analysis & Research Methodology**								
Course code	**24BSFS316R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 5th semester of second year of the program**								
Course Objectives	1. The course aims to enhances the students' a broad understanding of research methodology, including theory of science and qualitative and quantitative methods in research. 2. The course seeks to enhance the students' skills for developing critical thinking through research literature review in different domain. Consequently it aims to develop skills for preparation of a research proposal for a master' thesis project/Mini research. 3. To develop Students competency in planning, conducting, evaluating and presenting a research project.								
CO1	Explain research methodology, evaluate significance of research and identify research problems.								
CO2	Explain research design, sampling design and design experiment for research.								
CO3	Collection and representation of data and interpret the data with descriptive statistics.								
CO4	Explain to write report, article, reviews etc.								
CO5	Explain intellectual property right and related rights								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Research Methodology- An Introduction- meaning and objectives of research, motivation in research, types and significance of research, criteria of good research. Defining the Research Problems- definition of research problem, necessity of defining research problem	**2**	Knowledge on fundamental concepts of research methodology, including the meaning and objectives of research	1,2
II	Research Design- meaning and need of research design, features of a good design, different research designs, Sampling Design- steps in sampling design, Sample Size determination, criteria for selecting a sampling design, different types of sampling design, Experimental Design, Principles of Design of Experiment, One – way ANOVA, Two- Way ANOVA, CRD, RBD, LSD, 22, 23 Factorial Design	**4**	Able to understand and apply the fundamental principles of research design, including the meaning and necessity of research design	1,2
III	Types of data, sources of data collection, tools of data collection, Nominal, ordinal, interval and ratio – Attitude scale construction and measurement, rating scales, semantic differential (SD), Use of scale in statistical analysis, Schedules for interviews preparation and standardization, development of survey instruments and item analysis for the questionnaire	**3**	A good knowledge on different types of data and identify various sources and tools for data collection	1,2
IV	Planning and organizing research report, Format of research report, Different steps of writing	**3**	Able to organize and write a comprehensive	1,2

	report, lay out of the research report , How to organize thesis/Dissertation, mechanics of writing research report, standard methods of quoting- presenting the result, written and oral reports, Uses of abstract, format of research report, presentation of statistics - tabular and graphic references and uses of references, Bibliography and presentation of bibliography		research report	
V	Intellectual property right (IPR), Introduction and the need for IPR, IPR in India and worldwide, Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications, Patentable and non-patentable, patenting life, Filing of a patent application, The different layers of the international patent system, Case studies on Basmati rice, Turmeric, and Neem patents	**3**	Knowledge on importance of Intellectual Property Rights (IPR) both in India and globally	1,2
Practical	**Laboratory using R Software:** 1. Analysis of One way ANOVA; 2. Analysis of Two way ANOVA; 3. Analysis of CRD 4. Analysis of RBD 5. Analysis of 22 and 23 Factorial Experiment 6. Simulation-I using R (Bernoulli, Binomial, Poisson and Geometric distribution.). 7. Simulation-II using R (Exponential and Normal distribution). 8. Simple random Sampling 9. Stratified Random Sampling	**60**	Knowledge on various statistical experiments and simulations using R	1,2, 3,4

REFERENCES

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2. Coughlan M., Cronin P. and Ryan F. (2007). Step-by-step guide to critiquing research. Part 1: quantitative research. British journal of Nursing 16 (11).
3. Creswell, JW. (1998). Qualitative Inquiry and Research Design Choosing Among Five Traditions. Thousand Oaks, CA: Sage Publications.
4. Crotty, M. (1998). The Foundations of social research: Meaning and perspective in the research process. London: Sage.
5. Denzin, NK. (1978). Sociological Methods. New York: McGraw-Hill.
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7. Johnson & Christensen. (2004). Educational Research: Quantitative, qualitative and mixes approaches, 2nd Ed. Boston: Allyn & Bacon.
8. Kothari C., R. (2004). Research Methodology: Methods and Techniques. New Delhi. New Age International (P) Limited, Publishers.
9. Krueger, A. R. (1994). Focus Groups: A Practical guide for Applied Research, Thousand Oaks, CA: Sage Publications
10. L., L. Espinosa and M. Yamashita (2015). EvaluationToolkit. Evaluation Guide. Analyze Data.

Retrieved from: http://toolkit.pellinstitute.org/evaluation-guide/analyze/analyze-qualitative-data/
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12. Patton, MQ. (1999). "Enhancing the quality and credibility of qualitative analysis." HSR: Health Services Research. 34 (5) Part II. pp. 1189-1208.
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14. Strauss, A. & Corbin, J. (1994). "Grounded Theory Methodology." In NK Denzin & YS Lincoln (Eds.) Handbook of Qualitative Research (pp. 217-285). Thousand Oaks, Sage Publications.

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOME

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain research methodology, evaluate significance of research and identify research problems.	**3, 4, 8**
2	Explain research design, sampling design and design experiment for research.	**3, 4, 8**
3	Collection and representation of data and interpret the data with descriptive statistics.	**3, 4, 8**
4	Explain to write report, article, reviews etc.	**3, 4, 8**
5	Explain intellectual property right and related rights	**3, 4, 8**

SEMESTER – V									
Course Title	**Chemistry- 5**								
Course code	**24FSCH311R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 5th semester of second year of the program**								
Course Objectives	1. Understand preparation, properties, and reactions of nitrogen-containing organic compounds. 2. Analyze NMR spectroscopy principles and interpret simple PMR spectra. 3. Study thermodynamic relationships, chemical potential, and entropy concepts. 4. Explore photochemistry, photochemical laws, and excited-state processes. 5. Learn the biological role of essential trace elements and metalloporphyrins.								
CO1	Understand and gain knowledge about synthesis, physical properties and chemical reactions of nitrogen containing organic compounds such as nitro and amines and their named reactions.								
CO2	Understand and apply the concept of NMR in signals interpretation of PMR spectra of simple organic molecules.								
CO3	Understand the interaction of electromagnetic light with matter and the different laws of photochemistry associated with it.								
CO4	Understand the coordination of different metal ions present in the biological systems.								
CO5	Understand the molecular techniques associated with raman and electronic spectroscopy								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Organic Compounds of Nitrogen a) Nitro Compounds Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reactions in acidic, neutral and alkaline media, Picric acid. b) Amines Reactivity, structure and nomenclature of amines, physical properties. Stereochemistry of amines Separation of a mixture secondary and tertiary amines. Structural features effecting the basicity of amines. Amine salts as phase-transfer catalyst and preparation of alkyl and aryl amines (reduction of nitro compounds and nitriles), reductive amination of aldehydic and ketonic compounds Gabriel-phthalimide reaction, Hoffmann bromamide reaction.	**6**	Describe reactivity of nitrogen compounds	1,2

II	Spectroscopy-II: Nuclear magnetic resonance (NMR) spectroscopy. Proton magnetic resonance (1H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2 tribromoethane, ethyl acetate, toluene and acetophenone.	**6**	Interpret basic NMR spectra of organics.	1,2
III	Thermodynamics-III (15 hrs) Maxwell's relationships, Gibbs-Helmholtz equation, Partial molar properties, Concept of chemical potential, Gibbs-Duhem equation, Variation of chemical potential with T and P, Clapeyron-Clausius equation, Third law of thermodynamics, Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity	**6**	Apply thermodynamic equations and concepts.	1,2
IV	Photochemistry- Interaction of radiation with matter, difference between thermal and photochemical process. Laws of photochemistry: Grothus-Drapperlaw, Stark-Einstein law, Jablonski diagram depiciting various processes occurring in the excited state, qualitative description of fluorescence, non- radiative processes (internal conversion, intersystem crossing), quantum yield.	**6**	Explain photochemical processes and quantum yield.	1,2
V	Bioinorganic Chemistry - Essential and trace elements in biological processes, metalloporphyrins with special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca+2, Nitrogen fixation.	**6**	Understand the biological role of metal ions.	1,2
Practical	**1.** Synthesize nitroalkanes or nitroarenes and study their chemical properties. **2.** Separate a mixture of secondary and tertiary amines using chemical methods. **3.** Synthesize primary amines through the Gabriel-phthalimide reaction. **4.** Analyze the PMR spectra of simple organic molecules like ethanol, toluene, and ethyl acetate **5.** Measure fluorescence and determine the quantum yield of a photochemical reaction.	**30**		1,2,3,4

TEXT BOOKS:

T1: Fundamentals of Organic Chemistry, Solomons, John Wiley.

T2: Principles of Physical chemistry, Puri ,Sharma, Pathania.
T3: Spectroscopy, Pavia, Lampmann, Kriz,

REFERENCE BOOKS:

R1: Organic Chemsitry, Morrison and Boyd, Prentice- Hall.
R2: Organic Chemistry. F.A. Carey, McGraw Hill, Inc.
R3: S.M. Mukherji, S.P. Singh and R.P.Kapoor, Wiley Eastern Ltd (New Age International.

OTHER LEARNING RESOURCES:

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand and gain knowledge about synthesis, physical properties and chemical reactions of nitrogen containing organic compounds such as nitro and amines and their named reactions.	**1**
2	Understand and apply the concept of NMR in signals interpretation of PMR spectra of simple organic molecules.	**1**
3	Understand the interaction of electromagnetic light with matter and the different laws of photochemistry associated with it	**1**
4	Understand the coordination of different metal ions present in the biological systems	**1**
5	Understand the molecular techniques associated with raman and electronic spectroscopy.	**1**

SEMESTER – V									
Course Title	**Physics- 5**								
Course code	**24FSPH312R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 5th semester of second year of the program**								
Course Objectives	1. Understand nuclear constituents, binding energy, and mass-energy relations. 2. Study types of radioactivity and the principles of alpha, beta, and gamma decay. 3. Explore nuclear fission, fusion, and energy considerations in nuclear reactions. 4. Learn the principles and operation of nuclear detectors. 5. Understand the classification of elementary particles and types of interactions.								
CO1	Understand the constituents and general properties of nuclei, and learn about different nuclear models and the condition for Nuclear Stability.								
CO2	Explain the different types of radiation such as alpha, beta and gamma and their properties.								
CO3	Explain the different types of nuclear reaction and calculate the Q value of reaction.								
CO4	Discuss the basic idea of radiation detector								
CO5	Summarize the basic of particle physics, types of particles and conservation laws								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Constituents of nucleus and their intrinsic properties, isotopes and isobars, neutrons, discovery of neutrons, properties of neutrons, binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve.	**7**	Describe nuclear structure and binding energy.	1,2
II	Radioactivity, α, β, γ radiation and their properties, Alpha decay: basics of α-decay processes, theory of α- emission, Geiger-Nuttall law, β-decay: energy kinematics for β -decay, positron emission, electron capture, neutrino hypothesis, γ-decay: γ-rays emission & kinematics.	**5**	Explain alpha, beta, and gamma decay processes.	1,2
III	Nuclear fission and fusion, necessary condition for nuclear fusion, controlled thermonuclear reaction, energy consideration in nuclear reaction, Mass defect and Q-value of a nuclear reaction.	**8**	Understand nuclear fission, fusion, and mass defect.	1,2
IV	Basic idea of nuclear detector, Gas detectors, ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction and working of photo-multiplier tube (PMT). Semiconductor Detectors.	**5**	Operate and interpret readings from nuclear detectors.	1,2
V	Classification of elementary particles, baryons, leptons, mesons, particles and antiparticles, concept of quark model. Types of interactions, weak, strong and	**5**	Classify elementary particles and interaction types.	1,2

	electromagnetic interactions			
Practical	**1.** To study the radioactive decay of α, β, and γ sources. **2.** To measure the half-life of a radioactive isotope. **3.** To calculate the binding energy per nucleon of a nucleus. **4.** To observe the process of nuclear fission and measure the energy released. **5.** To study electron capture and positron emission.	**30**		1,2, 3,4

TEXT BOOKS:

T1: Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill).

REFERENCE BOOKS:

R1: Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
R2: Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi.
R3: Radiation detection and measurement, G.F. Knoll (John Wiley & Sons).

OTHER LEARNING RESOURCES: Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand the constituents and general properties of nuclei, and learn about different nuclear models and the condition for Nuclear Stability.	**1**
2	Explain the different types of radiation such as alpha, beta and gamma and their properties.	**1**
3	Explain the different types of nuclear reaction and calculate the Q value of reaction	**1**
4	Discuss the basic idea of radiation detector	**1**
5	Summarize the basic of particle physics, types of particles and conservation laws.	**1**

SEMESTER – V									
Course Title	**Biology- 5**								
Course code	**24FSBO313R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 5th semester of second year of the program**								
Course Objectives	1. Introduce general plant classification and forensic botany sub-specializations. 2. Teach identification and matching of woods, timbers, seeds, and leaves for forensic purposes. 3. Provide knowledge on poisonous plants and their forensic importance. 4. Explore the importance of wildlife, crimes, and acts related to wildlife protection								
CO1	Understand general plant classification and forensic sub-specializations								
CO2	Identify and match various types of woods, timbers, seeds, and leaves forensically.								
CO3	Recognize poisonous plants and their forensic significance.								
CO4	Comprehend the importance of wildlife, wildlife crimes, and relevant acts.								
CO5	Identify plants yielding drugs of abuse for forensic analysis								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	General plant types and their classification schemes. Sub specialization of forensic botany- plant morphology, plant anatomy, plant systematic, palynology, plant ecology, Plant achitecture- roots, stems, flowers, leaves.	**6**	History, types and policies of forest.	1,2
II	Types of woods, timbers, seeds and leaves and their forensic importance. Identification and matching of various types of wood, timber varieties, seeds and leaves. Types of fibers – forensic aspects of fiber examination- fluorescent, optical properties, refractive index, birefringence, dye analysis etc.	**6**	Importance, scope and morphology of woody forest and Ecotourism.	1,2
III	Plants of forensic importance - Abrus precatorius, Aconitum, Anacardium occidentale, Argemone mexicana, Calotropis, Cannabis sativa, Claviceps purpuria, Cinchona, Croton tiglium, Atropa belladonna, Erythroxylum coco, Gloriosa superb, Jatropha curcas, Lathyrus sativus, Manihot utilissima, Nerium indicum, Nicotiana tabacum, Cascabela thevetia, Ricinus communis.	**8**	Importance of tree physiology in relation to forestry	1,2

IV	Importance of wild life. Protected and endangered species of animals and plants. Sanctuaries and their importance. Relevant provision of wild life and environmental act. Types of wildlife crimes, different methods of killing and poaching of wildlife animals.	**5**	Importance of forest ecosystem, biotic and abiotic Components and forest management and ecotourism.	1,2
V	Plants yielding drugs of abuse – opium, cannabis, coco, tobacco, dhatura, Psilocybin mushrooms.	**5**	Principle of forest pathology causes of forest diseases and plant quarantine.	1,2
Practical	1. Morphological study of different types of plants like herbs, shrubs and trees. 2. Anatomical study of tissues of stem, root and leaf. 3. Identification and comparison of natural and man-made fibre. 4. Identification of Poisonous plants	**30**		1,2, 3,4

TEXT BOOKS:

T1: Agarwal, W.P. Forests in India. Oxford and I.B.H

T2: Arvind Kumar. Biodiversity and environment. A.P.M. Publishing Corporation, New Delhi

T3: Kumar and Asija. Biodiversity – Principles and conservation. Updesh Purohit, Agrobios, Jodhpur

REFERENCE BOOKS:

R1: Raghavendra AS. Physiology of Trees.

R2: John Wiley & Sons. Taiz, L. and Zeiger, E. Plant Physiology 4 th Ed. Sinauer Associates Inc. Publishers, Sunderland.

OTHER LEARNING RESOURCES:

Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand general plant classification and forensic sub-specializations.	**1**
2	Identify and match various types of woods, timbers, seeds, and leaves forensically.	**1**
3	Recognize poisonous plants and their forensic significance	**1**
4	Comprehend the importance of wildlife, wildlife crimes, and relevant acts	**1**
5	Identify plants yielding drugs of abuse for forensic analysis.	**1**

SEMESTER – VI									
Course Title	**Multimedia Forensic**								
Course code	**24BSFS321R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/ VI Semester of third year of the programme**								
Course Objectives	1. Acquire knowledge of imaging and data recovery techniques, including stand-alone machines, peripheral devices, storage media, CCTV systems, and mobile devices. 2. Understand remote acquisition methods, various acquisition software/hardware devices, file formats of forensic images, and deleted data recovery techniques. 3. Analyze registry and logging in various operating systems, conducting in-depth examinations of system logs, kernel logs, event logs, and application web servers/proxy logs. 4. Develop skills in forensic audio analysis, covering audio enhancement, digital media authentication, acoustic analysis, and automatic speaker recognition. 5. Explore video processing techniques, including re-sampling algorithms, compression history identification, and super resolution through linear dependency patterns.								
CO1	Describe the types of acquiring digital evidence from a variety of sources.								
CO2	Apply remote acquisition methods and employ various software/hardware tools for forensic image acquisition and deleted data recovery along with their practical aspects.								
CO3	Conduct comprehensive registry and logging analysis, including the examination of logs from standalone machines and servers, enhancing investigative capabilities.								
CO4	Utilize forensic audio analysis techniques for audio enhancement, digital media authentication, and automatic speaker recognition in laboratory settings along with their practical aspects.								
CO5	Analyze and interpret various audio and video evidences from various multimedia sources along with their practical aspects.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Imaging/acquisition & data recovery Acquisition of stand-alone machine, peripheral device, other storage media, CCTV, systems (both physical & logical), Acquisition or triage collection of live system, Acquisition of mobiles, PDA's, Tablets, Navigation systems etc.	**8**	Imaging/Acquisition & Data Recovery: Acquire and recover digital evidence from diverse sources, including stand-alone machines, mobile devices, and networked systems	1,2
II	Acquisition over the network i.e. remote acquisition, Understanding of various acquisition software/hardware device, details of various audio enhancement, digital media authentication, acoustic analysis, and automatic speaker recognition	**7**	Apply remote acquisition methods and utilize various software/hardware tools for forensic image acquisition and deleted data recovery.	1,2
III	Registry and Logging: Understanding and in-depth analysis of registry in various operating systems, Log analysis, machine and server, system logs, kernel logs, event logs, ftp/sftp, application Web Servers/ Proxy logs.	**10**	Conduct in-depth analysis of registry and logs from various operating systems, enhancing investigative capabilities in digital forensics	1,2

IV	File Forensics: Data Acquisition and Authentication Process, Windows Forensic Analysis of File Systems- FAT12, FAT16, FAT32 and NTFS, UNIX file Systems, mac file systems, Embedded System Analysis, Network Forensic Analysis Overview, Cloud Computing-an introduction.	**10**	Apply techniques in audio enhancement, digital media authentication, and automatic speaker recognition for effective forensic audio analysis in the laboratory.	1,2
V	Video processing: re-sampling algorithms (rotation scaling) and their identification, super resolution.	**10**	Apply advanced video processing techniques, including re-sampling algorithms and compression history identification, enhancing skills in forensic video analysis and evidence interpretation	1,2
Practical	1. Recording of speech samples using tape recorder & digital recorders and measures for keeping it in the safe custody. 2. Comparison of linguistic and phonetic features of audio recording voice samples of two speakers. 3. Perform Steganography and Steganalysis. 4. Encrypting and decrypting the partition using Bit locker. 5. Collection and preservation of volatile data from standalone computer. 6. Imaging and recovery of deleted files and folders from storage media.	**30**		1,2,3, 4

TEXT BOOKS:

T1: Husrev Taha Sencar and Nasir Memon, Digital Image Forensics: There is More to a Picture than Meets the Eye, Springer Science and Business Media, New York.

REFERENCE BOOKS:

R1: Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Prentice-Hall, Inc.Upper Saddle River, NJ, USA.

R2: Alan Bovik, Handbook of Image and Video Processing, Academic Press, USA.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Describe the types of acquiring digital evidence from a variety of sources.	**1, 6**
2	Apply remote acquisition methods and employ various software/hardware tools for forensic image acquisition and deleted data recovery along with their practical aspects.	**1, 2, 3**
3	Conduct comprehensive registry and logging analysis, including the examination of logs from standalone machines and servers, enhancing investigative capabilities	**1, 3**
4	Utilize forensic audio analysis techniques for audio enhancement, digital media authentication, and automatic speaker recognition in laboratory settings along with their practical aspects	**1, 6**
5	Analyze and interpret various audio and video evidences from various multimedia sources along with their practical aspects.	**1, 3**

SEMESTER – VI									
Course Title	**Forensic Medicine**								
Course code	**24BSFS322R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Winter/ VI Semester of third year of the programme**								
Course Objectives	1. Introduce students to the fundamental aspects and scope of forensic medicine, including different types of inquests and the roles of oral evidence and dying declarations. 2. Explore the medico-legal aspects of death, including the diagnosis, stages, and signs of death, as well as different types of fatal incidents. 3. Provide knowledge on the autopsy process, including internal and external examinations, sample collection, and the investigation of sexual offences and suicidal cases. 4. Educate students on the types and classification of injuries, including antemortem and post-mortem injuries, and specific injury types like bite marks and burn injuries. 5. Familiarize students with forensic entomology, including the estimation of time since death and the factors affecting decomposition.								
CO1	Understand the fundamental aspects and scope of forensic medicine and the different types of inquests and evidence in legal investigations.								
CO2	Diagnose the medico-legal aspects of death, recognizing the stages and signs of death and various causes of fatal incidents.								
CO3	Conduct thorough autopsies, including internal and external examinations, sample collection, and the investigation of specific cases like sexual offences and suicides								
CO4	Identify and classify different types of injuries, distinguishing between antemortem and postmortem injuries.								
CO5	Apply forensic entomology techniques to estimate the time since death and understand the decomposition process.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Forensic medicine, pathology, police inquest, magistrate inquest, oral evidence, dying declaration, kind of witnesses, Fundamental aspects and scope of forensic medicine.	**8**	Describe the scope of forensic medicine and the roles of different types of inquests and evidence.	1,2
II	Death & its medico legal aspects, diagnosis of death, stages of death, signs of death, ashyxial death, death due to Starvation, death due to drowning, death due to electrocution, Anaesthetics deaths.	**7**	Recognize the signs and stages of death and understand various causes of death from a medico- legal perspective.	1,2
III	Autopsy: medico legal aspect of death, internal and external examination, Sample collecting, sampling techniques, preservation of samples, Causes of death. Investigation of sexual offences, exhumation (buried bodies), suicidal cases	**10**	Perform autopsies, collect and preserve samples, and investigate specific medico-legal cases	1,2
IV	Injuries: Types and classification of injuries. Antemortem and post mortem injuries. Bite marks, burn injuries, head injury.	**10**	Identify and classify injuries, distinguishing between ante mortem and post-mortem injuries	1,2

V	Estimation of time since death, Stages of decomposition of corpse, geographical & seasonal effect on decomposition.	**10**	Estimate the time since death and understand the factors affecting decomposition	1,2
Practical	1. To design a questionnaire for the first responder to the death scene. 2. To design a checklist for the forensic scientists at the death scene. 3. To analyze and preserve bite marks 4. To design a canvass form giving description of an unidentified victim.	**30**		1,2,3 ,4

TEXT BOOKS:

T1: J P Modi, *A Textbook of Medical Jurisprudence and Toxicology,* Lexis Nexis

REFERENCE BOOKS:

R1: Gautam Biswas, *Review of Forensic Medicine and Toxicology*, 4th Edition, Jaypee Brothers Medical Publishers

R2: K S Narayan Reddy, *The Essentials of Forensic Medicine and Toxicology,* 34th Edition, Jaypee Brothers Medical Publishers

R3: F.G. Hofmann, A *Handbook on Drug and Alcohol Abuse*, 2nd Edition, Oxford University Press, New York.

R4: S.B. Karch, *The Pathology of Drug Abuse*, CRC Press, Boca Raton.

OTHER LEARNING RESOURCES:

E-Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Enable effective handling of death investigations through crime scene management and initial medical response.	**1, 2, 6**
2	Recognize suspects, conduct interrogations, and manage crime scenes, including crowd and media control.	**1, 3**
3	Discuss effective handling of buried body and suicide cases, emphasizing search methods and psychological assessment	**1, 3, 6**
4	Develop skills in conducting autopsies, evaluating injuries, and examining causes of death in forensic medicine	**1, 4, 8**
5	Identify, classify, and evaluate injuries, distinguishing between ante mortem and postmortem injuries and understanding aging and artificial aspects along with their practical aspects.	**1, 3**

SEMESTER – VI									
Course Title	**Chemistry- 6**								
Course code	**24FSCH321R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 5th semester of second year of the program**								
Course Objectives	1. To understand and gain knowledge about carbohydrates, proteins and nucleic acids. 2. To understand the preparation, characteristics and chemical reactions simple and condensed five and six membered heterocyclic compounds. 3. To understand the knowledge about bonding in metal carbonyls, as well as gain the idea about the different phases of matter								
CO1	Understand and gain knowledge about carbohydrates								
CO2	Understand and gain knowledge about protein and nucleic acid								
CO3	Understand the simple and condensed 5/6 membered heterocyclic compounds, their preparation, characteristics and chemical reactions.								
CO4	Discuss about preparation properties, application and the nature of bonding in metal carbonyl								
CO5	Identify the different phases of matte and their equilibria from which the stability and sustainability can be predicted.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Carbohydrates:** Classification and nomenclature, Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threodiastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers, and esters. Determination of ring size of monosaccharides. Cyclic structure of D (+)-glucose. Mechanism of mutarotation. Structures of ribose and deoxyribose. An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharide starch and cellulose without involving structure determination.	**10**	Classify and interconvert carbohydrates and derivatives.	1,2
II	**Amino Acids, Pcptides, Proteins and Nucleic Acid:** Classification, structure and stereochemistry of amino acids. Acid base behaviour, isoelectric point and electrophoresis. Preparation and reactions of α-amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical levels of protein structure. Protein denaturation/ renaturation. Nucleic acids: Introduction, Constituents of nucleic acids Ribonucleosides and ribonucleotides. The double helical structure of DNA.	**8**	Understand structure and properties of amino acids, peptides, proteins, and nucleic acids.	1,2
III	**Heterocyclic Compound:** Introduction:	**10**	Synthesize and react	1,2

	Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on mechanism of electrophlic substitution. Mechanism of nucleophlic substitution reaction in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis and Bischler- Napieralski synthesis. Mechanism of electrophlic substitution reactions of indole, quinoline and isoquinoline		heterocyclic compounds.	
IV	**Organometallic Chemistry**: Definition, Nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyls,of' Li, Al, Hg, Sn and Ti, a brief account of metal-ethylene complexes and homogeneous hydrogenation, mononuclear carbonyls and the nature of bonding in metal carbonyls.	**10**	Explain properties and applications of organometallic compounds.	1,2
V	Phase Equilibrium: Phase, Components, Degree of freedom, Derivation of phase rule, one-component systems, water system and S-system, two component systems, simple eutectic systems, Pb-Ag systems, formation of compounds with congruent melting points, and incongruent melting points.	**7**	Apply phase rule to phase equilibria systems.	1,2
Practical	**1.** To classify and identify monosaccharides such as glucose and fructose. **2.** To study the mutarotation and optical activity of D(+)-glucose. **3.** To prepare peptides and study the denaturation and renaturation of proteins **4.** To study the electrophoretic behavior of amino acids and proteins. **5.** To synthesize and study reactions of heterocyclic compounds like pyrrole, furan, thiophene, and pyridine	**30**		1,2, 3,4

TEXT BOOKS:

T1: Fundamentals of Organic Chemistry, Solomons, John Wiley.
T2: Principles of Physical chemistry, Puri ,Sharma, Pathania.
T3: Spectroscopy, Pavia, Lampmann, Kriz,

REFERENCE BOOKS:

R1: Organic Chemsitry, Morrison and Boyd, Prentice- Hall.
R2: Organic Chemistry. F.A. Carey, McGraw Hill, Inc.
R3: S.M. Mukherji, S.P. Singh and R.P.Kapoor, Wiley Eastern Ltd (New Age International.

OTHER LEARNING RESOURCES:

Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAMOUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand and gain knowledge about carbohydrates.	**1**
2	Understand and gain knowledge about protein and nucleic acid.	**1**
3	Understand the simple and condensed 5/6 membered heterocyclic compounds, their preparation, characteristics and chemical reactions	**1**
4	Discuss about preparation properties, application and the nature of bonding in metal carbonyl	**1**
5	Identify the different phases of matte and their equilibria from which the stability and sustainability can be predicted.	**1**

SEMESTER – VI									
Course Title	**Physics- 6**								
Course code	**24FSPH322R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 5th semester of second year of the program**								
Course Objectives	1. Understand the properties and working mechanisms of semiconductor diodes. 2. Explore applications of two-terminal devices like rectifiers, Zener diodes, and LEDs. 3. Study the characteristics and behavior of bipolar junction transistors (BJTs). 4. Learn the classification, working, and applications of amplifiers and op-amps. 5. Understand the fundamentals of analog and digital circuits, Boolean algebra, and logic gates								
CO1	Understand the basic process in the formation and fabrication of PN junction devices.								
CO2	Summarize the knowledge of rectifiers								
CO3	Understand versatile integrated circuits such as Op-Amp and its applications.								
CO4	Explain the basic idea of amplifiers and their frequency response.								
CO5	Understand the idea of analog and digital circuit and different types of gates								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Semiconductor Diodes: P and N type semiconductors, energy level diagram, conductivity and mobility, concept of drift velocity, fabrication of PN junction current flow mechanism in forward and reverse biased diodes.	**7**	Explain semiconductor diode behavior and current flow	1,2
II	Two-terminal devices and their applications: Half-wave rectifiers, full-wave rectifiers, bridge rectifiers, ripple factor and rectification efficiency, c-filter, Zener diode and voltage regulation, principle, Principle and structure of LEDs, Photodiode and Solar Cell.	**5**	Analyze rectifiers, Zener diodes, and LEDs in circuits	1,2
III	Bipolar Junction transistors: N-P-N and P-N-P transistors, I-V characteristics of CC, CB and CE configurations, current gains α and β and their relations.	**8**	Understand BJT characteristics and current gains.	1,2
IV	Amplifiers, classification of class A, B & C Amplifiers. Two stage RC-coupled amplifier and its frequency response, introduction, characteristics of an Op-Amp, Applications of Op-Amps.	**5**	Design and analyze amplifier circuits and Op-Amp applications.	1,2
V	Difference between analog and digital circuits, binary numbers, concepts of Boolean algebra, AND, OR and NOT gates (realization using diodes and transistor), NAND and NOR gates as universal gates, XOR and XNOR gates, Active and passive components, concepts of ICs (basic idea only)	**5**	Apply Boolean algebra and work with logic gates.	1,2

Practical	**1.** To study the current-voltage characteristics of a P-N junction diode. **2.** To design and test half-wave and full-wave rectifiers. **3.** To study the application of a Zener diode as a voltage regulator. **4.** To study the working principles of LED and Photodiode. **5.** To analyze the I-V characteristics of NPN and PNP transistors.	**30**		1,2, 3,4

TEXT BOOKS:

T1: Electronics fundamentals and applications –D. Chattopadhyay and P.C. Rakshit.

REFERENCE BOOKS:

R1: A Text Book Of Electronics –S.L. Kakani & K.C. Bhandari
R2: Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, PHI Learnin.
R3: Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed Tata McGra).

OTHER LEARNING RESOURCES:

Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped ProgramOutcome**
1	Understand the basic process in the formation and fabrication of PN junction devices.	**1**
2	Summarize the knowledge of rectifiers.	**1**
3	Understand versatile integrated circuits such as Op-Amp and its applications.	**1**
4	Explain the basic idea of amplifiers and their frequency response	**1**
5	Understand the idea of analog and digital circuit and different types of gates.	**1**

SEMESTER – VI									
Course Title	**Biology- 6**								
Course code	**24FSBO323R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T + 30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Forensic Science**								
Semester	**Fall/ 5th semester of second year of the program**								
Course Objectives	1. To impart the knowledge on importance of wildlife, ethics and management tactics for wildlife conservation. 2. To provide the information regarding different conservation programme adopted in India for the conservation of wildlife. 3. To provide knowledge on structure and function of ecosystem.								
CO1	Understand different conservation strategy and programmes adopted for the conservation of wildlife								
CO2	Understand the ethics and management tactics for wildlife conservation								
CO3	Discuss the structure and function of ecosystem								
CO4	Discuss about Wildlife Protection Act, 1972 and its implementation.								
CO5	Illustrate different conservation program adopted in India for the conservation of wildlife								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Wildlife Importance and Conservation- Definition and importance of wildlife**,** Causes of depletion, Important National Parks, Wildlife sanctuaries and biosphere reserves of India	**5**	Students will understand the importance of wildlife and the need of their conservation	1,2
II	Environmental Ethics and Management- Conservation and management of Wildlife, In-situ conservation and ex-situ conservation Innovative Methods in Wildlife: Camera Trap, Conservation Drones, Remote Sensing, Radio Telemetry, GIS, GPS, Mobile App, Capturing and marking techniques, Trapping, Darting, tagging and banding, Scat analysis, Sign surveys	**7**	Students will be able to know ethics and management tactics for wildlife conservation.	1,2
III	Ecosystem: Structure and Functions, Food chain, Food web, Pond as an example, Energy flow in an ecosystem, Ecological Pyramids, Concept of Habitat and Niche..	**6**	Students will know regarding various approaches of habitat management and its significance	1,2
IV	Wild life Protection Act and Projects: Wildlife Protection Act (1972) and its detailed structure, Recent amendments in WPA 1972 and their role in Wildlife protection and Conservation	**5**	Students will have basic idea on WPA, 1972 and its implementation	1,2

V	Conservation Biology: Principles of conservation**,** Major approaches to management**,** Indian case studies on conservation/ management strategy (Project Tiger, Biosphere reserves)	**7**	Students will have understanding on different conservation programme adopted in India for the conservation of wildlife	1,2
Practical	1. Documentation of different invertebrates/vertebrates present in the campus. 2. Activity budgeting of any one species. 3. Measurements of species diversity from provided data sheet using Shannon Winner Index (H′). 4. Measurements of similarity & dissimilarity index of species from provided data sheet. 5. Measurements of association index of species from provided data sheet	**30**		1,2, 3,4

TEXT BOOKS:

T1: An Introduction to Conservation Biology, Anna A. Sher and Richard B. Primack. Oxford University press.

T2: Indian Wildlife Protection Act 1972. Anon. Natraj Publishers, Dehra Dun. 104p.

T3: Fundamentals of Wildlife Management. Gopal, R. 1992. Justice Home. Allahabad. 668p

T4: Conservation Biology for All. Navjot S. Sodhi and Paul R. Ehrlich Oxford University press

T5: Conserving earth's biodiversity. Wilson, E. O., and D. Perlman. Island Press, Washington, D.C.

REFERENCE BOOKS:

R1: Principles of Conservation Biology. Meffe. G.K. and C.R. Carroll. Sinauer Associates, USA.

R2: Ecological Methods for Field and Laboratory Investigations. Michael, P.. Tata Mc Graw Hill Publishing Company Limited, New Delhi. 404 p.

R3: Conservation Biology: Voices from the Tropics. Peter H. Raven, Navjot S. Sodhi, Luke Gibson,. Willey Online library

R4: Fundamentals of Ecology. Odum, E.P.. Natraj Publishers, Dehra Dun 574p.

R5: Wildlife Ecology and Management. Robinson W.L. and Eric G. Bolen. Millen Publishing Co. New York

OTHER LEARNING RESOURCES:

Pathsala- Online Learning Platforms

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand different conservation strategy and programmes adopted for the conservation of wildlife.	**1**
2	Understand the ethics and management tactics for wildlife conservation.	**1**
3	Discuss the structure and function of ecosystem.	**1**
4	Discuss about Wildlife Protection Act, 1972 and its implementation	**1**
5	Illustrate different conservation program adopted in India for the conservation of wildlife.	**1**

Assam down town University

Curriculum and Syllabus

Bachelor of Science
in
Biotechnology

OUTCOME BASED EDUCATION FRAMEWORK

CHOICE BASED CREDIT SYSTEM

Version: 2.2

FACULTY OF SCIENCE

July, 2024

PREAMBLE

Assam down town University is a premier higher educational institution which offers Bachelor, Master, and Ph.D. degree programmes across various faculties. These programmes, collectively embodies the vision and mission of the university. In keeping with the vision of evolutionary changes taking place in the educational landscape of the country, the university has restructured the course curriculum as per the guidelines of National Education Policy 2020. This document contains outline of teaching and learning framework and complete detailing of the courses. This document is a guidebook for the students to choose desired courses for completing the programme and to be eligible for the degree. This volume also includes the prescribed literature, study materials, texts, and reference books under different courses as guidance for the students to follow.

Recommended by the Board of Studies (BOS) meeting of the Faculty of Science held on dated 16th & 17th July, 2024 and approved by the 51st Academic Council (AC) meeting held on dated 26/07/2024

Chairperson, Board of Studies

Member Secretary, Academic Council

Vision

To become a Globally Recognized University from North Eastern Region of India, Dedicated to the Holistic Development of Students and Making Society Better

Missions

1. Creation of curricula that address the local, regional, national, and international needs of graduates, providing them with diverse and well-rounded education.

2. Build a diverse student body from various socio-economic backgrounds, provide exceptional value-based education, and foster holistic personal development, strong academic careers, and confidence.

3. Achieve high placement success by offering students skill-based, innovative education and strong industry connections.

4. Become the premier destination of young people, desirous of becoming future professional leaders through multi disciplinary learning and serving society better.

5. Create a highly inspiring intellectual environment for exceptional learners, empowering them to aspire to join internationally acclaimed institutions and contribute to global efforts in addressing critical issues, such as sustainable development, Climate mitigation and fostering conflict-free global society.

6. To be renowned for creating new knowledge through high quality inter disciplinary research for betterment of society.

7. Become a key hub for the growth and excellence of AdtU's stake holders including educators, researchers and innovators

8. Adapt to the evolving needs and changing realities of our students and community by incorporating national and global perspectives, while ensuring our actions are in harmony with our foundational values and objectives of serving the community.

Programme Details

Programme Overview:

B.Sc. in Biotechnology is a 3-year undergraduate programme which deals with basic and advanced study provides a comprehensive understanding of cell biology, molecular biology, and genetic engineering. Students learn the fundamentals of cell structure and function, gene manipulation techniques, and the principles of genetic engineering. The curriculum includes practical lab work, covering techniques like PCR, RFLP, and RAPD, and applications in vaccine production, gene therapy, and environmental biotechnology. Additionally, the program emphasizes ethical, social, and environmental responsibilities, preparing students for diverse biotechnological careers and further studies in this rapidly evolving field.

I. Specific Features of the Curriculum:

This program outcome aims to provide students with an in-depth understanding of biotechnology's diverse applications, preparing them for future opportunities in this dynamic field. Students will gain hands-on experience with molecular biology techniques and biotechnological instruments, essential for analysis, measurement, and experimentation. Additionally, the curriculum emphasizes the importance of environmental, social, ethical, and professional responsibilities, ensuring that graduates are not only technically proficient but also mindful of the broader impacts of their work. This holistic approach prepares students to be innovative and responsible professionals in biotechnology.

II. Eligibility Criteria:

Minimum 45% in 10+2 with English, Biology & Chemistry. 5% relaxation for SC/ST, EWS, and Specially abled candidates.

III. Program Educational Objectives (PEOs):

PEO-1: AdtU Biotechnology graduates will be well prepared for successful careers in industry and/or in government in one or more following areas: genetic engineering, microbial biotechnology, plant and animal biotechnology, pharmaceutical industries and food processing industries.

PEO-2: AdtU Biotechnology Graduates will be academically prepared to become biotechnologist and will contribute effectively to the growth of the profession.

PEO-3: The Graduates will be successful in higher education in related disciplines of biotechnology if pursued.

IV. Program Specific Outcomes (PSOs):

PSO1: Research and Reasoning: Identify, formulate, review literature, and analyze complex biotechnological problems reaching substantial conclusions using logical and critical thinking, and scientific principles.

PSO2:Techno-Professional Efficiency: Apply the understanding of multidisciplinary concepts of biotechnology with interdisciplinary approaches in the service of mankind.

PSO3: Global Competency: Demonstrate global competency in addressing interdisciplinary biotechnological issues through international certification courses.

V. Program Outcome (PO):

PO1: Biotechnological Knowledge: Apply the knowledge of basic sciences, classical and applied biological sciences, bioinformatics and biostatistics to address the challenges of biological sciences.

PO2: **Problem-Solving:** Ability to integrate multidisciplinary knowledge by applying problem-solving abilities in addressing challenges in biotechnological processes.

PO3: Analytical Processes and Instrumentation: Apply principles, analytical processes and standard methods of modern instrumentation in measurement and systematic analysis.

PO4: **Environment and Sustainability:** Understand the impact of biotechnological solutions in socio-economic and environmental contexts, and reconfigure it sustainable development.

PO5: Values and Ethics: Comply with values and professional ethics.

PO6: Individual and Teamwork: Demonstrate proficiency both as individual and a member/leader in diverse teams and multidisciplinary environments.

PO7: Communication: Proficient in conveying information, creating presentation and preparing reports for effective communication with both the scientific community and society.

PO8: Continual Learning: Engage in lifelong learning aligned with advance biotechnological fields.

VI. Total Credits to be Earned: 133

VII. Career Prospects:

Graduates with a B.Sc in Biotechnology have excellent career prospects in research, healthcare, pharmaceuticals, agriculture, and environmental science. They can become research scientists, lab technicians, clinical research associates, or agricultural biotechnologists, driving innovation in medical therapies, crop improvement, and sustainable environmental solutions.

EVALUATION METHODS

The student performance shall be evaluated through In-semester (Sessional) and semester-end examinations. A weight age of 40% or as prescribed by the programme shall be added to the score of the end semester examination.

A. INTERNAL ASSESSMENT:

The teacher who offers the course shall be responsible for internal assessment by conducting in-semester (sessional) examination and evaluating the performance of the students pursuing that course. The components for internal assessment are illustrated in the table given below.

SN	Components/ Examinations	Marks Allotted
1.	In-Sem Exam – I (ISE-I) (Written Examination)*	30
2.	In-Sem Exam – II (ISE-II) (Written Examination)*	30
3.	Assignment	10
4.	Presentation (SP)	10
5.	Quiz	5
6.	Class Performance based score*	5

are compulsory

Note: *Total Internal assessment should be out of 40*

INSTRUCTION

1. If a student fails to appear in the any of the component without any valid reason he/she shall be marked zero in that component. However, the course teacher at his discretion may arrange for the missed test on an alternate date for the absentee students after determining ground with genuine/valid reasons for the absent.
2. The report of evaluation of an activity towards the in-semester (sessional) component of a course shall be duly notified by the concerned course teacher within a week of completion.
3. The program coordinators should upload the in-semester marks to the ERP and forward acknowledgement of all the courses of the program to the Controller of Examinations before the start of the End-semester examination.

B. SEMESTER END EXAMINATION:

Time table for end semester examination is published at least 25 days prior to the start of Examination.

I. Pre-Examination:

Eligibility Criteria for a student to appear in University Examinations:

The student shall only be allowed to appear in a University Examination, if:

i) He/ She is a registered student of the University;
ii) He/ She is of good conduct and character;
iii) He/ She has completed the prescribed Programme of study with minimum percentage of attendance as laid down in the Regulations of the Programme concerned.

Under special cases, a student may be allowed to appear for an examination without being registered in the University but the result of the said student will be kept on hold till the registration of the concerned student is completed.

II. Admit Card:

Admit card for the examination may be downloaded through ERP where the system will generate a Unique ID Cards through online.

The University shall have the right to cancel admission for examination of any candidate on valid grounds.

III. Pattern of Question Papers:

The question paper shall follow the principles of Bloom's Taxonomy.

Table

S. N.	Level	Questions /verbs for test
1	Remember	List, Define, tell, describe, recite, recall, identify, show who, when, where, etc.
2	Understand	Describe, explain, contrast, summarize, differentiate, discuss etc.
3	Apply	Predict, apply, solve, illustrate, determine, examine, modify
4	Analyze	Classify, outline, categorize, analyze, diagrams, illustrate, infer, etc.
5	Evaluate	Assess, summarize, choose, evaluate, recommend, justify, compare etc.
6	Create	Design, Formulate, Modify, Develop, integrate, etc.

Note: No course is to be evaluated on basis of **all 6 knowledge levels.**

The format of the question paper across all the program follow a unique pattern and the total marks is 60

Table 1: Question paper pattern for End semester examination

Sl no	Question pattern	Total marks
1	MCQs (10 Questions)	10
2	2 Marks questions (10 Questions)	20
3	4 Marks questions (5 Questions)	20
4	10 Marks questions (1 Question)	10

IV. Examination Duration:

Each paper of 60 marks shall ordinarily be of two hours duration.

V. Practical Examinations, Viva-Voice etc.:

i) Practical examination shall be conducted in the presence of one external expert and one or more internal examiners.

ii) Viva-Voice, Oral examinations of the Project report, Dissertation etc. shall be undertaken by a Board of Examiners constituted by the respective Dean of Program with the advice of Supervisor(s).

VI. Procedure of Expulsion:

If any candidate is found to be using any unfair-means during the examination, the invigilator may cease his/her answer sheet and report it directly to the Officer-in-Charge. The

Office-in-Charge of the center may take appropriate decisions as per the rules and procedure of the examination. The Officer-in-Charge may allow the students to write the exam with new answer sheet or may expel the student from appearing the paper depending on the nature of unfair-means. In case of Computer based test, the students may be directed to write an apology letter and sign in the prescribe expulsion form. The student may not be allowed to write that examination.

VII. Instruction to the Students:

(i) The students shall not bring to the Examination Hall, any electronic gadget used as a means of communication or record except electronic calculator, if required.

(ii) The students shall not receive any book or printed or hand written or photo copy (Xerox) or blank-paper from any other person while he/she is in the examination-room or in laboratory or in any other place to which he/she is allowed to have access during course of examination.

(iii) The students shall not communicate with any other candidate in the examination room or with any other person in and outside the examination-room.

(iv) The students shall not see, read or copy anything written by any other candidate, nor shall he/she knowingly or negligently permit any other candidate to see, read or copy anything written by him/her or conveyed by him/her.

(v) The students shall not write anything on the Question Paper or in other paper or materials during the examination, or pass any kind of paper to any other candidate in the examination-room, or to any person outside the room.

(vi) The students shall not disclose his/her identity to the examiner by writing his/her name or putting any sign / symbol in any part of his answer-script.

(vii) The students shall not use any abusive language or write any objectionable remark or make any appeal to examiner by writing in any part of his answer-script.

(viii) The students shall not detach any page from the answer-script or insert any authorized or unauthorized loose sheet into it. He /she shall also not insert any other answer-script / loose sheet by removing the pins of the origin answer-scripts and re-fixing it.

(ix) The students shall not resort to any disorderly conduct inside the examination-room or misbehave with the invigilator or any other examination official.

VIII. Provision for an Amanuensis (writer):

(i) A candidate may be provided with an Amanuensis (writer) to write down on dictation on his / her behalf on ground of his / her physical disability to write down by himself / herself due to accident or any other reason. The amanuensis may be provided till he / she recovers from the physical disability. The physical disability to write down by himself / herself must be supported by Medical Certificate from a competent Medical Officer.

(ii) The qualifications of the amanuensis so provided must not be equal or higher than that of the candidate. This is also to be supported by Certificate from the Faculty of Study where the Amanuensis is provided.

(iii) Such candidates are to be accommodated in a separate room under the supervision of an invigilator so that the fellow candidates are not disturbed in the process.

C. Credit Point:

It is the product of grade point and number of credits for a course, thus, CP = GP x CR

i. Credit:

A unit by which the course work is measured. It determines the number of hours of instructions required per week. 'Credit' refers to the weight age given to a course, usually in terms of the number of instructional hours per week assigned to it. Credits assigned for a single course always pay attention to how many hours it would take for an average learner to complete a single course successfully.

ii. Grade Point:

Grade Point is a numerical weight allotted to each Grade Letter on a 10-point scale.

iii. Letter Grade:

Letter Grade is an index of the performance of students in a said paper of a particular course. Grades are denoted by letters O, A+, A, B+, B, C, P, F and Abs. Student obtaining Grade F / Grade Abs shall be considered failed/ absent and, will be required to appear in the subsequent ESE. The UGC recommends a 10-point grading system with the following (Table: 1) Letter Grades:

(i) A Letter Grade shall signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point shall indicate the numerical weight of the Letter Grade on a 10-point scale.

(ii) There shall be 08 (eight) Letter Grades bearing specific Grade Points as listed in Table 1, where the Letter Grades 'O' to 'P' shall indicate successful completion of a course.

(iii) Apart from the 08 (eight) regular Letter Grades listed in Table 1, there shall be 03 (three) additional Letter Grades, which shall be awarded if a Course is withdrawn or spanned over the next Semester or remains incomplete as stated in Table 2.

Table 2: Letter Grades and Grade Points

Letter Grade	Grade Points	Description
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Abs	0	Absent
UFM	0	Unfair Means

iv. Grade Point Average:

a. SGPA (Semester Grade Point Average)

The SGPA of a student in a Semester shall be the weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered in that Semester, irrespective of whether he/she could or could not complete the Courses. More specifically, the calculation of SGPA shall take into account the Courses graded with Letter Grades 'O' to 'F' as given in Table 1.

$$\text{SGPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad (1.1)$$

The SGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.1) up to two decimal places, where n is the total number of Credit Courses registered by the student in that Semester, Gi is the Grade Point secured in the i^{th} registered Course and Ci is the Credit (weight) of that Course.

b. CGPA (Cumulative Grade Point Average)

(i) The CGPA of a student in a Semester of a Programme shall be the accumulated weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered and successfully completed so far starting from the enrollment in the Programme. In other words, taking into account all the Courses graded with 'O' to 'P' as given in Table 1.1, generally the CGPA of a student shall be calculated starting from the first Semester of his/her enrolled Programme, while the CGPA of a lateral-entry student shall be calculated starting from the Semester of his/her enrollment.

(ii) The CGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.2) up to two decimal places, where N is the total number of Credit Courses registered and successfully completed so far by the student, Gi is the Grade Point secured in the ith completed Course and Ci is the Credit (weight)of that Course.

$$\text{CGPA} = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i} \qquad (1.2)$$

(iii) The CGPA shall be convertible into equivalent percentage of marks using Equation Conversion of CGPA to percentage marks: = CGPA*10

D. Post-Examination

i. Transcript or Grade Card or Certificate:

A marking certificate shall be issued to all the registered students after every Semester. The Semester mark sheet will display the course details (code, title, number of credits, grade secured) along with total credit earned in that Semester.

ii. Grievance Readdress Mechanism:

Students with any dissatisfaction or grievance regarding the marks awarded in any of the Papers / Courses may appeal to the Controller of Examinations for remedial action such as Re-evaluation within 10 days of the declaration of result.

(i) A student has options to appeal for re-evaluation of his /her answer script to the Controller of Examination.

(ii) Application for re-evaluation / re-scrutiny of answer scripts shall be made in the definite proforma available with the Examination Office through the head of the

respective departments within 10 days of declaration of the results of the respective examinations.

(iii) The Controller of Examination may appoint an examiner for re-evaluation and will consider and recognize the evaluation done by a University appointed examiner.

(iv) There shall be no provision for re-evaluation of the Practical Papers, Project Work, and Dissertation etc. However, the students fail in practical examination or viva voce and wish to appear again may apply to be evaluated can do so with the next schedule.

(v) After screening the application for re-evaluation, the CoE may send the answer scripts of the student to the examiners appointed by the CoE with the approval of Vice Chancellor.

(vi) The marks/grades achieved by the students after the re-evaluation shall be final and binding.

(vii) Fresh Marks – sheets / Grade Card shall be issued only if the candidate secures pass marks / passing grade in the re-evaluated paper.

(viii) Revaluation of answer scripts shall be deemed to be an additional facility provided to the students with a view to improving upon their results at the preceding examination result for any reason whatsoever shall not confer any right upon them for admission to next higher class which matters always be regulated in accordance with the relevant rules or regulations framed by the University.

(ix) If as a result of revaluation of the candidate attracts the provision of condonation of deficiency, the same may be applied to his/her only for fresh attempt.

INSTRUCTION TO TEACHERS AND STUDENTS

(Teaching and Learning Methods)

In all the courses the teacher has to select topics for teacher-method which should not be less than 20 percent. The approach will be direct class room teaching through series of lectures delivering concepts using ITC facilities, white or black board. Notes may also be circulated to the students however; the students are to be involved in preparation of the notes. The teacher will be responsible in selecting the best note for circulation. The teacher- centric methodology has recently fallen out of favour because this strategy for teaching is seen to favour passive students.

1. Student- centric / Constructivist Approach:

The topics of the courses may be selected at the start of the class and assigned one topic to each of the student for studying by themselves, prepare presentations, notes etc., and present at respective class time after consultation and discussion with the course teachers. The teacher facilitate the learning of the students by guiding and providing input and explaining concepts. 60 percent of the course contents may be selected for this purpose. To avoid behavior problems, teachers must lay a lot of groundwork in student- centric classrooms. Typically, it involves instilling a sense of responsibility in students. In addition, students must learn internal motivation.

a. Project-Based Learning: The teacher may select 5 percent of topics for the purpose and may conduct visit to the laboratory for experiments or field and survey. The selection of the topic may be done considering the available facility for the purpose. However, in the final semester of each of the programme the student has to undergo a project-Based learning at least 4 months duration. This approach will help the student to think critically, evaluate, analyze, make decisions, collaborate, and more.

b. Inquiry-Based Learning: The teacher/ students are supposed to list at least five questions in each contact hour and student solve these question or search for answer which becomes the home work for the students "question-driven" learning approach. The teacher may look for the correctness of the solution or the best possible answer and discuss in the successive class. This will help in the preparation for various competitive examination and develop a habit for search for solutions.

c. Flipped Classroom: About 10 percent of the course content has to be completed by this method. In this approach the students are asked to watch video or lecture prepared by the teacher or any video available (relevant to the course). A set of questions may be given to the students for searching answers by the students. The idea is that students should have more time in-classroom focusing on achieving these higher levels of thinking and learning. The Flipped classroom is also an acronym. The letters FLIP represent the four pillars included in this type of learning: Flexible environment, Learning culture shift, Intentional content, and Professional educator. As you can see, the second pillar refers to a culture shift from the traditional approach where students are more passive to an approach where students are active participants. As a result, this approach is also a student- centric teaching method.

d. Cooperative Learning: The remaining five percent has to be completed by cooperative learning approach. In this approach the students are allotted with problems. During the library hours the student along with the teacher visits library search probable solution for the assigned problem. The same has to be done in group so that the students discuss among themselves for the appropriate answers. Essentially, cooperative learning believes that social

interactions can improve learning. In addition, the approach recreates real-world work situations in which collaboration and cooperation are required.

The percentage categorization for the completion of a theory course

Teacher- centric or Direct Classroom Teaching: Delivery by series of lectures	20%
Student- centric Approach, Student present and deliver lectures in presence of teacher and supervised by teacher	60%
Student visit fields or perform experiments or teacher perform demonstration	05%
Flipped Classroom approach	10%
Cooperative learning approach	05%

Inquiry based approach has to be followed in all of the classes

Teacher has to distribute the topics to be considered for teaching by the above-mentioned approaches and prepare lesson plan for execution and maintain a file.

SEMESTER WISE COURSE DISTRIBUTION

	S. N.	Course Code	Course Title	Course	Engagement							Maximum Marks for			
				Category	L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester I	1	24BSBT1101R	Cell Biology	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	2	24BSCH1101R	Basic Chemistry	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	3	24BSZO1101R	Animal Science	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	4	24BSBT1102R	Biotechnology for Human Welfare	DSC Minor	2	0	0	0	0	0	2	40	60	0	100
	5	24UBFS1101R	Basics of Statistics	MDC	3	0	0	0	0	0	3	40	60	0	100
	6	24UBPD1102R	Elementary English (CLPPD)	AEC	0	0	4	0	0	0	2	0	0	100	100
	7	24BSAG1101R	Agricultural Education	VAC	2	0	0	0	0	0	2	40	60	0	100
	8	24UBEC1101	Extra-curricular	Co/Extra-curricular	0	0	0	4	0	0	1	0	0	100	100
	Total										**20**				**1100**

	S. No.	Course Code	Course Title	Course	Engagement							Maximum Marks for			
				Category	L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester II	1	24BSBT1201R	Genetics	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	2	24BSFS1201R	Forensic Biology	DSC Minor	2	0	0	0	0	0	2	40	60	100	200
	3	24BSBT1202R	Human Disease Biology	DSC Minor	2	0	2	0	0	0	3	40	60	0	100
	4	24BSBT1203R	Biophysical chemistry	DSC Minor	2	0	2	0	0	0	3	40	60	100	200
	5	24BSAG1002R	Agricultural heritage	MDC	1	0	0	0	0	0		40	60	0	100
	6	24BAPS1206R	Psychology of Happiness	MDC	2	0	0	0	0	0		60	40	0	100
	7	24UBPD1202R	Implicit English	AEC	0	0	4	0	0	0		0	0	100	100
	8	24UBES1101R	Environmental Studies	VAC	2	0	0	0	0	0		60	40	0	100
	9	24BSBT1204R	Design thinking and Entrepreneurship/Ideation concept	SEC	0	0	2	0	0	0		0	0	100	100
	10	24UBCC1201	CO Curricular Activities	Co and extra-Curricular	0	0	0	4	0	0		0	0	100	100
		Total									**21**				**1200**

	S. No	Course Code	Course Title	Course	Engagement							Maximum Marks for			
				Category	L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester III	1	24BSBT2101R	Biomolecules	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	2	24BSBT2102R	Microbiology	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	3	24BSZO2101R	Entomology	DSC Minor	3	0	0	0	0	0	3	40	60	0	100
	4	24BSBO2101R	Forestry	DSC Minor	3	0	0	0	0	0	3	0	0	100	100
	5	24BSFD2001R	Basic of Food Science	DSC Minor	2	0	0	0	0	0	2	0	0	100	100
	6	24BSCH2001R	Natural product chemistry	MDC	2	0	0	0	0	0		60	40	0	100
	7		PDP English Courses	AEC	0	0	4	0	0	0		0	0	100	100
	8	24BSBT2103R	Mushroom cultivation	SEC	0	0	4	0	0	0		60	40	100	200
	9	24BSBT2104R	Field Training	Field Training	0	0	0	4	0	0		0	0	100	100
	Total										**23**				**1400**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester IV	1	24BSBT2201R	Enzymes and Metabolism	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	2	24BSBT2202R	Molecular Biology	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	3	24BSBT2203R	Bioinstrumentation	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	4	24BSBT2204R	Immunology	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	5		PDP English Course	AEC	0	0	4	0	0	0	2	0	0	100	100
	6	24UUFL202R	Financial Literacy	MDC	0	2	0	0	0	0	1	0	0	100	100
	7		Aptitude Course	SEC	0	0	0	8	0	0	2	0	0	100	100
	8	24UUHV2201R	UHV	VAC	1	0	0	0	0	0	1	40	60		100
	9		BLSS	VAC	0	0	2	0	0	0	1	0	0	100	100
	Total										**23**				**1200**

	S. No.	Course Code	Course Title	Course	Engagement							Maximum Marks for			
				Category	L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester V	1	24BSBT3101R	Plant Biotechnology	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	2	24BSBT3102R	Medical Biotechnology	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	3	24BSBT3103R	Animal Biotechnology	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	4	24BSBT3104R	Bioinformatics	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	5		Logic Reasoning Course	SEC	0	0	0	8	0	0	2	60	40	100	100
	6	24BSBT3105R	Biofertilizer production	SEC	0	0	4	0	0	0	2	60	40	100	100
	7	24BSBT3106R	Summer Internship	Internship	0	0	0	0	0	24	4	0	0	100	100
	8	24BSBT3107R	Mini Research (R1)	Research/industry internship	0	0	0	0	12	0	2	0	0	100	100
	Total										**26**				**1200**
	S. No.	**Course Code**	**Course Title**	**Course**	**Engagement**							**Maximum Marks for**			
				Category	**L**	**T**	**P**	**S**	**R**	**O**	**C**	**IA***	**SEE***	**PE***	**Total**
Semester VI	1	24BSBT3201R	Industrial Biotechnology	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	2	24BSBT3102R	Agriculture Biotechnology	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	3	24BSBT3203R	Research Methodology	DSC Major	4	0	0	0	0	0	4	40	60	0	100
	4	24BSBT3204R	Food Biotechnology	DSC Major	4	0	2	0	0	0	4	40	60	100	200
	5	24BSBT3205R	Mini Research (R2)	Research	0	0	0	0	24	0	4	0	0	100	100
											20				**800**
	Total										**133**				**6900**

***IA: Internal Assessment, SEE: Semester End Examination, PE: Practical Examination**

SEMESTER – I									
Course Title	**Cell Biology**								
Course code	**23BSBT111R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. Introduce and make students understand about the fundamentals and advances of cytology including structure and functions of cell and cell organelles, cell cycle, cell division, also by observing it under microscope. 2. To inculcate knowledge and skills on various staining techniques, and understand cell structure by observing them under microscope 3. Gain proficiency in laboratory techniques commonly used in cell biology research, including microscopy, cell culture, and molecular biology assays.								
CO1	Understand cellular organization, functions, microscopy and structural differences.								
CO2	Describe membrane structure, function, cell organization and the proteins involved in transportation.								
CO3	Elaborate chromosomal structure and types.								
CO4	Understand the mechanism of cell to cell communication.								
CO5	Describe the cell cycle and division in general and in some specific cell types.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Fundamentals of Cell Biology:** (Cell theory, Prokaryote and Eukaryote cell: Structure and Function of cells); **Tools and Technique of Cytology:** (Microscopy and Staining).	**7**	Describe, illustrate and explain cell organization and functions, microscopy and structural differences.	1,2
II	**Cell Membranes:** Model, Structure, function; Cell junctions and adhesion; Transport proteins; Membrane Proteins; Membrane potential; Transport across plasma membrane.	**10**	Describe, illustrate and explain membrane structure, function; cell organization and the proteins involved in transportation.	1,2
III	**Chromosomes:** Morphology (Structural organization: nucleosome, solenoid model, chromatid, centromere and telomere); Types (special type).	**10**	Describe, illustrate and explain chromosomal structure and types.	1,2
IV	**Cell trafficking and signalling**: cell signals; signalling pathways; cell surface receptors, protein phosphorylation; Quorum sensing phenomenon.	**8**	Describe, illustrate and explain the mechanism of cell to cell communication	1,2
V	**Cell Division & Cell Cycle:** regulation, growth and differentiation; Overview of Stem cells, Germ cells, Cancer cells, Apoptosis and Necrotic cell death	**10**	Describe, illustrate and explain the cell cycle and division in general and in some specific cell types	1,2
Practical	1. Staining and microscopic observation of various stages of Mitosis of given sample(s). 2. Staining and microscopic observation of various stages in Meiosis of given sample(s).	**30**	Describe, illustrate and explain and apply staining techniques and carry out microscopic examination.	1,2,3,4

TEXT BOOKS:

T1:Alberts B, Johnson A, Lewis J, et al. Molecular Biology of the Cell. 4th edition. New York: Garland Science; 2002.

REFERENCE BOOKS:

R1: Cooper GM. The Cell: A Molecular Approach. 2nd edition. Sunderland (MA): Sinauer Associates; 2000.

R2: Ambrose and Dorothy. Cell Biology. 2nd Edition. MEasty, ELBS Publications; 1970.

R3: Sharp, Lester W. Fundamentals of Cytology. 52th edition. Mc Graw Hill Company; 2011.

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/books/NBK9839/?term=cell%20Biolpgy

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand cellular organization, functions, microscopy and structural differences.	1, 2, 3
2	Describe membrane structure, function, cell organization and the proteins involved in transportation.	1, 2, 3
3	Elaborate chromosomal structure and types.	1, 2, 3
4	Understand the mechanism of cell to cell communication.	1, 3
5	Describe the cell cycle and division in general and in some specific cell types.	1, 2, 3

SEMESTER – I										
Course Title	**General Microbiology**									
Course code	**23BSBT112R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To introduce the history, concept and importance of microorganisms in the field of biotechnology, medical, agriculture etc. 2. To impart knowledge and skills on various instruments and techniques used for isolation, culture and identification of microbes.								
CO1	Describe fundamentals of microbiology and contributions made by many eminent scientists.								
CO2	Describe and explain microscopes and their principle and uses.								
CO3	Apply the knowledge on the use of autoclave, hot air oven, laminar air flow, microscope and isolate microbes, and culture.								
CO4	Explain the methods of classification of microorganisms.								
CO5	Describe the methods for culturing microorganisms.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Fundamentals of Microbiology**: History (Contributions of A.V. Leeuwenhoek, Louis Pasteur, Koch Joseph Lister, and Alexander Flamming); Scope; Terms & Definition; Importance of Microbiology; Branches of Microbiology.	**7**	Describe, fundamentals of microbiology and contributions made by many eminent scientists.	1,2
II	**Microscopy**: Simple, compound, phase contrast and electron microscope.	**10**	Able to describe and explain microscopes and their principle and uses	1,2
III	**Microbial Techniques:** Sterilization & filter **(Physical methods:** Autoclave, Hot air oven, Laminar airflow, Seitz filter, Sintered glass filter, membrane filter; **Chemical Methods**: Alcohol, Aldehydes, Phenols, Halogens and Gaseous agents; **Radiation:** UV rays and Gamma rays); **Staining Techniques**: Principles, Types (simple Structural stains, acid fast and Differential stains)	**10**	Describe, illustrate and explain the basic techniques such as sterilization, staining etc., used in a microbiological study.	1,2
IV	**Microbial Taxonomy**: Concept of species & strains; classification of bacteria; Typical bacterial cell (structure & function; forms); Gram positive & negative bacteria; Classification based on serotyping and nutrition of microbes; Microbes of extreme environment	**8**	Describe, illustrate and explain the methods of classification, structures and functions of a typical bacterial cell	1,2
V	**Culturing microbes:** Media & types; Isolation and screening; Growth curve; Maintenance and preservation of microbial cultures	**10**	Describe, illustrate and explain isolation, screening and culturing of microorganisms.	1,2
Practical	1. Laboratory Safety, preparation for experiment, and laboratory waste	**30**	Describe, illustrate and explain and apply	1,2, 3,4

	management. 2. Principle, operation and measurement of pH of a given sample 3. Principle and operation of Hot air oven, Autoclave, Laminar airflow and centrifuge. 4. Isolation of microbes from given sample by serial dilution techniques and estimation of the CFU (Pour plate and streak plate techniques also be learned) Staining (gram, acid fast, endospore or any appropriate staining) of the given microbial sample and observation under microscope.		laboratory safety rules, set a microbiological experiment for microbial isolation, prepare slides by applying staining techniques and observe them under microscope.	

REFERENCE BOOKS:

R1. L.E.J.R. Casida. Industrial Microbiology. 2nd edition. New AGE International Publisher, 2019

R2. P. S. Bisen. Fontiers in microbial technology. 1st edition. C.B.S. Publishers and Distributors; 1994

R3. Alan T. Bull. Biotechnology: International Trends and Perspectives, Issue 7. Organisation for Economic Co-operation and Development, 1982.

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/books/NBK7627/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe fundamentals of microbiology and contributions made by many eminent scientists.	1, 2, 3
2	Describe and explain microscopes and their principle and uses.	1, 2, 3
3	Apply the knowledge on the use of autoclave, hot air oven, laminar air flow, microscope and isolate microbes, and culture.	1, 2, 3
4	Explain the methods of classification of microorganisms.	1, 2, 3
5	Describe the methods for culturing microorganisms.	1, 2, 3

SEMESTER – I									
Course Title	**Bio-Molecules**								
Course code	**23BSBT112R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To impart knowledge and understanding on the various macro-molecules of life, their constitution, classification, structure and functions. 2. To develop skills for qualitative analysis of these molecules by biochemical methods.								
CO1	Comprehensive understanding of the structure, function and differentiation of the types of DNA and RNA								
CO2	Demonstrate the structure and correlate its properties, biological importance and the qualitative analytical tests for amino acid.								
CO3	Describe the various levels of protein organization and the forces driving them								
CO4	Outline the basics of carbohydrate in terms of its structure, classification, properties and the laboratory qualitative tests.								
CO5	Comprehensive understanding of the structure, function and differentiation of the types of lipids								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Nucleic acid**: Structure (Nitrogenous bases, ribose, deoxyribose, Nucleosides, nucleotides); glycosidic and phospodiester bonding, polynucleotide (formation, single letter code), DNA (Watson-Crick Model; forms [A,B,Z]; Physical Properties; denaturation and renaturation); RNA and its types; Clover leaf model of tRNA.	**10**	Describe, illustrate and explain the structure and function of nucleic acids including its different forms.	1,2
II	**Amino acids:** Classifications; Essential and Non-Essential amino acids; Properties (physical, chemical & optical); Importance.	**5**	Describe, illustrate and explain the structure and properties of amino acids and classify them.	1,2
III	**Protein:** Classification based on (shape [fibrous proteins (keratins, collagen and elastin), globular proteins (hemoglobin, myoglobin), lipoproteins, metallo proteins, glycoprotein and nucleoproteins]; chemical composition); Structure (primary, secondary, tertiary & quaternary); Denaturation and renaturation; Functions.	**10**	Describe, illustrate and explain the structure and function of proteins.	1,2
IV	**Carbohydrates:** Classification; Isomerism, (D and L forms); Anomers, Epimers, Mutarotation; Monosaccharides (linear and cyclic). Disaccharides (structure, occurrence,	**10**	Describe, illustrate and explain the structure and function of carbohydrates.	1,2

	properties and functions); Cellulose (occurrence, structure, properties and functions); Heteropolysacchrides (occurrence, types, composition and function), Homopolysaccharides.			
V	**Lipids**: fatty acids; glycerol; sphingosine; classifications; and characterization; Saponification and iodine number; Properties (glycerol, fats and oils); Properties and function (Phospholipids and Prostaglandins); Structure (sterols, Bile acids, steroid hormones, plant sterol, ergosterol, stigma sterol, cholesterol, glucocorticoid, mineralocorticoids); Lipoproteins (classification, composition and importance); Role of Lipids in cellular architecture and functions.	**10**	Describe, illustrate and explain the structure and function of lipids.	1,2
Practical	Qualitative analysis of Carbohydrate 1. Fehling's Test 2. Barfoed's Test 3. Molisch's Test 4. Benedict's test Qualitative analysis of proteins 5. Biuret Test 6. Xanthoproteic Test 7. Precipitation test 8. Heat and Acetic acid test Qualitative analysis of amino acids Ninhydrin Test	**30**	Describe, illustrate and explain apply qualitative analysis of carbohydrate, protein and amino acids.	1,2,3, 4

REFERENCE BOOKS:

R1. David L. Nelson, Michael Cox. Menninger Principles of Biochemistry. 7th Edition. WH Freeman; 2017.

R2. Rodwell et al. Harper's Illustrated Biochemistry. 29th edition. McGraw Hill; 2012.

R3. Voet and Voet. Biochemistry. 3rd edition. John Wiley & Sons, 2004.

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/books/NBK545161/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Comprehensive understanding of the structure, function and differentiation of the types of DNA and RNA	1,2
2	Demonstrate the structure and correlate its properties, biological importance and the qualitative analytical tests for amino acid.	1,2
3	Describe the various levels of protein organization and the forces driving them	1,3
4	Outline the basics of carbohydrate in terms of its structure, classification, properties and the laboratory qualitative tests.	1,2
5	Comprehensive understanding of the structure, function and differentiation of the types of DNA and lipids	1,2

SEMESTER – I									
Course Title	**Basic Chemistry**								
Course code	**23FSCH101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To give the knowledge about Chemical Kinetics and Ionic Equilibrium 2. To give a detailed description of atomic structure, different theories related to it and the knowledge of classical and quantum chemistry. 3. To give the knowledge of the periodic properties and HSAB theory								
CO1	Understand the order of the rate law equation, then characterize the "half-life" and temperature dependency of reaction rates using the Arrhenius equation.								
CO2	Explain the concepts of electrochemistry, electrochemical cells, acids/base, pH, buffers and solubility								
CO3	Illustrate atomic structure, Heisenberg Uncertainty principle, Quantum mechanics and Schrodinger wave equation.								
CO4	Elucidate the concepts of chemical bonding, periodic properties.								
CO5	Explain the different types of organic reactions along with their mechanisms, organic molecules and their stereochemistry.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Chemical Kinetics: Order-molecularity. First and second order-nth order rate equation, temperature dependence of rate of reactions.	**10**	Understand underlying concepts of electrochemistry, electrochemical cells, acids/base, pH, buffers and solubility	1,2
II	Ionic equilibrium: Electrolytic conductance, Faraday's Law of electrolysis, Electrolytes, Lewis theory, Arrhenius theory for dissociation of electrolytes, ionization constants of weak acids and bases, pH, buffers, solubility products, salt effects and solubility	**8**	Understand atomic structure, Heisenberg Uncertainty principle, Quantum mechanics and Schrodinger wave equation. To learn about the graphical representation of different atomic orbital and how the electrons are filled in the orbital.	1,2
III	Atomic Structure: Recapitulation of Bohr's theory and its limitations, dual behaviour of matter and radiation, deBroglie's relation, Heisenberg Uncertainty principle. Need of a new approach to Atomic structure. What is Quantum mechanics, Time independent Schrodinger equation and meaning of various terms in it. Wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. (Only graphical representation) Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals,	**10**	Understand the concepts of chemical bonding by using various theories, periodic properties like Atomic and Ionic size Ionization Energy Electron Affinity, Electro negativity of elements of periodic table.	1,2

	concept of exchange energy.			
IV	Chemical bonding- Various theories, covalent, hydrogen Bonding. Effective nuclear charge, atomic and ionic sizes. 6 Ionization energies, electron affinity and electro negativity, hard soft acids and bases.	**10**	Understand the different types of organic reactions along with their mechanisms. How to design syntheses of organic molecules. Acquire the knowledge of stereochemistry of organic molecules.	1,2
V	Organic Reactions and Stereochemistry: Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule, Representations of 3 dimensional structures, structural isomers and stereo isomers. Configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.	**10**	Understand underlying concepts of electrochemistry, electrochemical cells, acids/base, pH, buffers and solubility	1,2

REFERENCE BOOKS:

R1. Graham Solomons. Solomons's Organic Chemistry, Global Edition. Wiley; 2017.

R2. Bahl, Bahl. A Textbook Of Organic Chemistry. 22th Edition. S Chand Publishing; 2019.

R3. Eliel and Wilen. Stereochemistry of Organic Compounds. 1st Edition. Wiley-Interscience. 1994.

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5869253/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the order of the rate law equation, then characterize the "half-life" and temperature dependency of reaction rates using the Arrhenius equation.	1
2	Explain the concepts of electrochemistry, electrochemical cells, acids/base, pH, buffers and solubility	1,2
3	Illustrate atomic structure, Heisenberg Uncertainty principle, Quantum mechanics and Schrodinger wave equation.	1
4	Elucidate the concepts of chemical bonding, periodic properties.	1,2
5	Explain the different types of organic reactions along with their mechanisms, organic molecules and their stereochemistry.	1,2

SEMESTER – I									
Course Title	**Animal Science**								
Course code	**23FSZO101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. Analyze the diversity, structure, and classification of the animal kingdom, focusing on triploblastic coelomate organization. 2. Understand life processes including osmoregulation, excretion, neural conduction, endocrine regulation, and reproduction. 3. Examine the relationships between insects and microbes, and explore integrated pest management strategies. 4. Explore the principles of evolution, biodiversity, and genetics, including Mendelian and non-Mendelian inheritance patterns.								
CO1	Identify and classify species of animal kingdom.								
CO2	Explain various biochemical processes occurring in living being								
CO3	Explain and illustrate phenomena of animal reproductive biology								
CO4	Illustrate the evolution process, importance of biodiversity hotspot								
CO5	Describe classical genetics of living organism								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Diversity of Animal Kingdom: Triploblastic coelomate organization: Animals with mantle: Phylum Mollusca, Animals with enterocoel: Phylum Echinodermata, Phylum Hemichordata, Phylum Chordata, Subphylum Urochordata, Subphylum Cephalochordata, Subplylum Vertebrata, Super class: Agnatha, Class Cyclostomata, Superclass: Gnathostomata, Class Pisces (Cartilaginous and bony fish), Class Amphibia, Class Reptilia, Class Aves, Class Mammalia	**5**	Describe, illustrate and explain the basic concepts associated with each system of the body in vertebrates and invertebrates. Identify structures that are in place in the body systems to perform the functions according to the habits or habitats of the animals.	1,2
II	Life processes Concepts of osmoregulation and excretion, Categorization of animals on the basis of principle nitrogenous excretory products. Ornithine cycle, formation of urea, determination and detoxification.Control and Coordination, Irritability, Structure of neuron, sense organs - human eye and ear. Conduction of nerve impulse: Resting potential, action potential and refractory period. Synaptic transmission, Endocrine regulation: Hormones as chemical messengers, feedback mechanisms. Reproduction: Gametogenesis, structures of egg and sperm of mammal. Fertilization and in vitro fertilization, oviparity, viviparity and	**6**	Describe, illustrate and explain the knowledge of different life processes, endocrine regulation and reproductive biology of animal.	1,2

	ovo-viviparity.			
III	Insect microbiology: Mutualistic associations between insects and microbes Insect nutrition and the importance of microbe's Fungal symbioses: Ant fungal gardens and termites Microorganisms and insect behavior. Insects as Vectors of Animal pathogens; Integrated pest management for vector control	**5**	Describe, illustrate and explain different types of associations of insects, insect behaviour and role of insect as a vector of various diseases.	1,2
IV	Evolution and Biodiversity: Evolution, Origin of life: Emergence of life on primitive earth, Evolution and adaptations: Microevolution, Role of Natural Selection in microevolution, Co-evolution. Ecological niches and adaptations. Biodiversity, Definition, Biodiversity hotspots, Benefits of Biodiversity, Biodiversity conservation, Bio- wealth of India. Human activities affecting biodiversity. Future of evolution.	**7**	Describe, illustrate and explain the evolution and diversity.	1,2
V	Genetics: Gene and gene concepts, Mendel an inheritance: Monohybrid and dihybrid cross, Concept of dominance. Exception to Mendel an inheritance: incomplete dominance, co- dominance; Interaction of genes: (Epistasis: recessive, dominant, double recessive and double dominant epistasis), lethal genes, Cytoplasmic inheritance: Kappa particles in Paramecium, sigma factor in Drosophila and shell coiling in Limnea. Introduction to human genetics: Mendel an phenotypic traits in humans: Dominant, recessive and X- linked characters (2 examples each), Pedigreeanalysis: Dominant, recessive and X- linked traits, Genetic counselling, Risk of inheriting a disease from consanguineous marriage.	**7**	Describe, illustrate and explain theclassical genetics and learn about diseases associated with genetic disorder	1,2

Reference Books:

R1. Principles of Genetics by Snustad and Simmons (7thEdition) John Wiley and Sons, USA.

R2: Textbook of physiology by Dr. A.K. Jain. (9thEdition). APSbooks.

R3: EdwardO. Wilson, 1996, Biodiversity,521pp., National Academy Press.

OTHER LEARNING RESOURCES:
https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify and classify species of animal kingdom.	1
2	Explain various biochemical processes occurring in living being	1,2
3	Explain and illustrate phenomena of animal reproductive biology	1
4	Illustrate the evolution process, importance of biodiversity hotspot	1,2
5	Describe classical genetics of living organism	1,2

SEMESTER – I									
Course Title	**Elementary English**								
Course code	**23UBPD113R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To recognize and identify parts of a sentence and their significance in a language. 2. To enhance listening and speaking/skills for self-development. 3. To give insight into English pronunciation and into central concepts in phonetics. 4. Introduction to the various modes of communication will enhance their knowledge of communication.								
CO1	Equip students to recognize and apply parts of speech, articles, and auxiliary verbs, and to create both affirmative and negative sentences.								
CO2	Teach students to apply determiners, form different types of sentences, and comprehend degrees of comparison.								
CO3	Prepare students to confidently introduce themselves, use proper pronunciation, intonation, and stress, and effectively ask for and provide information.								
CO4	Help students grasp the communication process, differentiate between communication types, manage both formal and informal communication, and identify barriers to effective communication.								
	Teach students the key components of an effective presentation and how to use visual aids proficiently.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Basics of Grammar (Flipped classroom)** i. Parts of Speech ii. Articles iii. Auxiliary Verbs iv. Affirmative and Negative Sentences	**6**	Students will demonstrate a fundamental understanding of grammar rules.	1,2, 3
II	**Grammar (Flipped classroom)** i. Determiners ii. Sentence Construction iii. Types of Sentences (Assertive, Imperative, etc.) iv. Degree of Comparison	**6**	Students will construct grammatically correct and varied sentence types.	1,2, 3,4
III	**Speaking Skills** i. Introduction and Greetings ii. Pronunciation, Intonation, Stress iii. Asking and offering information	**5**	Students will confidently introduce themselves and engage in basic conversations with correct pronunciation.	1,2, 3
IV	**Communication Skills** i. Introduction to Communication ii. Process and Types of Communication, iii. Formal and informal communication iv. Understanding Barriers to Communication	**7**	Students will effectively communicate in both formal and informal settings.	1,2, 3

Textbooks:

1.Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.
2.Reed, James. 2016. 101 Job Interview Questions You'll Never Fear Again, Plume.
3.Pease, Barbara. 2006. The Definitive Book of Body Language, RHUS.
4.McDowell, GayleLaakmann.2008.Cracking the Coding Interview (Indian Edition)

Reference Books:

1.Zinsser, William.(2006) On Writing Well: The Classic Guide to Writing Nonfiction Harper Perennial
2.Taylor J. and Wright, J., IELTS Advantage Reading Skills: A step-by-step guide to a high IELTS reading score, Delta Publishing by Klett.
3.Kelley, Thea. 2021. Get That Job: The Quick and Complete Guide to a Winning Interview, Plovercrest Press.
4.Murphy, Raymond,.(2012) English Grammar in Use Book with Answers: A Self- Study and Practice Book for Intermediate Learners of English ,Cambridge University Press

OTHER LEARNING RESOURCES:

https://www.ef.com/wwen/english-resources/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Equip students to recognize and apply parts of speech, articles, and auxiliary verbs, and to create both affirmative and negative sentences.	1, 7
2	Teach students to apply determiners, form different types of sentences, and comprehend degrees of comparison.	1, 7
3	Prepare students to confidently introduce themselves, use proper pronunciation, intonation, and stress, and effectively ask for and provide information.	1, 7
4	Help students grasp the communication process, differentiate between communication types, manage both formal and informal communication, and identify barriers to effective communication.	1, 7

SEMESTER – I									
Course Title	**Extra-Curricular Activities**								
Course code	**23UBEC111**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To ascertain physical and mental development of the students and select best performers for state, national and international level competition. 2. To enhance and improve student's talents in the field of sports, yoga, music, dance, drama, etc through AdtU club activities and workshops.								
CO1	Demonstrate Enhanced Skill Proficiency								
CO2	Foster Personal Growth and Development								
CO3	Cultivate Ethical and Responsible Behaviour								
CO4	Promote Engagement and Commitment								
CO5	Enhance Social and Cultural Awareness								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Based on the learner's interest they can participate in various sports, music, and co-curricular activities joining the clubs of the University (Football, Footshal; Cricket; Swimming; Basket ball; Badminton; Table Tennis; athletics and other outdoor and indoor games; Dance; Music; Vocals; Photography; Drama; Literary activities); The students are encouraged to participate in regular club activities, workshops, competitions as per their interest and hobbies; Renowned skilled professionals/ personalities are invited organising workshops to promote the talents of the students.	**60**	Participation in university clubs across sports, music, and extra-curricular activities cultivates diverse skills and personal growth. Students develop teamwork, leadership, and creativity through sports like football, cricket, and athletics. Musical pursuits and dance foster self-expression and coordination, while literary and drama activities enhance communication and critical thinking. Workshops led by skilled professionals provide industry insights and mentorship opportunities, preparing students for future challenges. By encouraging participation based on interests and hobbies, universities nurture well-rounded individuals who excel academically and socially, equipped with practical skills and a broadened perspective on cultural diversity and personal fulfilment.	1,2

REFERENCE BOOKS:

R1: "Extracurricular Activities: Essential Guides for Students" by John G. Gabriel

R2: "Developing Personal, Social and Emotional Skills through Extra-Curricular Activities" by Sally Bailey

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Demonstrate Enhanced Skill Proficiency	5, 6, 8
2	Foster Personal Growth and Development	5, 6, 8
3	Cultivate Ethical and Responsible Behaviour	5, 6, 8
4	Promote Engagement and Commitment	5, 6, 8
5	Enhance Social and Cultural Awareness	5, 6, 8

SEMESTER – I									
Course Title	**Co-Curricular Activities**								
Course code	**23UBEC111**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To ascertain physical and mental development of the students and select best performers for state, national and international level competition. 2. To enhance and improve student's talents in the field of sports, yoga, music, dance, drama, etc through AdtU club activities and workshops.								
CO1	Students will learn to work well with others and communicate better.								
CO2	Students will learn to manage their time and stay organized.								
CO3	Students will enhance their creative abilities and think more critically.								
CO4	Students will improve their overall health and reduce stress.								
CO5	Students will become more aware of their role in society and contribute positively.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Co-curricular activities cover a wide range of experiences and pursuits that complement academic learning. They are typically organized and managed within educational institutions or communities and play a crucial role in holistic development. Some examples are 1. Sports and Physical Activities 2. Cultural Activities: 3. Academic Clubs and Competitions 4. Community Service and Volunteering 5. Leadership and Personal Development 6. Creative and Hobby-based Activities	**60**	1. Skill Development: Enhancing skills such as teamwork, leadership, communication, and critical thinking. 2. Holistic Growth: Supporting emotional, social, and physical development alongside academic learning. 3. Building Networks: Creating opportunities to interact with peers, mentors, and professionals. 4. Personal Fulfillment: Providing avenues for creativity, self-expression, and exploring personal interests.	1,2

REFERENCE BOOKS:

R1: "Co-curricular Activities: A Pathway to Careers" by Ferguson.

R2: "Rahman, S.R., Islam, M.A., Akash, P.P., Parvin, M., Moon, N.N. and Nur, F.N., 2021. Effects of co-curricular activities on student's academic performance by machine learning. *Current Research in Behavioral Sciences*, *2*, p.100057.

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will learn to work well with others and communicate better.	5, 6, 7, 8
2	Students will learn to manage their time and stay organized.	5, 6, 8
3	Students will enhance their creative abilities and think more critically.	7,8
4	Students will improve their overall health and reduce stress.	7,8
5	Students will become more aware of their role in society and contribute positively.	6, 8

SEMESTER – II									
Course Title	**Enzymes and Metabolism**								
Course code	**23BSBT121R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ II semester of first year of the programme**								
Course Objectives	1. To make the students understand about enzymes and their mechanisms of action, minerals & vitamins, their role in regulating the function of cells, harness energy by carbohydrate and protein metabolisms and the plant growth regulators. 2. To impart skills for quantitative estimation of DNA, RNA, proteins and carbohydrates and extraction								
CO1	Describe enzymes, enzyme kinetics, including carbohydrates, and proteinsmetabolism**.**								
CO2	Explain the physiological roles of vitamins and minerals and their contribution for overall growth and development of the human body.								
CO3	Describe the generation of cellular energy in our body through regulation of carbohydrate metabolism.								
CO4	Illustrate the interconnection between protein metabolism in our body and different associated metabolic pathways.								
CO5	Analyze the physiological effects of plant growth regulators in plant growth and development								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Enzyme:** History, Terminology, General characteristics Classification, nomenclature; Coenzyme; cofactor; active site; ribozyme; Mechanism OF action (Lock & key model; Induced fit model), **Enzyme Kinetics** (Michaelis- Menten equation, Line weaver Burk plot), Enzyme (inhibition, specificity, Application).	15	Able to describe, explain and illustrate the enzymes and enzyme kinetics.	1,2
II	**Vitamins and Minerals**: Definition; Types; Functions; classification; sources; deficiency Disorder.	10	Able to explain the types, sources and functions of vitamins and minerals.	1,2
III	**Carbohydrate metabolism:** Glycolysis, oxidation of pyruvate, TCA cycle, metabolism of glycogen, gluconeogenesis, pentose phosphate pathway, glyoxylate pathway, Mitochondrial electron transport, oxidative phosphorylation, inhibitors.	10	Able to explain and illustrate the pathway for carbohydrate metabolism and the enzymes involved.	1,2
IV	**Protein Metabolism**- Degradation of proteins, Oxidative, Non- Oxidative deamination and decarboxylation of amino acids, Urea Cycle and Creatinine formation.	10	Able to explain and illustrate the pathway for protein metabolism and the enzymes involved.	1,2
V	**Plant growth regulators**- Auxins, Gibberellins, Cytokinins. Abscisic acid and ethylene. **Photosynthesis**- Structure of photosynthetic apparatus, C3 and C4	15	Able to understand the plant growth regulators and their functions, and also explain and	1,2

	pathways, Light and Dark reaction, **Nitrogen metabolism** and fixation of nitrogen in leguminous plants.		illustrate CO2 and N2 Fixation.	
Practical	1. Quantitative estimation of Proteins (Lowry's method). 2. DNA (Diphenylamine method), 3. RNA (Orcinol method), 4. Amino acids (Ninhydrin reaction), 5. sugars (Dinitrosalicylic acid method) 6. Extraction of Protein from milk	30	Able to estimate the sugars, proteins, DNA,RNA and amino acids of given sample and extract protein from milk.	1,2,3,4

REFERENCE BOOKS:

R1. U Satyanarayana. Biochemistry. 13th edition. Elsevier Health Sciences; 2017.
R2. David L. Nelson, Michael Cox. Lehninger Principles of Biochemistry. 7th Edition. WH Freeman; 2017.
R3. Rodwell et al. Harper's Illustrated Biochemistry. 29th edition. McGraw Hill; 2012.

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4692135/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe enzymes, enzyme kinetics, including carbohydrates, and proteinsmetabolism**.**	1, 2,3
2	Explain the physiological roles of vitamins and minerals and their contribution for overall growth and development of the human body.	1,2
3	Describe the generation of cellular energy in our body through regulation of carbohydrate metabolism.	1, 2
4	Illustrate the interconnection between protein metabolism in our body and different associated metabolic pathways.	1, 2,3
5	Analyse the physiological effects of plant growth regulators in plant growth and development	1,2

SEMESTER – II									
Course Title	**Genetics**								
Course code	**23BSBT122R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ II semester of first year of the programme**								
Course Objectives	1. To familiarize with concepts of genetics, genetic materials, and the continuing process of evolution because of phenomenon such as linkage and crossing over, mutation etc. 2. To impart skills through hands on practice for some of the observational studies such as karyotyping and barr bodies etc.								
CO1	Describe structure of genetic material and Mendel's laws of inheritance and causes of variations.								
CO2	Explain the genetic mechanism of sex determination and dynamic structure of chromosomes.								
CO3	Illustrate the genetic mechanism crossing over that results recombination and genetic basis blood grouping in human.								
CO4	Analyze the genetic material exchange in bacteria through fundamental processes like transformation, conjugation, and transduction.								
CO5	Analyze various mechanisms of mutations and genetic stability and diversity in a population.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Fundamentals of Genetics:** Scope; DNA & RNA as genetic material, Structure (DNA & RNA); Mendel's Laws (Dominance, Segregation & Independent Assortment); Concepts (Alleles, Pleiotropy, Test cross, Incomplete dominance, Back cross and problems)	15	Able to describe, and explain genetic material and its implications..	1,2
II	**Sex Determination:** (Plants, animals, humans, Drosophila); Chromosome, Autosomes; Allosomes; Sex linked genes & dosage compensation of X- linked genes.	10	Develop understanding on sex determination.	1,2
III	**Linkage and Crossing Over**: Coupling & repulsion hypothesis; Linkage (maize, drosophila); Crossing over (mechanism, importance); chromosome mapping, (linkage mapping, physical mapping), gene interaction (supplementary factors, complementary factors, multiple factors, epistasis, allelism), blood groups in human.	10	Able to explain the linked genes and recombination because of crossing over and its role in evolution.	1,2

IV	**Cytoplasmic Inheritance**: Chloroplast inheritance (Mirabilis); Mitochondria (yeast); kappa particles (paramecium); **Bacterial Genetics:** (Transformation, conjugation, Transduction)	10	Able to describe the extra-nuclear inheritance including bacterial genetics	1,2
V	**Mutations:** (Spontaneous; induced); Chromosomal mutation (deletions duplications, inversions), Trisomy and polyploidy. Aneuploids – Nullisomics, Monosomics, and uisomics); Population genetics (Mendelian population, Hardy Weinberg equilibrium, maintenance and establishment of equilibrium)	15	Able to describe the various phenomenon associated with chromosomal aberration and mutations.	1,2
Practical	1. Preparation of buccal smear and observe the Barr bodies under a microscope, 2. Chromosomal staining for the observation of karyotypes 3. Practice on crosses based on Mendel's laws.	30	able to analyse the chromosome associated with various genetic problems	1,2,3,4

REFERENCE BOOKS:

R1. Gupta. Genetics. 8th edition. Rastogi Publications; 2009.
R2. Gardener et al. Principles of Genetics. 12th edition. Wiley; 2004.
R3. Verma, Agarwal. Cell Biology, Genetics, Evolution & Ecology. 1st edition. S Chand Publication; 2006.

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/books/NBK115568/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe structure of genetic material and Mendel's laws of inheritance and causes of variations.	1,2
2	Explain the genetic mechanism of sex determination and dynamic structure of chromosomes.	1,2
3	Illustrate the genetic mechanism crossing over that results recombination and genetic basis blood grouping in human.	1,2,3
4	Analyze the genetic material exchange in bacteria through fundamental processes like transformation, conjugation, and transduction.	1,2,3
5	Analyze various mechanisms of mutations and genetic stability and diversity in a population.	1,2,3

SEMESTER – II									
Course Title	**Bioinstrumentation**								
Course code	**23BSBT123R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ II semester of first year of the programme**								
Course Objectives	1. To make the students understand about the principle, types and applications of instruments such as chromatography, centrifugation, gel-electrophoresis, blotting, radioisotopes and spectroscopy. 2. To develop skills on operations of chromatography, centrifugation, gel-electrophoresis and spectroscopic analysis.								
CO1	Describe all the chromatographic techniques and their history, principles, working principle and applications in various fields.								
CO2	Explain centrifugation, its principles, and its diverse applications.								
CO3	Explain different techniques used in molecular biology techniques such as gel electrophoresis, pH measurement, dialysis, and blotting.								
CO4	Illustrate the principle, application of radioisotope dating and mechanism of radioactive decay.								
CO5	Analyze the working principle of various spectroscopic methods and their applications in determining concentration and molecular structure.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Chromatography:** History; Classification; Types, principles, operation, application & analysis (Paper, Column, Adsorption column, Partition, Thin layer, Ion exchange, quantitative Ion exchange, and Gel Chromatography):	15	Describe, illustrate and explain pH, buffers and related theories	1,2
II	**Centrifugation:** Types; Application; Principle; rotors; density gradient & analytical centrifugation.	10	Describe, illustrate and explain quantum mechanics and the laws associated with it.	1,2
III	**Gel Electrophoresis:** Application; Types; Principle; pH meter (Principle); Dialysis, **Blotting technique:** Southern, Western, & Northern blot	10	Describe and explain the different bonding and forces for interaction of a molecule	1,2
IV	**Radio- isotope dating technique:** Introduction, nature, detection & measurement of radioactivity, radioisotopes & radiation, units, radioactive decay.	10	Describe, illustrate and explain the laws of thermodynamics	1,2
V	**C Spectroscopic techniques:** Introduction, Principle and application of spectroscopy	15	Describe, illustrate and explain the mechanism of protein folding	1,2
Practical	Operation of molecules from given sample by 1. Paper chromatography 2. Column chromatography 3. Thin layer chromatography 4. Separation of DNA and protein molecules by gel electrophoresis	30	Able to use various instruments for analysis	1,2

REFERENCE BOOKS:

R1. Upadhyay. Biophysical chemistry: principle and technique. 12th edition. Himalaya Publishing House Pvt. Ltd; 2017.
R2. Kakkar. Atomic and Molecular Spectroscopy. 1st edition. Cambridge English; 2017.
R3. Evans. Handbook of Chromatography. 2nd Edition, Willford Press; 2019.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/22274891/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe all the chromatographic techniques and their history, principles, working principle and applications in various fields.	1,2,3
2	Explain centrifugation, its principles, and its diverse applications.	1,2,3
3	Explain different techniques used in molecular biology techniques such as gel electrophoresis, pH measurement, dialysis, and blotting.	1,2,3
4	Illustrate the principle, application of radioisotope dating and mechanism of radioactive decay.	1,2,3
5	Analyze the working principle of various spectroscopic methods and their applications in determining concentration and molecular structure.	1,2,3

SEMESTER – II									
Course Title	**IMPLICATIVE ENGLISH** (Communicative English & Soft Skills)								
Course code	**23UBPD123R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ II semester of first year of the programme**								
Course Objectives	1. To introduce the types of sentences and their significance. 2. To strengthen the vocabulary of the students to enhance student' vocabulary to enhance their speaking and writing skills it the importance of dress codes in various organisations. 3. To introduce the 3P's (Planning, prioritizing & performing) of Time Management.								
CO1	Provide students with the ability to transform sentence types, utilize different tenses, and address common grammatical mistakes.								
CO2	Empower students to proficiently apply one-word substitutions, differentiate between homonyms and homophones, avoid frequently confused words, and incorporate idioms and phrases in their vocabulary.								
CO3	Assist students in comprehending the various aspects and types of listening, and in identifying and overcoming obstacles to effective listening.								
CO4	Facilitate students in employing effective reading strategies, extracting relevant information from texts, and utilizing the SQ3R method.								
CO5	Instruct students on the significance of time management and provide foundational strategies to manage their time efficiently.								
CO6	Lead students in creating a well-rounded and professional LinkedIn profile.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Grammar (flipped classroom)** i. Interchange of Interrogative and Assertive Sentences, Exclamatory and Assertive Sentences ii. Types of Tenses iii. Common Errors	6	Students will accurately construct and transform various sentence types and correct grammatical errors.	1,2, 3
II	**Vocabulary Development** i. One word substitution ii. Homonyms and Homophones iii. Words often confused **iv.** Idioms and phrases	6	Students will enhance their vocabulary and use words accurately in context.	1,2, 3
III	**Listening Skills** i.What is listening? ii.Types of Listening iii. Understanding Listening Barriers	5	Students will demonstrate effective listening skills and identify listening barriers.	1,2, 3
IV	**Reading Skills** i. Techniques of Effective Reading ii. Gathering ideas and information from a text iii. The SQ3R Technique	5	Students will read efficiently and extract relevant information using the SQ3R technique.	1,2, 3
V	**Time-Management Skills** i. Introduction to Time Management ii. Purpose and Importance of Time Management iii. Basic Tips to Maintain Time	4	Students will effectively manage their time using various strategies.	1,2, 3

Textbooks:

1.Barrett, Grant.2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.
2.Reed, James. 2016. 101 Job Interview Questions You'll Never Fear Again, Plume.

3.Pease, Barbara. 2006. The Definitive Book of Body Language, RHUS.
4.McDowell, GayleLaakmann.2008. Cracking the Coding Interview(Indian Edition)

Reference Books:

1. Zinsser, William. (2006) On Writing Well: The Classic Guide to Writing Nonfiction Harper Perennial
2. Taylor J. and Wright, J., IELTS Advantage Reading Skills: A step-by-step guide to a high IELTS reading score, Delta Publishing by Klett.
3. Kelley, Thea. 2021. Get That Job: The Quick and Complete Guide to a Winning Interview, Plovercrest Press.
4. Murphy, Raymond,.(2012) English Grammar in Use Book with Answers: A Self- Study and Practice Book for Intermediate Learners of English ,Cambridge University Press

OTHER LEARNING RESOURCES:

https://www.ef.com/wwen/english-resources/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Provide students with the ability to transform sentence types, utilize different tenses, and address common grammatical mistakes.	1, 7
2	Empower students to proficiently apply one-word substitutions, differentiate between homonyms and homophones, avoid frequently confused words, and incorporate idioms and phrases in their vocabulary.	1, 7
3	Assist students in comprehending the various aspects and types of listening, and in identifying and overcoming obstacles to effective listening.	1, 7
4	Facilitate students in employing effective reading strategies, extracting relevant information from texts, and utilizing the SQ3R method.	1, 7
5	Instruct students on the significance of time management and provide foundational strategies to manage their time efficiently.	1, 7
6	Lead students in creating a well-rounded and professional LinkedIn profile.	1, 7

SEMESTER – II									
Course Title	**Environmental Science**								
Course code	**23UBES101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30	**2**	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ II semester of first year of the programme**								
Course Objectives	1. To prepare students for careers as leaders in understanding and addressing complex environmental issues from a problem-oriented, interdisciplinary perspective. 2. To develop a world population that is aware of and concerned about the environment and its associated problems and which has the knowledge, Skills, attitudes, motivations and commitment to work individually and collectively towards solutions of current problems and prevention of new ones.								
CO1	The students will be able to appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.								
CO2	Students will learn about natural resource, its importance and environmental impacts of Human activities on natural resource								
CO3	Gain knowledge about environment and ecosystem, Students will be able to understand the concept of biodiversity and respect them								
CO4	Gain knowledge about the conservation of biodiversity and its importance.								
CO5	Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Multidisciplinary nature of environmental studies:** Definition, scope and importance, Need for public awareness.	4	Environmental studies combines sciences to tackle environmental issues. Its multidisciplinary approach is key to solving complex problems. Public awareness and education are vital for promoting sustainability	1,2
II	**Natural Resources: Renewable and non-renewable resources,** Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs,	6	Natural resources, both renewable and non-renewable, face exploitation issues, including deforestation, overuse of water resources, environmental challenges with minerals and food, and land degradation. Individuals play a crucial role in conserving resources and promoting sustainability.	1,2

	renewable and non-renewable energy sources, use of alternate energy sources. Case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles			
III	**Ecosystems:** Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the Following ecosystem: - Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	4	This module covers ecosystems, including their concept, structure, functioning, and diversity. Students will learn about energy flow, ecological succession, and various ecosystem types like forests, grasslands, deserts, and aquatic ecosystems.	1,2
IV	**Biodiversity and its conservation:** Introduction – Definition: genetic, species and ecosystem diversity. Bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega diversity nation• Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.	5	This module covers biodiversity, including its definition, value, levels, and threats. Students will learn about India's bio-geographical classification, its status as a mega diversity nation, and key biodiversity hotspots. They'll also explore threats like habitat loss, wildlife poaching, and human-wildlife conflicts, crucial for conservation efforts.	1,2
V	**Environmental Pollution:** Definition Cause, effects and control measures of:-Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste, Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.	5	This module covers environmental pollution, including causes, effects, and control measures, alongside waste management and disaster preparedness strategies.	1,2
VI	**Social Issues and the Environment:** From Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and	6	This module explores social-environmental dynamics, including urban energy challenges, water conservation, and	1,2

	rehabilitation of people; its problems and concerns. Case Studies. **Environmental ethics:** Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Waste land reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.		resettlement issues. It delves into environmental ethics, climate change impacts, and relevant legislation like the Environment Protection Act, emphasizing public awareness and enforcement challenges.	
VII	**Human Population and the Environment:** Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Case Studies.	4	This module covers human population dynamics, including growth, impact on the environment and health, along with initiatives like Family Welfare Programs and the role of information technology, illustrated with case studies.	1,2
VIII	**Field work:** Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc. (**Field work Equal to 5 lecture hours**)	5	Fieldwork objectives include documenting environmental assets like rivers and forests, assessing pollution in urban or rural sites, and studying local biodiversity and ecosystems such as ponds and hill slopes	1,2

REFERENCE BOOKS:

R1**.** Bharucha. Textbook of Environmental Studies for Undergraduate Courses. 2nd edition. Orient Black swan Publishing; 2019.
R2Trivedy Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media(R). B.S. Publications; 2010.
R3. Trivedi, Goel. Introduction to air pollution. 1st publication. Techno-Science Publication (TB); 2003.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/22274891/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	The students will be able to appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.	1, 4
2	Students will learn about natural resource, its importance and environmental impacts of Human activities on natural resource	1, 4
3	Gain knowledge about environment and ecosystem, Students will be able to understand the concept of biodiversity and respect them	1, 4
4	Gain knowledge about the conservation of biodiversity and its importance.	1, 4
5	Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures.	1, 2, 4

SEMESTER – II									
Course Title	**Extra-Curricular Activities**								
Course code	**23UBEC121**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To ascertain physical and mental development of the students and select best performers for state, national and international level competition. 2. To enhance and improve student's talents in the field of sports, yoga, music, dance, drama, etc through AdtU club activities and workshops.								
CO1	Identify and describe various sports, music, and co-curricular activities available at the university, and explain the benefits of participating in these activities.								
CO2	Apply skills and techniques learned in workshops and club activities to participate effectively in sports, music, and other co-curricular competitions, and analyze their performance to identify areas of improvement.								
CO3	Discuss the reflective essay or presentation assessing how involvement in various activities has contributed to their personal and professional growth, and design a plan for future engagement and skill development.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Based on the learner's interest they can participate in various sports, music, and co-curricular activities joining the clubs of the University (Football, Footshal; Cricket; Swimming; Basket ball; Badminton; Table Tennis; athletics and other outdoor and indoor games; Dance; Music; Vocals; Photography; Drama; Literary activities); The students are encouraged to participate in regular club activities, workshops, competitions as per their interest and hobbies; Renowned skilled professionals/ personalities are invited organising workshops to promote the talents of the students.	**60**	Students will have the opportunity to explore and develop their interests by participating in a variety of sports, music, and co-curricular activities	1,2

REFERENCE BOOKS:

R1: "Extracurricular Activities: Essential Guides for Students" by John G. Gabriel

R2: "Developing Personal, Social and Emotional Skills through Extra-Curricular Activities" by Sally Bailey

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify and describe various sports, music, and co-curricular activities available at the university, and explain the benefits of participating in these activities.	5, 6, 8
2	Apply skills and techniques learned in workshops and club activities to participate effectively in sports, music, and other co-curricular competitions, and analyze their performance to identify areas of improvement.	5, 6, 8
3	Discuss the reflective essay or presentation assessing how involvement in various activities has contributed to their personal and professional growth, and design a plan for future engagement and skill development.	5, 6, 8

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

SEMESTER – II									
Course Title	**Co-Curricular Activities**								
Course code	**23UBEC111**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60	**0**	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	3. To ascertain physical and mental development of the students and select best performers for state, national and international level competition. 4. To enhance and improve student's talents in the field of sports, yoga, music, dance, drama, etc through AdtU club activities and workshops.								
CO1	Students will learn to work well with others and communicate better.								
CO2	Students will learn to manage their time and stay organized.								
CO3	Students will enhance their creative abilities and think more critically.								
CO4	Students will improve their overall health and reduce stress.								
CO5	Students will become more aware of their role in society and contribute positively.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Co-curricular activities cover a wide range of experiences and pursuits that complement academic learning. They are typically organized and managed within educational institutions or communities and play a crucial role in holistic development. Some examples are 7. Sports and Physical Activities 8. Cultural Activities: 9. Academic Clubs and Competitions 10. Community Service and Volunteering 11. Leadership and Personal Development 12. Creative and Hobby-based Activities	**60**	5. Skill Development: Enhancing skills such as teamwork, leadership, communication, and critical thinking. 6. Holistic Growth: Supporting emotional, social, and physical development alongside academic learning. 7. Building Networks: Creating opportunities to interact with peers, mentors, and professionals. 8. Personal Fulfillment: Providing avenues for creativity, self-expression, and exploring personal interests.	1,2

REFERENCE BOOKS:

R1: "Co-curricular Activities: A Pathway to Careers" by Ferguson.

R2: "Rahman, S.R., Islam, M.A., Akash, P.P., Parvin, M., Moon, N.N. and Nur, F.N., 2021. Effects of co-curricular activities on student's academic performance by machine learning. *Current Research in Behavioral Sciences*, *2*, p.100057.

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will learn to work well with others and communicate better.	2, 6, 8
2	Students will learn to manage their time and stay organized.	2, 6, 8
3	Students will enhance their creative abilities and think more critically.	2, 6, 8
4	Students will improve their overall health and reduce stress.	2, 6, 8
5	Students will become more aware of their role in society and contribute positively.	2, 6, 8

SEMESTER – III										
Course Title	**Immunology**									
Course code	**23BSB211R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T + 60P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	1. To introduce the students immunology, immunity, antigen, antibody, cytokines, interleukinc, vaccines and autoimmunity. 2. To explain the components of immune systems, antigen antibody reaction, serological techniques like RIA and ELISA, vaccines and their types and actions.								
CO1	Describe the general introduction of immunology and the various cells and organ involved in it.								
CO2	Discuss the mechanism of immune system.								
CO3	Demonstrate and analyse various immune based experiments using RIA, ELISA								
CO 4	Apply the concepts and types of vaccines and immunization process.								
CO 5	Illustrate the types and forms of auto immune diseases.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to Immunology:** Immune system; Natural & acquired immunity; General properties of immune responses: Cells, tissues and organ of immune system	**8**	Describe, illustrate and explain the immune system and its components	1,2
II	**Immunity:** Acquired, Innate, Cell mediated & humoral Immunity; T cell and B cell activation, maturation. **Antigen and antibody:** structure, function and diversity, Antigenicity and immunogenicity, Antigen antibody interactions	**10**	Describe, illustrate and explain Immunity, antigen and antibody interactions	1,2
III	**Cytokines and chemokine:** properties, families, cytokine antagonist; cytokine related disease, Immunogenicity. ELISA, RIA		Describe, illustrate and explain Cytokines and interleukins	1,2
IV	Protective Immunity: active or passive immunization; conjugate or multivalent vaccine; adjuvants; recombinant vaccine; DNA vaccine.	**10**	Describe, illustrate and explain different type of vaccines and vaccinations.	1,2
V	Autoimmunity & auto-immune diseases, factors contributing development of auto-immune diseases, mechanism of development, breakdown of self-tolerance, rejection of transplants, molecular mimicry, diagnosis & treatment of auto-immune diseases, eplacement therapy, suppression of autoimmune processes, transplantations	**10**	Describe, illustrate and explain autoimmunity and auto-immune diseases	1,2
Practical	Precipitation Reaction: i. Double Diffusion Reaction ii. Single Diffusion Reaction iii. Ouchterlony immunodiffusion iv. Immunoelectrodiffusion	**60**	Able to operate ELISA, RIA	1,2, 3,4

	Agglutination Reaction: (Qualitative and quantitative) WIDAL, ASO, VDRL, RPR, CRP Blood grouping and Rh typing, ELISA			

REFERENCE BOOKS:

R1. Abbas. Cellular and Molecular Immunology. 10th edition. Elsevier; 2021.

R2. Martin et al. Roitt's Essential Immunology (Essentials). 13th edition. Wiley-Blackwell, 2017.

R3. Westwood. Practical Immunology. 4th edition. Wiley-Blackwell; 2002.

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6156898/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1.	Describe the general introduction of immunology and the various cells and organ involved in it.	1, 2
2.	Discuss the mechanism of immune system.	1, 2
3.	Demonstrate and analyse various immune based experiments using RIA, ELISA	1, 2, 3
4.	Apply the concepts and types of vaccines and immunization process.	2, 3
5.	Illustrate the types and forms of auto immune diseases.	1, 2

SEMESTER – III										
Course Title	**Molecular Biology**									
Course code	**23BSBT212R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
		Total hours: 45T + 60P	**3**	**0**	**2**	**0**	**0**	**0**	**4**	
Pre-requisite	**Nil**	**Co-requisite**	**Nil**							
Programme	**Bachelor of Science in Biotechnology**									
Semester	**Fall/ II semester of first year of the programme**									
Course Objectives	1. To teach the basic concept of genome organisation and Nucleic acid, operon concept, holiday model. 2. To teach the central dogma of life in detail.									
CO 1	Explain the organization of genome, its components and functions.									
CO 2	Describe the process of replication, transcription, splicing, and protein synthesis									
CO 3	Describe the DNA repair mechanism and transposition.									
CO 4	Apply the knowledge of genomic and plasmid DNA isolation and their polymorphism									
CO 5	Illustrate genetic code, Wobble hypothesis.									

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Genome:** Introduction**;** prokaryote and eukaryote genome; the central dogma; c-value paradox; genes are made of DNA; semi conservative mode of DNA replication; DNA re-association kinetics (Cot curve analysis); repetitive DNA sequences (satellite DNA, LINE, SINE etc); DNA melting and buoyant density; neucleosome phasing.	**8**	Understand the blueprint of life and its function	1,2
II	**DNA Replication and Recombination:** Replication initiation, elongation and termination in prokaryotes and eukaryotes, Homologous recombination at the molecular level: Holliday model, double stranded break repair model	**8**	Describe, illustrate and explain the process of DNA replication and recombination	1,2
III	**DNA damage and Repair:** Mutation-Nonsense, missense and point mutations, Intragenic and Intergenic suppression, Frameshift mutations, Physical, chemical and biological mutagens, **Transposition** - Transposable genetic elements in prokaryotes and eukaryotes, Mechanisms of transposition, Role of transposons in mutation, Base excision repair, Nucleotide excision repair, Mismatch correction, SOS repair.	**8**	Describe, illustrate and explain the process of DNA damage and repair mechanisms.	1,2
IV	Prokaryotic & Eukaryotic Transcription. Post Transcriptional Modifications: Processing of hnRNA, tRNA, rRNA, 5'-Cap formation, 3'-end processing and polyadenylation, splicing, RNA editing, nuclear export of mRNA, mRNA stability	**8**	Describe, illustrate and explain the process of transcription and editing of various RNAs	1,2
V	Translation machinery, Ribosomes, Composition and assembly, Universal	**8**	Describe, illustrate and explain the	1,2

	genetic code, Degeneracy of codons, Termination codons, Isoaccepting tRNA, Wobble hypothesis, Mechanism of initiation,elongation and termination, Co- and post-translational modifications, Genomics and proteomics		translation machineries and mechanisms	
Practical	1. Isolation of plasmid/ genomic DNA of bacteria/ Plant/ Animal cell sample. 2. PCR amplification of selected genes 3. Separation of DNA molecules using gel electrophoresis 4. RFLP of PCR amplicons/ DNA typing by RAPD.	**60**	Able to isolate DNA, amplify and separate them and analyse them by RFLP or RAPD techniques	1,2,3,4

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1.	Explain the organization of genome, its components and functions.	1, 2
2.	Describe the process of replication, transcription, splicing, and protein synthesis	1, 2
3.	Describe the DNA repair mechanism and transposition.	1, 2
4.	Apply the knowledge of genomic and plasmid DNA isolation and their polymorphism	1, 2, 3
5.	Illustrate genetic code, Wobble hypothesis.	1, 2

SEMESTER - III									
Course Title	**Genetic Engineering**								
Course code	**23BSB213R**	**Total credits:3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	1. To familiarize the molecular and genetic tools used to analyse genomes, modify genetic material and techniques for modifying organisms to produce desired products. 2. Plan for and manage formulation and execution of protocols and innovative technologies and/or products. 3. To expose students to various techniques to enhance organisms so that they are better able to thrive in certain environments.								
CO1	Explain the concepts of genetic engineering								
CO2	Explain cloning techniques and the types.								
CO3	Explain and demonstrate molecular detection methods								
CO4	Describe the applications of recombinant DNA technology.								
CO5	Apply the methods of disease detection using molecular techniques.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to Genetic Engineering**: Definition, history and scope. Restriction enzymes: definition, characteristics and uses.	**8**	Understand the concepts of genetic engineering	1,2
II	**Cloning and cloning vectors**: plasmid vectors, λ vectors. Construction and screening of genomic DNA library and cDNA library	**10**	Describe and illustrate cloning techniques	1,2
III	**Molecular detection techniques**- Southern, Northern and Western hybridization, polymerase chain reaction (PCR), Restriction Fragment Length Polymorphism(RFLP), Random Amplified Polymorphic DNA (RAPD), DNA finger printing. Nucleic acid sequencing: Di- deoxy and chemical sequencing methods	**8**	Describe, illustrate and explain molecular detection and analysis methods	1,2
IV	Practical application of Recombinant DNA technology: Engineering of bacteria, genetically engineered biopharmaceuticals (insulin and growth hormones), Ti plasmid in plant biotechnology, Vaccine production	**10**	Describe, illustrate and explain the application of recombinant DNA technology	1,2
V	**Molecular detection of disease**: AIDS, Sickle chain anaemia, cystic fibrosis, Duchenne muscular dystrophy	**10**	Describe, illustrate and explain the methods for disease detection using molecules	1,2
Practical	Isolation of DNA from various sources, agarose gel electrophoresis, SDS PAGE, To measure concentration of DNA & RNA by UV Spectrophotometry	**60**	Able to use various methods for analysis of DNA, RNA and Proteins	1,2,3,4

REFERENCE BOOKS:

R1. Primrose S.B. et al. Principles of Gene Manipulation. 6th Edition. John Wiley Blackwell; 2001.
R2. Watson J. D. et al. Molecular Biology of the Gene. 7th edition. Pearson; 2013.
R3. Brown. T. A. Gene Cloning and DNA Analysis: an introduction. 7th edition. JOHN WILEY; 2016.

OTHER LEARNING RESOURCES:

https://www.annualreviews.org/doi/abs/10.1146/annurev-arplant-042809-112116

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the concepts of genetic engineering	1, 2
2	Explain cloning techniques and the types.	1, 2, 3
3	Explain and demonstrate molecular detection methods	1, 2, 3
4	Describe the applications of recombinant DNA technology.	1, 2, 3
5	Apply the methods of disease detection using molecular techniques.	1, 2, 3

SEMESTER- III									
Course Title	**English Language for Excellence**								
Course code	**23UBPD212R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours:60P	**0**	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	1. To acquaint students with the various tools of effective presentation. 2. To acquire the speaking skill instruct, influence, engage, educate, or appease the listeners. 3. To increase proficiency, present ability and quality of resume and provide guidance for self- promotion and self-evaluation in social media. 4. To prepare and train the students for the campus drives & walking interviews.								
CO1	Enable students to use prepositions, construct simple, complex, and compound sentences, and distinguish between active and passive voice.								
CO2	Teach students the basics of writing, how to avoid ambiguity, write paragraphs and letters, and prepare resumes and cover letters.								
CO3	Help students conduct SWOT analyses, practice self-regulation, and maintain personal hygiene.								
CO 4	Equip students with knowledge about non-verbal communication, types of body language, and their impact.								
CO 5	Train students in planning and conducting group discussions, effectively disagreeing, and summarizing to attain objectives.								
CO 6	Prepare students for personal interviews, answer common interview questions, follow telephone interview etiquettes, and adhere to dress code and grooming standards.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Grammar (Flipped classroom)** i. Use of Prepositions ii. Simple, complex, compound sentences iii. Active and Passive Voice	6	Students will correctly use prepositions, create various sentence structures, and convert between active and passive voice.	2, 3
II	**Writing Skills** I. The Basics of Writing; avoid ambiguity and vagueness II. Paragraph Writing III. Letter Writing IV. Resume and Cover Letter	6	Students will write clear and structured paragraphs, letters, resumes, and cover letters.	3, 4
III	**Self-Management Skills** i. SWOT Analysis ii. Self-Regulation iii. Personal Hygiene	5	Students will perform SWOT analyses, self-regulate, and adhere to personal hygiene practices.	3, 4
IV	**Non- Verbal Communication-Sciences of Body Language** i. What is Non-Verbal Communication & Body Language ii. Types of Body Language, iii. Importance and Impact of Body Language,	5	Students will understand and effectively use different types of body language in communication.	2, 3
V	**Group Discussion** i. Planning and Elements of Group Discussion ii. Effectively disagreeing, iii. Summarizing and Attaining the Objective.	5	Students will plan and participate in group discussions, disagree constructively, and summarize discussions.	3, 4
VI	**Interview Skills & Dress code Ethics** i.Personal Interview – Concept and Practice ii. Common Interview Questions and answering Strategies iii. Telephone Interview Etiquettes iv. Introduction to Dress Code and Grooming	5	Students will demonstrate effective interview techniques, answer common questions, follow telephone etiquettes, and dress appropriately.	2, 3

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Integrate presentation, communication, leadership, and interview skills.	6,7
2	Apply skills in real-world scenarios.	2, 6,7
3	Reflect on personal development.	5,6
4	Collaborate effectively in group activities.	6,7
5	Demonstrate professionalism and ethical behavior.	5,6

SEMESTER – III									
Course Title	**Techno-professional Skills – I (Biofertilizer Production)**								
Course code	**23BSB214R**	**Total credits: 1** **Total hours:30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	On successful completion of the course, the students will be able to Familiarize with the basic principle and techniques of Biofarming								
CO1	Explain the Importance of biofertilizers in plant development.								
CO2	Describe mass cultivation and inoculation.								
CO3	Explain the importance of Azolla as a biofertilizers.								
CO 4	Describe the importance of phosphate in biofertilizers.								
CO5	Apply the knowledge on the use of Fungi and Mycorrhiza.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Isolation , identification and analysis of the potentialities of N2 fixing bacteria, Isolation , identification and analysis of the potentialities of phosphate stabilizing bacteria, Isolation , identification and assess the potentialities of Arbuscular mycorrhizas fungi of rhizospheric soil	30	Students will be able to understand the process of biofertilizer production using microoranisms	1,2,3,4

REFERENCE BOOKS:

R1. Kannaiyan, S. 2002 Biotechnology of Biofertilizers. Narosa publishing house, New Delhi. Dubey, R.C. 2001.
R2. P. S. Bisen. Fontiers in microbial technology. 1st edition. C.B.S. Publishers and Distributors; 1994

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9227430/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1.	Explain the Importance of biofertilizers in plant development.	1,2
2.	Describe mass cultivation and inoculation.	1,2
3.	Explain the importance of Azolla as a biofertilizers.	1,2
4.	Describe the importance of phosphate in biofertilizers.	1,2
5.	Apply the knowledge on the use of Fungi and Mycorrhiza.	1,2

SEMESTER – III									
Course Title	**Extra-Curricular Activities**								
Course code	**23UBEC211**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	1. To ascertain physical and mental development of the students and select best performers for state, national and international level competition. 2. To enhance and improve student's talents in the field of sports, yoga, music, dance, drama, etc through AdtU club activities and workshops.								
CO1	Identify and describe various sports, music, and co-curricular activities available at the university, and explain the benefits of participating in these activities.								
CO2	Apply skills and techniques learned in workshops and club activities to participate effectively in sports, music, and other co-curricular competitions, and analyze their performance to identify areas of improvement.								
CO3	Discuss the reflective essay or presentation assessing how involvement in various activities has contributed to their personal and professional growth, and design a plan for future engagement and skill development.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Based on the learner's interest they can participate in various sports, music, and co-curricular activities joining the clubs of the University (Football, Footshal; Cricket; Swimming; Basket ball; Badminton; Table Tennis; athletics and other outdoor and indoor games; Dance; Music; Vocals; Photography; Drama; Literary activities); The students are encouraged to participate in regular club activities, workshops, competitions as per their interest and hobbies; Renowned skilled professionals/ personalities are invited organising workshops to promote the talents of the students.	**60**	Students will have the opportunity to explore and develop their interests by participating in a variety of sports, music, and co-curricular activities	1,2

REFERENCE BOOKS:

R1: "Extracurricular Activities: Essential Guides for Students" by John G. Gabriel

R2: "Developing Personal, Social and Emotional Skills through Extra-Curricular Activities" by Sally Bailey

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify and describe various sports, music, and co-curricular activities available at the university, and explain the benefits of participating in these activities.	1&3
2	Apply skills and techniques learned in workshops and club activities to participate effectively in sports, music, and other co-curricular competitions, and analyze their performance to identify areas of improvement.	1,2
3	Discuss the reflective essay or presentation assessing how involvement in various activities has contributed to their personal and professional growth, and design a plan for future engagement and skill development.	7.9,10

SEMESTER – III									
Course Title	**Co-Curricular Activities**								
Course code	**23UBEC111**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	1. To ascertain physical and mental development of the students and select best performers for state, national and international level competition. 2. To enhance and improve student's talents in the field of sports, yoga, music, dance, drama, etc through AdtU club activities and workshops.								
CO1	Students will learn to work well with others and communicate better.								
CO2	Students will learn to manage their time and stay organized.								
CO3	Students will enhance their creative abilities and think more critically.								
CO4	Students will improve their overall health and reduce stress.								
CO5	Students will become more aware of their role in society and contribute positively.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Co-curricular activities cover a wide range of experiences and pursuits that complement academic learning. They are typically organized and managed within educational institutions or communities and play a crucial role in holistic development. Some examples are 13. Sports and Physical Activities 14. Cultural Activities: 15. Academic Clubs and Competitions 16. Community Service and Volunteering 17. Leadership and Personal Development 18. Creative and Hobby-based Activities	**60**	1. Skill Development: Enhancing skills such as teamwork, leadership, communication, and critical thinking. 2. Holistic Growth: Supporting emotional, social, and physical development alongside academic learning. 3. Building Networks: Creating opportunities to interact with peers, mentors, and professionals. Personal Fulfillment: Providing avenues for creativity, self-expression, and exploring personal interests.	1,2

REFERENCE BOOKS:

R1: "Co-curricular Activities: A Pathway to Careers" by Ferguson.

R2: "Raman, S.R., Islam, M.A., Akash, P.P., Parvin, M., Moon, N.N. and Nur, F.N., 2021. Effects of co-curricular activities on student's academic performance by machine learning. *Current Research in Behavioral Sciences*, *2*, p.100057.

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will learn to work well with others and communicate better.	6,7
2	Students will learn to manage their time and stay organized.	2, 6,7
3	Students will enhance their creative abilities and think more critically.	5,6
4	Students will improve their overall health and reduce stress.	6,7
5	Students will become more aware of their role in society and contribute positively.	5,6

SEMESTER – III									
Course Title	**Entomology**								
Course code	**23FSZO301R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. Understand the classification, morphology, and key characteristics of insects, focusing on Class Insecta. 2. Explore the morphology and adaptations of insect mouthparts, antenna, and legs. 3. Analyze the life cycles and control measures of medically important pests and their impact on human health. 4. Investigate insect communication methods and behaviors, including their role in pest management and forensic science applications.								
CO1	Understand the overview of Class Insects different morphological modifications.								
CO2	Able to explain the life cycle and control measures of pest of medical importance.								
CO3	Able to explain, illustrate different communicating techniques and insect behavior adopted by insects.								
CO4	Able to explain, illustrate and implement different management strategy adopted for controlling insect pests.								
CO5	Gain knowledge on different insects of economic importance.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction to Entomology:** Overview of Class Insecta, its classification and characters. Insect morphology: Overview and modifications of mouthparts, antenna and legs.	**5**	Describe and explainthe class of Insects and its morphological peculiarities.	1,2
II	**Pest of medical importance:** Life cycle and control measures of *Musca domestica, Aedes aegypti, Culex quinquefasciatus, Anopheles, Phlebotomus spp, Glossina fuscipes, Cordylobiaanthropophaga, Simuliumdamnosum, Pulexirritans, Cimex lectularius, Triatoma infestans, Pediculus humanus*.	**7**	Describe, illustrate and explain the life cycle and control measures of pest of medical importance.	1,2
III	**Insect communication:** Chemical communication, Audio and tactile communication, Visual communication, Luminescent insects **Insect Behavior:** Chemotropism, Thigmotropism, Hydrotropism, Rheotropism, Anemotropism, Phototropism, thermotropism and geotropism.	**6**	Describe, illustrate and explainthe process of different communicating techniques and insect behavioradopted by insects.	1,2
IV	**Role of insects in pest management:** Brief about chemical and biological control of insect's pest, Role of insects in forensic science.	**5**	Describe, illustrate and explain the different management strategy adopted for controlling insect pests.	1,2
V	**Introduction to Applied Entomology:** Life cycle, by product and commercial method of farming of honey bee, silkworm and lac insect.	**7**	Describe, illustrate and explain about different insects of economic importance.	1,2

REFERENCE BOOKS:

R1: Insect pest management by Dent D R, (latest edition). Westville Publishing House: Delhi

R2: An ecological and social approach to biological control, Eilenberg J, (latest edition). Springer.

R3: Theory and Practice of Animal Taxonomy and Biodiversity by Kapoor V C 8Ed. Oxford and IBH publishing.

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the overview of Class Insects different morphological modifications.	1,2
2	Able to explain the life cycle and control measures of pest of medical importance.	1,2
3	Able to explain, illustrate different communicating techniques and insect behavior adopted by insects.	1,2
4	Able to explain, illustrate and implement different management strategy adopted for controlling insect pests.	1,2
5	Gain knowledge on different insects of economic importance.	1,2

SEMESTER – III									
Course Title	**Forestry**								
Course code	**23FSBO301R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. This course aims to educate student on concepts of forestry 2. Basic knowledge of forest dendrology, forest types 3. The course further deals with physiology of forest, forest management and forest pathology.								
CO1	Articulate the history and basic concept of Forestry.								
CO2	Importance of Dendrology and knowledge of wood forest								
CO3	Understanding of forest types and forest management								
CO4	Importance of physiology in forestry								
CO5	Understanding the forest pathology, causes of forest diseases								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction Forestry:** History of forestry, Classification of forest, Basic concepts on forest types of India. Important acts and policies related to Indian Forest. **Forest management:** Definition and scope of forest management, principle of forest management and their applications	**5**	Describe and explainHistory, types and policies of forest	1,2
II	**Dendrology:** Introduction, importance and scope of dendrology. Role of vegetative morphology in identification of woody forest flora **Ecotourism:** Definition and elements of ecotourism, Principles and objectives of ecotourism. Potential of ecotourism in India.	**7**	Describe, illustrate and explain Importance, scope and morphology of woody forest and Ecotourism	1,2
III	**Plant Physiology:** Introduction to tree physiology, Photosynthesis. Water relation of forest trees, transpiration from forest canopies, environmental effects on growth and development.	**6**	Describe, illustrate and explainImportance of tree physiology in relation to forestry.	1,2
IV	**Forest Ecology and Diversity:** Forest types of India, Forest Ecosystem-abiotic and biotic components and their interaction, Nutrient cycling, forest management. Conservation measurement of diversity, diversity hot spots, Principle of conservation.	**5**	Describe, illustrate and explain Importance of forest ecosystem, biotic and abiotic components and forest management and ecotourism.	1,2
V	**Forest Pathology:** Importance of forest pathology. Principles of forest pathology, causes of forest diseases-Physiological and pathological, general symptoms of forest tree disease, control of forest diseases, plant quarantine.	**7**	Describe, illustrate and explain Principle of for estpathology causes of forest diseases and plant quarantine.	1,2

REFERENCE BOOKS:

R1: Agarwal, W.P. Forests in India. Oxford and I.B.H
R2: Arvind Kumar. Biodiversity and environment. A.P.M. Publishing Corporation, New Delhi.
R3: Kumar and Asija. Biodiversity – Principles and conservation. Updesh Purohit, Agrobios, Jodhpur

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Articulate the history and basic concept of Forestry.	1,2
2	Importance of Dendrology and knowledge of wood forest	1,2
3	Understanding of forest types and forest management	1,2
4	Importance of physiology in forestry	1,2
5	Understanding the forest pathology, causes of forest diseases	1,2

SEMESTER – III									
Course Title	**Basic Life Saving Skills (BLSS)**								
Course code	**23UULS202R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**1**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	The aim of the course is to provide the learners with basic knowledge and practical skills needed in an emergency fire situation, and to provide appropriate basic management and treatment for injuries.								
CO1	The students will be able to recognize respiratory arrest/ cardiac arrest, and provide oxygen to the patients to sustain tissue viability								
CO2	The students will be able to perform the importance of early CPR on Adult, child and infants victims								
CO3	The students will be able to prevent injury from getting worse, aiding recovery, relieving pain and protecting the victims from deterioration								
CO4	Importance of physiology in environmental emergency								
CO5	The students will be able to learn about the fire equipments requirements, methods of operation and getting out alive.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Basic Life Support (BlS)** • Introduction of BLS • Chain of survival • ABCs Assessment • CPR and Ventilation Technique • AED • Choking for adult and children	**5**	Students will gain foundational knowledge and practical skills in Basic Life Support (BLS), enabling them to effectively respond to emergency situations.	1,2
II	**First Aid** • Golden rules of First aid • First aid Kits	**5**	Students will acquire essential knowledge and skills in First Aid	1,2
III	**Trauma emergencies** • Introduction • Priorities of Initial approach in pre-hospital care • Scene safety • Primary assessment • Bleeding control • Extrication of victims and safe transfer • Cervical spine stabilization and C-collar application • Splinting of broken Limbs	**5**	Students will acquire essential knowledge and skills in Trauma emergencies	1,2
IV	**Triage system** • Introduction • Flow chart approach of Triage • Triage of Single and Multiple Casualties in Pre-Hospital setting	**5**	Students will acquire essential knowledge and skills in Triage system	1,2
V	**Medical emergencies** Introduction Victim centred approach and Management of • Seizures • heart attack • asthma • diabetic emergencies • emergency childbirth	**3**	Students will acquire essential knowledge and skills in Medical emergencies	1,2

	• Respiratory distress and failure			
VI	**Environmental Emergency** • Recognizing and caring for heat related illness such as: Heat stroke, • heat cramps, heat exhaustion, dehydration. • Recognizing and caring for cold related illness such as frostbite, • hypothermia. • Poisoning, Snake bite.	**3**	Students will acquire essential knowledge and skills in Environmental Emergency	
VII	**Safety of people in the event of fire** • Recognition of possible fire sources and emergency procedures, • Construction techniques for eliminating fire. • Types of detecting devices and extinguishing agents and systems • Devising procedures in the event of fire and react to fire danger. • Safety goals and objectives, Identifying hazards and risks	**3**	Students will acquire essential knowledge and skills in Safety of people in the event of fire	

REFERENCE BOOKS:

R1: Nancy Caroline'S Emergency Care in the streets eight edition by Jones and Bartlett
R2: First Aid book by LC Gupta; Publisher Jaypee Brothers, 7th Edition.

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	The students will be able to recognize respiratory arrest/ cardiac arrest, and provide oxygen to the patients to sustain tissue viability	2, 3
2	The students will be able to perform the importance of early CPR on Adult, child and infants victims	2, 3, 6
3	The students will be able to prevent injury from getting worse, aiding recovery, relieving pain and protecting the victims from deterioration	3, 6
4	Students will be able to respond to environmental emergency like heat stroke, snake bite etc.	2, 3, 6
5	The students will be able to learn about the fire equipment requirements, methods of operation and getting out alive.	2, 3, 6

SEMESTER – III									
Course Title	**Personal Financial Planning**								
Course code	23UUFL202R	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**1**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. The course would offer an inclusive approach to understand the relevant concepts of money, borrowing, lending, taxes and their application to financial planning. 2. Assess the personal financial planning process, the life cycle of financial plans, and methods ofgoal achievement. 3. Formulate a budget, record-keeping system, and tax planning strategy based on current financialgoals								
CO1	Develop a cash management strategy and a plan to facilitate the home or automobile buying process								
CO2	Design a diversified investment portfolio that addresses several different investment objectives.								
CO3	Differentiate between open- and closed-end mutual funds, exchange-traded funds, and direct or indirect real estate investments.								
CO4	Create a financial plan that covers your income needs in retirement and helps protect you and your estate.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Fundamentals of Financial Planning –** i.Functions of money; ii.Inflation- Meaning, causes, how it can be controlled; iii.process official planning , iv.Time value of money-simple and compound interest; v.Net Present Value and Future value, vi.Power of Compounding; vii.Doubling period and Rule of 72.	**5**	Students will acquire essential knowledge of Fundamentals of Financial Planning	1,2
II	**Income Tax Planning**– i.Meaning of Income, ii.Direct & Indirect Taxes, Taxable Income, various heads of Income for tax Calculation, iii.Non-taxable Income, iv.Tax evasion and tax avoidance, v.GST, Tax Planning Strategies	**5**	Students will acquire essential knowledge and skills in Income Tax Planning	1,2
III	**Entrepreneurial planning** – i. Meaning of Entrepreneurship, prerequisites for becoming an entrepreneur, ii. Entrepreneurship Support Systems in India, iii. Institutional support systems for entrepreneurs, iv. Financial support systems for entrepreneurs; v. Venture Capital, Business Angels, vi. Assistant of Government, vii. Commercial Bank Loans and Overdraft.	**5**	Students will acquire essential knowledge and skills in Entrepreneurial planning.	1,2
IV	**Planning for investing in securities market –** i. Investment avenues offered by Securities Markets,. Primary Market and Secondary Market, ii. Stock market- meaning, features, functions of NSE,BSE DEMAT trading account, iii. Security repository, stock brokers, Operational aspects of securities markets: placement of orders, contract note, pay-in and pay-out, trading and settlement cycle,	**5**	Students will acquire essential knowledge and skills in securities market	1,2

	iv. Various risks involved in investing in securities markets; Role of Financial Intermediaries; Stock indices. v. Mutual Funds- meaning concept, definition, types, importance and drawbacks of mutual funds, mutual funds in India, investing in mutual funds, vi. Systematic Investment Plan (SIP) and its advantages.			
V	**Planning for debts and Retirement** i. Consumer credit - Introduction to consumer credit; choosing a source of credit, the cost of credit alternatives, ii. Consumer Legal Protection; iii. Housing Decision: Factors and Finance; Vehicle Decisions. iv. Retirement planning - Meaning of cost of living; retirement need analysis; development of retirement plan, various retirement schemes, v. Estate Planning; Pension and Medicare Planning; Wills.	**3**	Students will acquire essential knowledge and skills in Planning for debts and Retirement	1,2

REFERENCE BOOKS:

R1: Sinha Pradeep K. and Priti Sinha. Computer Fundamentals: Concepts Systems &The Million Dollar Financial Advisor: Powerful Lessons and Proven Strategies from Top Producers by DavidJ. Mullen Jr.
R2: Personal Finance and Planning by Dr. Rajni
R3: Peaceful Personal Finance: A Short Read on the Basics of Personal Finance and Planning Kindle Edition by Hema Singh

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Develop a cash management strategy and a plan to facilitate the home or automobile buying process	1,2,8
2	Design a diversified investment portfolio that addresses several different investment objectives.	1,2,8
3	Differentiate between open- and closed-end mutual funds, exchange-traded funds, and direct or indirect real estate investments.	1,2,8
4	Create a financial plan that covers your income needs in retirement and helps protect you and your estate.	1,2,8

SEMESTER – IV										
Course Title	**Food Biotechnology**									
Course code	**23BSBT221R**	**Total credits:4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ IV semester of first year of the programme**								
Course Objectives	1. The objective of this course is to combine the biotechnological applications studied in other courses and relate to food. 2. This will give students a comprehensive understanding of transgenic food, biotechnological food additives, biotechnological food diagnosis and regulations.								
CO1	Understand the foundational principles of biotechnology and its application in the food industry.								
CO2	Explore the science behind GMOs, their development, their role in food production and ethical issues.								
CO3	Learn the principles and applications of fermentation in food production.								
CO 4	Know about biotechnological approaches to ensuring food safety and extending shelf life.								
CO 5	Apply the knowledge on industry trends and innovations, including the development of functional foods, nutraceuticals, and bio fortification.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to Biotechnology in the Food Industry:** Overview of biotechnology and its relevance to food production, historical development and key milestones in biotechnology in food	**8**	Explain the relevance of biotechnology in the food industry	1,2
II	**Genetically Modified Organisms (GMOs) in Food Production:** Science behind GMOs: genetic engineering techniques and applications, Role of GMOs in improving crop yield, quality, and sustainability, Ethical considerations and controversies surrounding GMOs	**10**	Understand the role of GMOs in food production and crop improvement and their ethical considerations.	1,2
III	**Fermentation in Food Production**: Principles of fermentation and its significance in food processing, types of fermented foods and beverages across cultures, Industrial applications and technological advancements in fermentation.	**8**	Describe fermentation processes for the production of foods and beverages	1,2
IV	**Biotechnological Approaches to Food Safety and Shelf Life Extension:** Biotechnological methods for food safety assurance, Techniques for extending shelf life of food products, Case studies and examples of successful applications	**10**	Explain the role of biotechnology for extending food safety and preservation	1,2
V	**Industry Trends and Innovations in Functional Foods:** Emerging trends in functional foods and nutraceuticals, Biofortification techniques to enhance food	**10**	Explain the role of biotechnology for the production of functional foods.	1,2

	nutritional value, Regulatory aspects and consumer acceptance of functional foods			
Practical	1. Quality analysis of milk by MBRT 2. Isolation of food borne bacteria and fungi from food products. 3. Microbiological examination of canned foods. 4. Isolation of spoilage bacteria from fruits and vegetables. 5. Adulterant test: formalin and starch test 6. Effect of temperature on the spoilage of food products. 7. Production of fermented food: Yoghurt, Kim chi	**60**	Able to use various methods for the quality analysis food and fermented food production.	1,2,3,4

REFERENCE BOOKS:

R1. Introduction to Food Biotechnology. Author; Perry Johnson-Green. Publisher; CRC Press. Year; 2002.

R2. Brown. T. A. Gene Cloning and DNA Analysis: an introduction. 7th edition. JOHN WILEY; 2016.

OTHER LEARNING RESOURCES:

https://www.annualreviews.org/doi/abs/10.1146/annurev-arplant-042809-112116

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the foundational principles of biotechnology and its application in the food industry	1,2
2	Explore the science behind GMOs, their development, their role in food production and ethical issues.	1,2
3	Learn the principles and applications of fermentation in food production.	1,2
4	Know about biotechnological approaches to ensuring food safety and extending shelf life.	1,2
5	Apply the knowledge on industry trends and innovations, including the development of functional foods, nutraceuticals, and bio fortification.	1,2, 3

SEMESTER – IV									
Course Title	**Developmental Biology**								
Course code	**23BSBT222R**	**Total credits:3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ IV semester of first year of the programme**								
Course Objectives	1. To introduce animal and plant's embryonic development that is how an egg develops into an adult. 2. To prepare for advanced courses such as Animal and Plant Biotechnology								
CO1	Learn the concept of gametogenesis, fertilization in plants and animals.								
CO2	Describe the process of pollination and fertilization in plants								
CO3	Describe and illustrate post-fertilization process in plants and animals								
CO 4	Explicate the process of gamete formation in male and female animal								
CO 5	Discuss the fertilization and embryonic stages of mammals.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Gametogenesis-I (Male):** History and Scope of embryology; Typical Angiosperm Flower, Structure of stamen, Microsporogensis, Dehiscence**; Gametogenesis-II**(**Female**),Structure of carpel, Types of Ovule Megasporogenesis; Structure of typical embryo sac, (Polygonum, Allium and Adoxa type)	**7**	Understand, describe, illustrate and explain gametogenesis	1,2
II	**Pollination and fertilization**: Pollination, Pollen tube entry (Types), Syngamy and triple fusion, Double fertilization, Development of Endosperm	**10**	Understand, describe, illustrate and explain pollination and fertilization	1,2
III	**Post-fertilization:** Types of endosperm, suspensors and synergids, Apomixis, Polyembryony, Fruit- development and maturation	**10**	Understand, describe, illustrate and explain post fertilization	1,2
IV	**Gametogenesis in amimals-I**, Ultra structure of Testis in mammals. Spermatogenesis-Formation of spermatids and spermiogenesis, Ultra structure of Sperm. **Gametogenesis in amimals-II**, Ultra structure of Ovary in mammals, Oogenesis in mammals, Typical egg structure, Yolk-its function and significances	**8**	Understand, describe, illustrate and explain gametogenesis in animals	1,2
V	**Fertilization in Mammals:** Sperm egg encounter, Capacitation and Sperm transport, Acrosomal reaction, Ovum activation and Amphimixis. Cleavage- Salient features and Types of Clevage. Blastulation and Gastrulation Salient features and Significance	**10**	Understand, describe, illustrate and explain fertilization in mammals	1,2

REFERENCE BOOKS:

R1. Allan. Essentials of Human Embryology. 2nd edition. Oxford University Press, New York,1969.
R2. Rana. Human Embryology made Easy. 1st edition. CRC Press; 2019.
R3. Lersten. Flowering Plant Embryology. 1st edition. Wiley-Blackwell; 2004.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/28590698/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn the concept of gametogenesis, fertilization in plants and animals.	1,2
2	Describe the process of pollination and fertilization in plants	1,2
3	Describe and illustrate post-fertilization process in plants and animals	1,2
4	Explicate the process of gamete formation in male and female animal	1,2
5	Discuss the fertilization and embryonic stages of mammals.	1,2

SEMESTER – IV									
Course Title	**Bioinformatics**								
Course code	**23BSBT223R**	**Total credits:3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ IV semester of first year of the programme**								
Course Objectives	1. To give basic computer knowledge and their practical application. 2. Knowledge on computational database management system and its application in Biology 3. A basic idea on the structural biology using computer								
CO1	Learn basics of computer and its applications in Biology, including data analysis.								
CO2	Impart knowledge on various molecular sequence and structure databases.								
CO3	Develop skills in using bioinformatics tools for sequence alignment and analysis.								
CO 4	Demonstrate data retrieval and alignment of the sequences and various formats								
CO 5	Describe the existing biological database and their utilization								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Computer Fundamentals- History of computers, Generations and Classification of computers, Hardware and Software concepts, Block Diagram of Digital Computer, Limitations and Capabilities of computers, I/O devices, Storage devices, R A M ROM, Memory unit- primary and Auxiliary.	**7**	Understand the fundamentals of Computer Science	**1,2**
II	Internet and Networking - Introduction, Importance, Network – LAN, MAN, WAN, Electronic Mailing, Chatting, Search Engine, Web Pages, Virus, Antivirus, Malware, Multimedia - Introduction, Applications, Components and its Uses.	**5**	Understand the fundamentals of Computer Networking and utility	**1,2**
III	Database management system (DBMS) - Introduction to database management system(DBMS) and its different types.	**5**	Describe DBMS and their types	**1,2**
IV	Introduction to bioinformatics and data generation- commonly used tools for alignment (FASTA, BLAST, BLAT), visualization software (RASMOL, MMDB viewer, MolMol etc). Flatfile formats. Protein homology modeling, physiochemical property calculation	**8**	Data retrieval and alignment of the sequences and various formats	**1,2, 3**
V	Biological Database - Nucleotide sequence databases (NCBI, DDBJ, and EMBL).Protein sequence databases (SWISS-PROT, PIR, G e n P e p t) ,Specialized Genome databases: (SGD, TIGR etc).Structure databases (CATH, SCOP, and PDB, NDB, MMDB), pathway database(KEGG)	**5**	Describe the existing biological database a their utilization	**1,2, 3**
Practical	1. Alignment of givenquery (nucleotide/protein) sequence with database sequence and analysis 2. Computing protein parameters of a given protein sequence and nalysis 3. Computingthe3Dstructureofaproteinusing	**30**	Practice analyzings equence properties, alignment, identifying protein characteristics, and modelling protein structure	**1,2, 3,4**

REFERENCE BOOKS:

R1. Sharma T. R. Genome Analysis and Bioinformatics: A Practical Approach (English) (Paperback). 1st edition. Dreamtech Press; 2019.

R2. Orengo C.A. et al. Bioinformatics: Genes, proteins and computers. 1st edition. Taylor & Francis, 2002.

R3. Kangueane P., Mathura V. Bioinformatics: A Concept-Based Introduction. 1st edition. Springer-Verlag New York Inc. 2009.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/28590698/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn basics of computer and its applications in Biology, including data analysis.	1,2,3
2	Impart knowledge on various molecular sequence and structure databases.	1,2,3
3	Develop skills in using bioinformatics tools for sequence alignment and analysis.	1,2,3
4	Demonstrate data retrieval and alignment of the sequences and various formats	1,2,3
5	Describe the existing biological database and their utilization	1,2,3

SEMESTER – IV									
Course Title	**Biophysical chemistry**								
Course code	**23BSBT223R**	**Total credits:3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ IV semester of first year of the programme**								
Course Objectives	1. Introduce the students about concept of buffer, pH, acid and base, chemical bonding and the energy relationships 2. Make them understand how the protein folds and what phenomenon lead to protein folding								
CO1	Learn the concepts of pH, buffers and related theories.								
CO2	Explain quantum mechanics and the laws associated with it.								
CO3	Illustrate the different bonding and forces for interaction of a molecule.								
CO 4	Know the laws of thermodynamics.								
CO 5	Explain the mechanism of protein folding								

Unit -No.	Content	Contact Hour	Learning Outcome	K L
I	**PH & Buffer:** Introduction; Bronsted & Lowry theory; Lewis theory; Buffering action; Buffer Capacity; H-H equation; Biological Buffers; Properties of water	10	Describe, illustrate and explain pH, buffers and related theories	1,2
II	**Quantum mechanics**: Atomic structure (Shape of atomic orbital); Black body radiation; Plank's law; Photoelectric effect; Hybridization structure of atom.	10	Describe, illustrate and explain quantum mechanics and the laws associated with it.	1,2
III	**Chemical bonding:** Ionic, Covalent, Hydrogen bond; Peptidyl bond; Vander Waal forces	10	Describe and explain the different bonding and Forces for interaction of a molecule	1,2
IV	**Thermodynamics:** First law (concept of internal energy); Second law (free energy, enthalpy, entropy); free energy in biological system, 3rd law; Significance and limitation of the laws.	10	Describe, illustrate and explain the laws of thermodynamics	1,2
V	**Concepts of protein folding:**(Amino acids, hydrophilic, &hydrophobic properties);Biophysics of cell membranes.	8	Describe, illustrate and explain the mechanism of protein folding	1,2

REFERENCE BOOKS:

R1. Cantor and Schimmel. Biophysical Chemistry. 1st Ed., W.H. Freeman 6 Co., San Francisco; 1980.
R2. Holde, Johnson and Ho. Principles of Physical Biochemistry. 2ndEd.. Pearson Prentice Hall; 2005.
R3. S. E. Harding and Chowdhry. Protein-Ligand Interactions: Hydrodynamics and Calorimetry: A Practical Approach. 1st Ed. OUP Oxford; 2000.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/33254009/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn the concepts of pH, buffers and related theories.	1,2,3
2	Explain quantum mechanics and the laws associated with it.	1,2,3
3	Illustrate the different bonding and forces for interaction of a molecule.	1,2,3
4	Know the laws of thermodynamics.	1,2,3
5	Explain the mechanism of protein folding	1,2,3

SEMESTER – IV									
Course Title	**Basics of Food Science**								
Course code	**23BSFD401R**	**Total credits:3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**IV semester of first year of the programme**								
Course Objectives	1. Acquire a foundational understanding of the basic components of food. 2. Learn the fundamental principles of food processing techniques. 3. Explore the chemical reactions that occur during food processing and storage.								
CO1	Acquire a foundational understanding of the basic components of food.								
CO2	Learn the fundamental principles of food processing techniques.								
CO3	Explore the chemical reactions that occur during food processing and storage.								
CO4	Examine the basics of food microbiology.								
CO5	Gain insights into sensory evaluation techniques used to assess the taste, aroma, texture, and appearance of food products.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction to Food Science**: Overview of food science and its importance, basic components of food: carbohydrates, proteins, lipids, vitamins, minerals, water.	6	Learn basics of food science	1,2
II	**Food Processing Techniques**: principles and methods of food preservation (e.g., heat processing, drying, freezing), techniques for food packaging and storage	6	Understand basic food processing techniques	1,2
III	**Chemical Reactions in Food Processing and Storage**: Chemical changes during cooking, baking, fermentation, and aging, factors influencing chemical reactions: pH, temperature, enzymes	8	Explain chemical changes during food processing and storage	1,2
IV	**Food Microbiology**: Introduction to food borne pathogens and spoilage organisms, microbial growth kinetics and factors affecting microbial growth in foods	8	Understand microbial changes during fermentation	1,2
V	**Sensory Evaluation of Food:** principles of sensory evaluation: taste, aroma, texture, appearance, methods and techniques for sensory evaluation	8	Explain the principle of sensory evaluation of food for quality assessment.	1,2

REFERENCE BOOKS:

R1. Miriah Pace and Rick Parker. Introduction to Food Science and Food Systems. 2nd Ed., Delmar Cengage Learning; 2016.
R2. Srilakshmi. Food Science. 7th Ed., New Age International Publishers; 2018.
R3. Potter. Food Science; 5th Ed., CBS Publishers & Distributors Pvt Ltd, India; 2007.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/33254009/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Acquire a foundational understanding of the basic components of food.	1, 2
2	Learn the fundamental principles of food processing techniques.	1, 2
3	Explore the chemical reactions that occur during food processing and storage.	1, 2
4	Examine the basics of food microbiology.	1, 2
5	Gain insights into sensory evaluation techniques used to assess the taste, aroma, texture, and appearance of food products.	1, 2, 3

SEMESTER – IV									
Course Title	**Forensic Biology**								
Course code	23BSFS401R	**Total credits:3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**IV semester of first year of the programme**								
Course Objectives	1. Understand the significance and relevance of biological evidence in criminal investigations. 2. Understand the importance of DNA profiling in forensic identification and its limitations. 3. Learn methods for the detection and analysis of bloodstains, including presumptive and confirmatory tests.								
CO1	Acquire a foundational understanding of forensic biology.								
CO2	Learn the principles and techniques of DNA analysis.								
CO3	Explore the analysis of bodily fluids, with a focus on bloodstain pattern analysis and the identification of blood group antigens.								
CO 4	Investigate the role of entomology and anthropology in forensic investigations.								
CO 5	Understand the protocols and procedures involved in collecting, preserving, and analyzing biological evidence from crime scenes.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to Forensic Biology:** Overview of forensic biology: scope, applications, and historical development, legal aspects and ethical considerations in forensic biology	6	Understand basics of forensic biology	1,2
II	**Principles and Techniques of DNA Analysis**: DNA structure and function relevant to forensic applications, Techniques in DNA extraction, quantification, amplification (PCR), and analysis	6	Explain the principle of DNA profiling using PCR	1,2
III	**Analysis of Bodily Fluids**: Identification and characterization of bodily fluids (blood, semen, saliva), bloodstain pattern analysis: principles, methods, and interpretation	8	Explain the mechanism of detection and interpretation of bodily fluids	1,2
IV	**Blood Group Antigens and Serology:** Blood group systems and their forensic significance, techniques for blood group antigen testing and serological analysis	8	Descibe techniques for blood group detection.	1,2
V	**Role of Anthropology in Forensic Investigations**: Forensic anthropology: identification of human remains and biological profiling, methods in skeletal analysis and age estimation, Crime scene protocols for biological evidence collection and preservation	8	Discuss forensic anthropology	1,2

REFERENCE BOOKS:

R1. Schober, Li, Norman; Forensic Biology; 2nd Ed.; Taylor & Francis Ltd; 2021.
R2. Mia; Sharma; Singal. Handbook of Forensic Biology & Forensic Serology; 1st Ed.; Selective & Scientific Books, 2022.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/33809459/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Acquire a foundational understanding of forensic biology.	1, 2
2	Learn the principles and techniques of DNA analysis.	1, 2, 3
3	Explore the analysis of bodily fluids, with a focus on bloodstain pattern analysis and the identification of blood group antigens.	1, 2, 3
4	Investigate the role of entomology and anthropology in forensic investigations.	1, 2
5	Understand the protocols and procedures involved in collecting, preserving, and analysing biological evidence from crime scenes.	1, 2, 3

SEMESTER – IV									
Course Title	**Techno Professional Skill – II (Mushroom Cultivation)**								
Course code	**23BSBT224R**	**Total credits:2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**IV semester of first year of the programme**								
Course Objectives	1. To create awareness about the Mushroom among the people. 2. To strengthen the promotion of mushroom cultivation by establishing a well-equipped laboratory and offices. 3. To know and explore the cultivation in Assam								
CO1	Explain different classes of mushroom.								
CO2	Understand reproduction and growth of mushroom.								
CO3	Explain mushroom spawn production.								
CO 4	Discuss the methods of cultivation of mushroom.								
CO 5	Explain the techniques for the utilization of mushroom spent								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Setting of laboratory for mushroom cultivation; preparation and production of mother culture, mother and commercial spawn; preparation and cultivation of mushroom; mushroom spent management by vermicom posting.	6	Explain and demonstrate the techniques required to harness mushroom cultivation	1,2

REFERENCE BOOKS:

R1. Gogoi et al. Mushroom Cultivation Technology. 1st edition. Scientific Publishers Journals Dept. 2006.

R2. Fleming. The Mushroom Cultivation Guide: A Beginner's Bible with Step-by-Step Instructions to Grow Any Magical Mushroom at Home (DIY Mushroom). 1st edition. 2019.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/30027491/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain different classes of mushroom.	1,2,3
2	Understand reproduction and growth of mushroom.	1,2,3
3	Explain mushroom spawn production.	1,2,3
4	Discuss the methods of cultivation of mushroom.	1,2,3
5	Explain the techniques for the utilization of mushroom spent	1,2,3

SEMESTER – IV									
Course Title	**English for Employability**								
Course code	**23UBPD222R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 32	**0**	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Spring/ IV semester of second year of the programme**								
Course Objectives	1. To develop public speaking skills, including script preparation, understanding nonverbal cues, overcoming fear, and practicing speaking strategies. 2. To provide practical experience in preparing, submitting, and screening resumes and cover letters. 3. To teach email etiquette, including the structure of emails and effective drafting techniques. 4. To prepare students for interviews through practice with commonly asked questions and mock interview sessions. 5. To introduce conflict management, covering its definition, types, and effects.								
CO1	Enable students to prepare scripts, understand nonverbal cues, overcome fear, and practice public speaking strategies.								
CO2	Equip students with skills to prepare, submit, and screen resumes and cover letters.								
CO3	Teach students the different parts of an email and effective email drafting techniques.								
CO4	Prepare students for interviews by practicing commonly asked questions and participating in mock interview sessions.								
CO5	Students will understand the concept of conflict management, identify different types, and analyze its effects.								

Unit -No.	**Content**	**Contact Hour**	**Learning Outcome**	**K L**
I	**Public Speaking Skills** i**.** Preparation of Scripts and understanding Nonverbal cues of Public Speaking ii. Understanding and Overcoming Fear of Public Speaking ii. Practice strategies of Public Speaking	7	Students will be able to create effective speaking scripts, interpret nonverbal cues, manage public speaking anxiety, and practice effective speaking techniques.	3, 4
II	**Practical session on Resume and Cover letter** i. Preparation, submission & screening of Resume. ii. Practical session on cover letter screening session	5	Students will prepare, submit, and evaluate resumes and cover letters.	3
III	Email Etiquettes i. Different Parts of Email and Usage ii. Drafting emails effectively	5	Students will understand the structure of emails and draft them effectively.	2, 3
IV	Interview Skills (Mock sessions) i.Preparing Commonly asked Interview Questions ii.Mock Interview sessions	7	Students will answer common interview questions confidently and perform well in mock interviews.	3, 5
V	**Conflict Management** i. Definition ii. Type of Conflict Management iii. Effects of Conflict Management	8	Students will understand the concept of conflict management, identify different types, and analyze its effects.	2, 4

Textbooks:

1. Barrett, Grant.2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.
2.Reed, James. 2016. 101 Job Interview Questions You'll Never Fear Again, Plume.
3.Pease, Barbara. 2006. The Definitive Book of Body Language, RHUS.
4.McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition)

Reference Books:

1. Zinsser, William. (2006) On Writing Well: The Classic Guide to Writing Nonfiction Harper Perennial
2. Taylor J. and Wright, J., IELTS Advantage Reading Skills: A step-by-step guide to a high IELTS reading score, Delta Publishing by Klett.
3. Kelley, Thea. 2021. Get That Job: The Quick and Complete Guide to a Winning Interview, Plovercrest Press.
4. Murphy, Raymond,.(2012) English Grammar in Use Book with Answers: A Self- Study and Practice Book for Intermediate Learners of English ,Cambridge University Press

Other Learning Resources:

https://learning.shine.com/talenteconomy/career-help/top-group-discussionskills

https://www.coursera.org/articles/conflict-management

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Enable students to prepare scripts, understand nonverbal cues, overcome fear, and practice public speaking strategies.	1,2,3
2	Equip students with skills to prepare, submit, and screen resumes and cover letters.	1,2,3
3	Teach students the different parts of an email and effective email drafting techniques.	1,2,3
4	Prepare students for interviews by practicing commonly asked questions and participating in mock interview sessions.	1,2,3
5	Students will understand the concept of conflict management, identify different types, and analyze its effects.	1,2,3

SEMESTER – V									
Course Title	Plant Biotechnology								
Course code	23BSBT311R	**Total credits:4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**V semester of first year of the programme**								
Course Objectives	1. Introduce tissue culture techniques and its applications 2. To make the students understand about Somatic embryogenesis, somatic hybridization, DNA transfer and Biotechnology for Crop Improvement 3. Develop skill on media preparation, and cell culture								
CO1	Illustrate on basic techniques and concepts of plant tissue culture.								
CO2	Describe different methods for transformation of plants or plant cells, including their specific advantages and applications,								
CO3	Elaborate on somatic hybridization and associated techniques								
CO 4	Explain on the methods of genetic engineering technology.								
CO 5	Apply the concepts of biotechnological advances for crop improvement through genetic engineering technologies.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Basic techniques and tools in Plant Tissue Culture. Totipotency. Establishment of plant tissue culture lab: equipment, culture vessels Surface sterilization of various explants, pre-treatment of explant, Subculture and repeated transfer of explants and cultures. Composition of various tissue culture media and their preparation. Establishment of callus, suspension cultures	**10**	Describe Tissue culture Techniques	1,2
II	Somatic embryogenesis, Introduction to the processes of embryogenesis and organogenesis and their practical applications: Somaclonal variations andits significance.	**9**	Describe embryogenesis, organogenesis and somaclonal variation	1,2
III	Introduction of somatic hybridization, Introduction to protoplast isolation, Principles of protoplast isolation and applications, Testing of viability of isolated protoplasts, Various steps in the regeneration of protoplasts. Cybridization & Cybrids- definition and application	**10**	Explain somatic hybridization, protoplast isolation, cybridization	1,2
IV	Mechanisms of DNA transfer-Direct genetransfer- Particle bombardment, Electroporation, Microinjection Ultrasonification, Liposome mediated gene transfer, Mechanisms of DNA transfer-Indirect Gene transfer-, Features of Ti and Ri plasmids, Role of virulence genes Use of Ti and Ri as vectors	**8**	Explain DNA transfer methods	1,2
V	Biotechnology for Crop Improvement, Conventional methods for crop improvement, Pedegree breeding, Heterosis breeding, Mutation breeding, Tissue culture in crop improvement. Crop improvement by genetic engineering, transgenesis	**8**	Explain the application of biotechnology for crop improvement	1,2
Practical	1.Study of VAM from plant root, Bio inoculant:	**30**	Develop knowledge on	**1,2,**

	mass production of Rhizobium, 2. Tissue culture media preparation, 3. Callus and suspension cultures: initiation and maintenance of callus and suspension cultures, 4. Tissue and micro propagation, suspension culture, callus formation, regeneration, production of haploids, protoplast culture and somatic hybridization		plant tissue culture laboratory	

REFERENCE BOOKS:

R1. Singh B. D. Biotechnology; Expanding Horizon. 20th edition. Kalyani Publisher; 2020.
R2. Lindsey K. Plant Tissue Culture Manual: Supplement 1. 2nd edition. Springer, 1999.
R3. Razdan M K. Introduction to Plant Tissue Culture. 3rd edition. Oxford & IBH Publishing; 2019.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/33809459/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Illustrate on basic techniques and concepts of plant tissue culture.	1,2,3
2	Describe different methods for transformation of plants or plant cells, including their specific advantages and applications,	1,2,3
3	Elaborate on somatic hybridization and associated techniques	1,2,3
4	Explain on the methods of genetic engineering technology.	1,2,3
5	Apply the concepts of biotechnological advances for crop improvement through genetic engineering technologies.	1,2,3

SEMESTER – V									
Course Title	Medical Biotechnology								
Course code	23BSBT312R	**Total credits:4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**V semester of first year of the programme**								
Course Objectives	**1.** Introduce the application of biotechnology in the field of medical science. **2.** To make the students understand about gene therapy, stem cells, cancer biology and infectious diseases of human. **3.** Develop skill on handling human pathogens, AFB staining method, Identifying of pathogens using VDRL and Widaltests.								
CO1	Learn the utilization of medical biotechnology within the realm of medical science.								
CO2	Explain the process of gene therapy.								
CO3	Ability to provide an introduction to stem cell varieties, delve into the origins of stem cells, and outline their distinctive characteristics.								
CO 4	Explore on cancer biology by shedding light on the predisposing factors that contribute to the development of cancer.								
CO 5	Elaborate on the mode of infection and infectious diseases.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction to Medical biotechnology and its Scopes. Human Genome Project.	**10**	Explain medical biotechnology	**1,2**
II	Gene Therapy, Introduction Genes Targeted for Gene Therapy	**9**	Describe gene therapy	**1, 2**
III	Stem Cells: Introduction, Types of Stem Cells, Sources of Stem Cells; Properties of Stem Cells	**10**	Explain stem cell	**1, 2, 3**
IV	Cancer Biology: Introduction, Types of Tumor, Predisposing factors for cancer, Cellular changes involved in Tumor formation, Methods of Tumor detection, Treatment of cancer – Chemotherapy and Radiotherapy	**8**	Explain cancer biology	**1, 2, 3**
V	Microbial diseases in Human – mode of infection, symptoms, epidemiology and control measures, AIDS, Hepatitis – B, Rabies, HSV - 1, STD (sexually transmitted disease), TB, Plague, Aspergillosis, Histoplsmosis, Cryptococcosis, Malaria, Amoebiasis	**8**	Explain infectious diseases	**1, 2, 3,**
Practical	1. Study of Mycobacterium tuberculosis byAFB staining method. 2. Diagnosis of venereal disease by using VDRL test. 3.Study of Salmonella typhi by using Widaltest	**30**	Develop knowledge on Medical biotechnology	**1,2, 3,4**

REFERENCE BOOKS:

R1. Strachan T, Andrew P. Human Molecular Genetics. 2nd Edition. Wiley and sons; 1999.
R2. Mims C. et al. Medical Microbiology. 3rd Edition. Mosgy Inc. Publication, 2004.

R3. Balaji S. Nanobiotechnology, 1st edition. Neha Publishers & Distributors, 2021.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/32917468/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn the utilization of medical biotechnology within the realm of medical science.	1,2,3
2	Explain the process of gene therapy.	1,2,3
3	Ability to provide an introduction to stem cell varieties, delve into the origins of stem cells, and outline their distinctive characteristics.	1,2,3
4	Explore on cancer biology by shedding light on the predisposing factors that contribute to the development of cancer.	1,2,3
5	Elaborate on the mode of infection and infectious diseases.	1,2,3

SEMESTER – V									
Course Title	Research Methodology, Bioethics and IPR								
Course code	23BSBT313R	**Total credits:3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**V semester of third year of the programme**								
Course Objectives	**1.** Describe research objectives, design, methodology, analysis including types of researches **2.** Explain about IPR and ways of its protection along with the laws and regulations associated with the process. **3.** Explain moral and ethical issues associated with researches including various conventions								
CO1	Explain and illustrate research objectives, design, methodology, analysis and research.								
CO2	Describe data collection and sampling methods.								
CO3	explain property rights and ways of its protection along with the laws and regulations associated with the process.								
CO 4	Understand trademarks and geographical indications and process of obtaining them.								
CO 5	Explain moral and ethical issues associated with researches including various conventions								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction to Research Methods and Methodology- Format of thesis and dissertation, Research article, Reviews, Monographs, Bibliography, Literature search, Significance of research, Research methods versus methodology, Research and Scientific methods, Defining the research Problem and Research design. Scientific Methods, Hypotheses Generation and Evaluation, Various Steps in Scientific Research, Types of Research; Research Purposes - Research Design - Survey Research –Case Study Research.	**10**	Explain literature search, gap analysis, research question, types of research hypothesis design, and research methodology	**1,2**
II	Data collection and Sampling Design- Sources of Data: Primary Data, Secondary Data; Procedure Questionnaire- Survey and Experiments – Design of Survey and Experiments - Sampling Merits and Demerits - Control Observations - Procedures – Sampling Errors.	**9**	Explain data collection an presentation	**1, 2**
III	Introduction to Intellectual Property - Concept of Intellectual Property, Patents etc., kinds of Intellectual Property, Economic importance of Intellectual Property. International Scenario: Introduction to the leading international instruments concerning intellectual property rights: the Berne Convention, Universal Copyright Convention, the Paris Convention, TRIPS, the World Intellectual Property Rights Organization (WIPO) and the UNESCO	**10**	Describe IPR, and conventions	**1, 2, 3**
IV	An Introduction to Trademarks and Geographical Indications - Registration of Trademarks and Rights of Registered trademark owners, Concept of Appellations of Origin,	**8**	Explain trademarks, and GI	**1, 2, 3,**

	Indication of Source and geographical Indication			
V	Bio-ethics- Purpose and scope, Principles, Medical ethics, Perspectives and methodology, Moral and ethical issues in Biotechnology	**8**	Explain Bioethics	1, 2, 3,

REFERENCE BOOKS:

R1. Bendat and Piersol, Random data: Analysis and Measurement Procedures. 4th edition. Wiley Interscience, 2001.
R2. Cornish W.Ret al. Intellectual Property. 8th edition. Sweet & Maxwell, London; 2013
R3. Keeling D. et al. Kerly's Law of Trade Marks and Trade Names, 16th Edition, Sweet & Maxwell, 2017.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/32917468/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain and illustrate research objectives, design, methodology, analysis and research.	1,2,3
2	Describe data collection and sampling methods.	1,2,3
3	explain property rights and ways of its protection along with the laws and regulations associated with the process.	1,2,3
4	Understand trademarks and geographical indications and process of obtaining them.	1,2,3
5	Explain moral and ethical issues associated with researches including various conventions	1,2,3

SEMESTER – V									
Course Title	**Wild life conservation and Management**								
Course code	**23FSZO501R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ V semester of third year of the programme**								
Course Objectives	1. To understand the ecological principles that form the basis of wildlife conservation. 2. To learn various techniques for assessing and monitoring wildlife biodiversity. 3. To comprehend the significance of genetics in the conservation of wildlife species. 4. To develop strategies for resolving conflicts between human activities and wildlife conservation. 5. To gain knowledge of the legal and policy frameworks governing wildlife conservation.								
CO1	Explain ecological principles that underpin wildlife conservation efforts.								
CO2	Describe the techniques for assessing and monitoring wildlife biodiversity.								
CO3	Describe the role of genetics in wildlife conservation.								
CO4	Explain the strategies for mitigating conflicts between human activities and wildlife conservation goals.								
CO5	Describe the legal and policy frameworks that govern wildlife conservation								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Ecological Principles in Wildlife Conservation:** Introduction to ecological principles, ecosystem functions, species interactions, population dynamics, habitat requirements, and landscape ecology.	**10**	Understanding the fundamental ecological principles that support wildlife conservation.	1,2
II	**Techniques for Assessing and Monitoring Wildlife Biodiversity:** Survey methods, population estimation techniques, biodiversity indices, remote sensing, and GIS in wildlife monitoring.	**8**	Ability to describe and apply various techniques for biodiversity assessment and monitoring.	1,2
III	**Role of Genetics in Wildlife Conservation:** Genetic diversity, population genetics, conservation genetics, genetic drift, gene flow, inbreeding depression, and genetic management of small populations.	**10**	Understanding the role and importance of genetics in wildlife conservation.	1,2
IV	**Mitigating Conflicts Between Human Activities and Wildlife Conservation:** Human-wildlife conflict causes and impacts, conflict resolution strategies, community-based conservation, and sustainable development practices.	**10**	Ability to develop and explain strategies to mitigate conflicts between human activities and wildlife conservation.	1,2
V	**Legal and Policy Frameworks in Wildlife Conservation:** International conventions and agreements, national wildlife laws, protected area management policies, wildlife trade regulations, and enforcement mechanisms.	**7**	Knowledge of the legal and policy frameworks that govern wildlife conservation.	1,2

Textbooks:

1. "Principles of Conservation Biology" by Martha J. Groom, Gary K. Meffe, and C. Ronald Carroll.
2. Conservation Biology: Foundations, Concepts, Applications" by Fred Van Dyke and Rachel L. Lamb
3. "Essentials of Conservation Biology" by Richard B. Primack

Reference Books:

1. "Wildlife Ecology, Conservation, and Management" by John M. Fryxell, Anthony R. E. Sinclair, and Graeme Caughley.
2. "Fundamentals of Conservation Biology" by Malcolm L. Hunter Jr. and James P. Gibbs.
3. "Conservation Genetics: Case Histories from Nature" by John C. Avise and John L. Hamrick.

OTHER LEARNING RESOURCES:

Coursera, YouTube

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain ecological principles that underpin wildlife conservation efforts.	1,2,3
2	Describe the techniques for assessing and monitoring wildlife biodiversity.	1,2,3
3	Describe the role of genetics in wildlife conservation.	1,2,3
4	Explain the strategies for mitigating conflicts between human activities and wildlife conservation goals.	1,2,3
5	Describe the legal and policy frameworks that govern wildlife conservation	1,2,3

SEMESTER – V									
Course Title	**Toxicology**								
Course code	**23FSFS501R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ V semester of third year of the programme**								
Course Objectives	1. Explore the fundamental principles of toxicology, including the absorption, distribution, metabolism, and excretion (ADME) of toxic substances in living organisms. 2. Acquire proficiency in analytical techniques used for the detection, quantification, and characterization of toxic substances in biological, environmental, and occupational samples.								
CO1	Explain the foundation of toxicological principles.								
CO2	Classify different types of toxicants.								
CO3	Assess the risk associated with exposure to toxic substances.								
CO4	Explain the mechanism of absorption, distribution, metabolism, and excretion of toxic substances within the body.								
CO5	Utilize toxicological knowledge to assess and manage risks in environmental and occupational settings.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to Toxicology:** • Definition and scope of toxicology, • History and development of toxicological principles, • Relationship between dose and response	**10**	Explain the foundational principles of toxicology, including the history and development of the field, the definition and scope of toxicology, and the relationship between dose and response.	1,2
II	**Classification of Toxicants** • Types of toxicants: Chemical, biological, and physical • Sources and exposure routes of toxicants • Toxic kinetics and toxic dynamics	**8**	Classify different types of toxicants, understand their sources and routes of exposure, and describe the principles of toxic kinetics and toxic dynamics.	1,2
III	**Risk Assessment and Management** • Principles of risk assessment • Hazard identification and characterization • Dose-response assessment • Exposure assessment • Risk characterization and management	**10**	Assess the risk associated with exposure to toxic substances by applying principles of risk assessment, including hazard identification, dose-response assessment, exposure assessment, and risk characterization and management.	1,2
IV	**Mechanisms of Toxicity** • Absorption of toxic substances • Distribution of toxic substances • Metabolism of toxic substances • Excretion of toxic substances	**10**	Explain the mechanisms of absorption, distribution, metabolism, and excretion of toxic substances within the body, including the processes	1,2

	• Biotransformation and bioaccumulation		of biotransformation and bioaccumulation.	
V	**Toxicology in Environmental and Occupational Settings** • Environmental toxicology: Impact on ecosystems and human health • Occupational toxicology: Workplace exposure and safety • Regulatory aspects and safety guidelines	**7**	Utilize toxicological knowledge to assess and manage risks in environmental and occupational settings, understand the impact of toxicants on ecosystems and human health	1,2

Textbooks:

1. "Casarett & Doull's Essentials of Toxicology" by Curtis Klaassen and John B. Watkins.
2. "A Textbook of Modern Toxicology" by Ernest Hodgson

Reference Books:

1. "Patty's Toxicology" edited by Eula Bingham, Barbara Cohrssen, and Charles H. Powell
2. "Molecular, Clinical and Environmental Toxicology" edited by Andreas Luch
3. "Toxicology: The Basic Science of Poisons" by Curtis D. Klaassen

OTHER LEARNING RESOURCES:

Coursera, YouTube

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the foundation of toxicological principles.	1,2,3
2	Classify different types of toxicants.	1,2,3
3	Assess the risk associated with exposure to toxic substances.	1,2,3
4	Explain the mechanism of absorption, distribution, metabolism, and excretion of toxic substances within the body.	1,2,3
5	Utilize toxicological knowledge to assess and manage risks in environmental and occupational settings.	1,2,3

SEMESTER – V									
Course Title	**Mini Research**								
Course code	**23BSBT314R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 16P	**0**	**0**	**0**	**8**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ V semester of third year of the programme**								
Course Objectives	1. Equip students with the essential skills and methods needed to conduct independent research. 2. Develop a research proposal, formulating research questions, reviewing literature, interpreting data, and understanding the implications of research findings.								
CO1	Develop skills in crafting a concise and well-structured research proposal.								
CO2	Learn to formulate research questions, objectives, and hypotheses.								
CO3	Conduct a focused review of relevant literature related to the chosen mini research topic.								
CO4	Learn to interpret data, draw meaningful conclusions, and relate results to the research question.								
CO5	Develop an awareness of the implications of findings within the scope of the mini research.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Crafting a concise and well-structured research proposal, writing a draft of a research proposal on a chosen topic.	**15**	Develop skills in crafting a concise and well-structured research proposal.	1,2,3,4
II	Formulating Research Questions and Hypotheses in small groups, submitting formulated research questions and hypotheses for feedback.	**15**	Learn to formulate research questions, objectives, and hypotheses.	1,2,3,4
III	Use of academic databases and tools for literature review, conduct a literature review on the chosen research topic and submit a summary.	**20**	Conduct a focused review of relevant literature related to the chosen mini research topic.	1,2,3,4
IV	Hands-on practice with data analysis software, analyse sample data sets and interpret the results.	**10**	Learn to interpret data, draw meaningful conclusions, and relate results to the research question.	1,2,3,4
V	Presentations and discussions on the broader implications of students' research findings, reflect on the implications of the research findings and submit a final research report.	**10**	Develop an awareness of the implications of findings within the scope of the mini research.	1,2,3,4

Textbooks:

Reference Books:

R1. Creswell; Research Design: Qualitative, Quantitative, and Mixed Methods Approaches; 5th edition; 2018.
R2. Booth and Colomb; The craft of research; 4th edition, 2016.

OTHER LEARNING RESOURCES:

https://scholar.google.com/
https://pubmed.ncbi.nlm.nih.gov/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Develop skills in crafting a concise and well-structured research proposal.	1,2,3
2	Learn to formulate research questions, objectives, and hypotheses.	1,2,3
3	Conduct a focused review of relevant literature related to the chosen mini research topic.	1,2,3
4	Learn to interpret data, draw meaningful conclusions, and relate results to the research question.	1,2,3
5	Develop an awareness of the implications of findings within the scope of the mini research.	1,2,3

SEMESTER – V									
Course Title	**Techno professional skill III (Analytical Biochemistry)**								
Course code	**23BSBT314R**	**Total credits: 2** **Total hours: 60P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ V semester of third year of the programme**								
Course Objectives	This course provides a practical understanding of key concepts and techniques used in biochemistry including buffer preparation, pH measurement, spectrophotometry, enzyme kinetics, and enzyme activity modulation.								
CO1	Build concept on how to prepare buffer solutions which could be used in different molecular and biochemical experiments.								
CO2	Develop basic understanding on acid-base, pH of solution and use of pH meters.								
CO3	Understand the principle of Lambert-Beer law with the help of colorimeter and spectrophotometer.								
CO4	Understand the mechanism of enzyme kinetics applying Michaelis Menten equation.								
CO5	Illustrate the concept of enzyme activity modulation.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	1. Preparation of Buffer Solutions 2. Measure the pH of various solutions using pH meters. 3. Prepare titration curves by titrating acids and bases. 4. Determine the pKa of weak acids by analysing titration data. 5. Measure the absorbance of different solutions at specific wavelengths and prepare standard curves. 6. Perform enzyme assays to measure reaction rates at different substrate concentrations. 7. Investigate the effects of different inhibitors (competitive, non-competitive) on enzyme activity.	**30**	Gain practical insights into essential biochemistry techniques and concepts, including buffer preparation, pH measurement, spectrophotometry, enzyme kinetics, and enzyme activity modulation.	3,4

Reference Books:

R1. Weyers, Practical Skills in Biomolecular Sciences; 4th edition; Pearson Education India; 2013.

R2. David L. Nelson, Michael Cox. Menninger Principles of Biochemistry. 7th Edition. WH Freeman; 2017.

R3. Rodwell et al. Harper's Illustrated Biochemistry. 29th edition. McGraw Hill; 2012.

OTHER LEARNING RESOURCES:

https://www.sciencedirect.com/science/article/pii/S0003269799943208

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Build concept on how to prepare buffer solutions which could be used in different molecular and biochemical experiments.	1,2,3
2	Develop basic understanding on acid-base, pH of solution and use of pH meters.	1,2,3
3	Understand the principle of Lambert-Beer law with the help of colorimeter and spectrophotometer.	1,2,3
4	Understand the mechanism of enzyme kinetics applying Michaelis Menten equation.	1,2,3
5	Illustrate the concept of enzyme activity modulation.	1,2,3

SEMESTER – VI										
Course Title	**Animal Biotechnology**									
Course code	**23BSBT321R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**VI semester of third year of the programme**								
Course Objectives	1. Introduce Animal Cell Culture techniques, and application of the culture. 2. Elucidation of various cell to cell interaction; adhesion, motility and metabolic co-operation. 3. Impart skills on tools and techniques used for animal cell culture.								
CO1	Explain the evolution of animal cell culture.								
CO2	Describe the applications of animal cell culture technology with special reference to vaccines and proteins of medical importance.								
CO3	Illustrate on assisted reproduction techniques and basics of human fertilization process.								
CO4	Describe the overview on gene therapy and its techniques.								
CO5	Explain DNA forensics, molecular diagnostics, cloning, stem cell research and bio processing Techniques.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Introduction, history of animal cell culture.Basic requirement for animal cell culture, Animal cell, Tissue and organ cultures, Primary culture, secondary cell culture, Continuous cell lines, Suspension culture, Cell cloning and hybridization, 3Dcultures,Scalingup. Growth factors. Cellline and maintenance, viability test, cytotoxicity	**10**	Describe the basics of animal cell culture	**1,2**
II	Application of cell culture technology in production of different vaccines and pharmaceutical proteins.	**9**	Describe the cell culture and vaccine production	**1, 2**
III	Structure of sperms and ovum, cryopreservation of sperms and ova of live stocks, IVF, super ovulation, in-vitro fertilization, culture of embryos, cryopreservation of embryos, embryo transfer.	**10**	Explain reproductive structures and artificial fertilization	**1, 2, 3**
IV	Gene therapy: overview, history, types, applications, advantages and disadvantages, tissue, engineering overview. Transgenic and somatic cell nucleus transfer technology	**8**	Explain the applications of cell culture in gene therapy	**1, 2, 3,**
V	Cell differentiation during development and role of homeotic genes and other developmental genes in pattern formation (Drosophila). Human forensics, bio-terror agents, Bio-crimes and Bio-terrorism, ethical consideration on animal biotechnology.	**8**	Explain cell differentiation, understanding applications in various fields	**1, 2, 3,**

Practical	1. Laboratory safety 2. Setting of Animal cell culturelab 3. Field visit to animal cell culture laboratory 4. Examination of permanent slide samples and explanation to the observation 5. Measurement of cell size.	**30**	Develop knowledge on animal cell culture and laboratory	**1,2, 3,4**

Reference books:

R1. Satyanarayana U. Biotechnology. 15th edition. Books & Allied Ltd; 2020.
R2. Singh B. D. Biotechnology; Expanding Horizon. 20th edition. Kalyani Publisher; 2020.
R3. Brown T. A. Gene Cloning and DNA Analysis: an introduction. 7th edition. John Wiley; 2016.

OTHER LEARNING RESOURCES:

https://books.google.com/books?hl=en&lr=&id=K8eaAgAAQBAJ&oi=fnd&pg=PA1&dq=animal+biotechnology&ots=IZMN9XSg_X&sig=QibBdcSBHILUhmqwNASdWXWHnfg

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the evolution of animal cell culture.	1,2,3
2	Describe the applications of animal cell culture technology with special reference to vaccines and proteins of medical importance.	1,2,3
3	Illustrate on assisted reproduction techniques and basics of human fertilization process.	1,2,3
4	Describe the overview on gene therapy and its techniques.	1,2,3
5	Explain DNA forensics, molecular diagnostics, cloning, stem cell research and bio processing Techniques.	1,2,3

SEMESTER – VI									
Course Title	**Industrial Biotechnology**								
Course code	**23BSBT322R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**VI semester of third year of the programme**								
Course Objectives	1. Introduce application of biotechnological knowledge in industries. 2. To make the student understand fermenters, sterilisation techniques, cell growth kinetics, bioreactor production of Enzymes, Organic acids-citric acid, Amino acid-glutamic acid, Antibiotics-Penicillin, Solvent-Ethanol, Vitamins-Riboflavin and SCP. 3. Develop skill on Immobilization study by sodium alginate method (yeast), development of bioinoculant, production of yoghurt.								
CO1	Trace the historical evolution of fermentation, highlighting key milestones and advancements in the understanding and application of this process over time.								
CO2	Discuss the formulation of media in the context of a media preparation process, and delve into various sterilization techniques employed in the production of media for applications such as microbiology or cell culture.								
CO3	To Elaborate on the design and functionality of bioreactors, detailing the key components and principals involved in creating controlled environments for biological processes.								
CO4	Describe the process of producing microbial products, outlining the key steps involved in cultivating and harvesting microorganisms to obtain desired products.								
CO5	To explain about Biofertilizers, biopesticides, and mushroom technology represent sustainable and environmentally friendly approaches in agriculture.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Historical development in fermentation, Outline of upstream processing. Screening of industrially important microbes. Strain improvement, Inoculum development	**10**	Describe use of biotechnology in industry	**1,2**
II	Media formulation, sterilization, batch and continuous culture system, types of fermentation, Stoichiometry of cell growth and kinetics. Methods of immobilization	**9**	Describe culture and growth kinetics	**1, 2**
III	Biorector- Design, parts and their function. Types of bioreactor-cstr. Air lift, Bubble column, Packed bed, Tower, monitoring and control of process variables (Temperature, pH and DO)	**10**	Explain bioreactor	**1, 2, 3**
IV	Production of microbial products: Enzymes- amylase, Organic acids-citric acid, Amino acid- glutamic acid, Antibiotics-Penicillin, Solvent- Ethanol, Vitamins-Riboflavin and SCP	**8**	Explain production of enzymes, antibiotics, ethanol etc.	**1, 2, 3,**
V	Biofertilizers, Biopesticides, Mushroom technology, Vermitechnology, Biofuel technology, Biodyes, MEOR	**8**	Explain the biofertilizers, biotesticides etc.	**1, 2, 3,**
Practical	1. Immobilization study by sodium		Develop knowledge on	

	alginate method(yeast), 2. Bio inoculant: Study of the fermenter, 3. Production of yoghurt by using specific starter culture, 4. Visit to industry and biotech park and to be submitted along with the record	**30**	industrial application of biotechnology	**1,2, 3,4**

Reference books:

R1. PatelAH. Industrial microbiology, 2nd edition. Laxmi Publications; 2022.
R2. Crueger and Crueger. Industrial Microbiolgy. 3rd edition. Panima Books; 2004.
R3. Satyanarayana U. Biotechnology. 15th edition. Books & Allied Ltd; 2020.

OTHER LEARNING RESOURCES:

https://analyticalsciencejournals.onlinelibrary.wiley.com/doi/abs/10.1002/biot.200900127

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Trace the historical evolution of fermentation, highlighting key milestones and advancements in the understanding and application of this process over time.	1,2,3
2	Discuss the formulation of media in the context of a media preparation process, and delve into various sterilization techniques employed in the production of media for applications such as microbiology or cell culture.	1,2,3
3	To Elaborate on the design and functionality of bioreactors, detailing the key components and principals involved in creating controlled environments for biological processes.	1,2,3
4	Describe the process of producing microbial products, outlining the key steps involved in cultivating and harvesting microorganisms to obtain desired products.	1,2,3
5	To explain about Biofertilizers, biopesticides, and mushroom technology represent sustainable and environmentally friendly approaches in agriculture.	1,2,3

SEMESTER – VI									
Course Title	**Herbal Medicine**								
Course code	**23FSBO601R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Spring/ VI semester of third year of the programme**								
Course Objectives	1. To understand the pharmacological properties of medicinal plants. 2. To learn the methods of formulation of herbal medicine. 3. To evaluate scientific literature on herbal medicine. 4. To discuss the clinical applications of herbal medicine. 5. To comprehend the legal and ethical issues related to herbal medicine.								
CO1	Discuss pharmacological properties of medicinal plants.								
CO2	Explain the methods of formulation of herbal medicine.								
CO3	Evaluate scientific literature on herbal medicine.								
CO4	Discuss clinical applications of herbal medicine.								
CO5	Understand the legal and ethical issues on herbal medicine.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Pharmacological Properties of Medicinal Plants:** Introduction to pharmacognosy, bioactive compounds in plants, mechanisms of action, examples of commonly used medicinal plants.	**9**	Describe the pharmacological properties and mechanisms of action of bioactive compounds in medicinal plants.	1,2
II	**Methods of Formulation of Herbal Medicine:** Extraction methods, preparation of extracts, formulation techniques (tinctures, decoctions, infusions, tablets, capsules), standardization of herbal products.	**9**	Demonstrate knowledge of different extraction and formulation techniques used in herbal medicine.	2,3
III	**Evaluation of Scientific Literature on Herbal Medicine:** Research methodologies, critical appraisal of clinical studies, systematic reviews, meta-analyses, interpretation of results.	**9**	Critically evaluate and interpret scientific literature related to herbal medicine.	4,5
IV	**Clinical Applications of Herbal Medicine:** Use of herbal medicine in treating common ailments, evidence-based applications, safety and efficacy, interaction with conventional medicines.	**9**	Discuss the clinical applications, safety, and efficacy of herbal medicines in treating various conditions.	3,4
V	**Legal and Ethical Issues in Herbal Medicine:** Regulatory frameworks, quality control, intellectual property rights, ethical considerations in research and practice, patient consent.	**9**	Understand and discuss the legal and ethical issues related to the practice and research of herbal medicine.	1,2

REFERENCE BOOKS:

R1. Felrow and Avila; The Complete Guide to Herbal Medicines; 1st edition; Springhouse Publishing Co ,U.S.; 2000.
R2. Mills and Bones; Principles and Practice of Phytotherapy: Modern Herbal Medicine; 2nd edition; Churchill Livingstone; 2003.

OTHER LEARNING RESOURCES:

https://www.jstor.org/stable/24103844

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss pharmacological properties of medicinal plants.	1,2,3
2	Explain the methods of formulation of herbal medicine.	1,2,3
3	Evaluate scientific literature on herbal medicine.	1,2,3
4	Discuss clinical applications of herbal medicine.	1,2,3
5	Understand the legal and ethical issues on herbal medicine.	1,2,3

SEMESTER – VI									
Course Title	**Community Nutrition**								
Course code	**23FSFD601R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Spring/ VI semester of third year of the programme**								
Course Objectives	1. To understand the principles and practices of nutritional epidemiology. 2. To assess the nutritional needs of communities. 3. To implement and evaluate community nutrition programs. 4. To understand the role of advocacy and policy development in improving community nutrition. 5. To develop strategies for effective nutrition education and intervention programs.								
CO1	Explain the principles and practices of nutritional epidemiology.								
CO2	Assess community nutrition needs using appropriate tools and methodologies.								
CO3	Implement and evaluate community nutrition programs.								
CO4	Understand and apply advocacy and policy development to improve community nutrition.								
CO5	Develop and implement effective nutrition education and intervention programs.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Nutritional Epidemiology** • Principles of nutritional epidemiology • Study designs in nutritional epidemiology • Measurement of dietary intake • Biochemical markers in nutritional epidemiology	**9**	Explain the principles and practices of nutritional epidemiology.	1,2
II	**Community Nutrition Needs Assessment** • Methods of assessing community nutrition needs • Dietary surveys and nutritional status assessments • Use of anthropometry, biochemical, and clinical data • Interpretation of nutrition data	**9**	Assess community nutrition needs using appropriate tools and methodologies.	2,3
III	**Community Nutrition Programs** • Planning and implementing nutrition programs • Monitoring and evaluation of nutrition programs • Case studies of successful community nutrition programs • Challenges in implementing nutrition programs	**9**	Implement and evaluate community nutrition programs.	3,4
IV	**Advocacy and Policy Development** • Role of advocacy in community nutrition • Policy development process • Strategies for influencing nutrition	**9**		3,4

	policy • Case studies of nutrition advocacy and policy change			
V	**Nutrition Education and Intervention Programs** • Principles of nutrition education • Developing and implementing nutrition education programs • Behaviour changes communication strategies • Evaluating the effectiveness of nutrition interventions	**9**		4,5

Reference Books:

R1. Ross et al; Modern Nutrition in Health and Disease; 8th edition; Lea & Febiger,U.S; 1993.

R2. Battle; "Essentials of Public Health Biology: A Guide for the Study of Pathophysiology; 1st edition; Jones and Bartlett Publishers, Inc; 2008.

OTHER LEARNING RESOURCES:

Coursera, YouTube

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the principles and practices of nutritional epidemiology.	1,2,3
2	Assess community nutrition needs using appropriate tools and methodologies.	1,2,3
3	Implement and evaluate community nutrition programs.	1,2,3
4	Understand and apply advocacy and policy development to improve community nutrition.	1,2,3
5	Develop and implement effective nutrition education and intervention programs.	1,2,3

SEMESTER – VI									
Course Title	**Natural Product Chemistry**								
Course code	**23FSCH601R**	**Total credits:3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**VI semester of first year of the programme**								
Course Objectives	1. To provide students with an understanding of the chemistry of natural products. 2. To familiarize students with the structural diversity, biosynthesis, and biological activities of natural products. **3.**To impart knowledge about the extraction, isolation, and structural elucidation of natural products.								
CO1	Describe the structural features and classifications of various natural products.								
CO2	Understand the biosynthetic pathways of primary and secondary metabolites.								
CO3	Explain the methods used for the extraction and isolation of natural products.								
CO 4	Apply techniques for the structural elucidation of natural products.								
CO 5	Discuss the biological activities and pharmacological potential of natural products.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to Natural Products:** Definition and significance of natural products, Classification of natural products. Primary and secondary metabolites. Overview of natural product sources: plants, microorganisms, and marine organisms.	**10**	Classify Natural Products	**1,2**
II	**Biosynthesis of Natural Products:** Biosynthetic pathways: Primary and secondary metabolism., Shikimic acid pathway. Acetate pathway. Mevalonate and non-mevalonate pathways. Alkaloid biosynthesis.	**9**	Explain Biosynthetic Pathways	**1, 2**
III	**Extraction and Isolation of Natural Products:** Extraction techniques: Solvent extraction, steam distillation, and supercritical fluid extraction., Isolation techniques: Chromatographic methods (TLC, HPLC, GC). Purification techniques.	**10**	Utilize Extraction and Isolation Techniques	**1, 2, 3**
IV	**Structural Elucidation of Natural Products:** Spectroscopic methods: UV, IR, NMR, and Mass Spectrometry. Structure determination of terpenoids, alkaloids, flavonoids, and steroids.	**8**	Elucidate Structures Using Spectroscopic Methods	**1, 2, 3**
V	**Biological Activities of Natural Products:** Antibacterial, antifungal, antiviral, and anticancer activities. Natural products as therapeutic agents.	**8**	Evaluate Biological Activities	**1, 2, 3,**

REFERENCE BOOKS:

R1. Bhatt; Natural Products: Chemistry and Applications; 10th Edition, Narosa Publication; 2016.
R2. Xu, Ye and Zhao; Introduction to Natural Products Chemistry, 1st Edition, CRC Press; 2011.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/33297511/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the structural features and classifications of various natural products.	1,2,3
2	Understand the biosynthetic pathways of primary and secondary metabolites.	1,2,3
3	Explain the methods used for the extraction and isolation of natural products.	1,2,3
4	Apply techniques for the structural elucidation of natural products.	1,2,3
5	Discuss the biological activities and pharmacological potential of natural products.	1,2,3

SEMESTER – VI									
Course Title	**Dissertation**								
Course code	**23BSBT324R**	**Total credits: 5**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30R	**0**	**0**	**0**	**0**	**30**	**0**	**5**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ V semester of third year of the programme**								
Course Objectives	1. Equip students with the essential skills and methods needed to conduct independent research. 2. Develop a research proposal, formulating research questions, reviewing literature, interpreting data, and understanding the implications of research findings.								
CO1	Develop Research Proposal Skills								
CO2	Conduct Independent Research								
CO3	Critical Literature Review and Data Analysis								
CO4	Scholarly Writing and Communication								
CO5	Ethical Research Conduct and Contribution to Knowledge								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Crafting a concise and well-structured research proposal, writing a draft of a research proposal on a chosen topic.	**15**	Develop skills in crafting a concise and well-structured research proposal.	1,2,3,4
II	Formulating Research Questions and Hypotheses in small groups, submitting formulated research questions and hypotheses for feedback.	**15**	Learn to formulate research questions, objectives, and hypotheses.	1,2,3,4
III	Use of academic databases and tools for literature review, conduct a literature review on the chosen research topic and submit a summary.	**20**	Conduct a focused review of relevant literature related to the chosen mini research topic.	1,2,3,4
IV	Hands-on practice with data analysis software, analyse sample data sets and interpret the results.	**10**	Learn to interpret data, draw meaningful conclusions, and relate results to the research question.	1,2,3,4
V	Presentations and discussions on the broader implications of students' research findings, reflect on the implications of the research findings and submit a final research report.	**10**	Develop an awareness of the implications of findings within the scope of the mini research.	1,2,3,4

Textbooks:

Reference Books:

R1. Creswell; Research Design: Qualitative, Quantitative, and Mixed Methods Approaches; 5th edition; 2018.

R2. Booth and Colomb; The craft of research; 4th edition, 2016.

OTHER LEARNING RESOURCES:

https://scholar.google.com/

https://pubmed.ncbi.nlm.nih.gov/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Develop skills in crafting a concise and well-structured research proposal.	1,2,3
2	Learn to formulate research questions, objectives, and hypotheses.	1,2,3
3	Conduct a focused review of relevant literature related to the chosen mini research topic.	1,2,3
4	Learn to interpret data, draw meaningful conclusions, and relate results to the research question.	1,2,3
5	Develop an awareness of the implications of findings within the scope of the mini research.	1,2,3

SEMESTER – VI									
Course Title	**Techno-professional skill IV (Food packaging technology)**								
Course code	**23BSBT323R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Biotechnology**								
Semester	**Spring/ VI semester of third year of the programme**								
Course Objectives	1. Understand the principles and practices of food packaging technology, 2. Explain the importance, functions, and advancements in packaging materials and systems. 3. Gain knowledge of different packaging materials, systems for fresh and processed food groups, and emerging trends in food packaging technology.								
CO1	Discuss the importance, functions, needs and role of food packaging.								
CO2	Explain the role of different types of packaging materials.								
CO3	Describe various food packaging systems and process different forms of packaging.								
CO4	Describe various food packaging systems for fresh and process food groups.								
CO5	Describe the advancements in the field of packaging.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction to Food Packaging**: Importance, functions, and role of food packaging, historical development and evolution of food packaging.	**6**	Students will be able to analyze the historical development and evolution of food packaging, identifying key milestones and innovations that have shaped the field.	1,2
II	**Packaging Materials**: Types of packaging materials, Properties and suitability for different food products	**6**	Students will be able to evaluate the properties of different packaging materials and justify their suitability for specific types of food products based on their chemical, physical, and barrier properties.	2,3
III	**Food Packaging Systems**: Overview of packaging systems, Primary, secondary, and tertiary packaging, packaging for fresh and processed foods: packaging systems for fresh foods, challenges and considerations, design project proposal for fresh food packaging, shelf-life extension techniques.	**6**	Students will be able to propose a design project for fresh food packaging, considering primary, secondary, and tertiary packaging needs, and incorporating strategies for shelf-life extension techniques.	3,4
IV	**Sustainable Packaging** Trends and advancements in sustainable packaging, role and benefits of active and intelligent packaging, applications in food preservation and safety.	**6**	Students will be able to assess current trends and advancements in sustainable packaging, including the role and benefits of active and	3,4

			intelligent packaging technologies in enhancing food preservation and safety.	
V	**Packaging Regulations and Safety**: regulatory requirements for food packaging, food safety considerations in packaging design, packaging innovations and future trends, emerging technologies and future trends in food packaging.	**6**	Students will be able to explain regulatory requirements for food packaging and integrate food safety considerations into the design and development of packaging solutions, while also discussing emerging technologies and future trends shaping the field.	4,5

Reference Books:

R1. Ross et al; Modern Nutrition in Health and Disease; 8th edition; Lea & Febiger,U.S; 1993.
R2. Battle; "Essentials of Public Health Biology: A Guide for the Study of Pathophysiology; 1st edition; Jones and Bartlett Publishers, Inc; 2008.

OTHER LEARNING RESOURCES:

Coursera, YouTube

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss the importance, functions, needs and role of food packaging.	1,2,3
2	Explain the role of different types of packaging materials.	1,2,3
3	Describe various food packaging systems and process different forms of packaging.	1,2,3
4	Describe various food packaging systems for fresh and process food groups.	1,2,3
5	Describe the advancements in the field of packaging.	1,2,3

Assam down town University

Curriculum and Syllabus

Bachelor of Science
in
Microbiology

OUTCOME BASED EDUCATION FRAMEWORK
CHOICE BASED CREDIT SYSTEM
Version: 2.1

FACULTY OF SCIENCE

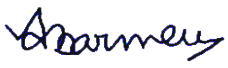
July, 2024

PREAMBLE

Assam down town University is a premier higher educational institution which offers Bachelor, Master, and Ph.D. degree programmes across various faculties. These programmes, collectively embodies the vision and mission of the university. In keeping with the vision of evolutionary changes taking place in the educational landscape of the country, the university has restructured the course curriculum as per the guidelines of National Education Policy 2020. This document contains outline of teaching and learning framework and complete detailing of the courses. This document is a guidebook for the students to choose desired courses for completing the programme and to be eligible for the degree. This volume also includes the prescribed literature, study materials, texts, and reference books under different courses as guidance for the students to follow.

Recommended by the Board of Studies (BOS) meeting of the Faculty of Science held on dated 16th & 17th July, 2024 and approved by the 51st Academic Council (AC) meeting held on dated 26/07/2024

Chairperson, Board of Studies



Member Secretary, Academic Council

Vision

To become a Globally Recognized University from North Eastern Region of India, Dedicated to the Holistic Development of Students and Making Society Better

Missions

1. Creation of curricula that address the local, regional, national, and international needs of graduates, providing them with diverse and well- rounded education.

2. Build a diverse student body from various socio-economic backgrounds, provide exceptional value-based education, and foster holistic personal development, strong academic careers, and confidence.

3. Achieve high placement success by offering students skill-based, innovative education and strong industry connections.

4. Become the premier destination of young people, desirous of becoming future professional leaders through multidisciplinary learning and serving societybetter.

5. Create a highly inspiring intellectual environment for exceptional learners, empowering them to aspire to join internationally acclaimed institutions and contribute to global efforts in addressing critical issues, such as sustainable development, Climate mitigation and fostering a conflict-free global society.

6. To be renowned for creating new knowledge through high quality interdisciplinary research for betterment of society.

7. Become a key hub for the growth and excellence of AdtU's stakeholders including educators, researchers and innovators

8. Adapt to the evolving needs and changing realities of our students and community by incorporating national and global perspectives, while ensuring our actions are in harmony with our foundational values and objectives of serving the community.

Programme Details

Programme Overview

Bachelor of Science in Microbiology is a 3-year undergraduate Programme which deals with fundamental and advanced study of the microorganisms, including microbial cellular processes, their harmful and beneficial aspects, microbes for human welfare, molecular details of microbial cells and develops knowledge and understanding for applying it for societal benefits which may include sectors such as healthcare, agriculture, soil and environment, food processing, pharmaceutical etc. The objective of this Programme is to produce intellectual and proficient microbiologists by enhancing the abilities and skills of students for application of microbiology theories and expertise in the live problems faced by the industry.

I. Specific Features of the Curriculum

Gaining proficiency in microbiology involves mastering both theoretical concepts and practical applications. This includes understanding how microorganisms cause infectious diseases and learning their diagnostic methods. It also involves exploring the beneficial roles of microorganisms in environmental, agricultural, and industrial sectors. Furthermore, expertise in molecular and immunological techniques is crucial. With this comprehensive knowledge, graduates are well-equipped to pursue entrepreneurial ventures in microbiology, utilizing their skills to innovate and lead in the field.

II. Eligibility Criteria:

A minimum of 45% in 10+2 with Biology, Chemistry and English as compulsory subjects from a recognized board.5% relaxation for SC/ST, EWS and specially abled candidates.

III. Program Educational Objectives (PEOs):

PEO-1: AdtU Microbiology Graduates will be prepared for successful careers in applied fields of microbiology in both government and private sectors and as entrepreneurs.

PEO-2: Microbiology Graduates will possess expertise in core microbiology areas as well as interdisciplinary fields for significant contributions to the service of humankind.

PEO-3: Graduates will be successful in higher education and research in areas of microbiology if pursued.

IV. Program Specific Outcomes (PSOs):

PSO1: Holistic Development: Exhibit interpersonal ability and adaptability in diverse sociocultural societies for efficient working in the profession through life-skill learning, and co-curricular and extracurricular activities.

PSO2: Global Certification: Demonstrate competency in the profession by attaining global certification offered by international universities of repute.

PSO3: Techno-Professional Proficiency: Apply the knowledge of interdisciplinary microbiological approaches with industrial applications to become competent professionals.

V. Program Outcome (PO):

PO1: Microbiological Knowledge: Apply the knowledge of basic sciences, fundamentals of microbiology and applied biological sciences to address issues related to agriculture, healthcare, industry and the environment.
PO2: **Problem Analysis:** Critically analyze microbiological problems in interdisciplinary aspects to resolve associated challenges with rational solutions.
PO3: Modern Techniques Usage: Apply standardized methods, contemporary analytical techniques and tools to conduct experiments and systematic analyses.
PO4: **Environmental Sustainability:** Assess the impacts of provided solutions on the environment, and redesign it for better sustainability.
PO5: Communication: Communicate scientific information effectively across diverse audiences, and prepare documents, reports, presentations etc.
PO6: Ethics and Values: Apply universal human values, and follow ethical principles and scientific norms in the profession.
PO7: Individual and Teamwork: Perform efficiently as an individual, and as a member/ leader in a team of diverse professionals, and in multidisciplinary settings.
PO8: Continual Learning: Engage in continuous learning, fostering advances in scientific knowledge and technology

VI. Total Credits to be Earned: 133

VII. Career Prospects:

Graduates with a B. Sc. in Microbiology can pursue a Master's degree in Microbiology or embark on diverse career paths. They can work as research scholars in research and development laboratories, serve as microbiologists in hospital laboratories, and take on roles as microbiologists or quality control officers in food processing industries. Opportunities also exist in beverage and pharmaceutical industries, biotechnological firms, and various agricultural and environmental organizations, allowing them to apply their expertise in a wide range of professional settings.

EVALUATION METHODS

The student performance shall be evaluated through In-semester (Sessional) and semester-end examinations. A weightage of 40% or as prescribed by the Programme shall be added to the score of the end-semester examination.

A. INTERNAL ASSESSMENT:

The teacher who offers the course shall be responsible for internal assessment by conducting in-semester (sessional) examination and evaluating the performance of the students pursuing that course. The components for internal assessment are illustrated in the table given below.

S.N.	Components/ Examinations	Marks Allotted
1.	In-Sem Exam – I (ISE-I) (Written Examination) *	30
2.	In-Sem Exam – II (ISE-II) (Written Examination) *	30
3.	Assignment	10
4.	Presentation (SP)	10
5.	Quiz	5
6.	Class Performance based score*	5

are compulsory

Note: *Total Internal assessment should be out of 40*

INSTRUCTION

1. If a student fails to appear in the any of the component without any valid reason he/she shall be marked zero in that component. However, the course teacher at his discretion may arrange for the missed test on an alternate date for the absentee students after determining ground with genuine/valid reasons for the absent.

2. The report of evaluation of an activity towards the in-semester (sessional) component of a course shall be duly notified by the concerned course teacher within a week of completion.

3. The program coordinators should upload the in-semester marks to the ERP and forward acknowledgement of all the courses of the program to the Controller of Examinations before the start of the End-semester examination.

B. SEMESTER END EXAMINATION:

Time table for end semester examination is published at least 25 days prior to the start of Examination.

I. Pre-Examination:

Eligibility Criteria for a student to appear in University Examinations:

The student shall only be allowed to appear in a University Examination, if:

i) He/ She is a registered student of the University;

ii) He/ She is of good conduct and character;

iii) He/ She has completed the prescribed Programme of study with minimum percentage of attendance as laid down in the Regulations of the Programme concerned.

Under special cases, a student may be allowed to appear for an examination without being registered in the University but the result of the said student will be kept on hold till the registration of the concerned student is completed.

II. Admit Card:

Admit card for the examination may be downloaded through ERP where the system will generate a Unique ID Cards through online.

The University shall have the right to cancel admission for examination of any candidate on valid grounds.

III. Pattern of Question Papers:

The question paper shall follow the principles of Bloom's Taxonomy.
Table

S. N.	Level	Questions /verbs for test
1	Remember	List, Define, tell, describe, recite, recall, identify, show who, when, where, etc.
2	Understand	Describe, explain, contrast, summarize, differentiate, discuss, etc.
3	Apply	Predict, apply, solve, illustrate, determine, examine, modify
4	Analyze	Classify, outline, categorize, analyze, diagrams, illustrate, infer, etc.
5	Evaluate	Assess, summarize, choose, evaluate, recommend, justify, compare etc.
6	Create	Design, Formulate, Modify, Develop, integrate, etc.

Note: No course is to be evaluated on basis of **all 6 knowledge levels.**

The format of the question paper across all the program follow a unique pattern and the total marks is 60

Table 1: Question paper pattern for End semester examination

Sl. No.	Question pattern	Total marks
1	MCQs (10 Questions)	10
2	2 Marks questions (10 Questions)	20
3	4 Marks questions (5 Questions)	20
4	10 Marks questions (1 Question)	10

IV. Examination Duration:

Each paper of 60 marks shall ordinarily be of two hours duration.

V. Practical Examinations, Viva-Voce etc.:

i) Practical examination shall be conducted in the presence of one external expert and one or more internal examiners.

ii) Viva-Voce, Oral examinations of the Project report, Dissertation etc. shall be undertaken by a Board of Examiners constituted by the respective Dean of Program with the advice of Supervisor(s).

VI. Procedure of Expulsion:

If any candidate is found to be using any unfair-means during the examination, the invigilator may cease his/her answer sheet and report it directly to the Officer-in-Charge. The Office-in-Charge of the center may take appropriate decisions as per the rules and procedure of the examination. The Officer-in-Charge may allow the students to write the exam with new answer sheet or may expel the student from appearing the paper depending on the nature of unfair-means. In case of Computer based test, the students may be directed to write an apology letter and sign in the prescribe expulsion form. The student may not be allowed to write that examination.

VII. Instruction to the Students:

(i) The students shall not bring to the Examination Hall, any electronic gadget used as a means of communication or record except electronic calculator, if required.

(ii) The students shall not receive any book or printed or hand written or photo copy (Xerox) or blank-paper from any other person while he/she is in the examination-room or in laboratory or in any other place to which he/she is allowed to have access during course of examination.

(iii) The students shall not communicate with any other candidate in the examination room or with any other person in and outside the examination-room.

(iv) The students shall not see, read or copy anything written by any other candidate, nor shall he/she knowingly or negligently permit any other candidate to see, read or copy anything written by him/her or conveyed by him/her.

(v) The students shall not write anything on the Question Paper or in other paper or materials during the examination, or pass any kind of paper to any other candidate in the examination-room, or to any person outside the room.

(vi) The students shall not disclose his/her identity to the examiner by writing his/her name or putting any sign / symbol in any part of his answer-script.

(vii) The students shall not use any abusive language or write any objectionable remark or make any appeal to examiner by writing in any part of his answer-script.

(viii) The students shall not detach any page from the answer-script or insert any authorized or unauthorized loose sheet into it. He /she shall also not insert any other answer-script / loose sheet by removing the pins of the origin answer-scripts and re-fixing it.

(ix) The students shall not resort to any disorderly conduct inside the examination-room or misbehave with the invigilator or any other examination official.

VIII. Provision for an Amanuensis (writer):

(i) A candidate may be provided with an Amanuensis (writer) to write down on dictation on his / her behalf on ground of his / her physical disability to write down by himself / herself due to accident or any other reason. The amanuensis may be provided till he / she recovers from the physical disability. The physical disability to write down by himself / herself must be supported by Medical Certificate from a competent Medical Officer.

(ii) The qualifications of the amanuensis so provided must not be equal or higher than that of the candidate. This is also to be supported by Certificate from the Faculty of Study where the Amanuensis is provided.

(iii) Such candidates are to be accommodated in a separate room under the supervision of an invigilator so that the fellow candidates are not disturbed in the process.

C. Credit Point:

It is the product of grade point and number of credits for a course, thus, CP = GP x CR

i. Credit:

A unit by which the course work is measured. It determines the number of hours of instructions required per week. 'Credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. Credits assigned for a

single course always pay attention to how many hours it would take for an average learner to complete a single course successfully.

ii. Grade Point:

Grade Point is a numerical weight allotted to each Grade Letter on a 10-point scale.

iii. Letter Grade:

Letter Grade is an index of the performance of students in a said paper of a particular course. Grades are denoted by letters O, A+, A, B+, B, C, P, F and Abs. Student obtaining Grade F / Grade Abs shall be considered failed/ absent and, will be required to appear in the subsequent ESE. The UGC recommends a 10-point grading system with the following (Table: 1) Letter Grades:

(i) A Letter Grade shall signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point shall indicate the numerical weight of the Letter Grade on a 10-point scale.

(ii) There shall be 08 (eight) Letter Grades bearing specific Grade Points as listed in Table 1, where the Letter Grades 'O' to 'P' shall indicate successful completion of a course.

(iii) Apart from the 08 (eight) regular Letter Grades listed in Table 1, there shall be 03 (three) additional Letter Grades, which shall be awarded if a Course is withdrawn or spanned over the next Semester or remains incomplete as stated in Table 2.

Table 2: Letter Grades and Grade Points

Letter Grade	Grade Points	Description
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Abs	0	Absent
UFM	0	Unfair Means

iv. Grade Point Average:

a. SGPA (Semester Grade Point Average)

The SGPA of a student in a Semester shall be the weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered in that Semester, irrespective of whether he/she could or could not complete the

Courses. More specifically, the calculation of SGPA shall take into account the Courses graded with Letter Grades 'O' to 'F' as given in Table 1.

$$\text{SGPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad (1.1)$$

The SGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.1) up to two decimal places, where n is the total number of Credit Courses registered by the student in that Semester, Gi is the Grade Point secured in the i^{th} registered Course and Ci is the Credit (weight) of that Course.

b. CGPA (Cumulative Grade Point Average)

(i) The CGPA of a student in a Semester of a Programme shall be the accumulated weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered and successfully completed so far starting from the enrollment in the Programme. In other words, taking into account all the Courses graded with 'O' to 'P' as given in Table 1.1, generally the CGPA of a student shall be calculated starting from the first Semester of his/her enrolled Programme, while the CGPA of a lateral-entry student shall be calculated starting from the Semester of his/her enrollment.

(ii) The CGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.2) up to two decimal places, where N is the total number of Credit Courses registered and successfully completed so far by the student, Gi is the Grade Point secured in the i^{th} completed Course and Ci is the Credit (weight) of that Course.

$$\text{CGPA} = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i} \qquad (1.2)$$

(iii) The CGPA shall be convertible into equivalent percentage of marks using Equation Conversion of CGPA to percentage marks: = CGPA*10

D. Post-Examination

i. Transcript or Grade Card or Certificate:

A marking certificate shall be issued to all the registered students after every Semester. The Semester mark sheet will display the course details (code, title, number of credits, grade secured) along with total credit earned in that Semester.

ii. Grievance Readdress Mechanism:

Students with any dissatisfaction or grievance regarding the marks awarded in any of the Papers / Courses may appeal to the Controller of Examinations for remedial action such as Re-evaluation within 10 days of the declaration of result.

(i) A student has options to appeal for re-evaluation of his /her answer script to the Controller of Examination.

(ii) Application for re-evaluation / re-scrutiny of answer scripts shall be made in the definite proforma available with the Examination Office through the head of the respective departments within 10 days of declaration of the results of the respective examinations.

(iii) The Controller of Examination may appoint an examiner for re-evaluation and will consider and recognize the evaluation done by a University appointed examiner.

(iv) There shall be no provision for re-evaluation of the Practical Papers, Project Work, and Dissertation etc. However, the students fail in practical examination or viva voce and wish to appear again may apply to be evaluated can do so with the next schedule.

(v) After screening the application for re-evaluation, the CoE may send the answer scripts of the student to the examiners appointed by the CoE with the approval of Vice Chancellor.

(vi) The marks/grades achieved by the students after the re-evaluation shall be final and binding.

(vii) Fresh Marks – sheets / Grade Card shall be issued only if the candidate secures pass marks / passing grade in the re-evaluated paper.

(viii) Revaluation of answer scripts shall be deemed to be an additional facility provided to the students with a view to improving upon their results at the preceding examination result for any reason whatsoever shall not confer any right upon them for admission to next higher class which matters always be regulated in accordance with the relevant rules or regulations framed by the University.

(ix) If as a result of revaluation of the candidate attracts the provision of condonation of deficiency, the same may be applied to his/her only for fresh attempt.

INSTRUCTION TO TEACHERS AND STUDENTS

(Teaching and Learning Methods)

In all the courses the teacher has to select topics for teacher-method which should not be less than 20 percent. The approach will be direct classroom teaching through a series of lectures delivering concepts using ITC facilities, white or blackboard. Notes may also be circulated to the students; however, the students are to be involved in the preparation of the notes. The teacher will be responsible for selecting the best note for circulation. The teacher-centric methodology has recently fallen out of favour because this strategy for teaching is seen to favour passive students.

1. Student- centric / Constructivist Approach:

The topics of the courses may be selected at the start of the class and assigned one topic to each of the students for studying by themselves, prepare presentations, notes, etc., and present at respective class time after consultation and discussion with the course teachers. The teacher facilitates the learning of the students by guiding and providing input and explaining concepts. 60 percent of the course contents may be selected for this purpose. To avoid behaviour problems, teachers must lay a lot of groundwork in student-centric classrooms. Typically, it involves instilling a sense of responsibility in students. In addition, students must learn internal motivation.

a. Project-Based Learning: The teacher may select 5 percent of topics for the purpose and may conduct visits to the laboratory for experiments or field surveys. The selection of the topic may be done considering the available facility for the purpose. However, in the final semester of each of the programme the student has to undergo project-based learning at least 4 months duration. This approach will help the student to think critically, evaluate, analyse, make decisions, collaborate, and more.

b. Inquiry-Based Learning: The teacher/ students are supposed to list at least five questions in each contact hour and student solve these question or search for answer which becomes the home work for the students “question-driven” learning approach. The teacher may look for the correctness of the solution or the best possible answer and discuss in the successive class. This will help in the preparation for various competitive examination and develop a habit for search for solutions.

c. Flipped Classroom: About 10 percent of the course content has to be completed by this method. In this approach the students are asked to watch video or lecture prepared by the teacher or any video available (relevant to the course). A set of questions may be given to the students for searching answers by the students. The idea is that students should have more

time in-classroom focusing on achieving these higher levels of thinking and learning. The Flipped classroom is also an acronym. The letters FLIP represent the four pillars included in this type of learning: Flexible environment, Learning culture shift, Intentional content, and Professional educator. As you can see, the second pillar refers to a culture shift from the traditional approach where students are more passive to an approach where students are active participants. As a result, this approach is also a student- centric teaching method.

d. Cooperative Learning: The remaining five percent has to be completed by cooperative learning approach. In this approach, the students are allotted problems. During library hours the students along with the teacher visit the library and search for probable solutions for the assigned problem. The same has to be done in groups so that the students discuss among themselves for the appropriate answers. Essentially, cooperative learning believes that social interactions can improve learning. In addition, the approach recreates real-world work situations in which collaboration and cooperation are required.

The percentage categorization for the completion of a theory course

Teacher-centric or Direct Classroom Teaching: Delivery by series of lectures	20%
Student-centric Approach, Students present and deliver lectures in the presence of Teacher and supervised by teacher	60%
Students visit fields or perform experiments or teachers perform demonstration	05%
Flipped Classroom approach	10%
Cooperative learning approach	05%

Inquiry-based approach has to be followed in all of the classes

The teacher has to distribute the topics to be considered for teaching by the above-mentioned approaches and prepare a lesson plan for execution and maintain a file.

SEMESTER WISE COURSE DISTRIBUTION

	Sl. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester I	1.	24BSMB1101R	Introduction to Microbiology	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	2.	24BSZO1101R	Animal Science	DSC- Minor	2	0	2	0	0	0	3	60	40	100	200
	3.	24BSCH1101R	Basic Chemistry	DSC- Minor	2	0	2	0	0	0	3	60	40	100	200
	4.	24BSMB1102R	Microbiology for Human Welfare	DSC- Minor	2	0	0	0	0	0	2	60	40	0	100
	5.	24UBFS1101R	Basic of Statistics	MDC	3	0	0	0	0	0	3	60	40	0	100
	6.	24UBPD1102R	Elementary English (CLPPD)	AEC	0	0	4	0	0	0	2	0	0	100	100
	7.	24BSAG1001R	Agricultural Education	VAC	2	0	0	0	0	0	2	60	40	0	100
	8.	24UBEC1101	Extra-Curricular Activities	Co and extra-Curricular	0	0	0	4	0	0	1	0	0	100	100
	Total										20				1100

	Sl. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester II	1.	24BSMB1201R	Cell Biology and Microbial Physiology	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	2.	24BSMB1202R	Human Disease Biology	DSC- Minor	2	0	2	0	0	0	3	60	40	100	200
	3.	24BSFS1201R	Forensic Biology	DSC- Minor	2	0	0	0	0	0	2	60	40	0	100
	4.	24BSMB1203R	Biophysical Chemistry	DSC- Minor	2	0	2	0	0	0	3	60	40	100	200
	5.	24BSAG1002R	Agricultural Heritage	MDC	1	0	0	0	0	0	1	60	40	0	100
	6.	24BAPS1206R	Psychology of Happiness	MDC	2	0	0	0	0	0	2	60	40	0	100
	7.	24UBPD1202R	Implicit English	AEC	0	0	4	0	0	0	2	0	0	100	100
	8.	24UBES1201R	Environmental Education (Online)	VAC	2	0	0	0	0	0	2	60	40	0	100
	9.	24UCDT1201R	Ideation and Design Thinking	SEC	0	0	2	0	0	0	1	0	0	100	100
	10.	24UBCC1201	CO Curricular Activities	Co and extra-Curricular	0	0	0	4	0	0	1	0	0	100	100
	Total										21				1300

	Sl. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester III	1.	24BSMB2101R	Biomolecules	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	2.	24BSMB2102R	MicrobialGenetics	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	3.	24BSZO2101R	Entomology	DSC- Minor	3	0	0	0	0	0	3	60	40	0	100
	4.	24BSBO2101R	Forestry	DSC- Minor	3	0	0	0	0	0	3	60	40	0	100
	5.	24BSFD2101R	Basics of Food Science	DSC- Minor	2	0	0	0	0	0	2	60	40	0	100
	6.	24BSCH2001R	Natural Product Chemistry	MDC	2	0	0	0	0	0	2	60	40	0	100
	7.		PDP English Courses	AEC	0	0	4	0	0	0	2	0	0	100	100
	8.	24BSMB2103R	Mushroom Cultivation	SEC	0	0	4	0	0	0	2	0	0	100	100
	9.	24BSMB2104R	Field Training	Field Training	0	0	0	4	0	0	1	0	0	100	100
	Total										23				1100

	Sl. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester IV	1.	24BSMB2201R	Enzymes and metabolism	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	2.	24BSMB2202R	Molecular Biology	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	3.	24BSMB2203R	Bioinstrumentation	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	4.	24BSMB2204R	Immunology	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	5.		PDP English Courses	AEC	0	0	4	0	0	0	2	0	0	100	100
	6.		Aptititute Course	SEC	0	0	0	8	0	0	2	0	0	100	100
	7.	24UUHV2201R	UHV	VAC	1	0	0	0	0	0	1	60	40	0	100
	8.		BLSS	VAC	0	0	2	0	0	0	1	0	0	100	100
			Financial Literacy	MDC	1	0	0	0	0	0	1	0	0	100	100
	Total										23				1300

	Sl. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester V	1.	24BSMB3101R	Soil and Agricultural Microbiology	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	2.	24BSMB3102R	Bioinformatics	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	3.	24BSMB3103R	Tissue Culture	DSC -Major	4	0	0	0	0	0	4	60	40	0	100
	4.	24BSMB3104R	RDT	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	5.	24BSMB3105R	Biofertilizer Production	SEC	0	0	4	0	0	0	2	0	0	100	100
	6.		Logical Resonaing Course	SEC	0	0	0	8	0	0	2	0	0	100	100
	7.	24BSMB3106R	Summer Internship	Internship	0	0	0	0	0	24	4	0	0	100	100
	8.	24BSMB3107R	Mini Research-R1	Research	0	0	0	0	12	0	2	0	0	100	100
	Total										26				1100

	Sl. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester VI	1.	24BSMB3201R	Research Methodology	DSC -Major	4	0	0	0	0	0	4	60	40	0	100
	2.	24BSMB3202R	Food and Dairy Microbiology	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	3.	24BSMB3203R	Medical Bacteriology and Virology	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	4.	24BSMB3204R	Medical Mycology and Parasitology	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	5.	24BSMB3205R	Mini Research-R2	Research	0	0	0	0	24	0	4	0	0	100	100
	Total										20				800

***IA: Internal Assessment, SEE: Semester End Examination, PE: Practical Examination**

SEMESTER – I										
Course Title	**Introduction to Microbiology**									
Course Code	**24BSMB111R**	**Total credits: 5** **Total hours: 45T+60P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**4**	**0**	**0**	**0**	**5**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ I semester of first year of the Programme**								
Course Objectives	1. The objective of this paper is to familiarize the students with the basic concepts of microbiology and diversity of microorganisms. 2. To teach the students about the different staining techniques of microorganisms. 3. The course provides insights concerning aspects of different types of microorganisms, culturing and staining of microorganisms.									
CO1	Describe the microbial classification and contributions of key microbiologists in development of microbiology.									
CO2	Describe the characteristic of bacteria and virus and their various habitats									
CO3	Explore the different culture media and the concepts of sterilization.									
CO4	Apply different bacteriological staining techniques for viewing.									
CO5	Explain the mechanism of antimicrobial compounds and their production.									

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**History of microbiology:** Contributions of Spallanzani, Pasteur, Joseph Lister, Koch, Edward Jenner and Fleming; Scopes of Microbiology; **Microbial Classification:** two kingdom, three kingdom and five kingdom classification**;** Morphology of bacteria, Ultrastructure of Bacterial cell, Nutritional types, classification on the basis of oxygen requirements.	**15**	Describe, illustrate and explain history of microbiology and classification of microorganisms, the morphology, cell structure and nutrition of bacteria.	1,2
II	Microbes in different environments: Thermophiles, hyperthermophiles, psychrophiles, acidophiles, alkaliphiles, halophiles, Barophiles, Methanogens General characteristics and structure of virus, lytic and lysogenic cycle. Ultrastructure of algal and fungal cells.	**13**	Describe, illustrate and explain different types of extremophiles. Understand the structure and replication of bacteriophage.	1,2
III	Culture media and types: Culture Preservation Methods, Concept of Sterilization - definition, types - Physical and chemical, Determination of phenol coefficient of disinfectant.	**7**	Describe, illustrate and explain the different types of culture media and Preservation Methods of microorganisms and the different methods of sterilization.	1,2
IV	Stains and Staining Techniques: Definition of auxochrome, chromophores and dyes. Types of staining - Gram, Acid Fast, Negative, Flagella and Endospore.	**7**	Describe, illustrate and explain the different staining techniques.	1,2
V	Antibiotics and types: Antibiotic producing microorganisms, Antifungal and antibacterial.	**3**	Describe and explain the different types of antibiotics.	1,2

Practical	1. The components, use and care of bright field microscope, and various microbiological instruments. 2. Enumeration (counting) of bacteria by plate count or serial dilution – Agar Plate Technique. 3. Counting of bacterial population by the use of spectrophotometer. 4. Preparation of bacterial smear and staining (Simple, Grams, Negative and Acid fast). 5. Preparation of culture media and isolation of pure culture – serial dilution, pour plates technique, spread plate technique, types of streaking. 6. Fungal staining: KOH mounting, LPCB. 7. Study of temperature and PH sensitivity of microbes.	**60**	Describe, illustrate and explain and apply staining techniques and carry out microscopic examination.	1,2,3,4

TEXT BOOKS:

1. Text book of Microbiology by Prescott, Harley, and Klein's
2. Text Book of Microbiology by PC Trivedi, S Pandey & S Bhadauria
3. Textbook of Microbiology by Ananthnarayanan and Panicker

REFERENCE BOOKS:

1. Microbiology – A systems Approach by Cowan and Talaro
2. Experiments in Microbiology, Plant Pathology and Biotechnology by K.R. Aneja

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the microbial classification and contributions of key microbiologists in development of microbiology.	**1,2,3,8**
2	Describe the characteristic of bacteria and virus and their various habitats	**1,2,8**
3	Explore the different culture media and the concepts of sterilization.	**1,2,3,8**
4	Apply different bacteriological staining techniques for viewing.	**1,2,3,8**
5	Explain the mechanism of antimicrobial compounds and their production.	**1,2,8**

SEMESTER – I									
Course Title	**Microbial Physiology**								
Course Code	**24BSMB112R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+24P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ I semester of first year of the Programme**								
Course Objectives	1. To build a strong foundation in the dynamics and bioenergetics of biochemical pathways 2. To teach the concept of transportation of biomolecules and metabolism of carbohydrates. 3. To teach about the molecular adaptation of bacteria								
CO1	Assess factors influencing bacterial growth and measurement of bacterial growth.								
CO2	Determine the movement of biomolecules in microbes, analyze the quorum sensing properties and biofilm formation.								
CO3	Describe different aerobic and anaerobic carbohydrate metabolism and pathways								
CO4	Illustrate the principles and pathways of photosynthesis in microbes.								
CO5	Describe microbial nitrogen fixation and adaptation.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Microbial Growth and Nutrition- Microbial Growth: Definition of growth, Growth curve, phases of growth, Influence of environmental factors on growth, generation time and specific growth rate. Synchronous growth, Continuous growth (chemostat and turbidostat), Diauxic growth. Measurement of Growth: Direct Microscopic count - Haemocytometer; Viable count, Membrane filtration; Electronic Coulter Counting method; Measurement of cell mass; Turbidity measurements- Nephelometer and spectrophotometer techniques. Growth Yield (definition of terms) Microbial Nutrition: Microbial nutrients, macro and micronutrients, classification of organisms based on nutritional requirements. Membrane Transport: Structure and organization of biological membranes, Types of cellular transport - passive, facilitated, active, group translocation, membrane bound protein transport system, carrier models, liposomes, ion channels, Na+ K+ -ATPase.	**10**	Describe and explain the mode of microbial growth and nutrition and influence of different factors on their growth	1,2
II	Movement of biomolecules: Facilitated diffusion, aquaporins, mechanosensitive/ion-channels, ABC transporters, Chemiosmotic driven transport (symport, antiport and uniport), Group translocation/ Phosphotransferase system (PTS), transport of Iron (Gram +Ve and Gram -Ve bacteria). Movement of whole cell: Chemotaxis, Quorum sensing and regulation of biofilm formation	**8**	Describe, illustrate and explain movement of biomolecules through diffusion, chemiosmotic driven transport, phosphotransferase system	1,2

III	Carbohydrate metabolism: Glucose catabolism (Embden-Meyerhof pathway (EMP) /glycolytic pathways, Entner-Doudoroff pathway and Pentose phosphate pathway (PPP) /hexose monophosphate shunt) and Glucose anabolism (Gluconeogenesis). Pyruvate decarboxylation. Pyruvate utilization pathways (TCA cycle, glyoxylate cycle). Fermentation pathways: Yeast fermentation, Fermentation to produce short-chain fatty acids and mixed acid types	**10**	Describe, illustrate and explain the concepts of carbohydrate metabolism and mechanism of the pathways.	1,2
IV	Principles and components of photosynthesis (light absorption, light driven electron flow). Carbon dioxide fixation pathways (dark reaction). Photophosphorylation (cyclic and non-cyclic (z-scheme)). Generation of reducing power. Oxygenic and non-oxygenic photosynthesis. Oxidative phosphorylation (PMF and Electron Transport System). Chemiosmotic theory of ATP synthesis	**8**	Describe, illustrate and explain the principles and components of photosynthesis and carbon dioxide pathways	1,2
V	Nitrogen metabolism: Biological nitrogen fixation, Component of Nitrogenase system, Inorganic nitrogen metabolism (denitrification and nitrification), Assimilation of inorganic nitrogen (ammonia), Molecular adaptations in microbes for nitrogen fixation (free living aerobic, free living anaerobic and symbiotic microbes). General reactions of amino acids and the Stickland Reaction.	**9**	Describe and explain the basic knowledge on the metabolism of nitrogen fixation and components of nitrogenase system	1,2
Practical	1. Microscopic count of bacteria. 2. To determine the growth curve of bacteria. 3. Measurement of turbidity	**30**	Describe, illustrate and explain and apply microscopic count and growth curve of bacteria	1,2,3,4

TEXT BOOKS:

1. The Microbial world‖ by Stanier, Ingraham, Wheelis and Painter. Mc Millan Ltd., London.
2. Microbial Physiology by Moat, Foster and Spector, Wiley.
3. Essentials of Bacterial Physiology by Umbreit.
4. Bacterial Physiology and Metabolism by Skokatch.
5. Microbial life in Extreme Environments by Kushner, D.J. Academic Press.
6. Cell Biology by Powar, C.B.
7. The control of Antibiotic Resistance in Bacteria by Harris C.H.S, Harris DM.
8. Biochemistry of Antimicrobial Action by Franklin and Snow, Chapman and Hall, New York

REFERENCE BOOKS:

1. Microbiology Including Immunology and Molecular Genetics. III Ed. By Davis.. Dulbecco, Eisen and Ginsberg.
2. Medical Laboratory Manual for Tropical Countries. Vol. II by Cheesbrough, M.
3. Essentials of Clinical Immunology 7th Edition by Misbah S.A., Spickett G.P., Dalm V.A.S.H. Wiley-Blackwell (2006).
4. Immunobiology: The Immune System in Health and Disease, 6th Revised edition by Charles A. Janeway, Paul Travers, Mark Walport and Mark J. Shlomchik, Churchill Livingstone; (2004)

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Assess factors influencing bacterial growth and measurement of bacterial growth.	**1,2,3,4,8**
2	Determine the movement of biomolecules in microbes, analyse the quorum sensing properties and biofilm formation.	**1,2,3,4,8**
3	Describe different aerobic and anaerobic carbohydrate metabolism and pathways	**1,2,3,8**
4	Illustrate the principles and pathways of photosynthesis in microbes.	**1,2,3,4,8**
5	Describe microbial nitrogen fixation and adaptation.	**1,2,3,4,8**

SEMESTER – I									
Course Title	**Bio-Molecules**								
Course Code	**24BSMB113R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ I semester of first year of the Programme**								
Course Objectives	1. Understand the structural components and bonding mechanisms of nucleic acids. 2. Comprehend the classification, properties, and significance of amino acids. 3. Analyze the classification, structure, and functions of proteins. 4. Examine the classification, properties, and biological roles of carbohydrates and lipids.								
CO1	Describe the structure, functions and types of DNA and RNA								
CO2	Outline the properties of essential and non-essential amino acid.								
CO3	Describe various structure of proteins and classification.								
CO4	Outline the basics of carbohydrate in terms of its structure, classification, properties and the laboratory qualitative tests in their analysis.								
CO5	Identify and categorize lipids and their derivatives.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Nucleic acid: Structure (Nitrogenous bases, ribose, deoxyribose, Nucleosides, nucleotides); glycoside and phosphodiester bonding, polynucleotide (formation, single letter code), DNA (Watson-Crick Model; forms [A, B, Z]; Physical Properties; denaturation and renaturation); RNA and its types; Clover leaf model of t RNA.	**10**	Describe, illustrate and explain the structure and function of nucleic acids including its different forms.	1,2
II	Amino acids: Classifications; Essential and Non- Essential amino acids; Properties (physical, chemical & optical); Importance.	**5**	Describe, illustrate and explain the structure and properties of amino acids and classify them.	1,2
III	Protein: Classification based on (shape [fibrous proteins (keratins, collagen and elastin), globular proteins (hemoglobin, myoglobin), lipoproteins, metallo proteins, glycoprotein and nucleoproteins]; chemical composition); Structure (primary, secondary, tertiary & quaternary); Denaturation and renaturation; Functions.	**10**	Describe, illustrate and explain the structure and function of proteins.	1,2
IV	Carbohydrates: Classification; Isomerism, (D and L forms); Anomers, Epimers, Muta-rotation; Monosaccharides (linear and cyclic). Disaccharides (structure, occurrence, properties and functions); Cellulose (occurrence, structure, properties and functions); Heteropolysacchrides (occurrence, types, composition and function), Homopolysaccharides.	**10**	Describe, illustrate and explain the structure and function of carbohydrates.	1,2
V	Lipids: fatty acids; glycerol; sphingosine; classifications; and characterization; Saponification and iodine number; Properties	**10**	Describe, illustrate and explain the structure and function of lipids.	1,2

	(glycerol, fats and oils); Properties and function (Phospholipids and Prostaglandins); Structure (sterols, Bile acids, steroid hormones, plant sterol, ergo sterol, stigma sterol, cholesterol, glucocorticoid, mineralocorticoids); Lipoproteins (classification, composition and importance); Role of Lipids in cellular architecture and functions.			
Practical	Qualitative analysis of Carbohydrate Fehling's Test Barfoed's Test Molisch's Test Benedict's test Qualitative analysis of proteins Biuret Test Xanthoproteic Test Precipitation test Heat and Acetic acid test Qualitative analysis of amino acids Ninhydrin Test	**30**	Describe, illustrate and explain apply qualitative analysis of carbohydrate, protein and amino acids.	1,2,3,4

TEXT BOOKS:

1. U Satyanarayana. Biochemistry. 13th edition. Elsevier Health Sciences; 2017.

REFERENCE BOOKS:

R1. David L. Nelson, Michael Cox. Lehninger Principles of Biochemistry. 7th Edition. WH Freeman; 2017.
R2. Rodwell et al. Harper's Illustrated Biochemistry. 29th edition. McGraw Hill; 2012.
R3. Voet and Voet. Biochemistry. 3rd edition. John Wiley & Sons, 2004.

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the structure, functions and types of DNA and RNA	**1,2,3,8**
2	Outline the properties of essential and non-essential amino acid.	**1,2,3,8**
3	Describe various structure of proteins and classification.	**1,2,3,8**
4	Outline the basics of carbohydrate in terms of its structure, classification, properties and the laboratory qualitative tests in their analysis.	**1,2,3,8**
5	Identify and categorize lipids and their derivatives.	**1,2,3,8**

SEMESTER – I										
Course Title	**Animal Science**									
Course code	**24FSZO101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**	
Pre-requisite	**Nil**	**Co-requisite**	**Nil**							
Programme	**Bachelor of Science in Microbiology**									
Semester	**Fall/ I semester of first year of the Programme**									
Course Objectives	1. Analyze the diversity, structure, and classification of the animal kingdom, focusing on triploblastic coelomate organization. 2. Understand life processes including osmoregulation, excretion, neural conduction, endocrine regulation, and reproduction. 3. Examine the relationships between insects and microbes, and explore integrated pest management strategies. 4. Explore the principles of evolution, biodiversity, and genetics, including Mendelian and non-Mendelian inheritance patterns.									
CO1	Identify and classify species of animal kingdom.									
CO2	Explain various biochemical processes occurring in living being									
CO3	Explain and illustrate phenomena of animal reproductive biology									
CO4	Illustrate the evolution process, importance of biodiversity hotspot									
CO5	Describe classical genetics of living organism									

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Diversity of Animal Kingdom: Triploblastic coelomate organization: Animals with mantle: Phylum Mollusca, Animals with enterocoel: Phylum Echinodermata, Phylum Hemichordate, Phylum Chordata, Subphylum Urochordata, Subphylum Cephalochordata, Subplylum Vertebrata, Super class: Agnatha, Class Cyclostomata, Superclass: Gnathostomata, Class Pisces (Cartilaginous and bony fish), Class Amphibia, Class Reptilia, Class Aves, Class Mammalia	**5**	Describe, illustrate and explain the basic concepts associated with each system of the body in vertebrates and invertebrates. Identify structures that are in place in the body systems to perform the functions according to the habits or habitats of the animals.	1,2
II	Life processes Concepts of osmoregulation and excretion, Categorization of animals on the basis of principle nitrogenous excretory products. Ornithine cycle, formation of urea, determination and detoxification. Control and Coordination, Irritability, Structure of neuron, sense organs - human eye and ear. Conduction of nerve impulse: Resting potential, action potential and refractory period. Synaptic transmission, Endocrine regulation: Hormones as chemical messengers, feedback mechanisms. Reproduction: Gametogenesis, structures of egg and sperm of mammal. Fertilization and in vitro fertilization, oviparity, viviparity and ovo-viviparity.	**6**	Describe, illustrate and explain the knowledge of different life processes, endocrine regulation and reproductive biology of animal.	1,2
III	Insect microbiology: Mutualistic associations between insects and microbes Insect nutrition and the importance of microbe's Fungal symbioses: Ant fungal gardens and termites Microorganisms and insect behavior. Insects as Vectors of	**5**	Describe, illustrate and explain different types of associations of insects, insect behaviour and role of insect as a vector of various diseases.	1,2

	Animal pathogens; Integrated pest management for vector control			
IV	Evolution and Biodiversity: Evolution, Origin of life: Emergence of life on primitive earth, Evolution and adaptations: Microevolution, Role of Natural Selection in microevolution, Co-evolution. Ecological niches and adaptations. Biodiversity, Definition, Biodiversity hotspots, Benefits of Biodiversity, Biodiversity conservation, Bio- wealth of India. Human activities affecting biodiversity. Future of evolution.	**7**	Describe, illustrate and explain the evolution and diversity.	1,2
V	Genetics: Gene and gene concepts, Mendelian inheritance: Monohybrid and dihybrid cross, Concept of dominance. Exception to Mendelian inheritance: incomplete dominance, co- dominance; Interaction of genes: (Epistasis: recessive, dominant, double recessive and double dominant epistasis), lethal genes, Cytoplasmic inheritance: Kappa particles in Paramecium, sigma factor in Drosophila and shell coiling in Limnea. Introduction to human genetics: Mendelian phenotypic traits in humans: Dominant, recessive and X-linked characters (2 examples each), Pedigree analysis: Dominant, recessive and X- linked traits, Genetic counselling, Risk of inheriting a disease from consanguineous marriage.	**7**	Describe, illustrate and explain the classical genetics and learn about diseases associated with genetic disorder	1,2

TEXT BOOKS:

1. Principles of Genetics by Snustad and Simmons (7th Edition) John Wiley and Sons, USA.
2. Textbook of physiology by Dr. A. K. Jain. (9th Edition). APS books.
3. Edward O. Wilson, 1996, Biodiversity, 521 pp., National Academy Press.
4. Alison J. Stattersfield, Michael J. Crosby, Adrian J. Long, and David C. Wege. 1998. Endemic Bird Areas of the World: Priorities for Biodiversity Conservation. 846pp.
5. Maule, A.G. and Dr. N.J. Marks Parasitic Flatworms, Molecular Biology, Biochemistry, Immunlogy, Physiology.

REFERENCE BOOKS:

1. Romer, A.S. Vertebrate Body.
2. Majupuria, T.S. Introduction to Chordates.
3. Hartl D. L. and A. G. Clark (1989 & 1997): Principles of Population Genetics. Sinauer
4. Ridley M. (1993): Evolution. Blackwell.
5. Microbiology: an Introduction by Tortora, G.J., Funke, B.R. and Case, C.L., 944 pp.

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify and classify species of animal kingdom.	**1,2,8**
2	Explain various biochemical processes occurring in living being	**1,2,8**
3	Explain and illustrate phenomena of animal reproductive biology	**1,2,8**
4	Illustrate the evolution process, importance of biodiversity hotspot	**1,2,8**
5	Describe classical genetics of living organism	**1,2,8**

SEMESTER – I										
Course Title	**Basic Chemistry**									
Course code	**24FSCH101R**	**Total Credits: 2** **Total Hours: 30T**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			2	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ I semester of first year of the Programme**								
Course Objectives	1. To give the knowledge about Chemical Kinetics and Ionic Equilibrium. 2. To give a detailed description of atomic structure, different theories related to it and the knowledge of classical and quantum chemistry. 3. To give the knowledge of the periodic properties and HSAB theory.									
CO1	Identify the order of the rate law equation, then characterize the "half-life" and temperature dependency of reaction rates using the Arrhenius equation.									
CO2	Describe concepts of electrochemistry, electrochemical cells, acids/base, pH, buffers and solubility									
CO3	Describe and analyze atomic structure, Heisenberg Uncertainty principle, Quantum mechanics and Schrodinger wave equation									
CO4	Describe concepts of chemical bonding, periodic properties.									
CO5	Describe the different types of organic reactions along with their mechanisms. Organic molecules and their stereochemistry.									

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Chemical Kinetics: Order-molecularity. First and second order, nth order rate equation, temperature dependence of rate of reactions.	**5**	To identify the order (0, 1 or 2) associated with each integrated rate law equation, to describe the "half- life" of a chemical reaction. Understand the temperature dependence of rate of reactions through Arrhenius equation.	1,2
II	Ionic equilibrium: Electrolytic conductance, Faraday's Law of electrolysis, Electrolytes, Lewis's theory, Arrhenius theory for dissociation of electrolytes, ionization constants of weak acids and bases, pH, buffers, solubility products, salt effects and Solubility	**6**	Describe, illustrate and explain the underlying concepts of electrochemistry, electrochemical cells, acids/base, pH, buffers and solubility	1,2
III	Atomic Structure: Recapitulation of Bohr's theory and its limitations, dual behavior of matter and radiation, DE Broglie's relation, Heisenberg Uncertainty principle. Need of a new approach to atomic structure. What is Quantum mechanics, Time independent Schrodinger equation and meaning of various terms in it. Wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. (Only graphical representation) Rules for filling electrons in various orbitals, electronic configurations of the atoms. Stability	**5**	Describe, illustrate and explain the atomic structure, Heisenberg Uncertainty principle, Quantum mechanics and Schrodinger wave equation. To learn about the graphical representation of different atomic orbital and how the electrons are filled in the orbital.	1,2

	of half-filled and completely filled orbitals, concept of exchange energy.			
IV	Chemical bonding- Various theories, covalent, hydrogen Bonding. Effective nuclear charge, atomic and ionic sizes. 6 Ionization energies, electron affinity and electronegativity, hard soft acids and bases.	**7**	Describe, illustrate and explain the concepts of chemical bonding by using various theories, periodic properties like Atomic and Ionic size Ionization Energy Electron Affinity, Electronegativity of elements of periodic table.	1,2
V	Organic Reactions and Stereochemistry: Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule, Representations of 3 dimensional structures, structural isomers and stereo isomers. Configurations and symmetry and chirality, enantiomers, disastereomers, optical activity, absolute configurations and conformational analysis.	**7**	Describe, illustrate and explain the different types of organic reactions along with their mechanisms. How to design syntheses of organic molecules. Acquire the knowledge of stereochemistry of organic molecules.	1,2

TEXT BOOKS:

1. L. Eliel: Stereochemistry of Carbon Compounds, Tata Mc Graw Hill
2. Organic chemistry: structure and function by P. Volhardt and N. Schore.
3. Essentials of Physical Chemistry, Arun Bahl., B.S. Bahl., G.D. Tuli.
4. Concise Inorganic Chemistry, J.D. Lee.

REFERENCE BOOKS:

1. T. W. Graham Solomon's: Organic Chemistry, John Wiley and Sons.
2. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
3. E. L. Eliel: Stereochemistry of Carbon Compounds, Tata Mc Graw Hill.

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify the order of the rate law equation, then characterize the "half-life" and temperature dependency of reaction rates using the Arrhenius equation.	**1,2,3,8**
2	Describe concepts of electrochemistry, electrochemical cells, acids/base, pH, buffers and solubility	**1,2,3,8**
3	Describe and analyse atomic structure, Heisenberg Uncertainty principle, Quantum mechanics and Schrodinger wave equation	**1,2,3,8**
4	Describe concepts of chemical bonding, periodic properties.	**1,2,3,8**
5	Describe the different types of organic reactions along with their mechanisms. Organic molecules and their stereochemistry.	**1,2,3,8**

SEMESTER – I									
Course Title	**Elementary English**								
Course code	**24UBPD111R**	**Total Credits: 2** **Total Hours: 32**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ I semester of first year of the Programme**								
Course Objectives	1. To enable students to identify and use parts of speech, articles, auxiliary verbs, and construct affirmative and negative sentences. 2. To master advanced grammar concepts: Enable students to use determiners, construct various types of sentences, and understand degrees of comparison. 3. To develop speaking skills: Enable students to introduce themselves, use correct pronunciation, intonation, and stress, and effectively ask and offer information. 4. To improve communication skills: Enable students to understand the communication process, types, formal and informal communication, and identify barriers to effective communication. 5. To enhance presentation skills: Enable students to understand the elements of a good presentation and effectively use visual aids.								
CO1	Equip students to recognize and apply parts of speech, articles, and auxiliary verbs, and to create both affirmative and negative sentences.								
CO2	Teach students to apply determiners, form different types of sentences, and comprehend degrees of comparison.								
CO3	Prepare students to confidently introduce themselves, use proper pronunciation, intonation, and stress, and effectively ask for and provide information.								
CO4	Help students grasp the communication process, differentiate between communication types, manage both formal and informal communication, and identify barriers to effective communication.								
CO5	Teach students the key components of an effective presentation and how to use visual aids proficiently.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Basics of Grammar (Flipped classroom)** i. Parts of Speech ii. Articles iii. Auxiliary Verbs iv. Affirmative and Negative Sentences	**6**	Students will demonstrate a fundamental understanding of grammar rules.	1,2, 3
II	**Grammar (Flipped classroom)** i. Determiners ii. Sentence Construction iii. Types of Sentences (Assertive, Imperative, etc.) iv. Degree of Comparison	**6**	Students will construct grammatically correct and varied sentence types.	1,2, 3,4
III	**Speaking Skills** i. Introduction and Greetings ii. Pronunciation, Intonation, Stress iii. Asking and offering information	**5**	Students will confidently introduce themselves and engage in basic conversations with correct pronunciation.	1,2, 3

IV	**Communication Skills** i. Introduction to Communication ii. Process and Types of Communication, iii. Formal and informal communication iv. Understanding Barriers to Communication	**7**	Students will effectively communicate in both formal and informal settings.	1,2, 3
V	**Presentation Skills** i. Introduction ii. Essential characteristics of a good presentation iii. Use of Visual Aids in Presentation	**8**	Students will deliver well-organized and visually supported presentations.	1,2

TEXT BOOKS:

1. Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.
2. Reed, James. 2016. 101 Job Interview Questions You'll Never Fear Again, Plume.
3. Pease, Barbara. 2006. The Definitive Book of Body Language, RHUS.
4. McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition)

REFERENCE BOOKS:

1. Zinsser, William. (2006) On Writing Well: The Classic Guide to Writing Nonfiction Harper Perennial
2. Taylor J. and Wright, J., IELTS Advantage Reading Skills: A step-by-step guide to a high IELTS reading score, Delta Publishing by Klett.
3. Kelley, Thea. 2021. Get That Job: The Quick and Complete Guide to a Winning Interview, Plover crest Press.
4. Murphy, Raymond, (2012) English Grammar in Use Book with Answers: A Self- Study and Practice Book for Intermediate Learners of English, Cambridge University Press

OTHER LEARNING RESOURCES:

https://www.ef.com/wwen/english-resources/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Equip students to recognize and apply parts of speech, articles, and auxiliary verbs, and to create both affirmative and negative sentences.	**5,8**
2	Teach students to apply determiners, form different types of sentences, and comprehend degrees of comparison.	**5,8**
3	Prepare students to confidently introduce themselves, use proper pronunciation, intonation, and stress, and effectively ask for and provide information.	**5,7,8**
4	Help students grasp the communication process, differentiate between communication types, manage both formal and informal communication, and identify barriers to effective communication.	**5,6,7,8**
5	Teach students the key components of an effective presentation and how to use visual aids proficiently.	**3,5,7,8**

SEMESTER – I										
Course Title	**Extra-Curricular Activities**									
Course code	**24UBEC111R**	**Total credits: 1** **Total hours: 60**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ I semester of first year of the Programme**								
Course Objectives	1. To ascertain physical and mental development of the students and select best performers for state, national and international level competition. 2. To enhance and improve student's talents in the field of sports, yoga, music, dance, drama, etc. through AdtU club activities and workshops.								
CO1	Enhance Leadership Skills-Students will develop leadership abilities through various activities.								
CO2	Improve Social Interaction-Students will learn to interact and build relationships with others.								
CO3	Develop Personal Interests and Hobbies- Students will explore and develop their personal interests and hobbies.								
CO4	Strengthen Problem-Solving Skills- Students will improve their ability to solve problems creatively and effectively.								
CO5	Foster Cultural Awareness- Students will gain a better understanding and appreciation of different cultures.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Based on the learner's interest they can participate in various sports, music, and co-curricular activities joining the clubs of the University (Football, Futsal; Cricket; Swimming; Basketball; Badminton; Table Tennis; athletics and other outdoor and indoor games; Dance; Music; Vocals; Photography; Drama; Literary activities); The students are encouraged to participate in regular club activities, workshops, competitions as per their interest and hobbies; Renowned skilled professionals/ personalities are invited organising workshops to promote the talents of the students.	**60**	By participating in various sports, music, and co-curricular activities offered through university clubs, students will develop physical and mental agility, leadership, teamwork, and creativity. They will enhance time management, gain practical knowledge through workshops with renowned professionals, and build self-confidence while fostering personal growth. These activities promote cultural awareness, inclusivity, and lifelong learning, encouraging students to pursue their interests, develop new skills, and cultivate passions that extend beyond their academic journey.	1,2

REFERENCE BOOKS:

R1: "Extracurricular Activities: Essential Guides for Students" by John G. Gabriel
R2: "Developing Personal, Social and Emotional Skills through Extra-Curricular Activities" by Sally Bailey

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Enhance Leadership Skills-Students will develop leadership abilities through various activities.	**6,7**
2	Improve Social Interaction-Students will learn to interact and build relationships with others.	**6,7**
3	Develop Personal Interests and Hobbies- Students will explore and develop their personal interests and hobbies.	**6,7**
4	Strengthen Problem-Solving Skills- Students will improve their ability to solve problems creatively and effectively.	**6,7**
5	Foster Cultural Awareness- Students will gain a better understanding and appreciation of different cultures.	**5,6,7**

SEMESTER – II									
Course Title	**Bioinstrumentation**								
Course code	**24BSMB121R**	**Total credits: 4** **Total hours: 45T+30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ II semester of first year of the Programme**								
Course Objectives	1. Explain the principles, types, and applications of various microscopy techniques. 2. Understand the history, classification, and separation techniques in chromatography. 3. Comprehend the principles and applications of centrifugation and gel electrophoresis. 4. Analyze the principles and applications of different spectroscopic techniques.								
CO1	Describe the different microscopy principles and techniques.								
CO2	Develop proficiency in different chromatographic techniques.								
CO3	Explore different analytical centrifugation and their applications.								
CO4	Explore different analytical centrifugation and their applications.								
CO5	Interpret the principles and applications of spectroscopy								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Microscopy: types of microscopes and their principle, resolving power, numerical aperture	**10**	Describe, illustrate and explain the applications of different types of microscopes	1,2
II	Chromatography: Introduction, History, Classification, Separation techniques, Choice of method. Column Chromatography: Adsorption column chromatography, Partition chromatography. Thin layer chromatography, Paper chromatography, Ion exchange chromatography	**10**	Describe, illustrate and explain the concept of chromatography and its types with its working principle that enables separation of a biomolecules from a mixture sample	1,2
III	Centrifugation: Introduction, principle, rotors, Application of density gradient and analytical centrifugation. Different types of Centrifugation and its application	**7**	Describe, illustrate and explain the fundamental knowledge of the centrifugation technique along with its different types and applications	1,2
IV	Gel Electrophoresis: Introduction, principle, types, application, Blotting technique: Southern blot, Western Blot and Northern blot	**10**	Describe, illustrate and explain the theoretical knowledge of the gel electrophoretic technique highlighting its working principle and application. Also enable learning about the different blotting techniques.	1,2
V	Electrophoresis – principle and application - agarose gel electrophoresis, SDS PAGE Spectroscopic techniques: Introduction, Principle and application of spectroscopy	**8**	Describe, illustrate and explain the technique of electrophoresis and spectroscopy in terms of its working principle and applications.	1,2

Practical	Operation of molecules from given sample by 1. Paper chromatography 2. Column chromatography 3. Thin layer chromatography 4. Separation of DNA and protein molecules by gel electrophoresis	**30**	Describe, illustrate and explain the use various instruments for analysis	1,2,3,4

TEXT BOOKS:

1. Biophysical Chemistry: principle and technique by Upadhyay and Nath.
2. Spectroscopy: atomic and molecular by Gurdeep R. Chatawal and Sham K. Anand.

REFERENCE BOOKS:

1. C.R. Cantor and P.R. Schimmel; Biophysical Chemistry (Vol. 2-3). W.H. Freeman, 1980.
2. T.E. Creighton; Protein Structure. I.R.E. Press, 1989.
3. T.G. Cooper; The Tools of Biochemistry. Wiley Intersciences, 1977.
4. D. Holme & H. Peck; Analytical Biochemistry. Longman, 1983.

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the different microscopy principles and techniques.	**1,2,3,5,8**
2	Develop proficiency in different chromatographic techniques.	**1,2,3,5,8**
3	Explore different analytical centrifugation and their applications.	**1,2,3,8**
4	Explore different analytical centrifugation and their applications.	**1,2,3,8**
5	Interpret the principles and applications of spectroscopy	**1,2,3,5,8**

SEMESTER – II									
Course Title	**Environmental Microbiology and Microbial Ecology**								
Course code	**24BSMB122R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ II semester of first year of the Programme**								
Course Objectives	1. Understand the role of microorganisms as agents of environmental change. 2. Recognize microorganisms as indicators of alteration of an ecosystem. 3. Understand microbial processes aimed to solve environmental problems.								
CO1	Enumerate the microbial diversity and their extreme habitat.								
CO2	Illustrate the occurrence and distribution of microorganism in the aquatic environment.								
CO3	Describe the role of microorganisms in nitrogen fixation and the genes involved.								
CO4	Explain the role of microorganism in degradation of environmental pollutant and Bioremediation.								
CO5	Describe the different types of microbial interactions and biogeochemical cycles.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Microbial Ecology: Interaction between abiotic and biotic factors in an ecosystem, ecological niche, concept of community, fluctuation and succession. Ecological pyramid, energy flow, food chain, food webs and their dynamism, stability. Diversity of microbes: Microbial communities in terrestrial and aquatic, Microbes in extreme environments – thermophiles, psychrophiles, barophiles, acidophiles, alkaliphiles and halophiles, Role of decomposers, Microbiology of air, enumeration of air microflora.	**13**	Describe, illustrate and explain the interaction between the microbes and other organisms in an ecosystem and the diversity of microorganisms in the environment	1,2
II	Aquatic Microbiology: The aquatic environment - major environmental conditions influencing microflora. Distribution of microorganisms in the aquatic environments - freshwater environment, estuaries and marine environment. Microbiology of drinking water, water pollution, purification of water for human consumption. Assessment of microbial status in water and waste water. Wastewater characteristics, Bacterial indicators – DO, BOD, COD.	**10**	Describe, illustrate and explain the Aquatic environment and the microorganisms present in the water bodies and to understand the microbiology and purification of drinking water.	1,2
III	Soil Microbiology: Soil microbes and soil fertility, Nitrogen fixation: Biochemistry of Nitrogen fixation - mechanism of nitrogenase - hydrogenase - Assay of nitrogen fixation - physiology of legume root nodule, leghaemoglobin - Synthesis, Genes involved in nitrogen fixation	**7**	Describe, illustrate and explain the microbes present in the soil and their role in nitrogen fixation enriching soil fertility.	1,2
IV	Bioremediation – Factors affecting the bioremediation process, Bioremediation of toxic waste sites; Bioremediation practices and technologies; Bioleaching of copper - Role of microbes; Microbial degradation of environmental	**8**	Describe, illustrate and explain the types of microbial interaction with other organisms and the role of microbe in the biogeochemical cycles	1,2

	pollutants- industrial solvents, pesticides, petroleum hydrocarbons, xenobiotics; Biodeterioration – paper, textile, wood, metal, Corrosion			
V	Microbial interaction: Competition, ammensalism, parasitism, mutualism, commensalism, synergism. Biogeochemical cycles – Carbon, Nitrogen.	**7**	Describe, illustrate and explain the technique of electrophoresis and spectro-scopy in terms of its working principle and applications.	1,2
Practical	1. Isolation and enumeration of air microbes by gravity settle method 2. Measurement of pH of given environmental samples 3. Isolation, Enumeration and Bacteriological examination of water samples 4. Isolation of microorganisms from soil samples 5. Isolation of microorganisms from other environmental samples	**30**	Describe, illustrate and explain the isolation of microorganisms from various sectors of environment like air, soil and water and study the types of microorganism present	1,2,3,4

TEXT BOOKS:

1. Environmental Microbiology by Eugene L Madsen
2. Environmental Microbiology, Blackwell Synergy, Blackwell publishing
3. Environmental Microbiology by P D Sharma, Alpha Science publishing
4. Environmental Microbiology by Alan and Malcolm

REFERENCE BOOKS:

1. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. Mc Graw Hill Book Company
2. Prescott, Harley and Klein's Microbiology.
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson
4. Experiments in Microbiology, Plant Pathology and Biotechnology by K.R. Aneja

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Enumerate the microbial diversity and their extreme habit	**1,2,8**
2	Illustrate the occurrence and distribution of microorganism in the aquatic environment.	**1,2,4,8**
3	Describe the role of microorganisms in nitrogen fixation and the genes involved.	**1,2,3,8**
4	Explain the role of microorganism in degradation of environmental pollutant and Bioremediation.	**1,2,3,4,8**
5	Describe the different types of microbial interactions and biogeochemical cycles.	**1,2,3,4,8**

SEMESTER – II									
Course Title	**Enzymes and Metabolism**								
Course Code	**24BSMB123R**	**Total Credits: 4** **Total Hours: 45T+30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ II semester of first year of the Programme**								
Course Objectives	1. Understand enzyme characteristics, classification, mechanisms, kinetics, and applications. 2. Describe the types, functions, and deficiency disorders of vitamins and minerals. 3. Analyze carbohydrate and protein metabolism, including key pathways and regulatory mechanisms. 4. Explain the roles of plant growth regulators and the processes of photosynthesis and nitrogen fixation in plants.								
CO1	Describe enzymes, enzyme kinetics, including carbohydrates, and proteins metabolism.								
CO2	Explain the physiological roles of vitamins and minerals and their contribution for overall growth and development of the human body.								
CO3	Describe the generation of cellular energy through carbohydrate metabolism and its regulation.								
CO4	Illustrate the interconnection between protein metabolism in our body and different associated metabolic pathways.								
CO5	Analyze the physiological effects of growth regulators in plant growth and development								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Enzyme: History, Terminology, General Characteristics Classification, nomenclature; Coenzyme; cofactor; active site; ribozyme; mechanism action (Lock & key model; Induced fit model), Enzyme Kinetics (Michaelis - Menten equation, Line weaver Burk plot), Enzyme (inhibition, specificity, Application).	**13**	Describe, illustrate and explain and enzyme kinetics.	1,2
II	Vitamins and Minerals: Definition; Types; Functions; classification; sources; deficiency disorder.	**10**	Describe, illustrate and explain the types, sources and functions of vitamins and minerals.	1,2
III	Carbohydrate metabolism: Glycolysis, oxidation of pyruvate, TCA cycle, metabolism of glycogen, gluconeogenesis, pentose phosphate pathway, glycosylates pathway, Mitochondrial electron transport, oxidative phosphorylation, inhibitors.	**7**	Describe, illustrate and explain the pathway for carbohydrate metabolism and the enzymes involved.	1,2
IV	Protein Metabolism- Degradation of proteins, Oxidative, non-oxidative deamination and decarboxylation of amino acids, Urea Cycle and Creatinine formation.	**8**	Describe, illustrate and explain the pathway for protein metabolism and the enzymes involved.	1,2
V	Plant growth regulators - Auxins, Gibberellins, Cytokinin's. Abscisic acid and ethylene. Photosynthesis- Structure of photosynthetic apparatus, C3 and C4 pathways, Light and Dark reaction, Nitrogen metabolism and fixation of nitrogen in leguminous plants.	**7**	Describe, illustrate and explain the plant growth regulators and their functions, and also explain and illustrate CO2 and N2 fixation.	1,2

Practical	A. Quantitative estimation of 1. Proteins (Lowry's method). 2. DNA (Diphenylamine method), 3. RNA (Orcinol method), 4. Amino acids (Ninhydrin reaction), 5. Sugars (Dinitrosalicylic acid method). B. Extraction of Protein from milk,	**30**	Describe, illustrate and explain estimate the sugars, proteins, DNA, RNA and amino acids of given sample and extract protein from milk.	1,2,3,4

TEXT BOOKS:

T1. U Satyanarayana. Biochemistry. 13th edition. Elsevier Health Sciences; 2017.

REFERENCE BOOKS:

R1. David L. Nelson, Michael Cox. Lehninger Principles of Biochemistry. 7th Edition. WH Freeman; 2017.

R2. Rodwell et al. Harper's Illustrated Biochemistry. 29th edition. McGraw Hill; 2012.

R3. Voet and Voet. Biochemistry. 3rd edition. John Wiley & Sons, 2004.

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe enzymes, enzyme kinetics, including carbohydrates, and proteins metabolism.	**1,2,3,8**
2	Explain the physiological roles of vitamins and minerals and their contribution for overall growth and development of the human body.	**1,2,8**
3	Describe the generation of cellular energy through carbohydrate metabolism and its regulation.	**1,2,3,8**
4	Illustrate the interconnection between protein metabolism in our body and different associated metabolic pathways.	**1,2,3,8**
5	Analyse the physiological effects of growth regulators in plant growth and development	**1,2,3,4,8**

SEMESTER – II									
Course Title	**Environmental Studies**								
Course code	**24UBES101R**	**Total Credits: 2** **Total Hours: 30**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			2	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ II semester of first year of the Programme**								
Course Objectives	1. To prepare students for careers as leaders in understanding and addressing complex environmental issues from a problem-oriented, interdisciplinary perspective. 2. To develop a world population that is aware of and concerned about the environment and its associated problems and which has the knowledge, Skills, attitudes, motivations and commitment to work individually and collectively towards solutions of current problems and prevention of new ones. 3. To gain knowledge about the conservation of biodiversity and its importance.								
CO1	The students will be able to appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.								
CO2	Students will learn about natural resource, its importance and environmental impacts of Human activities on natural resource								
CO3	Gain knowledge about environment and ecosystem, Students will be able to understand the concept of biodiversity and respect them								
CO4	Gain knowledge about the conservation of biodiversity and its importance.								
CO5	Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Multidisciplinary nature of environmental studies:** Definition, scope and importance, Need for public awareness.	4	Environmental studies combines sciences to tackle environmental issues. Its multidisciplinary approach is key to solving complex problems. Public awareness and education are vital for promoting sustainability	1,2
II	**Natural Resources: Renewable and non-renewable resources,** Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. Land resources: Land as a resource, land degradation, man induced	6	Natural resources, both renewable and non-renewable, face exploitation issues, including deforestation, overuse of water resources, environmental challenges with minerals and food, and land degradation. Individuals play a crucial role in conserving resources and promoting sustainability.	1,2

	landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles			
III	**Ecosystems:** Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the Following ecosystem: - Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	4	This module covers ecosystems, including their concept, structure, functioning, and diversity. Students will learn about energy flow, ecological succession, and various ecosystem types like forests, grasslands, deserts, and aquatic ecosystems.	1,2
IV	**Biodiversity and its conservation:** Introduction – Definition: genetic, species and ecosystem diversity. Bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega diversity nation• Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.	5	This module covers biodiversity, including its definition, value, levels, and threats. Students will learn about India's bio-geographical classification, its status as a mega diversity nation, and key biodiversity hotspots. They'll also explore threats like habitat loss, wildlife poaching, and human-wildlife conflicts, crucial for conservation efforts.	1,2
V	**Environmental Pollution:** Definition Cause, effects and control measures of:-Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste, Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.	5	This module covers environmental pollution, including causes, effects, and control measures, alongside waste management and disaster preparedness strategies.	1,2
VI	**Social Issues and the Environment:** From Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case Studies. **Environmental ethics:** Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Waste land reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of	6	This module explores social-environmental dynamics, including urban energy challenges, water conservation, and resettlement issues. It delves into environmental ethics, climate change impacts, and relevant legislation like the Environment Protection Act, emphasizing public awareness and enforcement challenges.	1,2

	environmental legislation. Public awareness.			
VII	**Human Population and the Environment:** Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Case Studies.	4	This module covers human population dynamics, including growth, impact on the environment and health, along with initiatives like Family Welfare Programs and the role of information technology, illustrated with case studies.	1,2
VIII	**Field work:** Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc. (**Field work Equal to 5 lecture hours**)	5	Fieldwork objectives include documenting environmental assets like rivers and forests, assessing pollution in urban or rural sites, and studying local biodiversity and ecosystems such as ponds and hill slopes	1,2

TEXT BOOKS:

T1. Bharucha. Textbook of Environmental Studies for Undergraduate Courses. 2nd edition. Orient Black Swan Publishing; 2019.

REFERENCE BOOKS:

R1. Trivedy Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media (R). B.S. Publications; 2010.

R2. Trivedi, Goel. Introduction to air pollution. 1st publication. Techno-Science Publication (TB); 2003.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/22274891/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	The students will be able to appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.	**1,4,6,8**
2	Students will learn about natural resource, its importance and environmental impacts of Human activities on natural resource	**1,2,4,6,8**
3	Gain knowledge about environment and ecosystem, Students will be able to understand the concept of biodiversity and respect them	**1,2,4,6,8**
4	Gain knowledge about the conservation of biodiversity and its importance.	**1,4,6,8**
5	Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures.	**1,2,4,5,8**

SEMESTER – II										
Course Title	**Implicative English** (Communicative English & Soft Skills)									
Course code	**24UBPD121R**	**Total Credits: 2** **Total Hours: 32**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ II semester of first year of the Programme**								
Course Objectives	1. To equip students with the skills to interchange sentence types, use various tenses, and correct common grammatical errors. 2. To enable students to effectively use one-word substitutions, understand homonyms and homophones, avoid commonly confused words, and use idioms and phrases. 3. To help students understand the nature and types of listening, and overcome barriers to effective listening. 4. To enable students to apply effective reading techniques, gather information from texts, and use the SQ3R technique. 5. To teach students the importance of time management and basic strategies to maintain it. 6. To guide students in developing a comprehensive and professional LinkedIn profile.									
CO1	Provide students with the ability to transform sentence types, utilize different tenses, and address common grammatical mistakes.									
CO2	Empower students to proficiently apply one-word substitutions, differentiate between homonyms and homophones, avoid frequently confused words, and incorporate idioms and phrases in their vocabulary.									
CO3	Assist students in comprehending the various aspects and types of listening, and in identifying and overcoming obstacles to effective listening.									
CO4	Facilitate students in employing effective reading strategies, extracting relevant information from texts, and utilizing the SQ3R method.									
CO5	Instruct students on the significance of time management and provide foundational strategies to manage their time efficiently.									
CO6	Lead students in creating a well-rounded and professional LinkedIn profile.									

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Grammar (flipped classroom)** i. Interchange of Interrogative and Assertive Sentences, Exclamatory and Assertive Sentences ii. Types of Tenses iii. Common Errors	6	Students will accurately construct and transform various sentence types and correct grammatical errors.	1,2, 3
II	**Vocabulary Development** i. One word substitution ii. Homonyms and Homophones iii. Words often confused **iv.** Idioms and phrases	6	Students will enhance their vocabulary and use words accurately in context.	1,2, 3
III	**Listening Skills** i. What is listening? ii. Types of Listening iii. Understanding Listening Barriers	5	Students will demonstrate effective listening skills and identify listening barriers.	1,2, 3
IV	**Reading Skills** i. Techniques of Effective Reading ii. Gathering ideas and information from a text iii. The SQ3R Technique	5	Students will read efficiently and extract relevant information using the SQ3R technique.	1,2, 3

V	**Time-Management Skills** i. Introduction to Time Management ii. Purpose and Importance of Time Management iii. Basic Tips to Maintain Time	4	Students will effectively manage their time using various strategies.	1,2, 3
VI	**Creation of LinkedIn Profile**	6	Students will create a professional LinkedIn profile.	2, 3

TEXT BOOKS:

1. Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writingand Speaking, Zephyros Press.
2. Reed, James. 2016. 101 Job Interview Questions You'll Never Fear Again, Plume.
3. Pease, Barbara. 2006. The Definitive Book of Body Language, RHUS.
4. McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition)

REFERENCE BOOKS:

1. Zinsser, William. (2006) On Writing Well: The Classic Guide to Writing Nonfiction Harper Perennial
2. Taylor J. and Wright, J., IELTS Advantage Reading Skills: A step-by-step guide to a high IELTS reading score, Delta Publishing by Klett.
3. Kelley, Thea. 2021. Get That Job: The Quick and Complete Guide to a Winning Interview, Plovercrest Press.
4. Murphy, Raymond,.(2012) English Grammar in Use Book with Answers: A Self- Study and Practice Book for Intermediate Learners of English ,Cambridge University Press

OTHER LEARNING RESOURCES:

https://www.ef.com/wwen/english-resources/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Provide students with the ability to transform sentence types, utilize different tenses, and address common grammatical mistakes.	**2,5,8**
2	Empower students to proficiently apply one-word substitutions, differentiate between homonyms and homophones, avoid frequently confused words, and incorporate idioms and phrases in their vocabulary.	**2,5,8**
3	Assist students in comprehending the various aspects and types of listening, and in identifying and overcoming obstacles to effective listening.	**2,5,6,8**
4	Facilitate students in employing effective reading strategies, extracting relevant information from texts, and utilizing the SQ3R method.	**2,5,8**
5	Instruct students on the significance of time management and provide foundational strategies to manage their time efficiently.	**2,6,7,8**

SEMESTER – II									
Course Title	**Co-Curricular Activities**								
Course code	**24UBCC121R**	**Total credits: 1** **Total hours: 60**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ II semester of first year of the Programme**								
Course Objectives	1. Develop students' interpersonal skills, emotional intelligence, and teamwork abilities through participation in diverse co-curricular activities. 2. Foster leadership qualities and organizational skills by providing opportunities for students to take on leadership roles and manage events or projects within co-curricular activities. 3. To be aware of their role in society and contribute positively.								
CO1	Improve Interpersonal and Teamwork Skills- Students will learn to work well with others and communicate better.								
CO2	Develop Time Management and Organizational Skills - Students will learn to manage their time and stay organized.								
CO3	Boost Creativity and Critical Thinking - Students will enhance their creative abilities and think more critically.								
CO4	Promote Physical and Mental Health - Students will improve their overall health and reduce stress.								
CO5	Encourage Social Responsibility and Civic Engagement - Students will become more aware of their role in society and contribute positively.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Based on the learner's interest they can improving interpersonal and teamwork skills, developing time management and organizational skills, boosting creativity and critical thinking, promoting physical and mental health, and encouraging social responsibility and civic engagement. They will engage in regular club activities, workshops, and competitions that align with their interests and hobbies, fostering their social and emotional development. Renowned professionals will conduct workshops to enhance students' talents. Assessments will include participation in activities, reflection essays, journals, and evaluations of their involvement in workshops and events. Through these experiences, students will learn to work well with others, communicate effectively, manage their time, stay organized, enhance creativity, think critically, improve their health, reduce stress, and contribute positively to society.	**60**	By participating in various sports, music, and co-curricular activities offered through university clubs, students will develop physical and mental agility, leadership, teamwork, and creativity. They will enhance time management, gain practical knowledge through workshops with renowned professionals, and build self-confidence while fostering personal growth. These activities promote cultural awareness, inclusivity, and lifelong learning, encouraging students to pursue their interests, develop new skills, and cultivate passions that extend beyond their academic journey.	1,2

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve Interpersonal and Teamwork Skills- Students will learn to work well with others and communicate better.	**6,7**
2	Develop Time Management and Organizational Skills - Students will learn to manage their time and stay organized.	**6,7**
3	Boost Creativity and Critical Thinking - Students will enhance their creative abilities and think more critically.	**6,7**
4	Promote Physical and Mental Health - Students will improve their overall health and reduce stress.	**6,7**
5	Encourage Social Responsibility and Civic Engagement - Students will become more aware of their role in society and contribute positively.	**5,6,7**

SEMESTER – III										
Course Title	**Immunology**									
Course code	**24BSMB211R**	**Total credits: 4** **Total hours: 45T+30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
			3	**0**	**2**	**0**	**0**	**0**	**4**	
Pre-requisite	**Nil**	**Co-requisite**	**Nil**							
Programme	**Bachelor of Science in Microbiology**									
Semester	**Fall/ III semester of second year of the Programme**									
Course Objectives	1. Identify and describe the contributions of key scientists to the development of immunology. 2. Explain the functions and properties of various immune cells and organs. 3. Differentiate between types of immunity and understand antibody-antigen interactions. 4. Analyse hypersensitivity, autoimmunity, vaccines, secondary immunodeficiency, and graft types.									
CO1	Describe the historical prospect and concept of innate and adaptive immunity.									
CO2	Illustrate the properties and functions of different Immune cell, organs.									
CO3	Discuss the structure and properties of antigen and antibody.									
CO4	Apply the principle of antigen antibody interaction for detection of disease									
CO5	Identify immunological disorders like hypersensitivity and autoimmunity.									

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Concept of Innate and Adaptive immunity: Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa	**10**	Describe, illustrate and explain the contributions of scientists towards the development of Immunology	1,2
II	Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT	**10**	Describe, illustrate and explain about Immune cells their functions and properties	1,2
III	Immunity – types - active passive Antibody – property structure, antigens– properties, happens,	**8**	Describe, illustrate and explain the different types of immunity, properties of antibody, antigen, happens and structure of antibody	1,2
IV	Antigen-antibody reactions – agglutination, precipitation, immune diffusion, ELISA, RIA, monoclonal antibodies functions	**8**	Describe, illustrate and explain the knowledge on principles and process of immune techniques	1,2
V	Hypersensitivity – types, autoimmunity-types, vaccines – types, secondary immunodeficiency, graft and its types	**9**	Describe, illustrate and explain the different types of Hypersensitivity, vaccines, graft and secondary immune deficiency	1,2
Practical	1. ABO Blood Grouping and Rh typing 2. Precipitation reaction: ODD, RID, WIDAL, VDRL / RPR, ASO, CRP, HCG 3. Demonstration of RIA and ELISA	**30**	Proficiency in various diagnostic disease diagnosis	1,2,3,4

TEXT BOOKS:

1. Immunology by Kuby, W.H Freeman & Co.
2. Immunology and Immunotechnology by Chakraborty, Oxford University Press
4. Clinical Immunology: Principles and Practice. Robert R. Rich, Thomas A. Fleisher, William T. Shearer, Harry W. Schroeder Jr., Anthony J. Frew, Cornelia M. Wey and. Elsevier Health Sciences, 2018
5. Basic Immunology, 6e: South Asia Edition Paperback, 2019, by, Andrew H. Lichtman, Shiv Pillai.
6. Practical Immunology, 4th Edition, C. Hay, Olwyn MR Westhood, Blackwell Series. 2008.

REFERENCE BOOKS:

1. Cellular and Molecular Immunology; Abbas and Lichtman. ed.: Malley, J.; Schmitt, B. - Fifth edition, updated. Elsevier Saunders, 2005.
2. An Introduction 1st Edition (English) 4th Edition, Ian Tizard, Brooks/Cole publication

OTHER LEARNING RESOURCES:
https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the historical prospect and concept of innate and adaptive immunity.	**1,2,8**
2	Illustrate the properties and functions of different Immune cell, organs.	**1,2,8**
3	Discuss the structure and properties of antigen and antibody.	**1,2,3,8**
4	Apply the principle of antigen antibody interaction for detection of disease	**1,2,3,8**
5	Identify immunological disorders like hypersensitivity and autoimmunity.	**1,2,3,6,8**

SEMESTER – III										
Course Title	**Microbial Genetics**									
Course code	**24BSMB212R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ III semester of second year of the Programme**								
Course Objectives	1. Understand the detailed structures of DNA forms (Z-DNA, A & B DNA) and genome organization in prokaryotes and eukaryotes. 2. Explain DNA replication mechanisms, transcription processes, and RNA types and their processing. 3. Analyse gene regulation mechanisms, mutagens, mutations, and DNA repair processes. 4. Describe bacterial recombination, transformation, conjugation, transduction, and transposable elements.									
CO1	Describe the DNA structure and its mode of replication.									
CO2	Illustrate the concept of transcription, post transcriptional modification, translation, post translational modification in prokaryotic and eukaryotic cells.									
CO3	Describe the DNA mutation, damage and their repair mechanism.									
CO4	Explain bacterial recombination in different mode of gene transfer									
CO5	Outline transposable elements and their different application.									

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Detailed structure of DNA, Z-DNA, A & B DNA, Genome organization in prokaryotes and eukaryotes, Enzymes involved in DNA replication, Modes of DNA replication- Detailed mechanism of Semiconservative replication. Plasmids: nature, classification, properties and replication.	**9**	Describe, illustrate and explain the structural organization of DNA and their Modes of replication	1,2
II	Prokaryotic and eukaryotic transcription: Structure and processing of m-RNA, r-RNA, t-RNA. Ribozyme, Genetic code and Wobble hypothesis, Translation in Prokaryotes. Post translational modifications, Gene regulation and expression – Lac operon, tryptophane operons, gene rearrangement, promoters, enhancer elements.	**10**	Describe, illustrate and explain about processes such as transcription and translation in both prokaryotes and eukaryotes	1,2
III	Types of mutagens, molecular basis of mutations, analysis of mutations, site directed mutagenesis. Detailed mutagenesis and repair mechanism of UV, Ethidium Bromide and Nitrus oxide. DNA damage and repair mechanisms. Isolation and applications of mutants.	**8**	Describe, illustrate and explain about the different types of mutations and their role in evolution	1,2
IV	Bacterial Recombination's- Discovery, gene transfer, molecular mechanism, detection, efficiency calculation and applications. Bacterial transformation- Competency and resistance.	**10**	Describe, illustrate and explain the different methods of transfer of genes from one organism to another	1,2

	Bacterial conjugation – Sex factor in bacteria, F and HFR transfer, linkage mapping. Bacterial transduction– transduction phenomenon, methods of transduction, generalized, specialized and abortive transduction, sex-ductions			
V	Transposable elements – Definition, detection of transposition in bacteria, types of bacterial transposons and applications of transposons	**8**	Describe, illustrate and explain about the rearrangement of genes are major force in evolution	1,2
Practical	1. Gel casting and gel loading 2. Isolation of DNA, protein 3. Agarose Gel Electrophoresis, PAGE 4. Demonstration of conjugation, transformation and Transduction 5. Blotting techniques	**30**	Proficiency in various molecular techniques for DNA, protein isolation	1,2,3,4

TEXT BOOKS:

1. Molecular Biology of the Gene 4th edition by J D Watson, N H Hoppkins, Roberts, Steitz and Weiner. 1987. The Benjamin Cummings Publication Co. Inc Californis
2. Microbial genetics. David Freifelder Jones and Bartlett, 1987

REFERENCE BOOKS:

1. Microbial genetics by Maloy et al. 1994, Jones and Bartlett Publishers
2. Molecular Genetics of Bacteria by J W Dale, 1994, John Wiley and Sons
3. Modern Microbial Genetics. 1991 by Streips and Yasbin. Niley Ltd.

OTHER LEARNING RESOURCES:
https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the DNA structure and its mode of replication.	**1,2,3,8**
2	Illustrate the concept of transcription, post transcriptional modification, translation, post translational modification in prokaryotic and eukaryotic cells.	**1,2,3,8**
3	Describe the DNA mutation, damage and their repair mechanism.	**1,2,3,8**
4	Explain bacterial recombination in different mode of gene transfer	**1,2,3,7,8**
5	Outline transposable elements and their different application.	**1,2,3,7,8**

SEMESTER – III									
Course Title	**Agricultural Microbiology and Plant Pathology**								
Course code	**24BSMB213R**	**Total credits: 4** **Total hours: 45T+30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ III semester of second year of the Programme**								
Course Objectives	1. Understand soil composition, microorganisms, and microbe-plant interactions, including siderophore roles. 2. Explain the nitrogen cycle, symbiotic and non-symbiotic nitrogen fixation, nitrogenase function, and if gene importance. 3. Apply knowledge of biofertilizers, biopesticides, genetic transformation, and cyanobacteria in agriculture. 4. Analyze host-parasite interactions, pathogenesis mechanisms, phytoalexin production, and strategies for plant disease control.								
CO1	Describe soil profiles, recognize microorganisms in soil and plants, and grasp the dynamics of positive and negative interactions between microbes and plants and comprehending the role of siderophores in nurturing relationships between microbes and plants.								
CO2	Proficient understanding of the nitrogen cycle, distinction between symbiotic and non-symbiotic nitrogen fixation mechanisms, clarification of nitrogenase enzyme functions and articulation of the importance of nif genes in nitrogen metabolism.								
CO3	Applying the use of associative cyanobacteria as biofertilizers, evaluating biopesticides for insect control, and recognizing the importance of Ti plasmid in plant transformation and Agrobacterium-mediated gene transfer.								
CO4	Analyze host-parasite interactions, examine enzymes and toxins in plant diseases, identify primary disease determinants, explore pathogenesis mechanisms, and understand phytoalexin production in plant defense.								
CO5	Study key plant diseases and their control methods and preventive strategies for post-harvest disease control.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Soil Profiles: Composition and Structure, Microorganisms in Soil and Plant Environments Positive and Negative Microbe-Plant Interactions. Role of Siderophores in Microbe-Plant Relationships	**9**	Describe and explain the soil composition and structure, identify soil and plant microorganisms, analyze plant-microbe interactions, and evaluate the role of siderophores in these relationships.	1,2
II	Overview of the Nitrogen Cycle. Symbiotic vs. Non-Symbiotic Nitrogen Fixation. Function of Nitrogenase Enzyme. Importance of nif Genes in Nitrogen Metabolism	**7**	Describe, illustrate and explain about Nitrogen Fixation. Function of Nitrogenase Enzyme and Importance of nif Genes in Nitrogen Metabolism	1,2
III	Biofertilizers, Biopesticides, and Genetic Transformation, Associative cyanobacteria as biofertilizers: Benefits and application methods. Biopesticides: Types, modes of action, and evaluation for insect control. Ti plasmid and its role in plant transformation. Agrobacterium-mediated gene transfer: Mechanism and applications.	**9**	Describe, illustrate and explain about Biofertilizers, Biopesticides, and Genetic Transformation	1,2

IV	Host-Parasite Interactions: Host parasite interaction, enzymes and toxins in relation to plant disease, primary disease determinant, mechanism of pathogenesis. Phytoalexin production and its role in plant defence.	**8**	Describe, illustrate and explain the host-parasite interactions, the roles of enzymes and toxins in plant diseases, primary disease determinants, pathogenesis mechanisms, and phytoalexin production in plant defense.	1,2
V	**Major diseases in Plants:** Study of the following diseases and their methods of control: late blight of potato, leaf spot disease of rice, loose smut of wheat, red rot of sugarcane, citrus canker and mosaic disease of tobacco. Preventive strategies for post-harvest disease control.	**12**	Describe, illustrate and explain about different plant diseases caused by microorganisms and implement effective preventive strategies for post-harvest disease control.	1,2
Practical	1. Isolation of bacteria and fungi from soil. 2. Isolation of nitrogen fixing bacteria from legume root nodules. 3. Isolation of phyllosphere microflora. 4. Study the symptoms, causal agents, and epidemiology of plant diseases.	**30**	Proficiency in isolating bacteria and fungi from soil, nitrogen-fixing bacteria from legume root nodules, phyllosphere microflora, and studying symptoms, causal agents, and epidemiology of plant diseases.	1,2,3,4

TEXT BOOKS:

1. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
2. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
3. Plant Pathology by G.N Agriose: January 2000, Academic Press

REFERENCE BOOKS:

1. Microbiology – Michael J. Pelczar, JR. E. C. S. Chan Noel K. Krieg, Vth Edition (2005), Publisher – TATA Mc Graw Hill.
2. Plant Diseases – R.S. Singh, IXth Edition, Oxford and IBH (N. Delhi).
3. Plant Pathology. J. C Walker, 1999 by the National Academy Press Washington.

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe soil profiles, recognize microorganisms in soil and plants, and grasp the dynamics of positive and negative interactions between microbes and plants and comprehending the role of siderophores in nurturing relationships between microbes and plants.	**1,2,8**
2	Proficient understanding of the nitrogen cycle, distinction between symbiotic and non-symbiotic nitrogen fixation mechanisms, clarification of nitrogenase enzyme functions and articulation of the importance of nif genes in nitrogen metabolism.	**1,2,3,8**
3	Applying the use of associative cyanobacteria as biofertilizers, evaluating biopesticides for insect control, and recognizing the importance of Ti plasmid in plant transformation and Agrobacterium-mediated gene transfer.	**1,2,3,4,8**
4	Analyze host-parasite interactions, examine enzymes and toxins in plant diseases, identify primary disease determinants, explore pathogenesis mechanisms, and understand phytoalexin production in plant defense.	**1,2,3,6,8**
5	Study key plant diseases and their control methods and preventive strategies for post-harvest disease control.	**1,2,3,4,8**

SEMESTER – III										
Course Title	**English Language for Excellence**									
Course code	**24UBPD212R**	**Total credits: 2** **Total hours: 32**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ III semester of second year of the Programme**								
Course Objectives	1. To understand and apply grammar rules effectively. 2. To develop clear and structured writing skills. 3. To cultivate self-management skills. 4. To understand and utilize non-verbal communication. 5. To enhance group discussion skills 6. To master interview skills and dress code ethics									
CO1	Enable students to use prepositions, construct simple, complex, and compound sentences, and distinguish between active and passive voice.									
CO2	Teach students the basics of writing, how to avoid ambiguity, write paragraphs and letters, and prepare resumes and cover letters.									
CO3	Help students conduct SWOT analyses, practice self-regulation, and maintain personal hygiene.									
CO4	Equip students with knowledge about non-verbal communication, types of body language, and their impact.									
CO5	Train students in planning and conducting group discussions, effectively disagreeing, and summarizing to attain objectives.									
CO6	Prepare students for personal interviews, answer common interview questions, follow telephone interview etiquettes, and adhere to dress code and grooming standards.									

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Grammar (Flipped classroom)** i. Use of Prepositions ii. Simple, complex, compound sentences iii. Active and Passive Voice	6	Students will correctly use prepositions, create various sentence structures, and convert between active and passive voice.	2, 3
II	**Writing Skills** I. The Basics of Writing; avoid ambiguity and vagueness II. Paragraph Writing III. Letter Writing IV. Resume and Cover Letter	6	Students will write clear and structured paragraphs, letters, resumes, and cover letters.	3, 4
III	**Self-Management Skills** i. SWOT Analysis ii. Self-Regulation iii. Personal Hygiene	5	Students will perform SWOT analyses, self-regulate, and adhere to personal hygiene practices.	3, 4
IV	**Non- Verbal Communication-Sciences of Body Language** i. What is Non-Verbal Communication & Body Language ii. Types of Body Language, iii. Importance and Impact of Body Language,	5	Students will understand and effectively use different types of body language in communication.	2, 3
V	**Group Discussion** i. Planning and Elements of Group Discussion ii. Effectively disagreeing, iii. Summarizing and Attaining the Objective.	5	Students will plan and participate in group discussions, disagree constructively, and	3, 4

			summarize discussions.	
VI	**Interview Skills & Dress code Ethics** i. Personal Interview – Concept and Practice ii. Common Interview Questions and answering Strategies iii. Telephone Interview Etiquettes iv. Introduction to Dress Code and Grooming	5	Students will demonstrate effective interview techniques, answer common questions, follow telephone etiquettes, and dress appropriately.	2, 3

TEXT BOOKS:

1. Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.
2. Reed, James. 2016. 101 Job Interview Questions You'll Never Fear Again, Plume.
3. Pease, Barbara. 2006. The Definitive Book of Body Language, RHUS.
4. McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition)

REFERENCE BOOKS:

1. Zinsser, William. (2006) On Writing Well: The Classic Guide to Writing Nonfiction Harper Perennial
2. Taylor J. and Wright, J., IELTS Advantage Reading Skills: A step-by-step guide to a high IELTS reading score, Delta Publishing by Klett.
3. Kelley, Thea. 2021. Get That Job: The Quick and Complete Guide to a Winning Interview, Plover crest Press.
4. Murphy, Raymond,.(2012) English Grammar in Use Book with Answers: A Self- Study and Practice Book for Intermediate Learners of English ,Cambridge University Press

OTHER LEARNING RESOURCES:

https://learning.shine.com/talenteconomy/career-help/top-group-discussionskills
https://www.coursera.org/articles/conflict-management

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Enable students to use prepositions, construct simple, complex, and compound sentences, and distinguish between active and passive voice.	**2,5,8**
2	Teach students the basics of writing, how to avoid ambiguity, write paragraphs and letters, and prepare resumes and cover letters.	**2,5,8**
3	Help students conduct SWOT analyses, practice self-regulation, and maintain personal hygiene.	**2,5,6,8**
4	Equip students with knowledge about non-verbal communication, types of body language, and their impact.	**2,5,8**
5	Train students in planning and conducting group discussions, effectively disagreeing, and summarizing to attain objectives.	**2,6,7,8**

SEMESTER – III									
Course Title	**Basic Life Saving Skills (BLSS)**								
Course code	**24UULS202R**	**Total credits: 1** **Total hours: 30T**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ III semester of second year of the Programme**								
Course Objectives	The aim of the course is to provide the learners with basic knowledge and practical skills needed in an emergency fire situation, and to provide appropriate basic management and treatment for injuries								
CO1	The students will be able to recognize respiratory arrest/ cardiac arrest, and provide oxygen to the patients to sustain tissue viability								
CO2	The students will be able to perform the importance of early CPR on Adult, child and infants victims								
CO3	The students will be able to prevent injury from getting worse, aiding recovery, relieving pain and protecting the victims from deterioration								
CO4	Importance of physiology in forestry								
CO5	The students will be able to learn about the fire equipment requirements, methods of operation and getting out alive.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Basic Life Support (BLS)** • Introduction of BLS • Chain of survival • ABCs Assessment • CPR and Ventilation Technique • AED • Choking for adult and children	**5**	Introduction about basic life support, about the chain of survival, different assessment techniques	1,2
II	**First Aid** • Golden rules of First aid • First aid Kits	**5**	Students will understand the golden rules of first aid and be able to prepare and utilize a first aid kid effectively in emergencies	1,2
III	**Trauma emergencies** • Introduction • Priorities of Initial approach in pre-hospital care • Scene safety • Primary assessment • Bleeding control • Extrication of victims and safe transfer •Cervical spine stabilization and C-collar application • Splinting of broken Limbs	**5**	Explains about different trauma emergencies and methods of managing trauma emergencies.	1,2,3
IV	**Triage system** • Introduction • Flow chart approach of Triage • Triage of Single and Multiple Casualties in Pre-Hospital setting	**5**	Illustrates the triage system and explains about multiple causality operations.	1,2,3,4
V	**Medical emergencies** Introduction Victim centred approach and Management	**4**	Describes different types of medical emergencies and its management.	1,2,3,4,5

	of:- • Seizures • heart attack • asthma • diabetic emergencies • emergency childbirth • Respiratory distress and failure			

REFERENCE BOOKS:

R1: Nancy Caroline's Emergency Care in the streets eight edition by Jones and Bartlett
R2: First Aid book by LC Gupta; Publisher Jaypee Brothers, 7th Edition.

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	The students will be able to recognize respiratory arrest/ cardiac arrest, and provide oxygen to the patients to sustain tissue viability	**2,5,7,8**
2	The students will be able to perform the importance of early CPR on Adult, child and infants victims	**2,5,7,8**
3	The students will be able to prevent injury from getting worse, aiding recovery, relieving pain and protecting the victims from deterioration	**2,5,7,8**
4	Importance of physiology in forestry	**2,4,6,8**
5	The students will be able to learn about the fire equipment requirements, methods of operation and getting out alive.	**2,5,7,8**

SEMESTER – III									
Course Title	**Personal Financial Planning**								
Course code	**24UUFL202R**	**Total credits: 2** **Total hours: 30**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ III semester of second year of the Programme**								
Course Objectives	1. The course would offer an inclusive approach to understand the relevant concepts of money, borrowing, lending, taxes and their application to financial planning. 2. Assess the personal financial planning process, the life cycle of financial plans, and methods of goal achievement. 3. Formulate a budget, record-keeping system, and tax planning strategy based on current financial goals								
CO1	Develop a cash management strategy and a plan to facilitate the home or automobile buying process								
CO2	Design a diversified investment portfolio that addresses several different investment objectives.								
CO3	Differentiate between open- and closed-end mutual funds, exchange-traded funds, and direct or indirect real estate investments.								
CO4	Create a financial plan that covers your income needs in retirement and helps protect you and your estate.								
CO5	Students will be able to analyze and plan effective strategies for managing consumer credit, housing, vehicle, retirement needs estate planning and legal protection to ensure financial stability and security.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Fundamentals of Financial Planning –** i. Functions of money; ii. Inflation- Meaning, causes, how it can be controlled; iii. process official planning, iv. Time value of money-simple and compound interest; v. Net Present Value and Future value, vi. Power of Compounding; vii. Doubling period and Rule of 72.	**6**	Students will acquire essential knowledge of fundamentals of financial planning	1,2
II	**Income Tax Planning–** i. Meaning of Income, ii. Direct & Indirect Taxes, Taxable Income, various heads of Income for tax Calculation, iii. Non-taxable Income, iv. Tax evasion and tax avoidance, v. GST, Tax Planning Strategies	**6**	Students will acquire essential knowledge and skills in income tax planning	1,2
III	**Entrepreneurial planning –** i. Meaning of Entrepreneurship, prerequisites for becoming an entrepreneur, ii. Entrepreneurship Support Systems in India, iii. Institutional support systems for entrepreneurs, iv. Financial support systems for entrepreneurs; v. Venture Capital, Business Angels, vi. Assistant of Government, vii. Commercial Bank Loans and Overdraft.	**6**	Students will acquire essential knowledge and skills in entrepreneur planning	1,2

IV	**Planning for investing in securities market –** i. Investment avenues offered by Securities Markets, Primary Market and Secondary Market, ii. Stock market- meaning, features, functions of NSE, BSE DEMAT trading account, iii. Security repository, stock brokers, Operational aspects of securities markets: placement of orders, contract note, pay-in and pay-out, trading and settlement cycle, iv. Various risks involved in investing in securities markets; Role of Financial Intermediaries; Stock indices. v. Mutual Funds- meaning concept, definition, types, importance and drawbacks of mutual funds, mutual funds in India, investing in mutual funds, vi. Systematic Investment Plan (SIP) and its advantages.	**6**	Students will acquire essential knowledge and skills in securities market	1,2
V	**Planning for debts and Retirement** i. Consumer credit - Introduction to consumer credit; choosing a source of credit, the cost of credit alternatives, ii. Consumer Legal Protection; iii. Housing Decision: Factors and Finance; Vehicle Decisions. iv. Retirement planning - Meaning of cost of living; retirement need analysis; development of retirement plan, various retirement schemes, v. Estate Planning; Pension and Medicare Planning; Wills.	**6**	Students will acquire essential knowledge and skills in planning for debts and retirement	1,2

REFERENCE BOOKS:

R1: Sinha Pradeep K. and Priti Sinha. Computer Fundamentals: Concepts Systems &The Million Dollar Financial Advisor: Powerful Lessons and Proven Strategies from Top Producers by David J. Mullen Jr.

R2: Personal Finance and Planning by Dr. Rajni

R3: Peaceful Personal Finance: A Short Read on the Basics of Personal Finance and Planning Kindle Edition by Hema Singh

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Develop a cash management strategy and a plan to facilitate the home or automobile buying process	**1,2,3,5,7,8**
2	Design a diversified investment portfolio that addresses several different investment objectives.	**1,2,3,8**
3	Differentiate between open- and closed-end mutual funds, exchange-traded funds, and direct or indirect real estate investments.	**1,2,5,8**
4	Create a financial plan that covers your income needs in retirement and helps protect you and your estate.	**1,2,4,5,8**
5	Students will be able to analyse and plan effective strategies for managing consumer credit, housing, vehicle, retirement needs estate planning and legal protection to ensure financial stability and security.	**1,2,3,6,8**

SEMESTER – III									
Course Title	**Analytical Biochemistry**								
Course Code	**24BSMB214R**	**Total Credits: 1** **Total Hours: 30**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ III semester of second year of the Programme**								
Course Objectives	1. **Principles of Analytical Techniques**: Understand the fundamental principles underlying analytical techniques commonly used in biochemistry, including spectroscopy (UV-visible, fluorescence, IR), chromatography (HPLC, GC), electrophoresis, mass spectrometry, and immunoassays. 2. **Quantitative Analysis:** Learn how to perform accurate and precise quantitative analysis of biomolecules such as proteins, nucleic acids, carbohydrates, lipids, and metabolites using various analytical techniques. 3. **Sample Preparation and Handling:** Develop skills in sample preparation and handling techniques essential for biochemical analysis, including extraction, purification, and derivatization methods.								
CO1	Acquire concept of buffer solutions and their role in various experiments.								
CO2	Develop basic understanding on acid and base, pH of solution and use of pH meters.								
CO3	Apply the principle of Lambert-Beer law with the help of colorimeter and spectrophotometer.								
CO4	Explain biomolecule separation through thin layer chromatography.								
CO5	Demonstrate paper chromatography and its use in amino acids separation								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Preparation of Buffer Solutions	**5**	Proficiency in buffer preparation.	3,4, 5
II	Determination of pH of given samples using pH meter	**7**	Proficiency in learning the operation and function of various analytical tools like pH meter	3,4, 5
III	Verification of Beer- Lambert's Law	**6**	Relating the theoretical concepts with practical application in terms of Beer-Lambert Law verification	3,4, 5
IV	Separation of a mixture of lipids using Thin-layer Chromatography	**5**	Proficiency in Chromatography technique	3,4, 5
V	Paper chromatographic separation and detection of amino acids and simple sugars	**7**	Proficiency in separation and detection of amino acids and simple sugars	3,4, 5

TEXT BOOKS:

1. Introductory Biochemistry Practical by Sawhney and Singh, Narosa Publishing House

REFERENCE BOOKS:

1. Laboratory manual in Biochemistry - Jayaraman.
2. Biochemical methods - S.Sadasivan and Manickam.
3. Introduction to Practical Biochemistry - David T. Plummer.

OTHER LEARNING RESOURCES:

ERP, YouTube links, Google etc.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Acquire concept of buffer solutions and their role in various experiments.	**1,2,3,8**
2	Develop basic understanding on acid and base, pH of solution and use of pH meters.	**1,2,3,8**
3	Apply the principle of Lambert-Beer law with the help of colorimeter and spectrophotometer.	**1,2,3,8**
4	Explain biomolecule separation through thin layer chromatography.	**1,2,3,8**
5	Demonstrate paper chromatography and its use in amino acids separation	**1,2,3,8**

SEMESTER – III									
Course Title	**Entomology**								
Course Code	**24FSZO301R**	**Total Credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ III semester of second year of the Programme**								
Course Objectives	1. Understand the classification, morphology, and key characteristics of insects, focusing on Class Insecta. 2. Explore the morphology and adaptations of insect mouthparts, antenna, and legs. 3. Analyze the life cycles and control measures of medically important pests and their impact on human health. 4. Investigate insect communication methods and behaviors, including their role in pest management and forensic science applications.								
CO1	Understand the overview of Class Insects different morphological modifications.								
CO2	Able to explain the life cycle and control measures of pest of medical importance.								
CO3	Able to explain, illustrate different communicating techniques and insect behavior adopted by insects.								
CO4	Able to explain, illustrate and implement different management strategy adopted for controlling insect pests.								
CO5	Gain knowledge on different insects of economic importance.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to Entomology:** Overview of Class Insecta, its classification and characters. Insect morphology: Overview and modifications of mouthparts, antenna and legs.	**5**	Describe and explain the class of Insects and its morphological peculiarities.	1,2
II	**Pest of medical importance:** Life cycle and control measures of *Musca domestica, Aedes aegypti, Culex quinquefasciatus, Anopheles, Phlebotomus spp, Glossina fuscipes, Cordylobia anthropophaga, Simulium damnosum, Pulex irritans, Cimex lectularius, Triatoma infestans, Pediculus humanus.*	**7**	Describe, illustrate and explain the life cycle and control measures of pest of medical importance.	1,2
III	**Insect communication:** Chemical communication, Audio and tactile communication, Visual communication, Luminescent insects **Insect Behavior:** Chemotropism, Thigmotropism, Hydrotropism, Rheotropism, Anemotropism, Phototropism, thermotropism and geotropism.	**6**	Describe, illustrate and explain the process of different communicating techniques and insect behavior adopted by insects.	1,2
IV	**Role of insects in pest management:** Brief about chemical and biological control of insect's pest, Role of insects in forensic science.	**5**	Describe, illustrate and explain the different management strategy adopted for controlling insect pests.	1,2
V	**Introduction to Applied Entomology:** Life cycle, by product and commercial method of farming of honey bee, silkworm and lac insect.	**7**	Describe, illustrate and explain about different insects of economic importance.	1,2

TEXT BOOKS:

1. Insect pest management by Dent D R, (latest edition). Westville Publishing House: Delhi
2. An ecological and social approach to biological control, Eilenberg J, (latest edition). Springer.
3. Theory and Practice of Animal Taxonomy and Biodiversity by Kapoor V C 8Ed. Oxford and IBH publishing.
4. The insects: structure and functions by R. F. Chapman (5th Edition). Cambridge University Press.
5. Handbook of entomology by T. V Prasad, (4th Edition). New Vishal Publications.

REFERENCE BOOKS:

1. Principles of Animal Taxonomy by G. G. Simpson, (latest edition). Scientific publisher Animal Taxonomy by H. E. Goto (latest Edition). Arnold
2. International Code of Zoological Nomenclature official publication
3. A Text Book of Fundamental and Applied Entomology by M.S. Ali, S.V.S. Raju and M. Raghuraman Tanweer Alam, (latest edition). Kalyani publisher
4. Introduction to general and applied entomology (Scientific Pub.: India) by Awasthi V B (latest Edition). Scientific publisher's journal Dept.

OTHER LEARNING RESOURCES:

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the overview of Class Insects different morphological modifications.	**1,2,8**
2	Able to explain the life cycle and control measures of pest of medical importance.	**1,2,8**
3	Able to explain, illustrate different communicating techniques and insect behaviour adopted by insects.	**1,2,3**
4	Able to explain, illustrate and implement different management strategy adopted for controlling insect pests.	**1,2,3,7,8**
5	Gain knowledge on different insects of economic importance.	**1,2,3,7,8**

SEMESTER – III									
Course Title	**Forestry**								
Course Code	**24FSBO301R**	**Total credits: 2** **Total hours: 30T**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			2	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ III semester of second year of the Programme**								
Course Objectives	1. This course aims to educate student on concepts of forestry 2. Basic knowledge of forest dendrology, forest types 3. The course further deals with physiology of forest, forest management and forest pathology.								
CO1	Articulate the history and basic concept of Forestry.								
CO2	Importance of Dendrology and knowledge of wood forest								
CO3	Understanding of forest types and forest management								
CO4	Importance of physiology in forestry								
CO5	Understanding the forest pathology, causes of forest diseases								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction Forestry:** History of forestry, Classification of forest, Basic concepts on forest types of India. Important acts and policies related to Indian Forest. **Forest management:** Definition and scope of forest management, principle of forest management and their applications	**5**	Describe and explain History, types and policies of forest	1,2
II	**Dendrology:** Introduction, importance and scope of dendrology. Role of vegetative morphology in identification of woody forest flora **Ecotourism:** Definition and elements of ecotourism, Principles and objectives of ecotourism. Potential of ecotourism in India.	**7**	Describe, illustrate and explain Importance, scope and morphology of woody forest and Ecotourism	1,2
III	**Plant Physiology:** Introduction to tree physiology, Photosynthesis. Water relation of forest trees, transpiration from forest canopies, environmental effects on growth and development.	**6**	Describe, illustrate and explain Importance of tree physiology in relation to forestry.	1,2
IV	**Forest Ecology and Diversity:** Forest types of India, Forest Ecosystem-abiotic and biotic components and their interaction, Nutrient cycling, forest management. Conservation measurement of diversity, diversity hot spots, Principle of conservation.	**5**	Describe, illustrate and explain Importance of forest ecosystem, biotic and abiotic components and forest management and ecotourism.	1,2
V	**Forest Pathology:** Importance of forest pathology. Principles of forest pathology, causes of forest diseases-Physiological and pathological, general symptoms of forest tree disease, control of forest diseases, plant quarantine.	**7**	Describe, illustrate and explain Principle of forest pathology causes of forest diseases and plant quarantine.	1,2

TEXT BOOKS:

1. Agarwal, W.P. Forests in India. Oxford and I.B.H
2. Arvind Kumar. Biodiversity and environment. A.P.M. Publishing Corporation, New Delhi.
3. Kumar and Asija. Biodiversity – Principles and conservation. Updesh Purohit, Agrobios, Jodhpur

REFERENCE BOOKS:

1. Raghavendra AS. 1991. Physiology of Trees.
2. John Wiley & Sons. Taiz, L. and Zeiger, E. 2007. Plant Physiology 4 th Ed. Sinauer Associates Inc. Publishers, Sunderland.

OTHER LEARNING RESOURCES:
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Articulate the history and basic concept of Forestry.	**1,2,4,6,8**
2	Importance of Dendrology and knowledge of wood forest	**1,2,3,4,8**
3	Understanding of forest types and forest management	**1,2,3,4,6,8**
4	Importance of physiology in forestry	**1,2,4,6,8**
5	Understanding the forest pathology, causes of forest diseases	**1,2,3,4,6,8**

SEMESTER – III									
Course Title	**Co-Curricular Activities**								
Course code	**24UBCC211R**	**Total Credits: 1** **Total Hours: 60**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ III semester of second year of the Programme**								
Course Objectives	1. Develop students' interpersonal skills, emotional intelligence, and teamwork abilities through participation in diverse co-curricular activities. 2. Foster leadership qualities and organizational skills by providing opportunities for students to take on leadership roles and manage events or projects within co-curricular activities.								
CO1	Improve Interpersonal and Teamwork Skills- Students will learn to work well with others and communicate better.								
CO2	Develop Time Management and Organizational Skills - Students will learn to manage their time and stay organized.								
CO3	Boost Creativity and Critical Thinking - Students will enhance their creative abilities and think more critically.								
CO4	Promote Physical and Mental Health - Students will improve their overall health and reduce stress.								
CO5	Encourage Social Responsibility and Civic Engagement - Students will become more aware of their role in society and contribute positively.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Based on the learner's interest they can improving interpersonal and teamwork skills, developing time management and organizational skills, boosting creativity and critical thinking, promoting physical and mental health, and encouraging social responsibility and civic engagement. They will engage in regular club activities, workshops, and competitions that align with their interests and hobbies, fostering their social and emotional development. Renowned professionals will conduct workshops to enhance students' talents. Assessments will include participation in activities, reflection essays, journals, and evaluations of their involvement in workshops and events. Through these experiences, students will learn to work well with others, communicate effectively, manage their time, stay organized, enhance creativity, think critically, improve their health, reduce stress, and contribute positively to society.	**60**	By participating in various sports, music, and co-curricular activities offered through university clubs, students will develop physical and mental agility, leadership, teamwork, and creativity. They will enhance time management, gain practical knowledge through workshops with renowned professionals, and build self-confidence while fostering personal growth. These activities promote cultural awareness, inclusivity, and lifelong learning, encouraging students to pursue their interests, develop new skills, and cultivate passions that extend beyond their academic journey.	1,2

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve Interpersonal and Teamwork Skills- Students will learn to work well with others and communicate better.	**6,7**
2	Develop Time Management and Organizational Skills - Students will learn to manage their time and stay organized.	**6,7**
3	Boost Creativity and Critical Thinking - Students will enhance their creative abilities and think more critically.	**6,7**
4	Promote Physical and Mental Health - Students will improve their overall health and reduce stress.	**6,7**
5	Encourage Social Responsibility and Civic Engagement - Students will become more aware of their role in society and contribute positively.	**5,6,7**

SEMESTER – IV										
Course Title	**Molecular Biology and RDT**									
Course code	**24BSMB221R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**	
Pre-requisite	**Nil**	**Co-requisite**	**Nil**							
Programme	**Bachelor of Science in Microbiology**									
Semester	**Spring/ IV semester of second year of the Programme**									
Course Objectives	1. To teach kea topics like DNA structure, central dogma, modifications in RNA and proteins, DNA repair and recombination. 2. To make students aware of various molecular biology techniques. 3. To make students understand the key topics like cloning, vectors, DNA sequencing, Genome mapping 4. To make students understand the application of RDT									
CO1	Describe the role of DNA as genetic material, its replication and transcription									
CO2	Explore the bacterial Recombination process with understanding their DNA repair mechanisms and applying the basic molecular biology techniques									
CO3	Summarize various restriction enzymes, vectors and their use in RDT									
CO4	Applying the DNA amplification techniques in practical scenarios									
CO5	Describe the various gene transfer techniques and recombinant DNA technology for producing pharmaceutical proteins.									

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Molecular biology an overview: Discovery of DNA as genetic material, Structure of DNA, RNAs and their structure & function, DNA as the carrier of genetic information, Chromosomes, chromatin and function, The Central Dogma. Eukaryotic DNA Replication: Enzymes and proteins involved in DNA replication. Eukaryotic Transcription, post transcriptional modifications Eukaryotic translation, post translational modification	**12**	Describe and explain the DNA structure, replication. Transcription and translation of eukaryotic DNA	1,2
II	Recombination: Homologous (Holliday model) and non-homologous recombination DNA repair: Base excision repair, nucleotide excision repair, Mismatch repair, SOS repair. Basic Molecular Biology Techniques a. Isolation of plasmid DNA, chromosomal DNA b. Agarose gel Electrophoresis c. Southern blot d. Northern blot e. Western blotting	**7**	Describe, illustrate and explain Process of recombination, basic molecular biology techniques for DNA isolation and separation	1,2
III	Overview Gene cloning tools - Restriction enzymes- class I, II and class III restriction enzymes, and their features. Ligases, polymerases, alkaline phosphatases, kinases, transferases and other DNA engineering enzymes. Vectors - Plasmid vectors, bacteriophage, cosmids and phagemids, Expression vectors, shuttle vectors	**7**	Describe, illustrate and explain the different tools for gene cloning and their application	1,2
IV	DNA amplification through PCR: Basic features and applications of PCR, types and modifications.	**8**	Describe, illustrate and explain the principle and process of PCR. DNA	1,2

	DNA sequencing techniques: Maxam – Gilbert's method, Sanger's dideoxy chain termination method, Automated DNA sequencing. Genome Mapping: Concept and applications. Restriction enzymedigestion and restriction mapping. Dot blots and slot blots. RFLP, RAPD, microarray		Sequencing process, Genome mapping and localization of a gene.	
V	Gene transfer: Microinjection, Electroporation, Microprojectile, Shot Gun method, Ultrasonication, Liposome fusion, Microlaser and Agrobacterium mediated gene transfer, Applications of Recombinant DNA technology: Production of recombinant proteins of pharmaceutical importance- insulin, human growth hormone, recombinant Vaccines (hepatitis B) etc. Transgenic plants and animals	**11**	Describe, illustrate and explain the gene transfer mechanism and application of RDT in production of recombinant proteins, transgenic animals and plants.	1,2
Practical	1. Demonstration of PCR 2. Demonstration of centrifuge 3. Demonstration of spectrophotometer 4. Isolation of Plasmid DNA, chromosomal DNA, Eukaryotic DNA, Study of Plasmid Vector 5. Competent cell preparation, Blue and white screening, Restriction digestion, Electrophoresis 6. Replica Plating Technique	**30**	Proficiency in DNA isolation and separation techniques. Transformation technique and screening	1,2,3,4

TEXT BOOKS:

1. Alberts, B., et al. Molecular Biology of the Cell, Garland, 4th ed., 2002
2. Lodish, H., et al. Molecular Cell Biology, WH Freeman, 2003.
3. Essentials of Molecular Biology by David Freifelder, 2009
4. Molecular Biology of gene, James d. Watson, Alexander gann, Tania a. Baker, Michael levine, Stephen p. Bell, Richard losick , Cold spring harbor laboratory press
5. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
6. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2008) Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

REFERENCE BOOKS:

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Basic Methods in Molecular Biology by Davis et al. 2007(Elsevier)
4. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
5. Glick BR and Pasternak JJ. (2003). Molecular Biotechnology. 3rd edition. ASM Press Washington D.C.
6. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.

7. Alcamo IE. (2001). DNA Technology: The Awesome Skill. 2nd edition. Elsevier Academic Press, USA.

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the role of DNA as genetic material, its replication and transcription	**1,3,8**
2	Explore the bacterial Recombination process with understanding their DNA repair mechanisms and applying the basic molecular biology techniques	**1,2,3,4,8**
3	Summarize various restriction enzymes, vectors and their use in RDT	**1,3,6,8**
4	Applying the DNA amplification techniques in practical scenarios	**1,3,4,8**
5	Describe the various gene transfer techniques and recombinant DNA technology for producing pharmaceutical proteins.	**1,2,3,6,8**

SEMESTER – IV									
Course Title	**Biophysical Chemistry**								
Course Code	**24BSMB222R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ IV semester of second year of the Programme**								
Course Objectives	1. Understand pH, buffer systems, and the properties of water, including buffering action and capacity, and the Henderson-Hasselbalch equation. 2. Explore quantum mechanics concepts, including atomic structure, black body radiation, Planck's law, photoelectric effect, and hybridization. 3. Analyze chemical bonding types such as ionic, covalent, hydrogen bonds, peptidyl bonds, and van der Waals forces. 4. Comprehend the principles of thermodynamics, including the laws of thermodynamics and their significance in biological systems, and the concepts of protein folding and cell membrane biophysics.								
CO1	Explain the concepts of pH, buffers and related theories.								
CO2	Explain quantum mechanics and the laws associated with it.								
CO3	Illustrate the different types of bonding in molecular interaction								
CO4	Outline the laws of thermodynamics.								
CO5	Explain the mechanism of protein folding.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	PH & Buffer: Introduction; Bronsted & Lowry theory; Lewis theory; Buffering action; Buffer Capacity; H-H equation; Biological Buffers; Properties of water	**7**	Describe, illustrate and explain pH, buffers and related theories	1,2
II	Quantum mechanics: Atomic structure (Shape of atomic orbital); Black body radiation; Plank's law; Photoelectric effect; Hybridization structure of atom.	**6**	Describe, illustrate and explain quantum mechanics and the laws associated with it.	1,2
III	Chemical bonding: Ionic, Covalent, Hydrogen bond; Peptidyl bond; Vander Waal forces	**5**	Describe and explain the different bonding and forces for interaction of a molecule	1,2
IV	Thermodynamics: First law (concept of internal energy); Second law (free energy, enthalpy, entropy); free energy in biological system, 3rd law; Significance and limitation of the laws.	**7**	Describe, illustrate and explain the laws of thermodynamics	1,2
V	Concepts of protein folding: (Amino acids, hydrophilic & hydrophobic properties); Biophysics of cell membranes.	**5**	Describe, illustrate and explain the mechanism of protein folding	1,2

TEXT BOOKS:

1. Allen J. P. Biophysical chemistry. 1st Edition. Wiley-Blackwell; 2009.

REFERENCE BOOKS:

1. Cantor and Schimmel. Biophysical Chemistry. 1st Ed., W.H. Freeman 6 Co., San Francisco; 1980.
2. Holde, Johnson and Ho. Principles of Physical Biochemistry. 2ndEd.. Pearson Prentice Hall; 2005.
3. S. E. Harding and Chowdhry. Protein-Ligand Interactions: Hydrodynamics and Calorimetry: A Practical Approach. 1st Ed. OUP Oxford; 2000.

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the concepts of pH, buffers and related theories.	**1,2,3,8**
2	Explain quantum mechanics and the laws associated with it.	**1,2,3,8**
3	Illustrate the different types of bonding in molecular interaction	**1,2,3,6,8**
4	Outline the laws of thermodynamics.	**1,2,3,4,6,8**
5	Explain the mechanism of protein folding.	**1,2,3,6,8**

SEMESTER – IV									
Course Title	**Bioinformatics**								
Course Code	**24BSMB223R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ IV semester of second year of the Programme**								
Course Objectives	1. To give basic computer knowledge and their practical application. 2. Knowledge on computational database management system and its application in Biology 3. A basic idea on the structural biology using computer.								
CO1	Explain the basics of computer and its applications in Biology, including data analysis								
CO2	Explain the basis and applications of internet in biology.								
CO3	Inculcate the foundation of database management								
CO4	To impart knowledge on various molecular sequence and structure databases								
CO5	Develop skills in using bioinformatics tools for sequence alignment and analysis.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Computer Fundamentals- History of computers, Generations and Classification of computers, Hardware and Software concepts, Block Diagram of Digital Computer, Limitations and Capabilities of computers, I/O devices, Storage devices, RAM ROM, Memory unit- primary and Auxiliary.	**5**	Describe and explain fundamental of computer and its capabilities and limitation	1,2
II	Introduction to MS office Tools- MS Word- Introduction, starting MS Word, Standard menus–file, edit, view, formatting a text, layouts, inserting a diagram, graph, page numbers, borders, bullet & numbering, spelling and grammar, letter and mailing, mail merge, tables and its applications. MS Excel and MS PowerPoint. Internet and Networking - Introduction, Importance, Network– LAN, MAN, WAN, Electronic Mailing, Chatting, Search Engine, Web Pages, Virus, Antivirus, Malware, Multimedia- Introduction, Applications, Components and its Uses.	**5**	Describe, illustrate and explain use of MS office tools in Biology, networking, multimedia and its uses	1,2
III	Database management system (DBMS) - Introduction to database management system (DBMS) and its different types.	**5**	Describe, illustrate and explain formation of a database and its application in biology	1,2
IV	Introduction to bioinformatics and data generation- What is bioinformatics and its relation with molecular biology. Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, Pubmed, PDB) and visualization software (RASMOL, MMDB viewer, MolMol etc). Applications of Bioinformatics, Pharmaceutical companies and Bioinformatics. Flat file formats. Protein homology modelling, physiochemical property	**7**	Describe, illustrate and explain bioinformatics and its relation with molecular biology and its application	1,2

	calculation, introduction to different literature database			
V	Biological Database and its Types- General Introduction of Biological Databases: Nucleotide sequence databases (NCBI, DDBJ and EMBL). Protein sequence databases (SWISS-PROT, PIR, Gen Pept), Specialized Genome databases: (SGD, TIGR etc.). Structure databases (CATH, SCOP, and PDB, NDB, MMDB), introduction to cheminformatics, immunoinformatics, pharmacoinformatics,	**8**	Describe, illustrate and explain the various biological databases, including nucleotide, protein, genome, and structure databases, and an introduction to cheminformatics, immunoinformatics, and pharmacoinformatics.	1,2
Practical	1. Base sequence analysis of gene/ protein sequence. 2. Computer aided survey of scientific literature. 3. Computer aided visualization of amino acid sequence of protein and its 3D structure. 4. To identify various protein parameters of a protein. 5. To perform nucleotide sequence alignment using BLAST of a given sequence. 6. To perform protein sequence alignment using BLAST of a given sequence. 7. To Perform Homology Modelling of Protein using SWISS-MODEL 8. To Perform Homology Modelling of Unknown Structure of Protein Using Geno 3d. 9. Various analysis of DNA and protein sequences through EMBL, SCF Bio Tool box	**30**	Proficiency in retrieving the information as well as the use of different tools and server for solving different biological problems	1,2,3,4

TEXT BOOKS:

1. Fundamental of Bioinformatics: Harisha S.
2. Instant Notes: Bioinformatics. DR Westhead, JH Parish, RM Twyman. BIOS Scientific Publishers, Oxford, 2002.

REFERENCE BOOKS:

1. Genome Analysis and Bioinformatics: A Practical Approach (English) (Paperback) by T. R. Sharma, I K International Publishing House
2. Bioinformatics: Genes, proteins and computers. C.A. Orengo, D.T. Jones and J.M. Thornton
3. Introduction to Bioinformatics: T.K. Attwood, D.J. Parry-Smith and S. Phukan

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the basics of computer and its applications in Biology, including data analysis	**1,3**
2	Explain the basis and applications of internet in biology.	**1,3**
3	Inculcate the foundation of database management	**3**
4	To impart knowledge on various molecular sequence and structure databases	**1,3**
5	Develop skills in using bioinformatics tools for sequence alignment and analysis.	**1,3,8**

SEMESTER – IV										
Course Title	**Food Microbiology**									
Course Code	**24BSMB224R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**	
Pre-requisite	**Nil**	**Co-requisite**	**Nil**							
Programme	**Bachelor of Science in Microbiology**									
Semester	**Spring/ IV semester of second year of the Programme**									
Course Objectives	1. To teach students the microbial ecology of foods and the ecological factors that affect the presence, survival, growth and death of microorganisms in food. 2. To teach students about the principles of food preservation techniques 3. To teach students about the microbiology of various food and dairy products and the pathogenesis of the food borne and water borne diseases.									
CO1	Understanding the various natural microflora in different foods types and comprehending the fundamental principles of microbial spoilage in food.									
CO2	Remembering the various principles underlying physical and chemical methods of food preservation with the Application of Preservation Technique									
CO3	Determine the basic composition of milk and its nutritional components with the factors influencing the quality of milk and Recognizing sources of contamination in milk and examining the fermentation processes of cheese, butter, and buttermilk.									
CO4	Remembering the various food borne diseases with their causative agents and preventive measures.									
CO5	Analysis the various Detection Methods of water samples and understanding the Membrane Filter Technique and Hands-On Competence.									

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Introduction To Food Microbiology: Natural flora and Sources of contamination of foods in general. Microbial spoilage: principles, intrinsic and extrinsic factors that affect growth and survival of microbes in foods Spoilage of vegetables, fruits, meat, eggs, cereals, canned foods.	**9**	Describe and explain the general microbes present in foods and the factors that support the growth and spoilage of various food products	1,2
II	Principles and methods of food preservation: Principles, physical methods of food preservation: Low temperature, High temperature, Pasteurization, Drying, Canning; Irradiation; Chemical methods of food preservation: salt, sugar, organic acids, SO2 and antibiotics.	**9**	Describe, illustrate and explain the principles and methods of food preservation technique	1,2
III	Role of microbes in milk and dairy products: Composition of milk, Sources, contamination and spoilage of milk and milk products, Various types of microbiological analysis of milk. Fermented dairy products - Fermented Cheese, butter, buttermilk, curd	**9**	Describe, illustrate and explain the composition of milk, the source of contamination of milk and milk products, various microbiological analysis of milk and the fermented dairy products	1,2
IV	Food Borne Diseases- Definition of food poisoning, food infections and toxication. Causative agents, foods involved, symptoms and preventive measures. Food intoxications: *Staphylococcus aureus, Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus, Escherichia coli, Shigella, Listeria monocytogenes, Salmonella, Cholera*	**9**	Describe, illustrate and explain the various types of food borne diseases, their pathogenesis, symptoms, and prevention	1,2

V	Treatment and safety of drinking (potable) water: methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique	**9**	Describe, illustrate and explain the methods to detect portability of water samples.	1,2
Practical	1. MBRT of milk samples and their standard plate count. 2. Isolation of food borne bacteria and fungi from food products. 3. Most Probable Number Analysis 4. Microbiological examination of canned foods. 5. Isolation of spoilage bacteria from fruits and vegetables. 6. Adulterant test: formalin and starch test 7. Effect of temperature on the spoilage of food products. 8. Production of fermented food and their microbial examination	**30**	Proficiency in various tests to determine the quality of milk, water and food products	1, 2, 3, 4

TEXT BOOKS:

1. Frazier W.C. and Westhoff D.C. (2008) Food Microbiology, 4th Edn. Tata McGraw Hill Publishing Co., New Delhi.
2. Bamforth C.W. (2005) Food, Fermentation and Microorganisms, Blackwell Science.

REFERENCE BOOKS:

1. Doyle M.P. and Buchanan R.L. (Ed.) (2013) Food Microbiology: Fundamentals and Frontiers, 4th Edn. ASM press.
2. Jay J.M., Loessner M.J. and Golden D.A. (2005) Modern Food Microbiology, 7th Edn. Springer Publishers.
3. Robinson R.K. (2002) Dairy Microbiology: Milk and Milk Products, 3rd Edn. Wiley Publishers

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understanding the various natural microflora in different foods types and comprehending the fundamental principles of microbial spoilage in food.	**1,2,4,8**
2	Remembering the various principles underlying physical and chemical methods of food preservation with the Application of Preservation Technique	**1,2,3,4,8**
3	Determine the basic composition of milk and its nutritional components with the factors influencing the quality of milk and Recognizing sources of contamination in milk and examining the fermentation processes of cheese, butter, and buttermilk.	**1,2,3,4,8**
4	Remembering the various food borne diseases with their causative agents and preventive measures.	**1,2,3,4,6,8**
5	Analysis the various Detection Methods of water samples and understanding the Membrane Filter Technique and Hands-On Competence.	**1,2,3,4,6,7,8**

SEMESTER – IV									
Course Title	**Microbial Culture Techniques**								
Course code	**24BSMB223R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ IV semester of second year of the Programme**								
Course Objectives	1. Develop proficiency in aseptic techniques for handling microorganisms safely and preventing contamination in microbial cultures. 2. Acquire skills in culturing and isolating diverse microorganisms from natural environments, clinical samples, and industrial sources. 3. Understand the principles of microbial growth kinetics and physiology by monitoring growth parameters such as optical density, colony-forming units, biomass, and metabolic activity using spectrophotometry, viable cell counts, and biochemical assays.								
CO1	Proficient in aseptic techniques to prevent contamination.								
CO2	Ability to prepare diverse culture media for microbial growth.								
CO3	Competence in isolating and identifying microorganisms using various techniques.								
CO4	Understanding of culture maintenance principles and preservation methods.								
CO5	Develop critical analysis skills and troubleshoot common issues in microbial cultures.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Bacterial and Fungal Culture Techniques: Preparation of liquid, semi solid and solid media (plates and slants).	**7**	Proficiency in various microbial culture techniques for bacterial and fungal identification.	1,2, 3, 4, 5
II	Isolation of Pure culture from different sources. (Serial dilution, pour platting, spread platting, streak platting)	**5**		
III	Culturing in basal media, differential media, selective media and enriched media.	**5**		
IV	Interpretation of colony characteristics on different media.	**7**		
V	Evaluation of growth parameters: Temperature, PH, nutrients.	**6**		

TEXT BOOKS:

1. Experiments in microbiology, brand petrology, tissue culture, and microbial biotechnology by KR Aneja, New Age international publication.
2. Benson's Microbiological Applications Laboratory Manual in General Microbiology by Alfred Brown and Auburn University Heidi Smith, McGraw-Hill Education.
3. Handbook of MICROBIOLOGICAL MEDIA, Ronald M. Atlas, ASM press

OTHER LEARNING RESOURCES:

https://microbenotes.com/

https://www.youtube.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Proficient in aseptic techniques to prevent contamination.	**1,2,3,6,8**
2	Ability to prepare diverse culture media for microbial growth.	**1,2,3,4,6,8**
3	Competence in isolating and identifying microorganisms using various techniques.	**1,2,3,6,7,8**
4	Understanding of culture maintenance principles and preservation methods.	**1,2,3,4,6,8**
5	Develop critical analysis skills and troubleshoot common issues in microbial cultures.	**1,2,3,6,8**

SEMESTER – IV									
Course Title	**English for Employability**								
Course code	**24UBPD222R**	**Total credits: 2** **Total hours: 32**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ IV semester of second year of the Programme**								
Course Objectives	1. To develop public speaking skills, including script preparation, understanding nonverbal cues, overcoming fear, and practicing speaking strategies. 2. To provide practical experience in preparing, submitting, and screening resumes and cover letters. 3. To teach email etiquette, including the structure of emails and effective drafting techniques. 4. To prepare students for interviews through practice with commonly asked questions and mock interview sessions. 5. To introduce conflict management, covering its definition, types, and effects.								
CO1	Enable students to prepare scripts, understand nonverbal cues, overcome fear, and practice public speaking strategies.								
CO2	Equip students with skills to prepare, submit, and screen resumes and cover letters.								
CO3	Teach students the different parts of an email and effective email drafting techniques.								
CO4	Prepare students for interviews by practicing commonly asked questions and participating in mock interview sessions.								
CO5	Students will understand the concept of conflict management, identify different types, and analyze its effects.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Public Speaking Skills** i. Preparation of Scripts and understanding Nonverbal cues of Public Speaking ii. Understanding and Overcoming Fear of Public Speaking ii. Practice strategies of Public Speaking	7	Students will be able to create effective speaking scripts, interpret nonverbal cues, manage public speaking anxiety, and practice effective speaking techniques.	3, 4
II	**Practical session on Resume and Cover letter** i. Preparation, submission & screening of Resume. ii. Practical session on cover letter screening session	5	Students will prepare, submit, and evaluate resumes and cover letters.	3
III	Email Etiquettes i. Different Parts of Email and Usage ii. Drafting emails effectively	5	Students will understand the structure of emails and draft them effectively.	2, 3
IV	Interview Skills (Mock sessions) i. Preparing Commonly asked Interview Questions ii. Mock Interview sessions	7	Students will answer common interview questions confidently and perform well in mock interviews.	3, 5
V	**Conflict Management** i. Definition ii. Type of Conflict Management iii. Effects of Conflict Management	8	Students will understand the concept of conflict management, identify different types, and analyse its effects.	2, 4

TEXT BOOKS:

1. Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writingand Speaking, Zephyros Press.
2. Reed, James. 2016. 101 Job Interview Questions You'll Never Fear Again, Plume.
3. Pease, Barbara. 2006. The Definitive Book of Body Language, RHUS.
4. McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition)

REFERENCE BOOKS:

1. Zinsser, William. (2006) On Writing Well: The Classic Guide to Writing Nonfiction Harper Perennial
2. Taylor J. and Wright, J., IELTS Advantage Reading Skills: A step-by-step guide to a high IELTS reading score, Delta Publishing by Klett.
3. Kelley, Thea. 2021. Get That Job: The Quick and Complete Guide to a Winning Interview, Plovercrest Press.
4. Murphy, Raymond,.(2012) English Grammar in Use Book with Answers: A Self- Study and Practice Book for Intermediate Learners of English ,Cambridge University Press

OTHER LEARNING RESOURCES:

https://learning.shine.com/talenteconomy/career-help/top-group-discussionskills

https://www.coursera.org/articles/conflict-management

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Enable students to prepare scripts, understand nonverbal cues, overcome fear, and practice public speaking strategies.	**2,5,8**
2	Equip students with skills to prepare, submit, and screen resumes and cover letters.	**2,5,8**
3	Teach students the different parts of an email and effective email drafting techniques.	**2,5,6,8**
4	Prepare students for interviews by practicing commonly asked questions and participating in mock interview sessions.	**2,5,8**
5	Students will understand the concept of conflict management, identify different types, and analyse its effects.	**2,6,7,8**

SEMESTER – IV										
Course Title	**Basic Acclimatizing Skills (BAS)**									
Course Code	**24UULS201R**	**Total Credits: 1** **Total Hours: 30**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ IV semester of second year of the Programme**								
Course Objectives	1. To impart knowledge of the fundamentals of Hospitality industry and its applications. 2. Students will be able to familiarize with the cooking equipment & Utensils. 3. Students will be able to handle different modes of reservations.								
CO1	Students will have basic knowledge of cooking methods.								
CO2	Students will gain the knowledge of organizing & Cleaning of Rooms.								
CO3	Students will be able to gain the travel management concept.								
CO4	Students will be able to acquire the knowledge of basic household's amenities for day-to-day use.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction to Accommodation Management** • Telephone handling technique • Organizing of Rooms. • Cleaning agents. • Cleaning equipment's and uses. • Bed making Process.	8	Develop the ability to handle telephonic communication, organize rooms, utilize cleaning agents and equipment effectively, and perform bed-making processes.	3, 4
II	**Fundamentals of Cooking** • Definition of cookery –Aim & Objectives of cooking. • Use of basic cooking equipment's • Personal Hygiene and Safety • Use of Fire & Fuels	7	Understand the objectives of cooking, use basic cooking equipment, and maintain personal hygiene and safety in the kitchen.	3
III	**Methods of Cooking** • Different Cuts. • Use of Herbs and Spices. • Basic Food and Beverage Preparation. • Regional food Habits.	7	Acquire knowledge of food preparation techniques, different cuts, herbs and spices, and regional food habits.	2, 3
IV	**Forms & Format's** • C –form • Reservation form • Registration form • Passport Application form • Legal Rent Agreement	8	Gain proficiency in completing and understanding essential forms such as reservation forms, registration forms, C-forms, and legal documents like rent agreements and passport applications.	3, 5

TEXT BOOKS:

1. Arora K (2011). Theory of cookery, Frank brothers & company (pub) pvt ltd-New Delhi.
2. Bruce H. Axler, Carol A. Litrides (2010) Food and Beverage Service Volume 1 of Wiley Professional Restauranteur, Guides.
3. Mohammed Zulfikar (2010) - Introductions to Tourism and Hotel Industry Introduction to Tourism and Hotel Industry. Vikas Publishing.

4. Sudhir Andrews (2013) Food and Beverage Service: A Training Manual, Tata McGraw Hill, 2013.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

S.N.	Course Outcome (CO)	Mapped Program Outcome
1	Students will have basic knowledge of cooking methods.	**1,3,4,8**
2	Students will gain the knowledge of organizing & Cleaning of Rooms.	**3,4,6,7**
3	Students will be able to gain the travel management concept.	**2,4,6,7**
4	Students will be able to acquire the knowledge of basic household's amenities for day-to-day use.	**1,3,4,8**

SEMESTER – IV									
Course Title	**Basic Digital Literacy**								
Course code	**24UUDL101R**	**Total credits: 1** **Total hours: 30**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ IV semester of second year of the Programme**								
Course Objectives	1. Students will be able to identify and analyses computer hardware, software and their uses. 2. Students will be able to use MS-Office suite for various purposes. 3. Students will be able to use the Internet efficiently for required information as well as for digital financial transactions.								
CO1	Students will have basic understanding of Computer Hardware, Software and Computer handling.								
CO2	Students will be able to solve basic information management issues using MS-Office Products.								
CO3	Students will be able to efficiently search the Internet for required information.								
CO4	Students will be able to use computing technically ethically, safely, securely and legally for day-to-day use.								
CO5	Students will gain knowledge of digital payment system and acquire practical skills in creating accounts and using various payment methods								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Fundamentals of Computer Systems** i. Components of a Computer and their functions. ii. Different Types of Computers and their Applications.	7	Students will understand the components and functions of computers and explore different types of computers and their applications.	3, 4
II	**Introduction to MS-Office** i. Components of the MS-Office suite. ii. Creating documents with MS-Word. iii. Creating Presentations with MS-PowerPoint. iv. Creating Spreadsheets with MS-Excel.	5	Students will learn to use MS-Office tools, including MS-Word, MS-PowerPoint, and MS-Excel, to create documents, presentations, and spreadsheets.	3
III	**Introduction to Internet & Cyber World** i. Introduction to Computer Networks and Internet. ii. World Wide Web, Websites and Web portals, Web browsing. ii. Web Searching, Search engines, Introduction to Google Search Engine; How to search using Keywords, topics of Interest, etc. iii. Creation and use of Email Accounts. iv. Cyber Crimes.	5	Students will acquire knowledge about computer networks, the internet, web browsing, search engines, and email creation, while understanding cybercrimes.	2, 3
IV	**Introduction to Social Media** i. The Power of social media, Relevance of social media in present scenario. ii. Creating accounts and using some popular social media portals and Apps like	7	Students will explore the power and relevance of social media, create accounts on popular social media platforms, and learn proper social media	3, 5

	WhatsApp, Facebook, Twitter, Instagram, LinkedIn. iii. Social Media Etiquettes.		etiquette.	
V	**Digital Payments** i. Introduction to Digital Payment Systems. ii. Creating accounts and using Digital Payment Systems like Credit Cards, Debit Cards, Net banking, UPI.	6	Students will gain the ability to use digital payment systems like credit cards, debit cards, net banking, and UPI by creating and managing accounts.	2, 3

TEXT BOOKS:

1. Sinha Pradeep K. and Priti Sinha.*Computer Fundamentals: Concepts Systems & Applications*. 3rd ed. New Delhi: BPB Publications.
2. Goel, A, 2010. Computer Fundamentals, Pearson India.

REFERENCE BOOKS:

1. Balaguruswamy, E. 2009 Fundamentals of Computers, Tata McGraw-Hill Education.
2. Balaguruswamy, 2014. E. Fund Of Comp & Programming (Updated Ed Sem. I, Au) Tata McGraw-Hill Education.
3. Lawson, C. 2022. Introduction to Social Media, Oklahoma State University.

OTHER LEARNING RESOURCES:

1. https://www.w3schools.com
2. https://edu.gcfglobal.org
3. https://www.tutorialspoint.com
4. https://www.javatpoint.com/
5. Latest updates available in WWW.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will have basic understanding of Computer Hardware, Software and Computer handling.	**3,8**
2	Students will be able to solve basic information management issues using MS-Office Products.	**2,3**
3	Students will be able to efficiently search the Internet for required information.	**2,3,7,8**
4	Students will be able to use computing technically ethically, safely, securely and legally for day-to-day use.	**2,3,8**
5	Students will gain knowledge of digital payment system and acquire practical skills in creating accounts and using various payment methods	**2,3,6,8**

SEMESTER – IV									
Course Title	**Forensic Biology**								
Course code	**24FSFS401R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ IV semester of second year of the Programme**								
Course Objectives	1. Understand the significance and relevance of biological evidence in criminal investigations. 2. Understand the importance of DNA profiling in forensic identification and its limitations. 3. Learn methods for the detection and analysis of bloodstains, including presumptive and confirmatory tests.								
CO1	Acquire a foundational understanding of forensic biology.								
CO2	Learn the principles and techniques of DNA analysis.								
CO3	Explore the analysis of bodily fluids, with a focus on bloodstain pattern analysis and the identification of blood group antigens.								
CO4	Investigate the role of entomology and anthropology in forensic investigations.								
CO5	Understand the protocols and procedures involved in collecting, preserving, and analyzing biological evidence from crime scenes.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to Forensic Biology:** Overview of forensic biology: scope, applications, and historical development, legal aspects and ethical considerations in forensic biology	6	Understand basics of forensic biology	1,2
II	**Principles and Techniques of DNA Analysis**: DNA structure and function relevant to forensic applications, Techniques in DNA extraction, quantification, amplification (PCR), and analysis	6	Explain the principle of DNA profiling using PCR	1,2
III	**Analysis of Bodily Fluids**: Identification and characterization of bodily fluids (blood, semen, saliva), bloodstain pattern analysis: principles, methods, and interpretation	8	Explain the mechanism of detection and interpretation of bodily fluids	1,2
IV	**Blood Group Antigens and Serology:** Blood group systems and their forensic significance, techniques for blood group antigen testing and serological analysis	8	Describe techniques for blood group detection.	1,2
V	**Role of Anthropology in Forensic Investigations**: Forensic anthropology: identification of human remains and biological profiling, methods in skeletal analysis and age estimation, Crime scene protocols for biological evidence collection and preservation	8	Discuss forensic anthropology	1,2

REFERENCE BOOKS:

R1. Schober, Li, Norman; Forensic Biology; 2nd Ed.; Taylor & Francis Ltd; 2021.

R2. Mia; Sharma; Singal. Handbook of Forensic Biology & Forensic Serology; 1st Ed.; Selective & Scientific Books, 2022.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/33809459/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Acquire a foundational understanding of forensic biology.	**1,5,8**
2	Learn the principles and techniques of DNA analysis.	**1,2,3,6**
3	Explore the analysis of bodily fluids, with a focus on bloodstain pattern analysis and the identification of blood group antigens.	**1,2,3,4**
4	Investigate the role of entomology and anthropology in forensic investigations.	**1,2,4,8**
5	Understand the protocols and procedures involved in collecting, preserving, and analysing biological evidence from crime scenes.	**1,2,3,4,8**

SEMESTER – IV									
Course Title	**Basics of Food Science**								
Course code	**24FSFN401R**	**Total Credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ IV semester of second year of the Programme**								
Course Objectives	1. Acquire a foundational understanding of the basic components of food. 2. Learn the fundamental principles of food processing techniques. 3. Explore the chemical reactions that occur during food processing and storage.								
CO1	Acquire a foundational understanding of the basic components of food.								
CO2	Learn the fundamental principles of food processing techniques.								
CO3	Explore the chemical reactions that occur during food processing and storage.								
CO4	Examine the basics of food microbiology.								
CO5	Gain insights into sensory evaluation techniques used to assess the taste, aroma, texture, and appearance of food products.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction to Food Science**: Overview of food science and its importance, basic components of food: carbohydrates, proteins, lipids, vitamins, minerals, water.	6	Learn basics of food science	1,2
II	**Food Processing Techniques**: principles and methods of food preservation (e.g., heat processing, drying, freezing), techniques for food packaging and storage	6	Understand basic food processing techniques	1,2
III	**Chemical Reactions in Food Processing and Storage**: Chemical changes during cooking, baking, fermentation, and aging, factors influencing chemical reactions: pH, temperature, enzymes	8	Explain chemical changes during food processing and storage	1,2
IV	**Food Microbiology**: Introduction to foodborne pathogens and spoilage organisms, microbial growth kinetics and factors affecting microbial growth in foods	8	Understand microbial changes during fermentation	1,2
V	**Sensory Evaluation of Food:** principles of sensory evaluation: taste, aroma, texture, appearance, methods and techniques for sensory evaluation	8	Explain the principle of sensory evaluation of food for quality assessment.	1,2

REFERENCE BOOKS:

R1. Miriah Pace and Rick Parker. Introduction to Food Science and Food Systems. 2nd Ed., Delmar Cengage Learning; 2016.

R2. Srilakshmi. Food Science. 7th Ed., New Age International Publishers; 2018.

R3. Potter. Food Science; 5th Ed., CBS Publishers & Distributors Pvt Ltd, India; 2007.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/33254009/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Acquire a foundational understanding of the basic components of food.	**1,4,8**
2	Learn the fundamental principles of food processing techniques.	**1,2,3,8**
3	Explore the chemical reactions that occur during food processing and storage.	**1,2,3,4,8**
4	Examine the basics of food microbiology.	**1,2,3,4,6**
5	Gain insights into sensory evaluation techniques used to assess the taste, aroma, texture, and appearance of food products.	**1,3,5**

SEMESTER – IV									
Course Title	**Extra-Curricular Activities**								
Course code	**24UBEC221R**	**Total Credits: 1** **Total Hours: 60**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ IV semester of second year of the Programme**								
Course Objectives	1. To ascertain physical and mental development of the students and select best performers for state, national and international level competition. 2. To enhance and improve student's talents in the field of sports, yoga, music, dance, drama, etc. through AdtU club activities and workshops.								
CO1	Enhance Leadership Skills-Students will develop leadership abilities through various activities.								
CO2	Improve Social Interaction-Students will learn to interact and build relationships with others.								
CO3	Develop Personal Interests and Hobbies- Students will explore and develop their personal interests and hobbies.								
CO4	Strengthen Problem-Solving Skills- Students will improve their ability to solve problems creatively and effectively.								
CO5	Foster Cultural Awareness- Students will gain a better understanding and appreciation of different cultures.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Based on the learner's interest they can participate in various sports, music, and co-curricular activities joining the clubs of the University (Football, Futsal; Cricket; Swimming; Basketball; Badminton; Table Tennis; athletics and other outdoor and indoor games; Dance; Music; Vocals; Photography; Drama; Literary activities); The students are encouraged to participate in regular club activities, workshops, competitions as per their interest and hobbies; Renowned skilled professionals/ personalities are invited organising workshops to promote the talents of the students.	**60**	By participating in various sports, music, and co-curricular activities offered through university clubs, students will develop physical and mental agility, leadership, teamwork, and creativity. They will enhance time management, gain practical knowledge through workshops with renowned professionals, and build self-confidence while fostering personal growth. These activities promote cultural awareness, inclusivity, and lifelong learning, encouraging students to pursue their interests, develop new skills, and cultivate passions that extend beyond their academic journey.	1,2

REFERENCE BOOKS:

R1: "Extracurricular Activities: Essential Guides for Students" by John G. Gabriel

R2: "Developing Personal, Social and Emotional Skills through Extra-Curricular Activities" by Sally Bailey

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Enhance Leadership Skills-Students will develop leadership abilities through various activities.	**6,7**
2	Improve Social Interaction-Students will learn to interact and build relationships with others.	**6,7**
3	Develop Personal Interests and Hobbies- Students will explore and develop their personal interests and hobbies.	**6,7**
4	Strengthen Problem-Solving Skills- Students will improve their ability to solve problems creatively and effectively.	**6,7**
5	Foster Cultural Awareness- Students will gain a better understanding and appreciation of different cultures.	**5,6,7**

SEMESTER – V									
Course Title	**Medical Bacteriology and Virology**								
Course code	**24BSMB311R**	**Total credits: 5**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+60P	**3**	**0**	**4**	**0**	**0**	**0**	**5**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ V semester of third year of the Programme**								
Course Objectives	1. To familiarize the students about the different diseases caused by bacteria & viruses and prevention and control measures of the diseases 2. To teach different diagnostic tests to identify the causative organisms								
CO1	Describe the types and characteristics of normal and transient flora of human body.								
CO2	Compare different virulence factors of viral and bacterial pathogens and their role in pathogenesis.								
CO3	Explain Common Bacterial Pathogens and Strategies for Prevention and Control								
CO4	Apply different staining and biochemical test for diagnosis of bacterial disease.								
CO5	Explain Viral Pathogens and Effective Disease Management Strategies.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Beneficial Microbial Interactions with Human: Normal microbial population - Skin, mouth, upper respiratory tract, intestinal tract, urino-genital tract, eye.	**6**	Describe and explain the normal microbial inhabitants of human body	1,2
II	Harmful Microbial Interactions with Human: Definitions of Pathogen Infection, Invasion, Endemic, Pandemic and Epidemic. Virulence and Virulence factors, Entry of pathogens into the host and mechanism of bacterial pathogenicity, exotoxins, enterotoxins, endotoxins, neurotoxins, Carriers and their types, Opportunistic infections, Nosocomial infections, Transmission of infections, Sepsis and septic shock., types of bacterial pathogens	**6**	Describe, illustrate and explain the microbial virulence factors and pathogenicity	1,2
III	Human diseases caused by bacterial pathogens- List of diseases of various organ systems and their causative agents, symptoms, mode of transmission, pathogenicity, prophylaxis and control of the following diseases. *Staphylococcus aureus Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis, Escherichia coli, Salmonella, Vibrio cholerae, Helicobacter pylori, Bacillus anthracis, Clostridium, Treponema pallidum*	**14**	Describe, illustrate and explain the different bacterial diseases, their causative organisms, mode of transmission, pathogenesis, prophylaxis.	1,2
IV	Staining techniques and biochemical test used in diagnosis of pathogens – Staining techniques: Endospore, cell wall, flagella, metachromatic granules, hanging drop. Biochemical tests: IMViC, Catalase, Coagulase, Oxidase, TSI, fermentation of carbohydrates, starch hydrolysis, urease, gelatine liquefaction, Use of selective media for specific bacteria	**9**	Describe, illustrate and explain the principle and process of different diagnostic tests for identification of a bacterial pathogen	1,2

V	Basic Virology: – General properties, Morphology, Epidemiology, pathogenesis-pathology- diagnostics procedure - clinical manifestation - prevention and control measures of- HIV, Pox virus, Influenza virus, Rabies virus, Polio Virus, Hepatitis Virus, Mumps, Measles, Rubella, Arbovirus	**10**	Describe, illustrate and explain the different viral diseases, their causative organisms, mode of transmission, pathogenesis, prophylaxis.	1,2
Practical	1. Study of normal micro-biota of mouth; isolation, identification and preservation of microorganisms 2. Study of normal micro-biota of skin; isolation identification and preservation of microorganisms 3. Staining – Capsular staining by negative staining, endospore staining, metachromatic granules, motility, fungal staining 4. Biochemical tests: IMViC, Catalase, Coagulase, Oxidase, TSI, fermentation of carbohydrates, starch hydrolysis, urease, gelatine liquefaction 5. Use of selective media for specific bacteria 6. Antibiotic Sensitivity test 7. Methods of isolation and identification of fungi from Human Body: Staining methods- KOH and LPCB.	**60**	Proficiency in various diagnostic tests for bacterial and fungal identification.	1,2,3,4

TEXT BOOKS:

1. Medical Microbiology by David Green Wood Richard slack & John Peuthrer. Churchill Livingston Company.
2. Medical Microbiology by Jawelz, Melnick, Geo R.Brokes Me Graw-Hill Company.
3. Medical Microbiology by Anantanarayan & Panekar, Orient Longman Limited.
4. Textbook Virology by Rhodes & Van Royen
5. Practical Microbiology by C.P. Baweja

REFERENCE BOOKS:

1. Bacterial Diseases by Wilson &Topley. Medical Microbiology by Cruckshank- Vol.I &Vol.II.
2. General Virology by Luria & Parnel Virology by Dimmock.

OTHER LEARNING RESOURCES:

https://microbenotes.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the types and characteristics of normal and transient flora of human body.	**1,2,8**
2	Compare different virulence factors of viral and bacterial pathogens and their role in pathogenesis.	**1,2,8**
3	Explain Common Bacterial Pathogens and Strategies for Prevention and Control	**1,2,4,8**
4	Apply different staining and biochemical test for diagnosis of bacterial disease.	**1,3,5,8**
5	Explain Viral Pathogens and Effective Disease Management Strategies.	**1,2,6,8**

SEMESTER – V									
Course Title	**Medical Mycology and Parasitology**								
Course code	**24BSMB312R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ V semester of third year of the Programme**								
Course Objectives	1. To familiarize the students about the Morphology and taxonomy of fungi and the parasites. 2. To familiarize students about different diseases caused by fungi and parasites 3. To familiarize about the prevention and control measures of the diseases caused by fungi and parasites								
CO1	Comprehend the basic concepts of medically significant fungi and its application in detecting and recovering fungi from clinical samples.								
CO2	Enhance the knowledge of superficial, subcutaneous, cutaneous, systemic, and opportunistic infections with respect to etiology, pathogenesis, clinical manifestations, laboratory diagnosis, treatment, and preventive measures.								
CO3	Build foundation of the structures and the pathogenicity associated with various mycotoxins								
CO4	Acquire proficiency in the classification, morphology, pathogenicity, and laboratory diagnosis of prevalent protozoan diseases								
CO5	Developing skills in diagnosing in parasitic metazoan diseases through laboratory techniques and methods								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	General Introduction: Morphology and taxonomy of fungi of medical importance. Detection and recovery of fungi from clinical specimens. Yeasts of medical importance, dimorphic fungi	**10**	Describe and explain the morphology and taxonomy of medically important fungi and the diagnostic procedure from the clinical specimens.	1,2
II	Mycoses – superficial, sub cutaneous, cutaneous, systemic and opportunistic– etiology, pathogenesis, clinical manifestation, lab diagnosis, treatment, prevention	**15**	Describe, illustrate and explain the pathogenesis, clinical manifestation, lab diagnosis, treatment and prevention of superficial, sub cutaneous, cutaneous, systemic, opportunistic mycoses	1,2
III	Fungal toxins- mycotoxins- structure, types and its pathogenicity	**5**	Describe, illustrate and explain the types of fungal toxins and disease	1,2
IV	Classification, Morphology, Pathogenicity, lab diagnosis of common protozoan diseases-Amoebiasis, Giardiasis, Trypanosomiasis, Malaria, Toxoplasmosis, Leishmaniasis. Classification Morphology, Pathogenicity	**10**	Describe, illustrate and explain the types of parasites host, source of infection, mode of infection, lab diagnosis and the morphology, pathogenesis and lab diagnosis of Protozoa, Flagelletes, Sporozoa	1,2
V	Laboratory diagnosis of common parasitic metazoan diseases– Ascariasis, Hook worm, Filariasis, Taenia infection	**5**	Describe, illustrate and explain the morphology, pathogenesis and lab diagnosis of Ascaris, Hookworm, Filariasis, Taenia infection	1,2

Practical	1. Microscopic Examination of filamentous fungi and yeast 2. Staining- lactophenol cotton blue staining, gram's staining 3. KOH mount, skin scrapping, cultivation 4. Preparation of Sabouraud's medium with and without antibiotics 5. Identification, sensitivity tests for antifungal agents 6. Leishman Staining and Giemsa Staining	**30**	Proficiency in various diagnostic tests for fungal and parasitic identification	1,2,3,4

TEXT BOOKS:

1. Medical Microbiology by Anantanarayan & Panikar Orient Longman Limited.
2. Medical Parasitology by Arora and Arora, CBS Publishers & Distributors.

REFERENCE BOOKS:

1. Medical Microbiology by David Green Wood Richard slack & John Peuthrer. Churchill Livingston Company.
2. Parasitology by K.P.Chattergy Medical Microbiology by Jawelz, Melnick, Geo R.Brokes Me Graw-Hill Company.
3. Medical Mycology by Jagedeese Chander
4. Medical Microbiology by Jawetz

OTHER LEARNING RESOURCES:

www.youtube.com
https://www.microrao.com/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Comprehend the basic concepts of medically significant fungi and its application in detecting and recovering fungi from clinical samples.	**1,2,3,6,8**
2	Enhance the knowledge of superficial, subcutaneous, cutaneous, systemic, and opportunistic infections with respect to Etiology, pathogenesis, clinical manifestations, laboratory diagnosis, treatment, and preventive measures.	**1,2,3,4,6,8**
3	Build foundation of the structures and the pathogenicity associated with various mycotoxins	**1,2,3,6,8**
4	Acquire proficiency in the classification, morphology, pathogenicity, and laboratory diagnosis of prevalent protozoan diseases	**1,2,3,6,8**
5	Developing skills in diagnosing in parasitic metazoan diseases through laboratory techniques and methods	**1,2,3,4,6,8**

SEMESTER – V									
Course Title	**Bio fertilizer Production**								
Course Code	**24BSMB314R**	**Total Credits: 1** **Total Hours:30**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ V semester of third year of the Programme**								
Course Objectives	On successful completion of the course, the students will be able to Familiarize with the basic principle and techniques of Bio farming								
CO1	Demonstrate proficiency in the isolation techniques for N2-fixing bacteria from various environmental samples, including soil and plant root nodules								
CO2	Apply molecular and biochemical methods for the accurate identification and classification of N2-fixing bacteria.								
CO3	Utilize selective media and culture techniques to isolate phosphate stabilizing bacteria from diverse soil and rhizospheric samples.								
CO4	Apply molecular and morphological methods for the accurate identification and classification of AMF species.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Isolation, identification and analysis of the potentialities of N2 fixing bacteria, Isolation, identification and analysis of the potentialities of phosphate stabilizing bacteria, Isolation, identification and assess the potentialities of Arbuscular mycorrhizas fungi of rhizospheric soil	30	Students will be able to understand the process of biofertilizer production using microorganisms	1,2,3,4

REFERENCE BOOKS:

R1. Kannaiyan, S. 2002 Biotechnology of Biofertilizers. Narosa publishing house, New Delhi. Dubey, R.C. 2001.

R2. P. S. Bisen. Fontiers in microbial technology. 1st edition. C.B.S. Publishers and Distributors; 1994

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9227430/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Demonstrate proficiency in the isolation techniques for N2-fixing bacteria from various environmental samples, including soil and plant root nodules	**1,2,3,4,8**
2	Apply molecular and biochemical methods for the accurate identification and classification of N2-fixing bacteria.	**1,2,3,4,8**
3	Utilize selective media and culture techniques to isolate phosphate stabilizing bacteria from diverse soil and rhizospheric samples.	**1,2,3,4,8**
4	Apply molecular and morphological methods for the accurate identification and classification of AMF species.	**1,2,3,4,8**

SEMESTER – V									
Course Title	**Wild Life Conservation and Management**								
Course code	**24FSZO501R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ V semester of third year of the Programme**								
Course Objectives	1. To understand the ecological principles that form the basis of wildlife conservation. 2. To learn various techniques for assessing and monitoring wildlife biodiversity. 3. To comprehend the significance of genetics in the conservation of wildlife species. 4. To develop strategies for resolving conflicts between human activities and wildlife conservation. 5. To gain knowledge of the legal and policy frameworks governing wildlife conservation.								
CO1	Explain ecological principles that underpin wildlife conservation efforts.								
CO2	Describe the techniques for assessing and monitoring wildlife biodiversity.								
CO3	Describe the role of genetics in wildlife conservation.								
CO4	Explain the strategies for mitigating conflicts between human activities and wildlife conservation goals.								
CO5	Describe the legal and policy frameworks that govern wildlife conservation								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Ecological Principles in Wildlife Conservation:** Introduction to ecological principles, ecosystem functions, species interactions, population dynamics, habitat requirements, and landscape ecology.	**10**	Understanding the fundamental ecological principles that support wildlife conservation.	1,2
II	**Techniques for Assessing and Monitoring Wildlife Biodiversity:** Survey methods, population estimation techniques, biodiversity indices, remote sensing, and GIS in wildlife monitoring.	**8**	Ability to describe and apply various techniques for biodiversity assessment and monitoring.	1,2
III	**Role of Genetics in Wildlife Conservation:** Genetic diversity, population genetics, conservation genetics, genetic drift, gene flow, inbreeding depression, and genetic management of small populations.	**10**	Understanding the role and importance of genetics in wildlife conservation.	1,2
IV	**Mitigating Conflicts Between Human Activities and Wildlife Conservation:** Human-wildlife conflict causes and impacts, conflict resolution strategies, community-based conservation, and sustainable development practices.	**10**	Ability to develop and explain strategies to mitigate conflicts between human activities and wildlife conservation.	1,2
V	**Legal and Policy Frameworks in Wildlife Conservation:** International conventions and agreements,	**7**	Knowledge of the legal and policy frameworks that govern wildlife conservation.	1,2

	national wildlife laws, protected area management policies, wildlife trade regulations, and enforcement mechanisms.			

TEXT BOOKS:

1. "Principles of Conservation Biology" by Martha J. Groom, Gary K. Meffe, and C. Ronald Carroll.
2. Conservation Biology: Foundations, Concepts, Applications" by Fred Van Dyke and Rachel L. Lamb
3. "Essentials of Conservation Biology" by Richard B. Primack

REFERENCE BOOKS:

1. "Wildlife Ecology, Conservation, and Management" by John M. Fryxell, Anthony R. E. Sinclair, and Graeme Caughley.
2. "Fundamentals of Conservation Biology" by Malcolm L. Hunter Jr. and James P. Gibbs.
3. "Conservation Genetics: Case Histories from Nature" by John C. Avise and John L. Hamrick.

OTHER LEARNING RESOURCES:

Coursera, YouTube

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain ecological principles that underpin wildlife conservation efforts.	**1,2,3**
2	Describe the techniques for assessing and monitoring wildlife biodiversity.	**1,2,3**
3	Describe the role of genetics in wildlife conservation.	**1,2,3**
4	Explain the strategies for mitigating conflicts between human activities and wildlife conservation goals.	**1,2,3**
5	Describe the legal and policy frameworks that govern wildlife conservation	**1,2,3**

SEMESTER – V									
Course Title	**Toxicology**								
Course Code	**24FSFS501R**	**Total Credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ V semester of third year of the Programme**								
Course Objectives	1. Explore the fundamental principles of toxicology, including the absorption, distribution, metabolism, and excretion (ADME) of toxic substances in living organisms. 2. Acquire proficiency in analytical techniques used for the detection, quantification, and characterization of toxic substances in biological, environmental, and occupational samples.								
CO1	Explain the foundation of toxicological principles.								
CO2	Classify different types of toxicants.								
CO3	Assess the risk associated with exposure to toxic substances.								
CO4	Explain the mechanism of absorption, distribution, metabolism, and excretion of toxic substances within the body.								
CO5	Utilize toxicological knowledge to assess and manage risks in environmental and occupational settings.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to Toxicology:** • Definition and scope of toxicology, • History and development of toxicological principles, • Relationship between dose and response	**10**	Explain the foundational principles of toxicology, including the history and development of the field, the definition and scope of toxicology, and the relationship between dose and response.	1,2
II	**Classification of Toxicants** • Types of toxicants: Chemical, biological, and physical • Sources and exposure routes of toxicants • Toxicokinetics and toxicodynamics	**8**	Classify different types of toxicants, understand their sources and routes of exposure, and describe the principles of toxic kinetics and toxic dynamics.	1,2
III	**Risk Assessment and Management** • Principles of risk assessment • Hazard identification and characterization • Dose-response assessment • Exposure assessment • Risk characterization and management	**10**	Assess the risk associated with exposure to toxic substances by applying principles of risk assessment, including hazard identification, dose-response assessment, exposure assessment, and risk characterization and management.	1,2

IV	**Mechanisms of Toxicity** • Absorption of toxic substances • Distribution of toxic substances • Metabolism of toxic substances • Excretion of toxic substances • Biotransformation and bioaccumulation	**10**	Explain the mechanisms of absorption, distribution, metabolism, and excretion of toxic substances within the body, including the processes of biotransformation and bioaccumulation.	1,2
V	**Toxicology in Environmental and Occupational Settings** • Environmental toxicology: Impact on ecosystems and human health • Occupational toxicology: Workplace exposure and safety • Regulatory aspects and safety guidelines	**7**	Utilize toxicological knowledge to assess and manage risks in environmental and occupational settings, understand the impact of toxicants on ecosystems and human health	1,2

TEXT BOOKS:

1. "Casarett & Doull's Essentials of Toxicology" by Curtis Klaassen and John B. Watkins.
2. "A Textbook of Modern Toxicology" by Ernest Hodgson

REFERENCE BOOKS:

1. "Patty's Toxicology" edited by Eula Bingham, Barbara Cohrssen, and Charles H. Powell
2. "Molecular, Clinical and Environmental Toxicology" edited by Andreas Luch
3. "Toxicology: The Basic Science of Poisons" by Curtis D. Klaassen

OTHER LEARNING RESOURCES:

Coursera, YouTube

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the foundation of toxicological principles.	**1,2,3**
2	Classify different types of toxicants.	**1,2,3**
3	Assess the risk associated with exposure to toxic substances.	**1,2,3**
4	Explain the mechanism of absorption, distribution, metabolism, and excretion of toxic substances within the body.	**1,2,3**
5	Utilize toxicological knowledge to assess and manage risks in environmental and occupational settings.	**1,2,3**

SEMESTER – V									
Course Title	**Research I (Review of literature)**								
Course Code	**24BSMB316R**	**Total Credits: 2** **Total Hours: 60**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**0**	**12**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ V semester of third year of the Programme**								
Course Objectives	1. Apply experimental methods to solve a given scientific task, collect data for evaluation and for statistical treatment, if relevant, 2. Use relevant scientific literature.								
CO1	Learn to tabulate research data								
CO2	Analyze research outcome								
CO3	Correlate with existing literature								
CO4	Prepare and effective dissertation report								
CO5	Able to communicate research outcome								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction, Comprehension on research search engines, Selection of Topic	**30**	Gain and understanding research search engine and methods for selecting a research topic effectively	1,2,3
II	Tools for reference citation, Different methods for writing citation and references, Introduction to structure of Review and specific features of review, Plagiarism, ethnical issue in writing the review, Mapping and selection of Journal of specific knowledge of discipline and submission for publications.	**30**	Understand the essential structure and unique characteristics of a research review and develop awareness of plagiarism and ethical practices in scholarly writing	1,2,3

REFERENCE BOOKS:

R1. "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" by John W. Creswell and J. David Creswell

R2. "The Craft of Research" by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams

R3. Research Methodology: Methods and Techniques" by C.R. Kothari

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6153617/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn to tabulate research data	**1,2,3,4,8**
2	Analyse research outcome	**1,2,3,4,8**
3	Correlate with existing literature	**1,2,3,4,8**
4	Prepare and effective dissertation report	**1,2,3,4,8**
5	Able to communicate research outcome	**1,2,3,4,8**

SEMESTER – V									
Course Title	**Extra-Curricular Activities**								
Course code	**24UBEC311R**	**Total Credits: 1** **Total Hours: 60**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ V semester of third year of the Programme**								
Course Objectives	1. To ascertain physical and mental development of the students and select best performers for state, national and international level competition. 2. To enhance and improve student's talents in the field of sports, yoga, music, dance, drama, etc. through AdtU club activities and workshops.								
CO1	Enhance Leadership Skills-Students will develop leadership abilities through various activities.								
CO2	Improve Social Interaction-Students will learn to interact and build relationships with others.								
CO3	Develop Personal Interests and Hobbies- Students will explore and develop their personal interests and hobbies.								
CO4	Strengthen Problem-Solving Skills- Students will improve their ability to solve problems creatively and effectively.								
CO5	Foster Cultural Awareness- Students will gain a better understanding and appreciation of different cultures.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Based on the learner's interest they can participate in various sports, music, and co-curricular activities joining the clubs of the University (Football, Futsal; Cricket; Swimming; Basketball; Badminton; Table Tennis; athletics and other outdoor and indoor games; Dance; Music; Vocals; Photography; Drama; Literary activities); The students are encouraged to participate in regular club activities, workshops, competitions as per their interest and hobbies; Renowned skilled professionals/ personalities are invited organising workshops to promote the talents of the students.	**60**	By participating in various sports, music, and co-curricular activities offered through university clubs, students will develop physical and mental agility, leadership, teamwork, and creativity. They will enhance time management, gain practical knowledge through work-shops with renowned professionals, and build self-confidence while fostering personal growth. These activities promote cultural awareness, inclusivity, and lifelong learning, encouraging students to pursue their interests, develop new skills, and cultivate passions that extend beyond their academic journey.	1,2

REFERENCE BOOKS:

R1: "Extracurricular Activities: Essential Guides for Students" by John G. Gabriel

R2: "Developing Personal, Social and Emotional Skills through Extra-Curricular Activities" by Sally Bailey

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Enhance Leadership Skills-Students will develop leadership abilities through various activities.	**6,7**
2	Improve Social Interaction-Students will learn to interact and build relationships with others.	**6,7**
3	Develop Personal Interests and Hobbies- Students will explore and develop their personal interests and hobbies.	**6,7**
4	Strengthen Problem-Solving Skills- Students will improve their ability to solve problems creatively and effectively.	**6,7**
5	Foster Cultural Awareness- Students will gain a better understanding and appreciation of different cultures.	**5,6,7**

SEMESTER – VI									
Course Title	**Fermentation Technology**								
Course code	**24BSMB321R**	**Total Credits: 4** **Total Hours: 45T+30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ VI semester of third year of the Programme**								
Course Objectives	1. The objective of this paper is to familiarize the students with the concept of fermentation processes & the use of different microorganisms in industries. 2. To teach the students about the different industrial products produced by microorganisms.								
CO1	Understand bioreactors and their various types, enabling them to apply this knowledge in diverse bioprocessing scenarios.								
CO2	Understand different types of fermentation processes, empowering them to make informed decisions in biotechnological applications.								
CO3	Students will be well versed with fermentation media, inoculum preparation, Scale up Processes and with the various downstream processes of fermentation industries								
CO4	Students will be well versed with the screening techniques, Microbial assays, Primary & Secondary metabolites.								
CO5	Understand the production process of different types of fermentation product.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Design of a basic fermenter, bioreactor. Configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices	**5**	Describe and explain the structure and different parts of fermenter	1,2
II	Growth of cultures in the fermenter- types- batch, continuous and fed batch, importance of media in fermentation, media formulation and modification	**5**	Describe, illustrate and explain the different type's fermentation processes and formulation of media for fermentation.	1,2
III	Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration, extraction, purification by different methods, drying and crystallization	**8**	Describe, illustrate and explain the different methods of biomass separation and cell disintegration	1,2
IV	Isolation, selection and improvement of microbial cultures: Screening and isolation of microorganisms, Primary and secondary metabolites, preservation of cultures after strain improvement programme Immobilization of cells and enzymes- Principle, Method of mobilization and its applications	**10**	Describe, illustrate and explain the different methods of isolation and preservation of industrially important microorganisms and the process of cell immobilization.	1,2
V	Production of pharmaceuticals: Antibiotics (penicillin), hormones (humulin), vaccines (Hepatitis B), Vitamin B12, Production of organic acids: Acetic Acid, Citric Acid, Lactic Acid, Production of Amino acids: Lysine, Glutamic Acid, Production of	**17**	Describe, illustrate and explain the different products produced by microorganisms by fermentation.	1,2

	Enzymes: Protease, Amylase Production of Fuels: Ethanol, Methanol, Mushroom Cultivation and Wine production			
Practical	1. Preparation of Sauerkraut 2. Role of yeast in bread making 3. Wine preparation 4. Vinegar production 5. Production of mushroom 6. Citric acid estimation 7. Lactic acid estimation 8. Production of fermented milk products	**30**	Proficiency in preparing various products using industrial useful microorganism.	1,2,3,4

TEXT BOOKS:

1. Stanbury P.F., A. Whitaker, S.j. Hall, Principles of Fermentation Technology Publisher: Butterworth-Heinemann
2. Shuler M.L. and F. Kargi: Bioprocess Engineering Basic Voncepts by Publisher Prentice Hall

REFERENCE BOOKS:

1. Prescott and Dunn's Industrial Microbiology, Publisher: Gerald Reed: Books
2. W. Crueger and A. Crueger: Biotechnology. A textbook of Industrial Microbiology, Publisher: Sinauer Associates.

OTHER LEARNING RESOURCES:
https://microbenotes.com

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand bioreactors and their various types, enabling them to apply this knowledge in diverse bioprocessing scenarios.	**1,2,3,8,**
2	Understand different type's fermentation processes, empowering them to make informed decisions in biotechnological applications.	**1,2,3,8**
3	Students will be well versed with fermentation media, inoculum preparation, Scale up Processes and with the various downstream processes of fermentation industries	**1,2,3,4,6,8**
4	Students will be well versed with the screening techniques, Microbial assays, Primary & Secondary metabolites.	**1,2,3,6,8**
5	Understand the production process of different types of fermentation product.	**1,2,3,4,6,7,8**

SEMESTER – VI									
Course Title	**Industrial and Pharmaceutical Microbiology**								
Course code	**24BSMB322R**	**Total Credits: 4** **Total Hours: 45T+30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ VI semester of third year of the Programme**								
Course Objectives	1. To incorporate a strong understanding and in-depth knowledge of pharmaceutical microbiology principles, techniques, processes 2. Study the strategies in order to avoid any potentially costly and life-threatening failures and consequences.								
CO1	Understand basic pharmaceutical concepts such as definitions, sources, terminology, and classification, and recognize the primary aspects of pharmacodynamics, including actions, therapeutic effects, and potential adverse or toxic reactions.								
CO2	Comprehend the fundamentals of pharmacokinetics, covering absorption, distribution, metabolism, interaction, and excretion processes.								
CO3	Understand the principles and apply the knowledge of Good Manufacturing Practices (GMP) in the pharmaceutical and cosmetic industries.								
CO4	Attain proficiency in quality management and regulatory aspects related to premises and contamination control, encompassing knowledge in location, design, structure, layout, services, and cleaning protocols.								
CO5	Acquire expertise in the analytical aspects of pharmaceutical and cosmetic product quality control, incorporating Good Clinical Laboratory Practices (GCLP) principles.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Introduction to pharmacology: Definitions, sources, terminology used, classification, Pharmacodynamics– Actions, Therapeutic, Adverse, toxic	**9**	Describe and explain the Pharmacodynamics of drugs	1,2
II	Pharmacokinetics– absorption, distribution, metabolism, interaction, excretion, Routes of drug administration, Storage of various drugs	**9**	Describe, illustrate and explain the Pharmacokinetics of drugs and mode of drug storage	1,2
III	Principles and applications of GMP in pharmaceuticals and cosmetics Principles– Applications and Definitions The concept of Quality, The regulatory factors QC, QA and GMP Quality assurance beyond GMP ISO, Sanitary practices in cosmetic manufacturing	**9**	Describe, illustrate and explain quality aspect of drug manufacturing, quality assurance, sanitary practice	1,2
IV	Quality management and regulatory aspects Premises and contamination control, location, design, structure, layout, services and cleaning. Personnel management, training, Hygiene and health. Documentation Quality control and GCLP Sterile and other products. Global regulatory and toxicological aspects of cosmetic preservation	**9**	Describe, illustrate and explain about quality management aspect of premises, Personnel Hygiene, documentation and regulatory.	1,2
V	Analytical aspects for pharmaceutical and cosmetic Products, Quality control and GCLP Sterile and other products. Validation Cosmetics microbiology-testing methods	**9**	Describe, illustrate and explain about Sterile and non-sterile pharmaceutical products, efficacy and	1,2

	and preservation antimicrobial preservation efficacy and microbial content testing, Validation method for cosmetics Preservation strategy, Evaluation of antimicrobial mechanism		evaluation of preservatives use in pharmaceuticals and cosmetics	
Practical	1. Wine preparation 2. Vinegar production 3. Ethanol Production 4. Screening of Antibiotic Producing Microorganisms from Soil	**30**	Students will learn fermentation processes for wine, acetification for vinegar, ethanol production from various substrates, and methods to isolate antibiotic-producing microorganisms from soil.	1,2,3,4

TEXT BOOKS:

1. Pharmaceutical Microbiology, by Dr. C. R. Kokare
2. Pharmaceutical Microbiology, Tim Sandle

REFERENCE BOOKS:

1. Pharmacology by Harvey and Champe, Wolters Kluwer Publication, 4Th Edition
2. Principles of Pharmacology, Armstrong, Wolters Kluwer Publication
3. Basic and Clinical Pharmacology, by Katzung, McGraw Hill, 10th edition
4. Pharmacology, Principles and Practice, Bachmann, Hecker, Messer, AP Publication

OTHER LEARNING RESOURCES:

https://www.pharmanotes.org/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand basic pharmaceutical concepts such as definitions, sources, terminology, and classification, and recognize the primary aspects of pharmacodynamics, including actions, therapeutic effects, and potential adverse or toxic reactions.	**1,2,6,8**
2	Comprehend the fundamentals of pharmacokinetics, covering absorption, distribution, metabolism, interaction, and excretion processes.	**1,2,6,8**
3	Understand the principles and apply the knowledge of Good Manufacturing Practices (GMP) in the pharmaceutical and cosmetic industries.	**1,2,3,4,6,8**
4	Attain proficiency in quality management and regulatory aspects related to premises and contamination control, encompassing knowledge in location, design, structure, layout, services, and cleaning protocols.	**1,2,3,4,6,8**
5	Acquire expertise in the analytical aspects of pharmaceutical and cosmetic product quality control, incorporating Good Clinical Laboratory Practices (GCLP) principles.	**1,2,3,6,8**

SEMESTER – VI										
Course Title	**Mushroom Cultivation**									
Course Code	**24BSMB323R**	**Total Credits: 1** **Total Hours:30**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Fall/ V semester of third year of the Programme**								
Course Objectives	1. To create awareness about the Mushroom among the people. 2. To strengthen the promotion of mushroom cultivation by establishing a well-equipped laboratory and offices. 3. To know and explore the cultivation in Assam								
CO1	Explain different classes of mushroom.								
CO2	Understand reproduction and growth of mushroom.								
CO3	Explain mushroom spawn production								
CO4	Discuss the methods of cultivation of mushroom								
CO5	Explain the techniques for the utilization of mushroom spent								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Setting of laboratory for mushroom cultivation; preparation and production of mother culture, mother and commercial spawn; preparation and cultivation of mushroom; mushroom spent management by vermicomposting.	30	The student will be able to cultivate mushrooms	1,2,3,4

REFERENCE BOOKS:

R1. Gogoi, R., Rathaiah, Y., & Borah, T. R. (2019). Mushroom cultivation technology. Scientific Publishers.

R2. Suman, B. C., & Sharma, V. P. (2007). Mushroom cultivation in India. Daya Books.

R3. Petre, M. (2015). Mushroom biotechnology: developments and applications. Academic Press.

OTHER LEARNING RESOURCES:

https://www.researchgate.net/profile/Samarendra-Hazarika/publication/342082516_Spawan_Production_Mushroompdf/data/5ee11b24299bf1b17a8b66ed/Spawan-Production-Mushroom.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain different classes of mushroom.	**1,2,3,8**
2	Understand reproduction and growth of mushroom.	**1,2,3,8**
3	Explain mushroom spawn production	**1,2,3,8**
4	Discuss the methods of cultivation of mushroom	**1,2,3,8**
5	Explain the techniques for the utilization of mushroom spent	**1,2,3,8**

SEMESTER – VI									
Course Title	**Herbal Medicine**								
Course Code	**24FSBO601R**	**Total Credits: 3** **Total Hours: 45T**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ VI semester of third year of the Programme**								
Course Objectives	1. To understand the pharmacological properties of medicinal plants. 2. To learn the methods of formulation of herbal medicine. 3. To evaluate scientific literature on herbal medicine. 4. To discuss the clinical applications of herbal medicine. 5. To comprehend the legal and ethical issues related to herbal medicine.								
CO1	Discuss pharmacological properties of medicinal plants.								
CO2	Explain the methods of formulation of herbal medicine.								
CO3	Evaluate scientific literature on herbal medicine.								
CO4	Discuss clinical applications of herbal medicine.								
CO5	Understand the legal and ethical issues on herbal medicine.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Pharmacological Properties of Medicinal Plants:** Introduction to pharmacognosy, bioactive compounds in plants, mechanisms of action, examples of commonly used medicinal plants.	**9**	Describe the pharmacological properties and mechanisms of action of bioactive compounds in medicinal plants.	1,2
II	**Methods of Formulation of Herbal Medicine:** Extraction methods, preparation of extracts, formulation techniques (tinctures, decoctions, infusions, tablets, capsules), standardization of herbal products.	**9**	Demonstrate knowledge of different extraction and formulation techniques used in herbal medicine.	2,3
III	**Evaluation of Scientific Literature on Herbal Medicine:** Research methodologies, critical appraisal of clinical studies, systematic reviews, meta-analyses, interpretation of results.	**9**	Critically evaluate and interpret scientific literature related to herbal medicine.	4,5
IV	**Clinical Applications of Herbal Medicine:** Use of herbal medicine in treating common ailments, evidence-based applications, safety and efficacy, interaction with conventional medicines.	**9**	Discuss the clinical applications, safety, and efficacy of herbal medicines in treating various conditions.	3,4
V	**Legal and Ethical Issues in Herbal Medicine:** Regulatory frameworks, quality control, intellectual property rights, ethical considerations in research and practice, patient consent.	**9**	Understand and discuss the legal and ethical issues related to the practice and research of herbal medicine.	1,2

TEXT BOOKS:

1. **"Pharmacognosy and Phytochemistry"** by Vinod D. Rangari
2. **"Textbook of Pharmacognosy"** by C.K. Kokate, A.P. Purohit, and S.B. Gokhale.
3. **"Herbal Medicine: Biomolecular and Clinical Aspects"** edited by Iris F.F. Benzie and Sissi Wachtel-Galor

REFERENCE BOOKS:

1. "The Complete Guide to Herbal Medicines" by Charles W. Fetrow and Juan R. Avila
2. "Principles and Practice of Phytotherapy: Modern Herbal Medicine" by Simon Mills and Kerry Bone
3. "Herbal Medicine: Expanded Commission E Monographs" by Mark Blumenthal

OTHER LEARNING RESOURCES:
Coursera, YouTube

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss pharmacological properties of medicinal plants.	**1,2,3**
2	Explain the methods of formulation of herbal medicine.	**1,2,3**
3	Evaluate scientific literature on herbal medicine.	**1,2,3**
4	Discuss clinical applications of herbal medicine.	**1,2,3**
5	Understand the legal and ethical issues on herbal medicine.	**1,2,3**

SEMESTER – VI										
Course Title	**Community Nutrition**									
Course code	**24FSFD601R**	**Total Credits: 3** **Total Hours: 45T**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Microbiology**								
Semester	**Spring/ VI semester of third year of the Programme**								
Course Objectives	1. To understand the principles and practices of nutritional epidemiology. 2. To assess the nutritional needs of communities. 3. To implement and evaluate community nutrition programs. 4. To understand the role of advocacy and policy development in improving community nutrition. 5. To develop strategies for effective nutrition education and intervention programs.									
CO1	Explain the principles and practices of nutritional epidemiology.									
CO2	Assess community nutrition needs using appropriate tools and methodologies.									
CO3	Implement and evaluate community nutrition programs.									
CO4	Understand and apply advocacy and policy development to improve community nutrition.									
CO5	Develop and implement effective nutrition education and intervention programs.									

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Nutritional Epidemiology** • Principles of nutritional epidemiology • Study designs in nutritional epidemiology • Measurement of dietary intake • Biochemical markers in nutritional epidemiology	**9**	Explain the principles and practices of nutritional epidemiology.	1,2
II	**Community Nutrition Needs Assessment** • Methods of assessing community nutrition needs • Dietary surveys and nutritional status assessments • Use of anthropometry, biochemical, and clinical data • Interpretation of nutrition data	**9**	Assess community nutrition needs using appropriate tools and methodologies.	2,3
III	**Community Nutrition Programs** • Planning and implementing nutrition programs • Monitoring and evaluation of nutrition programs • Case studies of successful community nutrition programs • Challenges in implementing nutrition programs	**9**	Implement and evaluate community nutrition programs.	3,4
IV	**Advocacy and Policy Development** • Role of advocacy in community nutrition • Policy development process • Strategies for influencing nutrition policy • Case studies of nutrition advocacy and policy change	**9**	Understand the significance of advocacy in promoting community nutrition innitiatives and learn the steps involved in developing effective nutrition policies	3,4
V	**Nutrition Education and Intervention Programs** • Principles of nutrition education • Developing and implementing nutrition education programs • Behaviour changes communication	**9**	Understand the core principal guiding effective nutrition education program and gain skills to design and implement nutrition education programs.	4,5

	strategies • Evaluating the effectiveness of nutrition interventions			

TEXT BOOKS:

1. "**Nutrition in Public Health: Principles, Policies, and Practice**" by Arlene Spark, Lauren M. Dinour, and Janel Obenchain.
2. **"Community Nutrition in Action: An Entrepreneurial Approach"** by Marie A. Boyle and David H. Holben

REFERENCE BOOKS:

1. "Modern Nutrition in Health and Disease" edited by A. Catharine Ross, Benjamin Caballero, Robert J. Cousins, Katherine L. Tucker, and Thomas R. Ziegler
2. "Essentials of Public Health Biology: A Guide for the Study of Pathophysiology" by Constance Battle.

OTHER LEARNING RESOURCES:

Coursera, YouTube

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the principles and practices of nutritional epidemiology.	**1,2,3**
2	Assess community nutrition needs using appropriate tools and methodologies.	**1,2,3**
3	Implement and evaluate community nutrition programs.	**1,2,3**
4	Understand and apply advocacy and policy development to improve community nutrition.	**1,2,3**
5	Explain the principles and practices of nutritional epidemiology.	**1,2,3**

Assam down town University

Curriculum and Syllabus

Bachelor of Science

in

Food, Nutrition and Dietetics

OUTCOME BASED EDUCATION FRAMEWORK

CHOICE BASED CREDIT SYSTEM

Version: 2.2

FACULTY OF SCIENCE

July, 2024

PREAMBLE

Assam down town University is a premier higher educational institution which offers Bachelor, Master, and Ph.D. degree programmes across various faculties. These programmes, collectively embodies the vision and mission of the university. In keeping with the vision of evolutionary changes taking place in the educational landscape of the country, the university has restructured the course curriculum as per the guidelines of National Education Policy 2020. This document contains outline of teaching and learning framework and complete detailing of the courses. This document is a guidebook for the students to choose desired courses for completing the programme and to be eligible for the degree. This volume also includes the prescribed literature, study materials, texts, and reference books under different courses as guidance for the students to follow.

Recommended by the Board of Studies (BOS) meeting of the Faculty of Science held on dated 16th & 17th July, 2024 and approved by the 51st Academic Council (AC) meeting held on dated 26/07/2024

Chairperson, Board of Studies

Member Secretary, Academic Council

Vision

To become a Globally Recognized University from North Eastern Region of India, Dedicated to the Holistic Development of Students and Making Society Better

Missions

1. Creation of curricula that address the local, regional, national, and international needs of graduates, providing them with diverse and well–rounded education.

2. Build a diverse student body from various socio–economic backgrounds, provide exceptional value–based education, and foster holistic personal development, strong academic careers, and confidence.

3. Achieve high placement success by offering students skill-based, innovative education and strong industry connections.

4. Become the premier destination of young people, desirous of becoming future professional leaders through multi disciplinary learning and serving society better.

5. Create a highly inspiring intellectual environment for exceptional learners, empowering them to aspire to join internationally acclaimed institutions and contribute to global efforts in addressing critical issues, such as sustainable development, Climate mitigation and fostering a conflict–free global society.

6. To be renowned for creating new knowledge through high quality inter disciplinary research for betterment of society.

7. Become a key hub for the growth and excellence of AdtU's stake holders including educators, researchers and innovators

8. Adapt to the evolving needs and changing realities of our students and community by incorporating national and global perspectives, while ensuring our actions are in harmony with our foundational values and objectives of serving the community.

Programme Details

Programme Overview:

B.Sc. in Food, Nutrition and Dietetics is a 3-year undergraduate programme which deals with offers a wide range of courses covering various basic and applied areas of nutritional sciences. The student develops an aptitude and scientific temperament to apply the technical skills in various important areas of Nutrition and Food such as Food Science, Nutritional biochemistry, Food Microbiology, Clinical Nutrition, Food Technology and Food Science. The course also offers various techno specific skills, universal ethics and elective courses considering overall development and employability scopes in research, industry and teaching sectors. The course duration is for a period of 3 years.

I. Specific Features of the Curriculum:

- Experiential learning
- Constructivist approach to learn
- Practical and project-based learning

II. Eligibility Criteria:

Minimum 45% in 10+2 with English, Biology & Chemistry 5% relaxation for SC/ST, EWS, and Specially abled candidates.

III. Program Educational Objectives (PEOs):

PEO 1-AdtU nutrition and dietetics graduates will be well-prepared for successful careers in industry, institution and/ or government sectors in one or more relevant disciplines/ subdisciplines.

PEO 2-The nutrition and dietetics graduates will be academically prepared to become diet counsellor/ certified dieticians for evaluating nutritional status to improve health.

PEO 3-AdtU nutrition and dietetics graduates will actively participate in professional endeavours to elevate personal standing while concurrently making impactful contributions to the profession and society, achieving success in higher education within specific or interdisciplinary domains if pursued.

IV. Program Specific Outcomes (PSOs):

PSO 1: Techno-Professional Ability: Demonstrate a comprehensive understanding of multidisciplinary concepts of food nutrition and dietetics with an interdisciplinary approach to address nutritional challenges.
PSO 2: Outreach Competency: Fostering outreach competency for creating awareness in society through nutrition education and intervention for better public health.
PSO 3: Global Proficiency: Exhibit global competency to excel in the profession through international certification courses

V. Program Outcome (PO):

PO1- Disciplinary Knowledge: Apply the knowledge of food science and dietetics principles, human biology, biochemistry, microbiology and fundamentals of nutraceuticals and functional foods for better human health.

PO2- Problem-Solving: Identify, assess, analyze and plan an appropriate diet for specific health conditions.

PO3- Communication: Effectively communicate to provide diet counselling, and personalized diet plans, conveying specialized nutritional knowledge to the individuals and community at large.

PO4- Professional Ethics and Values: Comply with human values and ethics and its strict application in the profession.

PO5- Research-In-Practice: Foster evidence-based advancements in nutritional science and dietary practices to address emerging challenges and improve public health.

PO6- Food Formulation: Formulation and standardization of food products for value addition applying interdisciplinary knowledge.

PO7- Individual and Teamwork: Function efficiently as an individual or a member/ leader in multidisciplinary teams.

PO8- Lifelong learning: Ability to engage in independent lifelong learning in the broadest context of lifestyle, healthcare and technological advancement.

VI. Total Credits to be Earned: 134

VII. Career Prospects:

B.Sc. in Food Nutrition and Dietetics offers a range of dynamic career opportunities. Graduates can work in research and development, hospitals, and food processing industries. Roles include nutritionist, quality control analysts, and clinical researchers. Opportunities also exist in academia and education, where graduates can contribute to scientific knowledge and train future professionals.

EVALUATION METHODS

The student performance shall be evaluated through In-semester (Sessional) and semester-end examinations. A weightage of 40% or as prescribed by the programme shall be added to the score of the end semester examination.

A. INTERNAL ASSESSMENT:

The teacher who offers the course shall be responsible for internal assessment by conducting in-semester (sessional) examination and evaluating the performance of the students pursuing that course. The components for internal assessment are illustrated in the table given below.

SN	Components/ Examinations	Marks Allotted
1.	In-Sem Exam – I (ISE-I) (Written Examination) *	30
2.	In-Sem Exam – II (ISE-II) (Written Examination) *	30
3.	Assignment	10
4.	Presentation (SP)	10
5.	Quiz	5
6.	Class Performance based score*	5

are compulsory

Note: *Total Internal assessment should be out of 40*

INSTRUCTION

1. If a student fails to appear in the any of the component without any valid reason he/she shall be marked zero in that component. However, the course teacher at his discretion may arrange for the missed test on an alternate date for the absentee students after determining ground with genuine/valid reasons for the absent.

2. The report of evaluation of an activity towards the in-semester (sessional) component of a course shall be duly notified by the concerned course teacher within a week of completion.

3. The program coordinators should upload the in-semester marks to the ERP and forward acknowledgement of all the courses of the program to the Controller of Examinations before the start of the End-semester examination.

B. SEMESTER END EXAMINATION:

Time table for end semester examination is published at least 25 days prior to the start of Examination.

I. Pre-Examination:

Eligibility Criteria for a student to appear in University Examinations:

The student shall only be allowed to appear in a University Examination, if:

i) He/ She is a registered student of the University;
ii) He/ She is of good conduct and character;
iii) He/ She has completed the prescribed Programme of study with minimum percentage of attendance as laid down in the Regulations of the Programme concerned.

Under special cases, a student may be allowed to appear for an examination without being registered in the University but the result of the said student will be kept on hold till the registration of the concerned student is completed.

II. Admit Card:

Admit card for the examination may be downloaded through ERP where the system will generate a Unique ID Cards through online.

The University shall have the right to cancel admission for examination of any candidate on valid grounds.

III. Pattern of Question Papers:

The question paper shall follow the principles of Bloom's Taxonomy.

Table

S. N.	Level	Questions /verbs for test
1	Remember	List, Define, tell, describe, recite, recall, identify, show who, when, where, etc.
2	Understand	Describe, explain, contrast, summarize, differentiate, discuss etc.
3	Apply	Predict, apply, solve, illustrate, determine, examine, modify
4	Analyze	Classify, outline, categorize, analyze, diagrams, illustrate, infer, etc.
5	Evaluate	Assess, summarize, choose, evaluate, recommend, justify, compare etc.
6	Create	Design, Formulate, Modify, Develop, integrate, etc.

Note: No course is to be evaluated on basis of all 6 knowledge levels.

The format of the question paper across all the program follow a unique pattern and the total marks is 60

Table 1: Question paper pattern for End semester examination

Sl no	Question pattern	Total marks
1	MCQs (10 Questions)	10
2	2 Marks questions (10 Questions)	20
3	4 Marks questions (5 Questions)	20
4	10 Marks questions (1 Question)	10

IV. Examination Duration:

Each paper of 60 marks shall ordinarily be of two hours duration.

V. Practical Examinations, Viva-Voce etc.:

i) Practical examination shall be conducted in the presence of one external expert and one or more internal examiners.

ii) Viva-Voce, Oral examinations of the Project report, Dissertation etc. shall be undertaken by a Board of Examiners constituted by the respective Dean of Program with the advice of Supervisor(s).

VI. Procedure of Expulsion:

If any candidate is found to be using any unfair-means during the examination, the invigilator may cease his/her answer sheet and report it directly to the Officer-in-Charge. The Office-in-

Charge of the center may take appropriate decisions as per the rules and procedure of the examination. The Officer-in-Charge may allow the students to write the exam with new answer sheet or may expel the student from appearing the paper depending on the nature of unfair-means. In case of Computer based test, the students may be directed to write an apology letter and sign in the prescribe expulsion form. The student may not be allowed to write that examination.

VII. Instruction to the Students:

(i) The students shall not bring to the Examination Hall, any electronic gadget used as a means of communication or record except electronic calculator, if required.

(ii) The students shall not receive any book or printed or hand written or photo copy (Xerox) or blank-paper from any other person while he/she is in the examination-room or in laboratory or in any other place to which he/she is allowed to have access during course of examination.

(iii) The students shall not communicate with any other candidate in the examination room or with any other person in and outside the examination-room.

(iv) The students shall not see, read or copy anything written by any other candidate, nor shall he/she knowingly or negligently permit any other candidate to see, read or copy anything written by him/her or conveyed by him/her.

(v) The students shall not write anything on the Question Paper or in other paper or materials during the examination, or pass any kind of paper to any other candidate in the examination-room, or to any person outside the room.

(vi) The students shall not disclose his/her identity to the examiner by writing his/her name or putting any sign / symbol in any part of his answer-script.

(vii) The students shall not use any abusive language or write any objectionable remark or make any appeal to examiner by writing in any part of his answer-script.

(viii) The students shall not detach any page from the answer-script or insert any authorized or unauthorized loose sheet into it. He /she shall also not insert any other answer-script / loose sheet by removing the pins of the origin answer-scripts and re-fixing it.

(ix) The students shall not resort to any disorderly conduct inside the examination-room or misbehave with the invigilator or any other examination official.

VIII. Provision for an Amanuensis (writer):

(i) A candidate may be provided with an Amanuensis (writer) to write down on dictation on his / her behalf on ground of his / her physical disability to write down by himself / herself due to accident or any other reason. The amanuensis may be provided till he / she recovers from the physical disability. The physical disability to write down by himself / herself must be supported by Medical Certificate from a competent Medical Officer.

(ii) The qualifications of the amanuensis so provided must not be equal or higher than that of the candidate. This is also to be supported by Certificate from the Faculty of Study where the Amanuensis is provided.

(iii) Such candidates are to be accommodated in a separate room under the supervision of an invigilator so that the fellow candidates are not disturbed in the process.

C. Credit Point:

It is the product of grade point and number of credits for a course, thus, CP = GP x CR

i. Credit:

A unit by which the course work is measured. It determines the number of hours of instructions required per week. 'Credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. Credits assigned for a single course always pay attention to how many hours it would take for an average learner to complete a single course successfully.

ii. Grade Point:

Grade Point is a numerical weight allotted to each Grade Letter on a 10-point scale.

iii. Letter Grade:

Letter Grade is an index of the performance of students in a said paper of a particular course. Grades are denoted by letters O, A+, A, B+, B, C, P, F and Abs. Student obtaining Grade F / Grade Abs shall be considered failed/ absent and, will be required to appear in the subsequent ESE. The UGC recommends a 10-point grading system with the following (Table: 1) Letter Grades:

(i) A Letter Grade shall signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point shall indicate the numerical weight of the Letter Grade on a 10-point scale.
(ii) There shall be 08 (eight) Letter Grades bearing specific Grade Points as listed in Table 1, where the Letter Grades 'O' to 'P' shall indicate successful completion of a course.
(iii) Apart from the 08 (eight) regular Letter Grades listed in Table 1, there shall be 03 (three) additional Letter Grades, which shall be awarded if a Course is withdrawn or spanned over the next Semester or remains incomplete as stated in Table 2.

Table 2: Letter Grades and Grade Points

Letter Grade	Grade Points	Description
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Abs	0	Absent
UFM	0	Unfair Means

iv. Grade Point Average:

a. SGPA (Semester Grade Point Average)

The SGPA of a student in a Semester shall be the weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered in that Semester, irrespective of whether he/she could or could not complete the Courses. More specifically, the calculation of SGPA shall take into account the Courses

graded with Letter Grades 'O' to 'F' as given in Table 1.

$$\text{SGPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad (1.1)$$

The SGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.1) up to two decimal places, where n is the total number of Credit Courses registered by the student in that Semester, Gi is the Grade Point secured in the i^{th} registered Course and Ci is the Credit (weight) of that Course.

b. CGPA (Cumulative Grade Point Average)

(i) The CGPA of a student in a Semester of a Programme shall be the accumulated weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered and successfully completed so far starting from the enrollment in the Programme. In other words, taking into account all the Courses graded with 'O' to 'P' as given in Table 1.1, generally the CGPA of a student shall be calculated starting from the first Semester of his/her enrolled Programme, while the CGPA of a lateral-entry student shall be calculated starting from the Semester of his/her enrollment.

(ii) The CGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.2) up to two decimal places, where N is the total number of Credit Courses registered and successfully completed so far by the student, Gi is the Grade Point secured in the ith completed Course and Ci is the Credit (weight)of that Course.

$$\text{CGPA} = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i} \qquad (1.2)$$

(iii) The CGPA shall be convertible into equivalent percentage of marks using Equation Conversion of CGPA to percentage marks: = CGPA*10

D. Post-Examination

i. Transcript or Grade Card or Certificate:

A marking certificate shall be issued to all the registered students after every Semester. The Semester mark sheet will display the course details (code, title, number of credits, grade secured) along with total credit earned in that Semester.

ii. Grievance Readdress Mechanism:

Students with any dissatisfaction or grievance regarding the marks awarded in any of the Papers / Courses may appeal to the Controller of Examinations for remedial action such as Re-evaluation within 10 days of the declaration of result.

(i) A student has options to appeal for re-evaluation of his /her answer script to the Controller of Examination.

(ii) Application for re-evaluation / re-scrutiny of answer scripts shall be made in the definite proforma available with the Examination Office through the head of the respective departments within 10 days of declaration of the results of the respective examinations.

(iii) The Controller of Examination may appoint an examiner for re-evaluation and will consider and recognize the evaluation done by a University appointed examiner.

(iv) There shall be no provision for re-evaluation of the Practical Papers, Project Work, and Dissertation etc. However, the students fail in practical examination or viva voce and wish to appear again may apply to be evaluated can do so with the next schedule.

(v) After screening the application for re-evaluation, the CoE may send the answer scripts of the student to the examiners appointed by the CoE with the approval of Vice Chancellor.

(vi) The marks/grades achieved by the students after the re-evaluation shall be final and binding.

(vii) Fresh Marks – sheets / Grade Card shall be issued only if the candidate secures pass marks / passing grade in the re-evaluated paper.

(viii) Revaluation of answer scripts shall be deemed to be an additional facility provided to the students with a view to improving upon their results at the preceding examination result for any reason whatsoever shall not confer any right upon them for admission to next higher class which matters always be regulated in accordance with the relevant rules or regulations framed by the University.

(ix) If as a result of revaluation of the candidate attracts the provision of condonation of deficiency, the same may be applied to his/her only for fresh attempt.

INSTRUCTION TO TEACHERS AND STUDENTS

(Teaching and Learning Methods)

In all the courses the teacher has to select topics for teacher-method which should not be less than 20 percent. The approach will be direct class room teaching through series of lectures delivering concepts using ITC facilities, white or black board. Notes may also be circulated to the students however; the students are to be involved in preparation of the notes. The teacher will be responsible in selecting the best note for circulation. The teacher- centric methodology has recently fallen out of favor because this strategy for teaching is seen to favor passive students.

1. Student- centric / Constructivist Approach:

The topics of the courses may be selected at the start of the class and assigned one topic to each of the student for studying by themselves, prepare presentations, notes etc., and present at respective class time after consultation and discussion with the course teachers. The teacher facilitate the learning of the students by guiding and providing input and explaining concepts. 60 percent of the course contents may be selected for this purpose. To avoid behavior problems, teachers must lay a lot of groundwork in student- centric classrooms. Typically, it involves instilling a sense of responsibility in students. In addition, students must learn internal motivation.

a. Project-Based Learning: The teacher may select 5 percent of topics for the purpose and may conduct visit to the laboratory for experiments or field and survey. The selection of the topic may be done considering the available facility for the purpose. However, in the final semester of each of the programme the student has to undergo a project-Based learning at least 4 months duration. This approach will help the student to think critically, evaluate, analyze, make decisions, collaborate, and more.

b. Inquiry-Based Learning: The teacher/ students are supposed to list at least five questions in each contact hour and student solve these question or search for answer which becomes the home work for the students "question-driven" learning approach. The teacher may look for the correctness of the solution or the best possible answer and discuss in the successive class. This will help in the preparation for various competitive examination and develop a habit for search for solutions.

c. Flipped Classroom: About 10 percent of the course content has to be completed by this method. In this approach the students are asked to watch video or lecture prepared by the teacher or any video available (relevant to the course). A set of questions may be given to the students for searching answers by the students. The idea is that students should have more time in-classroom focusing on achieving these higher levels of thinking and learning. The Flipped classroom is also an acronym. The letters FLIP represent the four pillars included in this type of learning: Flexible environment, Learning culture shift, Intentional content, and Professional educator. As you can see, the second pillar refers to a culture shift from the traditional approach where students are more passive to an approach where students are active participants. As a result, this approach is also a student- centric teaching method.

d. Cooperative Learning: The remaining five percent has to be completed by cooperative learning approach. In this approach the students are allotted with problems. During the library hours the student along with the teacher visits library search probable solution for the assigned

problem. The same has to be done in group so that the students discuss among themselves for the appropriate answers. Essentially, cooperative learning believes that social interactions can improve learning. In addition, the approach recreates real-world work situations in which collaboration and cooperation are required.

The percentage categorization for the completion of a theory course

Teacher- centric or Direct Classroom Teaching: Delivery by series of lectures	20%
Student- centric Approach, Student present and deliver lectures in presence of teacher and supervised by teacher	60%
Student visit fields or perform experiments or teacher perform demonstration	05%
Flipped Classroom approach	10%
Cooperative learning approach	05%

Inquiry based approach has to be followed in all of the classes

Teacher has to distribute the topics to be considered for teaching by the above-mentioned approaches and prepare lesson plan for execution and maintain a file.

SEMESTER WISE COURSE DISTRIBUTION

	Sl. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester I	1.	24BSFD1101R	Food Science I	DSC -Major	3	0	2	0	0	0	4	60	40	100	200
	2.	24BSFD1102R	Basics of Human Physiology and Anatomy	DSC- Minor	3	0	0	0	0	0	3	60	40	0	100
	3.	24BSCH1101R	Basic Chemistry	DSC- Minor	2	0	2	0	0	0	3	60	40	100	200
	4.	24BSFD1103R	Human Nutrition	DSC- Minor	2	0	0	0	0	0	2	60	40	0	100
	5.	24UBFS1101R	Basic of Statistics	MDC	3	0	0	0	0	0	3	60	40	0	100
	6.	24UBPD1102R	Elementary English (CLPPD)	AEC	0	0	4	0	0	0	2	0	0	100	100
	7.	24BSAG1001R	Agricultural Education	VAC	2	0	0	0	0	0	2	60	40	0	100
	8.	24UBEC11016	Extra-Curricular Activities	Co and extra-Curricular	0	0	0	4	0	0	1	0	0	100	100
	Total										20				1100

	Sl. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester II	1.	24BSFD1201R	Food Science II	DSC - Major	3	0	2	0	0	0	4	60	40	100	200
	2.	24BSMB1201R	Food Microbiology	DSC-Minor	3	0	2	0	0	0	4	60	40	100	200
	3.	24BSBC1201R	Nutritional Biochemistry	DSC-Minor	3	0	2	0	0	0	4	60	40	100	200
	4.	24BSAG1002R	Agriculture heritage	MDC	0	0	2	0	0	0	1	0	0	100	100
	5.	24BAPS1206R	Psychology of Happiness	MDC	2	0	0	0	0	0	2	60	40	0	100
	6.	24UBPD1202R	PDP English Courses	AEC	0	0	4	0	0	0	2	0	0	100	100
	7.	24UBES1101R	Environmental Education (online)	VAC	2	0	0	0	0	0	2	60	40	0	100
	8.		Design thinking and Entrepreneurship/ Ideation concept	SEC	1	0	0	0	0	0	1	0	0	0	100
		24UBCC1201	CO Curricular Activities	Co and extra-Curricular	0	0	0	4	0	0	1	0	0	100	100
	Total										21				1200

	Sl. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester III	1.	24BSFD2101R	Food Technology	DSC - Major	3	0	2	0	0	0	4	60	40	100	200
	2.	24BSFD2102R	Food Preservation	DSC - Major	3	0	2	0	0	0	4	60	40	100	200
	3.	24BSFD2001R	Entrepreneurship Development	DSC- Minor	3	0	0	0	0	0	3	60	40	0	100
	4.	24BSFD2002R	Catering Management	DSC- Minor	3	0	0	0	0	0	3	60	40	0	100
	5.	24BSFD2003R	Rural Sociology and Gender inclusion in Agriculture	DSC- Minor	2	0	0	0	0	0	2	60	40	0	100
	7.	24BSCH2001R	Natural Product Chemistry	MDC	2	0	0	0	0	0	2	60	40	0	100
	8.		PDP English Courses	AEC	0	0	4	0	0	0	2	0	0	100	100
	9.	24BSFD2103R	Techniques of preservation	SEC	0	0	4	0	0	0	2	60	40	100	200
	10.	24BSFD2104R	Field Training	Field Training	0	0	0	4	0	0	1	0	0	100	100
	Total										23				1300

	Sl. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester IV	1.	24BSFD2201R	Basic Dietetics	DSC - Major	3	0	2	0	0	0	4	60	40	100	200
	2.	24BSFD2202R	Advance Food Technology	DSC - Major	3	0	2	0	0	0	4	60	40	100	200
	3.	24BSFD2203R	Nutrition through life cycle	DSC - Major	4	0	0	0	0	0	4	60	40	100	100
	4.	24BSFD2204R	Community Nutrition	DSC - Major	3	0	2	0	0	0	4	60	40	100	200
	5.		PDP English Courses	AEC	0	0	4	0	0	0	2	0	0	100	100
	6.		Aptitude Course	SEC	0	0	0	8	0	0	2	0	0	100	100
	7.	24UUHV2201	UHV	VAC	1	0	0	0	0	0	1	60	40	0	100
	8.		BLSS	VAC	0	0	2	0	0	0	1	0	0	100	100
	9.	24UUFL	Financial Literacy	MDC	1	0	0	0	0	0	1	0	0	0	100
	Total										23				100

	Sl. No.	Course Code	Course Title	Course Category	Engagement						C	Maximum Marks for			
					L	T	P	S	R	O		IA*	SEE*	PE*	Total
Semester V	1.	24BSFD3101R	Advance Dietetics and counselling	DSC - Major	3	0	2	0	0	0	4	60	40	100	200
	2.	24BSFD3102R	Food product development	DSC - Major	3	0	2	0	0	0	4	60	40	100	200
	3.	24BSFD3103R	Post-harvest technology	DSC - Major	3	0	2	0	0	0	4	60	40	100	200
	4.	24BSFD3104R	Geriatric and Pediatric Nutrition	DSC - Major	4	0	0	0	0	0	4	60	40	0	100
	5.		Logical Reasoning Course	SEC	0	0	0	8	0	0	2	0	0	100	100
	6.	24BSFD3105R	Bakery Science	SEC	0	0	0	8	0	0	2	0	0	100	100
	7.	24BSFD3106R	Summer Internship	Internship	0	0	0	0	0	24	4	0	0	100	100
	8.		Mini Research -R1		0	0	0	0	12	0	2	0	0	100	100
	Total										26				1200
	Sl. No.	Course Code	Course Title	Course Category	Engagement						C	Maximum Marks for			
					L	T	P	S	R	O		IA*	SEE*	PE*	Total
Semester VI	1.	24BSFD3201R	Research Methodology	DSC - Major	4	0	0	0	0	0	4	60	40	0	100
	2.	24BSFD3202R	Hospital/Food Industry Internship	DSC - Major	0	0	10	20	0	0	10	0	0	200	200
	3.	24BSFD3203R	Research Project (Mini Research-R2)	Research	0	0	0	0	24	0	4	0	0	100	100
	Total										20				400

***IA: Internal Assessment, SEE: Semester End Examination, PE: Practical Examination**

SEMESTER – I										
Course Title	**BASICS OF FOOD SCIENCE**									
Course Code	**24BSFD111R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre Requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To introduce the students the basics of nutrition. 2. To study the basic food groups, cooking methods in details. 3. To learn the new concept of food science.								
CO1	Discuss the fundamentals of food and nutrition and cooking methods.								
CO2	Explain the structure, composition and nutritive value of cereals and starch								
CO3	Explain the nutritional aspect, selection, preparation, and application of pulses, nuts and oilseeds and its toxic constituents								
CO4	Explain the nutritional importance, storage and cooking techniques and changes during cooking of vegetables and fruits								
CO5	Summarize the culinary role, nutritive value of sugar, fats and oil and the key processes like caramelization, hydrolysis and crystallization								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Food Groups:** Definition, classification of food according to origin and functions, functions of food groups, need for grouping foods, ICMR five food groups, balanced diet. **Methods of Cooking:** Objectives / reasons & advantage of cooking, different cooking media, different cooking methods, merits and demerits of different cooking methods, their effect on nutrients	**10**	To make them understand the deference between the groups of food. Cooking activities for students can confidence and skills that can prepare them for a lifetime of healthy habits	1,2
II	**Cereals:** Structure, composition, nutritive value of cereals, storage and care, breakfast cereals, Characteristics of starch, use in variety of preparations selection	**9**	Learning about cereals and composition	1,2
III	**Pulses, Nuts & Oilseeds:** Chemical composition, Selection and variety, use in variety of preparation, nutritional aspects and cost, effect of cooking & storage on nutritive value of pulses, nuts & oilseeds, Nutritive value of commonly used nuts & oilseeds in our diet, Highlighting soyabeans, Toxic constituents of pulses, Lathyrism.	**10**	To learn about the nutritional composition, anti-nutritional factor and their health benefits**.**	1,2
IV	**Vegetables & Fruits**- Classification, composition & nutritive value, importance in human nutrition, storage, cooking of vegetables, changes in vegetables and fruits on cooking, effects of heat, acids & alkali	**8**	Learning the difference between vegetable and their health benefits	1,2
V	**Fats & Oils-** Nutritive values, types of fats & oils, role of fat in cookery. **Sugar and Related Products:** Nutritive	**9**	Learning the importance of fat & oil and sugar in diet and	1,2

	value, Properties, characteristics & uses, sugar cookery, Form of sugar and liquid sweetness, Caramelization, Hydrolysis, Crystallization.		chemical reactions.	
Practical	1. Prepare a recipe from each food group 2. Determination of hundred grain weight 3. Determination of moisture content of legumes and oil seeds. 4. Analyze the ph of different fruit juices by titration method 5. Study about different extraction process of oils	**30**	Learning and analyzing the importance of recipe from different food groups	1,2,3,4

TEXT BOOKS:

T1: Norman N. Potter and Joseph H. Hotchkiss, Food Science, CBS publishers and distributors, Fifth edition, 2000

T2: Manay Shakunthala, N and Shadaksharaswamy M. Foods facts and Principles, New Age International (P) Ltd Publishers, 4th edition 2020.

REFERENCE BOOKS:

R1: Srilakshmi B. Food Science, New Age International (P) Ltd Publishers, 7th edition, 2018.

R2: Rangana (2017) Manual Analysis of Fruits and Vegetables Product. Tata McGraw Hill Co. Ltd., New Delhi.

OTHER LEARNING RESOURCES:

https://agritech.tnau.ac.in/nutrition/nutri_food_diet_icmr%20food%20groups.html

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss the fundamentals of food and nutrition and cooking methods.	**1,8**
2	Explain the structure, composition and nutritive value of cereals and starch	**1,2,8**
3	Explain the nutritional aspect, selection, preparation, and application of pulses, nuts and oilseeds and its toxic constituents	**1,2,8**
4	Explain the nutritional importance, storage and cooking techniques and changes during cooking of vegetables and fruits	**1,2,8**
5	Summarize the culinary role, nutritive value of sugar, fats and oil and the key processes like caramelization, hydrolysis and crystallization.	**1,2,6,8**

SEMESTER – I									
Course Title	**BASICS OF HUMAN PHYSIOLOGY AND ANATOMY**								
Course Code	**24BSFD112R**	**Total Credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre Requisite	**NIL**	**Co-Requisite**	**NIL**						
Programmes	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To learn about the anatomical positions, gross and microscopic structure of the organs and skeleton in the human body. 2. To assist students in developing a better grasp of the anatomical structure and basic physiological functions of various body regions. 3. Gain learn about the gross structure of different systems and bones in the body.								
CO1	Understand the normal position, functional and cross sectional anatomy of various structures of the body.								
CO2	Get a comprehensive knowledge on cell, organs and organ system and their function								
CO3	Have insight knowledge about the different blood cells, different types of blood groups and blood coagulating factors.								
CO4	Have a basic knowledge on the gross structure of digestive system, respiratory and cardiovascular systems								
CO5	Have a descriptive knowledge on the gross structure of Musculo – skeletal -system and bones in the body.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction To Anatomical Terms, Basic Structure and Function of Cell** • Level of Organization – Body Parts and Areas, Planes and Sections. Common anatomical terminology • Structure and Function of Cell Membrane, Cellular Transport	**7**	Students will be able to know the anatomical terminology and the basic function of the cell and cell organelles.	1,2
II	**Musculo – Skeletal System and Bones** • Bones: Classification & types according to morphology. • Tissue and its types • Cartilage • Joints: definition, classification, and movements of joints. • Muscle and its types **For Specific programs-** **Radiology:** Importance of different bones of human body.	**10**	To learn about the basic of Musculo skeletal system and bones	1,2
III	**Digestive System-** • Anatomy of gastrointestinal tract and accessory organs of digestive system. • Composition and functions of gastric, pancreatic, intestinal, and biliary secretion.	**8**	Student will be equipped with extensive knowledge about digestive System.	1,2
IV	**Respiratory System-** • Anatomy of the respiratory tract • Mechanisms and Regulation of respiration.	**10**	Students will understand and able to apply the knowledge of respiratory system	1,2

	• Gaseous exchange in lung and tissues. • lung volumes, and capacities. • Respiratory abnormalities: Hypoxia, cyanosis, dyspnoea, Asphyxia, hyperventilation, hypoventilation, tachypnoea and bradypnea **Specific Program** **ECC:** Intrapleural and intrapulmonary pressures and their changes with respiration, Hypoxia. **For Specific programs-** **ECC:** Description of larynx, trachea, and respiratory centers.			
V	**Cardio vascular System and Blood:** • Mediastinum – division • Structure of heart and blood vessels. • Systemic circulation, pulmonary circulation, and coronary circulation • Cardiac output, cardiac cycle, conducting system of heart. • Heart sounds, pulse, blood pressure and their regulation. • Composition and functions of blood, Plasma, and body fluids. • Functions of RBC, WBC, and platelets • Hemoglobin. • Blood hemostasis • Blood groups	**10**	Student will learn about the mediastinum and its contents, structures of heart blood vessels with their functions.	1,2

TEXT BOOKS

T1: Fundamentals of Anatomy by Pamela K Levangie, Cynthia C Norkin, JP Bros Medical Publishers, New Delhi
T2: Fundamentals of Medical Anatomy by Duane nudson, 2nd ed. 2007 Publisher Springer.
T3: A book of Physiology, Dr Khurana
T4: Ross and Wilson Anatomy and Physiology

REFERENCE BOOKS

R1: Medical anatomy, JP Bros Medical Publishers, Bangalore, 1st Indian Ed 1997
R2: Clinical Anatomy, JP Bros Medical Publishers, Bangalore, 5th Ed 1996, 1st Indian Ed 1998
R3: Review of Medical Physiology- Ganong William F.
R4: Physiological basis of Medical practice – Best & Taylor

OTHER LEARNING RESOURCES

https://admissions.uiowa.edu/academics/human-physiology

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Recognize the functional and cross sectional anatomy of various structures of the body.	**1,8**
2	Gain comprehensive knowledge on cell, organs and organ system and their function.	**1,8**
3	Explain different blood cells, different types of blood groups and blood coagulating factors.	**1,8**
4	Discuss the gross structure of digestive system, respiratory and cardiovascular systems	**1,8**
5	Have a descriptive knowledge on the gross structure of Musculo – skeletal - system and bones in the body.	**1,8**

SEMESTER – I									
Course Title	**HUMAN NUTRITION**								
Course Code	**24BSFD113R**	**Total Credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre Requisite	**Nil**	**Co-Requisite**	**Nil**						
Programmes	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To introduce the students the basics of nutrition, importance of food. 2. To understand the functions, digestion, absorption, sources of nutrients. 3. To understand the symptoms of different deficiency diseases.								
CO1	Understand the basic terms related to nutrition and its correlation with human health								
CO2	Understand the functioning of nutrients in details.								
CO3	Analyze the function of nutrients in terms of disease condition.								
CO4	Illustrate the types of disease and their treatments								
CO5	Analyze the symptoms of the deficiency disease								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Food, Nutrition and Health:** Basic definitions, function of food, classification of food according to function and nutritive value, physiological, psychological and social function of food, history of nutrition and importance of food and nutrition in day today life. **Recommended Dietary Allowances:** Definition, biological value, bioavailability, Minimal and optimal Nutritional Requirements, Formulation of RDA and Dietary Guidelines- Reference Man and Reference women, factors affecting RDA.	**8**	Understand the relation of food and health	1,2
II	**Energy:** Energy Balance, Assessment of Energy Requirements, Deficiency and Excess. **Carbohydrates:** Definition, classification and function. Digestion and absorption, glycemic index, dietary fiber and its importance, RDA, sources, metabolic disorder associated with carbohydrate.	**12**	To understand the requirement of energy and importance of CHO	1,2
III	**Protein**: Definition, classification and function, Assessment of protein quality (BV, PER, NPU), digestion and absorption, RDA, sources, disorders due to deficiency or excess.	**12**	To understand the classification, composition and requirement of protein	1,2
IV	**Fat**: Definition, classification and functions, digestion and absorption, Types of fatty acids, role and nutritional significance (SFA, MUFA, PUFA, omega-3). RDA, sources, disorders due to deficiency or excess, dietary fat and coronary heart disease.	**10**	To understand the classification, composition and requirement of fat	1,2
V	**Vitamins**: Physiological role, Bio-availability and requirements, sources, deficiency and excess (Fat soluble and water soluble) **Minerals**: Physiological role, bio-availability and requirements, sources, Deficiency and Excess	**8**	To understand the classification, composition and requirement of Vitamins and minerals and learn	1,2

	(Calcium, Phosphorus, Magnesium, Iron, Fluoride, Zinc, Iodine) **Water:** Distribution of water in the body, function of water, requirements and human water balance system, acid base balance		the importance of water in healthy lifestyle.	

TEXT BOOKS

T1: Sumathi R. Mudambi, Rajagopal, M.V., Fundamentals of Foods and Nutrition, New Age International (P) Ltd, Publishers, 6th edition, 2020.

REFERENCE BOOKS

R1: Bamji, M.S., Textbook of Human Nutrition, Oxford, IBH Publishing (P) Ltd, 4th edition 2019.
R2: Srilakshmi, B. Nutrition Science, New Age International (P) Ltd, Publishers 7th edition (2017).

OTHER LEARNING RESOURCES:

https://agritech.tnau.ac.in/nutrition/nutri_food_diet_icmr%20food%20groups.html

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the basic terms related to nutrition and its correlation with human health	**1,2,8**
2	Understand the functioning of nutrients in details.	**1,2,8**
3	Analyze the function of nutrients in terms of disease condition.	**1,2,8**
4	Illustrate the types of disease and their treatments	**1,2,8**
5	Analyze the symptoms of the deficiency disease	**1,2,8**

SEMESTER – I									
Course Title	**ELEMENTARY ENGLISH**								
Course code	**24UBPD111R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre Requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To enable students to identify and use parts of speech, articles, auxiliary verbs, and construct affirmative and negative sentences. 2. To master advanced grammar concepts: Enable students to use determiners, construct various types of sentences, and understand degrees of comparison. 3. To develop speaking skills: Enable students to introduce themselves, use correct pronunciation, intonation, and stress, and effectively ask and offer information.								
CO1	Equip students to recognize and apply parts of speech, articles, and auxiliary verbs, and to create both affirmative and negative sentences.								
CO2	Teach students to apply determiners, form different types of sentences, and comprehend degrees of comparison.								
CO3	Prepare students to confidently introduce themselves, use proper pronunciation, intonation, and stress, and effectively ask for and provide information.								
CO4	Help students grasp the communication process, differentiate between communication types, manage both formal and informal communication, and identify barriers to effective communication.								
CO5	Teach students the key components of an effective presentation and how to use visual aids proficiently.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Basics of Grammar (Flipped classroom)** i. Parts of Speech ii. Articles iii. Auxiliary Verbs iv. Affirmative and Negative Sentences	**6**	Students will demonstrate a fundamental understanding of grammar rules.	1,2, 3
II	**Grammar (Flipped classroom)** i. Determiners ii. Sentence Construction iii. Types of Sentences (Assertive, Imperative, etc.) iv. Degree of Comparison	**6**	Students will construct grammatically correct and varied sentence types.	1,2, 3,4
III	**Speaking Skills** i. Introduction and Greetings ii. Pronunciation, Intonation, Stress iii. Asking and offering information	**5**	Students will confidently introduce themselves and engage in basic conversations with correct pronunciation.	1,2, 3
IV	**Communication Skills** i. Introduction to Communication ii. Process and Types of Communication, iii. Formal and informal communication iv. Understanding Barriers to Communication	**7**	Students will effectively communicate in both formal and informal settings.	1,2, 3
V	**Presentation Skills** i. Introduction ii. Essential characteristics of a good	**8**	Students will deliver well-organized and visually supported	1,2

	presentation iii. Use of Visual Aids in Presentation		presentations.	

TEXTBOOKS:

T1. Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.
T2. Reed, James. 2016. 101 Job Interview Questions You'll Never Fear Again, Plume.
T3. Pease, Barbara. 2006. The Definitive Book of Body Language, RHUS.
T4. McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition)

REFERENCE BOOKS:

R1. Zinsser, William. (2006) On Writing Well: The Classic Guide to Writing Nonfiction Harper Perennial
R2. Taylor J. and Wright, J., IELTS Advantage Reading Skills: A step-by-step guide to a high IELTS reading score, Delta Publishing by Klett.
R3. Kelley, Thea. 2021. Get That Job: The Quick and Complete Guide to a Winning Interview, Plovercrest Press.
R4. Murphy, Raymond,.(2012) English Grammar in Use Book with Answers: A Self- Study and Practice Book for Intermediate Learners of English ,Cambridge University Press

OTHER LEARNING RESOURCES:
https://www.ef.com/wwen/english-resources/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Equip students to recognize and apply parts of speech, articles, and auxiliary verbs, and to create both affirmative and negative sentences.	**3,4,8**
2	Teach students to apply determiners, form different types of sentences, and comprehend degrees of comparison.	**3,4,8**
3	Prepare students to confidently introduce themselves, use proper pronunciation, intonation, and stress, and effectively ask for and provide information.	**3,4,8**
4	Help students grasp the communication process, differentiate between communication types, manage both formal and informal communication, and identify barriers to effective communication.	**3,4,8**
5	Teach students the key components of an effective presentation and how to use visual aids proficiently.	**3,4,8**

SEMESTER – I									
Course Title	**EXTRA-CURRICULAR ACTIVITIES**								
Course code	**24UBEC111R**	**Total credits: 0.5**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**2**	**0**	**0**	**0.5**
Pre Requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To ascertain physical and mental development of the students and select best performers for state, national and international level competition. 2. To enhance and improve student's talents in the field of sports, yoga, music, dance, drama, etc through AdtU club activities and workshops. 3. To strengthen Problem-Solving Skills to solve problems creatively and effectively.								
CO1	Enhance Leadership Skills-Students will develop leadership abilities through various activities.								
CO2	Improve Social Interaction-Students will learn to interact and build relationships with others.								
CO3	Develop Personal Interests and Hobbies- Students will explore and develop their personal interests and hobbies.								
CO4	Strengthen Problem-Solving Skills- Students will improve their ability to solve problems creatively and effectively.								
CO5	Foster Cultural Awareness- Students will gain a better understanding and appreciation of different cultures.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Based on the learner's interest they can participate in various sports, music, and co-curricular activities joining the clubs of the University (Football, Futsal; Cricket; Swimming; Basketball; Badminton; Table Tennis; athletics and other outdoor and indoor games; Dance; Music; Vocals; Photography; Drama; Literary activities); The students are encouraged to participate in regular club activities, workshops, competitions as per their interest and hobbies; Renowned skilled professionals/ personalities are invited organising workshops to promote the talents of the students.	**60**	Students will develop and refine their interests and talents through active participation in diverse sports, music, and co-curricular clubs, benefiting from expert guidance and engaging in workshops and competitions.	1,2

REFERENCE BOOKS:

R1: "Extracurricular Activities: Essential Guides for Students" by John G. Gabriel
R2: "Developing Personal, Social and Emotional Skills through Extra-Curricular Activities" by Sally Bailey

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Enhance Leadership Skills-Students will develop leadership abilities through various activities.	**3,4,8**
2	Improve Social Interaction-Students will learn to interact and build relationships with others.	**3,4,8**
3	Develop Personal Interests and Hobbies- Students will explore and develop their personal interests and hobbies.	**3,4,8**
4	Strengthen Problem-Solving Skills- Students will improve their ability to solve problems creatively and effectively.	**3,4,8**
5	Foster Cultural Awareness- Students will gain a better understanding and appreciation of different cultures.	**3,4,8**

SEMESTER – I									
Course Title	**BASIC CHEMISTRY**								
Course code	**24FSCH101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre Requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To give the knowledge about Chemical Kinetics and Ionic Equilibrium. 2. To give a detailed description of atomic structure, different theories related to it and the knowledge of classical and quantum chemistry. 3. To give the knowledge of the periodic properties and HSAB theory.								
CO1	Identify the order of the rate law equation, then characterize the "half-life" and temperature dependency of reaction rates using the Arrhenius equation.								
CO2	Describe concepts of electrochemistry, electrochemical cells, acids/base, pH, buffers and solubility								
CO3	Describe and analyze atomic structure, Heisenberg Uncertainty principle, Quantum mechanics and Schrodinger wave equation								
CO4	Describe concepts of chemical bonding, periodic properties.								
CO5	Describe the different types of organic reactions along with their mechanisms. organic molecules and their stereochemistry.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Chemical Kinetics:** Order-molecularity. First and second order, nth order rate equation, temperature dependence of rate of reactions.	**5**	To identify the order (0, 1 or 2) associated with each integrated rate law equation, to describe the "half- life" of a chemical reaction. Understand the temperature dependence of rate of reactions through Arrhenius equation.	1,2
II	**Ionic equilibrium:** Electrolytic conductance, Faraday's Law of electrolysis, Electrolytes, Lewis's theory, Arrhenius theory for dissociation of electrolytes, ionization constants of weak acids and bases, pH, buffers, solubility products, salt effects and Solubility	**6**	Describe, illustrate and explain the underlying concepts of electrochemistry, electrochemical cells, acids/base, pH, buffers and solubility	1,2
III	**Atomic Structure:** Recapitulation of Bohr's theory and its limitations, dual behavior of matter and radiation, deBroglie's relation, Heisenberg Uncertainty principle. Need of a new approach to atomic structure. What is Quantum mechanics, Time independent Schrodinger equation and meaning of various terms in it. Wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. (Only graphical representation) Rules for filling electrons in various orbitals, electronic	**5**	Describe, illustrate and explain the atomic structure, Heisenberg Uncertainty principle, Quantum mechanics and Schrodinger wave equation. To learn about the graphical representation of different atomic orbital and how the electrons are filled in the orbital.	1,2

	configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy.			
IV	**Chemical bonding:** Various theories, covalent, hydrogen Bonding. Effective nuclear charge, atomic and ionic sizes. 6 Ionization energies, electron affinity and electronegativity, hard soft acids and bases.	**7**	Describe, illustrate and explain the concepts of chemical bonding by using various theories, periodic properties like Atomic and Ionic size Ionization Energy Electron Affinity, Electronegativity of elements of periodic table.	1,2
V	**Organic Reactions and Stereochemistry:** Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule, Representations of 3 dimensional structures, structural isomers and stereo isomers. Configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.	**7**	Describe, illustrate and explain the different types of organic reactions along with their mechanisms. How to design syntheses of organic molecules. Acquire the knowledge of stereochemistry of organic molecules.	1,2

REFERENCE BOOKS:

R1: Graham Solomons. Solomons's Organic Chemistry, Global Edition. Wiley; 2017.
R2: Bahl, Bahl. A Textbook Of Organic Chemistry. 22th Edition. S Chand Publishing; 2019.
R3: Eliel and Wilen. Stereochemistry of Organic Compounds. 1st Edition. Wiley-Interscience. 1994.

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5869253/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the order of the rate law equation, then characterize the "half-life" and temperature dependency of reaction rates using the Arrhenius equation.	**1**
2	Explain the concepts of electrochemistry, electrochemical cells, acids/base, pH, buffers and solubility	**1,2**
3	Illustrate atomic structure, Heisenberg Uncertainty principle, Quantum mechanics and Schrodinger wave equation.	**1**
4	Elucidate the concepts of chemical bonding, periodic properties.	**1,2**
5	Explain the different types of organic reactions along with their mechanisms, organic molecules and their stereochemistry.	**1,2**

SEMESTER – I									
Course Title	**CELL BIOLOGY**								
Course code	**24BSZO101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre Requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. Introduce and make students understand about the fundamentals and advances of cytology including structure and functions of cell and cell organelles, cell cycle, cell division, also by observing it under microscope. 2. To inculcate knowledge and skills on various staining techniques, and understand cell structure by observing them under microscope 3. Gain proficiency in laboratory techniques commonly used in cell biology research, including microscopy, cell culture, and molecular biology assays.								
CO1	Understand cellular organization, functions, microscopy and structural differences.								
CO2	Describe membrane structure, function, cell organization and the proteins involved in transportation.								
CO3	Elaborate chromosomal structure and types.								
CO4	Understand the mechanism of cell to cell communication.								
CO5	Describe the cell cycle and division in general and in some specific cell types.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Fundamentals of Cell Biology:** (Cell theory, Prokaryote and Eukaryote cell: Structure and Function of cells); **Tools and Technique of Cytology:** (Microscopy and Staining).	**7**	Describe, illustrate and explain cell organization and functions, microscopy and structural differences.	1,2
II	**Cell Membranes:** Model, Structure, function; Cell junctions and adhesion; Transport proteins; Membrane Proteins; Membrane potential; Transport across plasma membrane.	**10**	Describe, illustrate and explain membrane structure, function; cell organization and the proteins involved in transportation.	1,2
III	**Chromosomes:** Morphology (Structural organization: nucleosome, solenoid model, chromatid, centromere and telomere); Types (special type).	**10**	Describe, illustrate and explain chromosomal structure and types.	1,2
IV	**Cell trafficking and signalling**: cell signals; signalling pathways; cell surface receptors, protein phosphorylation; Quorum sensing phenomenon.	**8**	Describe, illustrate and explain the mechanism of cell to cell communication	1,2
V	**Cell Division & Cell Cycle:** regulation, growth and differentiation; Overview of Stem cells, Germ cells, Cancer cells, Apoptosis and Necrotic cell death	**10**	Describe, illustrate and explain the cell cycle and division in general and in some specific cell types	1,2

TEXT BOOKS:

T1: Alberts B, Johnson A, Lewis J, et al. Molecular Biology of the Cell. 4th edition. New York: Garland Science; 2002.

REFERENCE BOOKS:

R1: Cooper GM. The Cell: A Molecular Approach. 2nd edition. Sunderland (MA): Sinauer Associates; 2000.
R2: Ambrose and Dorothy. Cell Biology. 2nd Edition. MEasty, ELBS Publications; 1970.
R3: Sharp, Lester W. Fundamentals of Cytology. 52th edition. Mc Graw Hill Company; 2011.

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/books/NBK9839/?term=cell%20Biolpgy

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand cellular organization, functions, microscopy and structural differences.	**1, 2, 3**
2	Describe membrane structure, function, cell organization and the proteins involved in transportation.	**1, 2, 3**
3	Elaborate chromosomal structure and types.	**1, 2, 3**
4	Understand the mechanism of cell to cell communication.	**1, 3**
5	Describe the cell cycle and division in general and in some specific cell types.	**1, 2, 3**

SEMESTER-II									
Course Title	**COMMUNITY NUTRITION**								
Course Code	**24BSFD121R**	**Total Credits: 4** **Total hours: 45T+30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**2**	**0**	**0**	**0**	**4**
Pre Requisite	**Nil**	**Co-Requisite**	**Nil**						
Programmes	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Spring/ II semester of first year of the programme**								
Course Objectives	1.To know about nutritional problems prevailing in India. 2.To impart nutrition education to the community. 3.To understand and learn assessing nutritional status.								
CO1	Familiarize with nutritional problem**s** revealing among various communities in the society								
CO2	Enable to assess nutritional status of people/groups through different method of assessment.								
CO3	Plan, implement and evaluate nutrition intervention programs to combat malnutrition								
CO4	Understand on national and international agencies to uplifting nutritional status								
CO5	Different method of assessing nutritional status.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Nutrition and Health in National development. Definition, IMR, NMR and MMR. RAP, nutritional status assessment and surveillance. **Nutritional Problems in India**-Malnutrition-meaning, factors contributing to malnutrition, overnutrition. Nutritional disorders-Epidemiology, clinical features, prevention and dietary treatment for Protein Energy malnutrition, nutritional anaemias & vitamin deficiency disorders.	**10**	Learning about nutrition, health and deficiency disorder	1,2
II	**Methods of assessing nutritional status:** a) Sampling techniques, Identification of risk groups, b) Direct assessment-Diet surveys, anthropometric, clinical and biochemical estimation. **c)** Indirect assessment- Food balance sheet, ecological parameters and vital statistics. **Growth chart** Meaning, WHO Chart, and charts used in India, uses, meaning of reference curve and growth curve.	**9**	Learning about various methods to assess the nutritional status	1,2
III	**Communication methods**-introduction, need, audio-visual aids, teaching aids **Nutrition education-** Meaning, objectives, types and methods; Principles of planning, execution and evaluation of nutrition education program; Merits and limitations. **Improvement of nutrition of a community:** Modern methods of improvement or nutritional quality of food, food fortification, enrichment and nutrient supplementations. Nutrition education themes and messages in nutrition and health, Antenatal and postnatal care.	**12**	Learning about nutritional education to improve communication	1,2

IV	**Nutritional and infection relationship:** Immunization and its importance, Food borne infection and intoxication diseases, foods involved, methods of prevention, Infestation of food borne diseases, Outbreak, Prevention signs and control of infection.	**7**	Learning about nutritional deficiency and its relationship	1,2
V	**National and International agencies in uplifting the nutritional status**-WHO, UNICEF, CARE, ICMR, ICAR, CSIR	**8**	Learning about various	1,2
Practical	1. Diet and nutrition surveys: Identification of vulnerable and risk groups. 2. Diet survey for breast-feeding and weaning practices of specific groups. Use of anthropometric measurement in children. 3. Preparation of visual aids. 4. Field visit to observe the working of nutrition and health oriented programmes (survey based result). 5. Visit to hospitals to observe nutritional deficiencies.	**30**	Equip students with the knowledge and skills to conduct dietary and nutritional surveys to identify vulnerable and at-risk populations, particularly focusing on breastfeeding and weaning practices	1,2,3, 4

TEXT BOOKS:

T1: Public Nutrition, Indira Gandhi National Open University School of Continuing Education

REFERENCE BOOKS:

R1: Temple, N. J. and Steyn, N. Community Nutrition for Developing Countries Athabasca University Press and UNISA Press 2016

OTHER LEARNING RESOURCES:

https://www.youtube.com/watch?v=UT4uitoPnwk

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Familiarize with nutritional problems revealing among various communities in the society	**1,2, 8**
2	Enable to assess nutritional status of people/groups through different method of assessment.	**1,2,3,7, 8**
3	Plan, implement and evaluate nutrition intervention programs to combat malnutrition	**1,2,3,7, 8**
4	Understand on national and international agencies to uplifting nutritional status	**1,2,3,7, 8**
5	Different method of assessing nutritional status.	**1,2,3,7, 8**

SEMESTER – II									
Course Title	**FOOD PRESERVATION**								
Course code	**24BSFD122R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Spring/ II semester of first year of the programme**								
Course Objectives	1. To understand importance and need of preservation. 2. To understand principles and process of preservation. 3. To understand different preservation methods.								
CO1	Learn and discuss different preservation techniques and methods in India								
CO2	Provide knowledge on principles and methods of preservation								
CO3	Analyze various canning methods and their effects on the nutritional aspects of food.								
CO4	Describe the processing of Vegetables.								
CO5	Explain the fruit processing methods, focusing on fruit beverages, jam, jelly, marmalade, preserves, candies.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to preservation:** History of Food Preservation. Scope of Food and Vegetable Preservation in India.	**8**	To learn and understand the chronology of food processing and Preservation	1,2
II	**Principles and methods of preservation:** Food Spoilage, Principles of preservation, Methods of preservation: Pasteurization, sterilization, blanching, canning, drying, refrigeration.	**10**	To learn the different preservation method and its principal	1,2
III	**Canning of fruits and vegetables:** Canning: Introduction, can manufacture, canning process, selection of fruits and vegetables, grading, washing, peeling, cutting, blanching, cooling, filling, exhausting, sealing, processing, cooling and storage; types of canning pressure canning and water bath canning, common causes of spoilage in canning of foods.	**12**	To learn the different process of preservation applicable in fruits and vegetable	1,2
IV	**Processing of vegetables:** Pickling, chutneys and Sauces/ketchups, mushroom processing, potato processing, Some other Valuable Products from vegetables.	**10**	To learn the processing and development of preserved product of vegetable	1,2
V	**Processing of fruits:** Fruit Beverages, Jam, Jelly and Marmalade, Preserve, Candied and Crystallized Fruits, Some other Valuable Products from Fruits	**12**	To learn the processing and development of preserved product of fruits	1,2
VI Practical	• Pickling of fruits and vegetables • Pickling of meat and fish • Preparation of chutneys • Preparation of Sauces/ketchups • Preparation of jam and jellies • Preparation of squash, RTS etc.	**30**	Learning and application of processing and preservation of different food groups	1,2,3,4

TEXT BOOKS:

T1: Desrosier, N. W. and Desrosier, J. N. (1987). The Technology of Food Preservation. CBS Publishers and Distributors, New Delhi

REFERENCE BOOKS:

R1: Srivastava, R. P. and Kumar, S. (1998). Fruit and Vegetable preservation –Principles and practices. CBS Publishers and Distributors, New Delhi

OTHER LEARNING RESOURCES:

https://actascientific.com/ASNH/pdf/ASNH-03-0529.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn and discuss different preservation techniques and methods in India	**1,8**
2	Provide knowledge on principles and methods of preservation	**1,2,6,8**
3	Analyze various canning methods and their effects on the nutritional aspects of food.	**1,2,6**
4	Describe the processing of Vegetables.	**1,6**
5	Explain the fruit processing methods, focusing on fruit beverages, jam, jelly, marmalade, preserves, candies.	**1,6**

SEMESTER – II									
Course Title	**BASIC DIETETICS**								
Course code	**24BSFD123R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Spring/ II semester of first year of the programme**								
Course Objectives	1. To study about different aspect of diet modification and adaptations. 2. To study about the different nutrient modification at different disease state. 3. To have comprehensive understanding of diet therapy and the crucial role of dietitians in the healthcare industry								
CO1	Explain the concept of diet therapy and role of a dietician in health care industry.								
CO2	Apply different aspects of diet modification and adaptations for weight management.								
CO3	Explain the importance of a hospital diet in febrile conditions.								
CO4	Apply the knowledge of nutrition in diet modification for gastrointestinal tract disorders.								
CO5	Apply the knowledge of nutrition in diet modification for liver and biliary system problems								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Concept of diet therapy**: growth and source of dietetics, purpose and principles of Therapeutic diets, modification of normal diet, classification of therapeutic diets, role of Dietician, definition of nutritional care, interpersonal relationship with patient, planning and implementary dietary care. Nutritional care process. Medical History assessment. Assessment of patient needs. Dietary counseling-Evaluation of the effectiveness of counseling. Education of the patient and follow up. Role of Dietitian–Professional code and ethics of a dietitian. Problems in feeding children at the hospitals, Psychology of feeding the patient.	**9**	Learning about different concept of diet therapy	1,2
II	**Nutritional care for weight management-** Obesity and overweight: Identification, etiology, dietary management and behavioural modifications. Underweight: Etiology, assessment and dietary management.	**7**	Learning about nutritional care for weight management	1,2
III	**Nutritional care for febrile condition**– Acute, chronic and recurrent: Malaria, Typhoid and TB–Etiology, symptoms and dietary management.	**7**	Learning about nutritional care	1,2
IV	**Nutritional care for diseases of the gastrointestinal tract-** Gastric and duodenal ulcer, diarrhoea, constipation, malabsorption syndrome, hemorrhoids, ulcerative colitis, flatulence and steatorrhea–Etiology,	**7**	Learning about nutritional care for diseases	1,2

	symptoms and dietary management.			
V	**Nutritional care for diseases of liver and biliary system-** Viral hepatitis, cirrhosis of liver, cholelithiasis and cholecystitis: Etiology, symptoms and dietary management.	**10**	Learning about nutritional care for various clinical condition	1,2
VI Practical	Planning, preparations and calculations of diets with modified consistency Planning, preparations and calculations of diets with modified fibre and residue Planning, preparation and calculation of diets in diarrhea Planning, preparation and calculation of diets in constipation Planning, preparation and calculation of diets in peptic ulcer. Planning, preparations and calculations of diets with modified consistency	**30**	Learn to plan & prepare different diet with modified fibre and residue	1,2,3,4

TEXT BOOKS:

T1: Srilakshmi, B., Dietetics, New Age International (P) limited Publications, 2004.

REFERENCE BOOKS:

R1: Joshi, S. A., Nutrition and Dietetics, Tata McGraw Hill Publications, New Delhi, 2004.

OTHER LEARNING RESOURCES:

https://www.youtube.com/watch?v=2K07gJ2t5u8
https://www.youtube.com/watch?v=PXWZ8vzcJI0

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the concept of diet therapy and role of a dietician in health care industry.	**1, 8**
2	Apply different aspects of diet modification and adaptations for weight management.	**1,2,5,8**
3	Explain the importance of a hospital diet in febrile conditions.	**1,2,5,8**
4	Apply the knowledge of nutrition in diet modification for gastrointestinal tract disorders.	**1,2,5,8**
5	Apply the knowledge of nutrition in diet modification for liver and biliary system problems	**1,2,5,8**

SEMESTER – II									
Course Title	**ENVIRONMENTAL SCIENCE**								
Course code	**24UBES101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ II semester of first year of the programme**								
Course Objectives	1. To prepare students for careers as leaders in understanding and addressing complex environmental issues from a problem-oriented, interdisciplinary perspective. 2. To develop a world population that is aware of and concerned about the environment and its associated problems and which has the knowledge, Skills, attitudes, motivations and commitment to work individually and collectively towards solutions of current problems and prevention of new ones. 3. To gain knowledge about the conservation of biodiversity and its importance.								
CO1	The students will be able to appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.								
CO2	Students will learn about natural resource, its importance and environmental impacts of Human activities on natural resource								
CO3	Gain knowledge about environment and ecosystem, Students will be able to understand the concept of biodiversity and respect them								
CO4	Gain knowledge about the conservation of biodiversity and its importance.								
CO5	Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Multidisciplinary nature of environmental studies:** Definition, scope and importance, Need for public awareness.	**4**	Environmental studies combines sciences to tackle environmental issues. Its multidisciplinary approach is key to solving complex problems. Public awareness and education are vital for promoting sustainability	1,2
II	**Natural Resources: Renewable and non-renewable resources,** Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case	**6**	Natural resources, both renewable and non-renewable, face exploitation issues, including deforestation, overuse of water resources, environmental challenges with minerals and food, and land degradation. Individuals play a crucial role in conserving resources and promoting sustainability.	1,2

	studies. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles			
III	**Ecosystems:** Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the Following ecosystem: - Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	**4**	This module covers ecosystems, including their concept, structure, functioning, and diversity. Students will learn about energy flow, ecological succession, and various ecosystem types like forests, grasslands, deserts, and aquatic ecosystems.	1,2
IV	**Biodiversity and its conservation:** Introduction – Definition: genetic, species and ecosystem diversity. Bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a megadiversity nation• Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.	**5**	This module covers biodiversity, including its definition, value, levels, and threats. Students will learn about India's bio-geographical classification, its status as a megadiversity nation, and key biodiversity hotspots. They'll also explore threats like habitat loss, wildlife poaching, and human-wildlife conflicts, crucial for conservation efforts.	1,2
V	**Environmental Pollution:** Definition Cause, effects and control measures of:- Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste, Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.	**5**	This module covers environmental pollution, including causes, effects, and control measures, alongside waste management and disaster preparedness strategies.	1,2
VI	**Social Issues and the Environment:** From Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water	**6**	This module explores social-environmental dynamics, including urban energy challenges, water conservation, and resettlement	1,2

	harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case Studies. **Environmental ethics:** Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Waste land reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.		issues. It delves into environmental ethics, climate change impacts, and relevant legislation like the Environment Protection Act, emphasizing public awareness and enforcement challenges.	
VII	**Human Population and the Environment:** Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Case Studies.	**4**	This module covers human population dynamics, including growth, impact on the environment and health, along with initiatives like Family Welfare Programs and the role of information technology, illustrated with case studies.	1,2
VIII	**Field work:** Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc. (**Field work Equal to 5 lecture hours**)	**5**	Fieldwork objectives include documenting environmental assets like rivers and forests, assessing pollution in urban or rural sites, and studying local biodiversity and ecosystems such as ponds and hill slopes	1,2

REFERENCE BOOKS:

R1**:** Bharucha. Textbook of Environmental Studies for Undergraduate Courses. 2nd edition. Orient Blackswan Publishing; 2019.
R2: Trivedy Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media (R). B.S. Publications; 2010.
R3: Trivedi, Goel. Introduction to air pollution. 1st publication. Techno-Science Publication (TB); 2003.

OTHER LEARNING RESOURCES:

https://pubmed.ncbi.nlm.nih.gov/22274891/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	The students will be able to appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.	**1, 4**
2	Students will learn about natural resource, its importance and environmental impacts of Human activities on natural resource	**1, 4**
3	Gain knowledge about environment and ecosystem, Students will be able to understand the concept of biodiversity and respect them	**1, 4**
4	Gain knowledge about the conservation of biodiversity and its importance.	**1, 4**
5	Aware students about problems of environmental pollution, its impact on human and ecosystem and control measures.	**1, 2, 4**

SEMESTER – II									
Course Title	**IMPLICATIVE ENGLISH (COMMUNICATIVE ENGLISH & SOFT SKILLS)**								
Course code	**24UBPD123R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ II semester of first year of the programme**								
Course Objectives	1. To equip students with the skills to interchange sentence types, use various tenses, and correct common grammatical errors. 2. To enable students to effectively use one-word substitutions, understand homonyms and homophones, avoid commonly confused words, and use idioms and phrases. 3. To help students understand the nature and types of listening, and overcome barriers to effective listening.								
CO1	Provide students with the ability to transform sentence types, utilize different tenses, and address common grammatical mistakes.								
CO2	Empower students to proficiently apply one-word substitutions, differentiate between homonyms and homophones, avoid frequently confused words, and incorporate idioms and phrases in their vocabulary.								
CO3	Assist students in comprehending the various aspects and types of listening, and in identifying and overcoming obstacles to effective listening.								
CO4	Facilitate students in employing effective reading strategies, extracting relevant information from texts, and utilizing the SQ3R method.								
CO5	Instruct students on the significance of time management and provide foundational strategies to manage their time efficiently.								
CO6	Lead students in creating a well-rounded and professional LinkedIn profile.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Grammar (flipped classroom)** i. Interchange of Interrogative and Assertive Sentences, Exclamatory and Assertive Sentences ii. Types of Tenses iii. Common Errors	**6**	Students will accurately construct and transform various sentence types and correct grammatical errors.	1,2, 3
II	**Vocabulary Development** One word substitution Homonyms and Homophones Words often confused Idioms and phrases	**6**	Students will enhance their vocabulary and use words accurately in context.	1,2, 3
III	**Listening Skills** i. What is listening? ii. Types of Listening iii. Understanding Listening Barriers	**5**	Students will demonstrate effective listening skills and identify listening barriers.	1,2, 3
IV	**Reading Skills** i. Techniques of Effective Reading ii. Gathering ideas and information from a text iii. The SQ3R Technique	**5**	Students will read efficiently and extract relevant information using the SQ3R technique.	1,2, 3
V	**Time-Management Skills** i. Introduction to Time Management ii. Purpose and Importance of Time	**4**	Students will effectively manage their time using various strategies.	1,2, 3

	Management iii. Basic Tips to Maintain Time			
VI	**Creation of LinkedIn Profile**	**6**	Students will create a professional LinkedIn profile.	2, 3

Textbooks:

T1: Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.
T2: Reed, James. 2016. 101 Job Interview Questions You'll Never Fear Again, Plume.
T3: Pease, Barbara. 2006. The Definitive Book of Body Language, RHUS.
T4: McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition)

Reference Books:

R1: Zinsser, William. (2006) On Writing Well: The Classic Guide to Writing Nonfiction Harper Perennial
R2: Taylor J. and Wright, J., IELTS Advantage Reading Skills: A step-by-step guide to a high IELTS reading score, Delta Publishing by Klett.
R3: Kelley, Thea. 2021. Get That Job: The Quick and Complete Guide to a Winning Interview, Plovercrest Press.
R4: Murphy, Raymond,.(2012) English Grammar in Use Book with Answers: A Self- Study and Practice Book for Intermediate Learners of English ,Cambridge University Press

OTHER LEARNING RESOURCES:

https://www.ef.com/wwen/english-resources/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Provide students with the ability to transform sentence types, utilize different tenses, and address common grammatical mistakes.	**2,3,4,8**
2	Empower students to proficiently apply one-word substitutions, differentiate between homonyms and homophones, avoid frequently confused words, and incorporate idioms and phrases in their vocabulary.	**2,3,4,8**
3	Assist students in comprehending the various aspects and types of listening, and in identifying and overcoming obstacles to effective listening.	**2,3,4,8**
4	Facilitate students in employing effective reading strategies, extracting relevant information from texts, and utilizing the SQ3R method.	**2,3,4,8**
5	Instruct students on the significance of time management and provide foundational strategies to manage their time efficiently.	**2,3,4,8**

SEMESTER – II									
Course Title	**CO-CURRICULAR ACTIVITIES**								
Course code	**24UBCC121R**	**Total credits: 0.5**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**2**	**0**	**0**	**0.5**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ II semester of first year of the programme**								
Course Objectives	1. Develop students' interpersonal skills, emotional intelligence, and teamwork abilities through participation in diverse co-curricular activities. 2. Foster leadership qualities and organizational skills by providing opportunities for students to take on leadership roles and manage events or projects within co-curricular activities. 3. To be aware of their role in society and contribute positively.								
CO1	Improve Interpersonal and Teamwork Skills- Students will learn to work well with others and communicate better.								
CO2	Develop Time Management and Organizational Skills - Students will learn to manage their time and stay organized.								
CO3	Boost Creativity and Critical Thinking - Students will enhance their creative abilities and think more critically.								
CO4	Promote Physical and Mental Health - Students will improve their overall health and reduce stress.								
CO5	Encourage Social Responsibility and Civic Engagement - Students will become more aware of their role in society and contribute positively.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Based on the learner's interest they can improving interpersonal and teamwork skills, developing time management and organizational skills, boosting creativity and critical thinking, promoting physical and mental health, and encouraging social responsibility and civic engagement. They will engage in regular club activities, workshops, and competitions that align with their interests and hobbies, fostering their social and emotional development. Renowned professionals will conduct workshops to enhance students' talents. Assessments will include participation in activities, reflection essays, journals, and evaluations of their involvement in workshops and events. Through these experiences, students will learn to work well with others, communicate effectively, manage their time, stay organized, enhance creativity, think critically, improve their health, reduce stress, and contribute positively to society.	**60**	Skill Development: Enhancing skills such as teamwork, leadership, communication, and critical thinking. Holistic Growth: Supporting emotional, social, and physical development alongside academic learning. Building Networks: Creating opportunities to interact with peers, mentors, and professionals. Personal Fulfillment: Providing avenues for creativity, self-expression, and exploring personal interests.	1,2

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve Interpersonal and Teamwork Skills- Students will learn to work well with others and communicate better.	**2,3,4,8**
2	Develop Time Management and Organizational Skills - Students will learn to manage their time and stay organized.	**2,3,4,8**
3	Boost Creativity and Critical Thinking - Students will enhance their creative abilities and think more critically.	**2,3,4,8**
4	Promote Physical and Mental Health - Students will improve their overall health and reduce stress.	**2,3,4,8**
5	Encourage Social Responsibility and Civic Engagement - Students will become more aware of their role in society and contribute positively.	**2,3,4,8**

SEMESTER – III									
Course Title	**FOOD MICROBIOLOGY**								
Course code	**24BSFD214R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. To know about microbiology. 2. To know food contamination and spoilage. 3. To Acquire knowledge of the morphology, classification, and role virus and algae.								
CO1	Discuss the history of microbiology.								
CO2	Describe the role and importance of bacteria in food microbiology.								
CO3	Comprehend the morphology, physiology, and role of fungi in food microbiology.								
CO4	Understand the occurrence, classification, and diseases caused by viruses.								
CO5	Acquire knowledge of the morphology, classification, and role of algae.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction & History of Microbiology-**The theory of Spontaneous generation, different terminology, heterotrophic nutrition, autotrophic nutrition, saprophytic holozoic, host culture, parasites	**3**	Learning about basic terms related to microbiology	1,2
II	**Bacteria** - morphology, reproduction, growth curve, genera, importance in food microbiology	**5**	Learning about role of bacteria in food microbiology	1,2
III	**Fungi** - Morphology, reproduction, classification, physiology & nutrition,	**7**	Learning about role of Fungi in food microbiology	1,2
IV	**Virus**- Occurrence, morphology, reproduction, classification, diseases	**5**	Learning about role of virus in food microbiology	1,2
V	**Algae**-Occurrence, morphology, reproduction, importance, general principles of spoilage, fitness & refines, of food microorganisms in food factors affecting growth.	**5**	Learning about role of algae in food microbiology	1,2
VI Practical	Study of equipments in a microbiology lab Preparation of laboratory media and special media, cultivation of bacteria, yeasts and molds Staining of bacteria: gram-staining Cultivation and identifications of important molds and yeast in food items Demonstration of available rapid methods and diagnostic kits used in identification of microorganisms or their products.	**30**	Learning about equipments used in microbiology lab Learning about preparation of media, straining of bacteria, molds and yeasts in food items and diagnostic methods for identification of microorganisms	1,2, 3,4

TEXT BOOKS:

T1: Ray B. and Bhunia A. Fundamental Food Microbiology, CRC Press Fifth Edition, 2014

REFERENCE BOOKS:

R1: Frazier, Westhoff, Vanitha N M, Food Microbiology, 5th Edition, 2014

OTHER LEARNING RESOURCES:

https://www.researchgate.net/publication/358954675_introduction_history_and_development_of_microbiology

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss the history of microbiology.	**1,2**
2	Describe the role and importance of bacteria in food microbiology.	**1,2**
3	Comprehend the morphology, physiology, and role of fungi in food microbiology.	**1,2**
4	Understand the occurrence, classification, and diseases caused by viruses.	**1,2**
5	Acquire knowledge of the morphology, classification, and role of algae.	**1,2**

SEMESTER – III									
Course Title	**NUTRITIONAL BIOCHEMISTRY**								
Course code	**24BSFD213R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. To review about the different biochemical metabolism reaction of the body. 2. To understand how this metabolism takes place in co-relation with the nutrients of the food. 3. To assess fluid, electrolyte, and acid-base balance and to make informed clinical management strategies during imbalance								
CO1	Discuss the basic metabolic reaction of the body.								
CO2	Apply the knowledge of enzymes in terms of their structure, classification, properties and metabolic processes.								
CO3	Analyze the various classes of lipids and correlate their catabolic and anabolic pathways								
CO4	Demonstrate the ability to assess fluid, electrolyte, and acid-base balance and to make informed clinical management strategies during imbalance.								
CO5	Explain the importance and clinical manifestations of hormones and their associated imbalances and disorders								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Carbohydrates-**Definition, classification. Structure (linear) of Monosaccharide-Glucose, fructose and galactose; Disaccharides-Maltose, lactose and sucrose; Polysaccharides-Starch and glycogen. Metabolism-Glycolytic pathway, electron transport chain and oxidative phosphorylation. Metabolism of carbohydrates: glycolysis and tricarboxylic acid (TCA) cycle, HMP shunt.	**9**	Learning about the structure and function of carbohydrates	1,2
II	**Protein-** Definition, classification, structure, physical properties, chemical properties and utilization. Metabolism of proteins:- Transamination, deamination, decarboxylation, urea cycle. Enzymes and co-enzymes-Definition, types, classification and factors affecting velocity of enzyme catalyzed reactions. Diagnostic value of serum enzymes - Creatinine kinase, Alkaline phosphatase, Acid phosphatase, LDH, SGOT, SGPT, Amylase, Lipase, Carbonican hydrase etc.	**10**	Learning about the structure and function of proteins	1,2
III	**Lipids-**Definition, classification and properties. Metabolism- Oxidation and biosynthesis of fatty acids. Ketone bodies, ketogenesis and ketosis.	**10**	Learning about the structure and function of lipids	1,2
IV	**Acid – base balance-** Acid-base balance in normal health, definition of buffers, principles of buffers, major sources of acid	**13**	Learning about the role of fluids and electrolytes	1,2

	produced in the body, physiological buffer system and role of different buffer systems. **Fluid and electrolyte balance-**Distribution of fluids in the body, ECF, ICF, Water metabolism, dehydration. Maintenance in normal health.			
V	**Hormones -** Classification, general mode of action, hormones of Pituitary, Thyroid, Parathyroid, Adrenals, Reproductive Glands, Pancreas, hormonal disorders, counter regulatory hormones.	**12**	Learning about the classification and function of hormones	1,2
VI Practical	Identification of carbohydrates (Qualitative Tests) Identification of proteins (Qualitative Tests) To study general properties of the enzyme Urease & Achromatic time of salivary amylase. Estimation of glucose in urine by Benedict's methods Urine analysis - normal and abnormal constituents of urine.	**30**	Learning about analysis of carbohydrates Learning about analysis of proteins Learning about properties of enzymes Learning about analysis of glucose Learning about analysis of urine	1,2,3 ,4

TEXT BOOKS:

T1: Deb. A C., Fundamental of Biochemistry, New Central Book Agency (P) Ltd, reprint 2004

REFERENCE BOOKS:

R1: Pattabiraman. T.N. Concise text Book of Bio- Chemistry, 2nd edition, All India Publishers and Distributors, Regd., 1998.
R2: Ambika Shanmugam, Fundamentals of biochemistry for Medical students, Karthik printers, 7th edition, 1992.

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/books/NBK557556/
https://dhingcollegeonline.co.in/attendence/classnotes/files/1603564542.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss the basic metabolic reaction of the body.	**1**
2	Apply the knowledge of enzymes in terms of their structure, classification, properties and metabolic processes.	**1,8**
3	Analyze the various classes of lipids and correlate their catabolic and anabolic pathways	**1**
4	Demonstrate the ability to assess fluid, electrolyte, and acid-base balance and to make informed clinical management strategies during imbalance.	**1,2**
5	Explain the importance and clinical manifestations of hormones and their associated imbalances and disorders	**1**

SEMESTER – III									
Course Title	**FOOD TECHNOLOGY I**								
Course code	**24BSFD212R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science Food, Nutrition & Dietetics**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. To know about processing of cereals, pulses, oilseeds, fruits and vegetables, meat etc. 2. To know about preservation of various foods. 3. To learn about post-mortem changes in meat and various preservation methods.								
CO1	Learn about the processing technology and composition of cereals and millet.								
CO2	Explain the processing technology and composition of pulses and legumes.								
CO3	Acquire knowledge about the processing and quality attributes of fats and oils.								
CO4	Learn about the classification and post-harvest changes in fruits and vegetables.								
CO5	Analyze the post-mortem changes in meat and various preservation methods.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Cereal & Millets:** Processing of cereals, Composition and uses, by-products of cereals and coarse cereals, Process of malting, Gelatinization of starch, types of browning. Rice-Composition of rice obtained by different dehusking methods, milling of rice, by-products of rice milling, Processing-Milling, polishing, parboiling, flaking, parching, roasting. Millets-Varieties, composition and uses of maize, sorghum, barley, rye, oats, triticale, pearl millet and finger millet.	**9**	Learning about structure, use and processing of cereals and millets	1,2
II	**Pulses & Legumes:** Milling of legumes, processing of pulses-soaking, germination, decortications, cooking and fermentation. Toxic constituents in pulses and its detoxification processes. New improved technologies of legume processing- canning, quick cooking legumes, instant legume powder, legume protein concentrates	**10**	Learning about structure, use and processing of pulses and legumes	1,2
III	**Fats and Oils** - Methods of oil extraction, refining of oil, types- steam refining, alkali refining, bleaching, steam, deodorization, hydrogenation, winterization, randomization/ Interest erification, Rancidity - hydrolytic and oxidative rancidity and its prevention. Define - margarine, butter, hydrogenated vegetable oil, lard.	**13**	Learning about processing and quality attributes of fats and oils	1,2
IV	**Fruits and Vegetables** Classification of fruits and vegetables, general composition, enzymatic browning, names and sources of pigments, Post harvest change in fruits and vegetables – Climateric rise, horticultural maturity, physiological maturity, physiological changes, physical changes, chemical changes,	**10**	Learning about quality attributes, Use and processing of fruits and vegetables	1,2

	pathological changes during the storage of fruits and vegetables.			
V	**Meat** - post mortem changes, ageing of meat, tenderizing meat, storage & preservation of meat, cuts & grades of meat. **Fish**-preservation of fish-drying, curing, brining, fermentation. **Poultry**- Preservation of eggs, egg powder, frozen eggs.	**12**	Learning about quality attributes and preservation methods of meat, fish and poultry	1,2
VI Practical	Market survey on processed foods Introduction to laboratory Instrutments/equipments Development of processed cereal products Development of processed pulse products Development of processed product from meat and fish	**30**	Learning about the availability of different processed foods in the market equipments used for processing and preservation.	1,2,3,4

TEXT BOOKS:

T1: Rahman, M. S., Handbook of Food Preservation. MARCELDEKKER Inc. 1999

REFERENCE BOOKS:

R1: James G. Brennan, Food Processing Handbook, 2011

OTHER LEARNING RESOURCES:

https://www.fssai.gov.in/upload/uploadfiles/files/Manual_Meat_Fish_09_01_2017(1).pdf
https://www.pfndai.org/Document/Association_News/dairy_processing/Dairy_Products_Processing-_Dr_Kanade.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn about the processing technology and composition of cereals and millet.	**1**
2	Explain the processing technology and composition of pulses and legumes.	**1**
3	Acquire knowledge about the processing and quality attributes of fats and oils.	**1**
4	Learn about the classification and post-harvest changes in fruits and vegetables.	**1,8**
5	Analyze the post-mortem changes in meat and various preservation methods.	**1,2**

SEMESTER – III									
Course Title	**TECHNO PROFESSIONAL COURSE I (TECHNIQUES OF PRESERVATION)**								
Course code	**24BSFD214R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ III semester of second year of the programme III**								
Course Objectives	1. To understand importance and need of preservation. 2. To understand principles and process of preservation. 3. To understand different preservation methods.								
CO1	To equip learners with practical knowledge and skills in various food preservation methods.								
CO2	To develop an understanding of the principles behind different preservation techniques.								
CO3	To enhance food safety and hygiene practices during food preservation.								
CO4	To promote the utilization of locally available resources for food preservation.								
CO5	To foster entrepreneurial skills related to food preservation.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Hands-on training in various preservation techniques. Traditional Preservation Methods	**8**	To learn and understand the chronology of food processing and preservation	1,2
II	Demonstration and practice of food hygiene and safety practices	**10**	To learn the different preservation method and its principal	1,2
III	Preparation of preserved food products. Pickling, chutneys and Sauces/ketchups, mushroom processing, potato processing, Some other Valuable Products from vegetables.	**12**	To learn the different process of preservation applicable in fruits and vegetable	1,2
IV	Packaging and labeling of preserved products	**10**	To learn the development and labeling of preserved product of vegetable	1,2
V	Mock food stalls and market simulations	**12**	To learn the techniques of selling the products in market	1,2

TEXT BOOKS:

T1: Desrosier, N. W. and Desrosier, J. N. (1987). The Technology of Food Preservation. CBS Publishers and Distributors, New Delhi

REFERENCE BOOKS:

R1: Srivastava, R. P. and Kumar, S. (1998). Fruit and Vegetable preservation –Principles and practices. CBS Publishers and Distributors, New Delhi

OTHER LEARNING RESOURCES:

https://actascientific.com/ASNH/pdf/ASNH-03-0529.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	To equip learners with practical knowledge and skills in various food preservation methods.	**1,8**
2	To develop an understanding of the principles behind different preservation techniques.	**1,2,6,8**
3	To enhance food safety and hygiene practices during food preservation.	**1,2,6**
4	To promote the utilization of locally available resources for food preservation.	**1,6**
5	To foster entrepreneurial skills related to food preservation.	**1,6**

SEMESTER – III									
Course Title	**ENGLISH LANGUAGE FOR EXCELLENCE**								
Course code	**24UBPD212R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. To understand and apply grammar rules effectively. 2. To develop clear and structured writing skills. 3. To cultivate self-management skills.								
CO1	Enable students to use prepositions, construct simple, complex, and compound sentences, and distinguish between active and passive voice.								
CO2	Teach students the basics of writing, how to avoid ambiguity, write paragraphs and letters, and prepare resumes and cover letters.								
CO3	Help students conduct SWOT analyses, practice self-regulation, and maintain personal hygiene.								
CO4	Equip students with knowledge about non-verbal communication, types of body language, and their impact.								
CO5	Train students in planning and conducting group discussions, effectively disagreeing, and summarizing to attain objectives.								
CO6	Prepare students for personal interviews, answer common interview questions, follow telephone interview etiquettes, and adhere to dress code and grooming standards.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Grammar (Flipped classroom)** i. Use of Prepositions ii. Simple, complex, compound sentences iii. Active and Passive Voice	**6**	Students will correctly use prepositions, create various sentence structures, and convert between active and passive voice.	2, 3
II	**Writing Skills** i. The Basics of Writing; avoid ambiguity and vagueness ii. Paragraph Writing iii. Letter Writing iv. Resume and Cover Letter	**6**	Students will write clear and structured paragraphs, letters, resumes, and cover letters.	3, 4
III	**Self-Management Skills** i. SWOT Analysis ii. Self-Regulation iii. Personal Hygiene	**5**	Students will perform SWOT analyses, self-regulate, and adhere to personal hygiene practices.	3, 4
IV	**Non- Verbal Communication-Sciences of Body Language** i. What is Non-Verbal Communication & Body Language ii. Types of Body Language, iii. Importance and Impact of Body Language,	**5**	Students will understand and effectively use different types of body language in communication.	2, 3
V	**Group Discussion** i. Planning and Elements of Group Discussion ii. Effectively disagreeing, iii. Summarizing and Attaining the Objective.	**5**	Students will plan and participate in group discussions, disagree constructively, and summarize discussions.	3, 4

VI	**Interview Skills & Dress code Ethics** i. Personal Interview – Concept and Practice ii. Common Interview Questions and answering Strategies iii. Telephone Interview Etiquettes iv. Introduction to Dress Code and Grooming	**5**	Students will demonstrate effective interview techniques, answer common questions, follow telephone etiquettes, and dress appropriately.	2, 3

TEXTBOOKS:

T1: Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.
T2: Reed, James. 2016. 101 Job Interview Questions You'll Never Fear Again, Plume.
T3: Pease, Barbara. 2006. The Definitive Book of Body Language, RHUS.
T4: McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition)

REFERENCE BOOKS:

R1: Zinsser, William. (2006) On Writing Well: The Classic Guide to Writing Nonfiction Harper Perennial
R2: Taylor J. and Wright, J., IELTS Advantage Reading Skills: A step-by-step guide to a high IELTS reading score, Delta Publishing by Klett.
R3: Kelley, Thea. 2021. Get That Job: The Quick and Complete Guide to a Winning Interview, Plovercrest Press.
R4: Murphy, Raymond, (2012) English Grammar in Use Book with Answers: A Self- Study and Practice Book for Intermediate Learners of English, Cambridge University Press

OTHER LEARNING RESOURCES:

https://learning.shine.com/talenteconomy/career-help/top-group-discussionskills
https://www.coursera.org/articles/conflict-management

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Enable students to use prepositions, construct simple, complex, and compound sentences, and distinguish between active and passive voice.	**3,4,7,8**
2	Teach students the basics of writing, how to avoid ambiguity, write paragraphs and letters, and prepare resumes and cover letters.	**3,4,7,8**
3	Help students conduct SWOT analyses, practice self-regulation, and maintain personal hygiene.	**3,4,7,8**
4	Equip students with knowledge about non-verbal communication, types of body language, and their impact.	**3,4,7,8**
5	Train students in planning and conducting group discussions, effectively disagreeing, and summarizing to attain objectives.	**3,4,7,8**

SEMESTER – III									
Course Title	**BASIC LIFE SAVING SKILLS (BLSS)**								
Course code	**24UULS202R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. The aim of the course is to provide the learners with basic knowledge and practical skills needed in an emergency fire situation. 2. To provide appropriate basic management and treatment for injuries. 3. To learn about the fire equipments requirements, methods of operation and getting out alive.								
CO1	The students will be able to recognize respiratory arrest/ cardiac arrest, and provide oxygen to the patients to sustain tissue viability								
CO2	The students will be able to perform the importance of early CPR on Adult, child and infants victims								
CO3	The students will be able to prevent injury from getting worse, aiding recovery, relieving pain and protecting the victims from deterioration								
CO4	Importance of physiology in forestry								
CO5	The students will be able to learn about the fire equipments requirements, methods of operation and getting out alive.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Basic Life Support (BlS)** • Introduction of BLS • Chain of survival • ABCs Assessment • CPR and Ventilation Technique • AED • Choking for adult and children	**5**	To acquire the knowledge and skills necessary to effectively perform cardiopulmonary resuscitation (CPR), use an automated external defibrillator (AED), and manage choking emergencies in adults and children within the context of the chain of survival.	1,2
II	**First Aid** • Golden rules of First aid • First aid Kits	**5**	To understand and apply the Golden Rules of First Aid and the appropriate use of First Aid Kits in emergency situations	1,2
III	**Trauma emergencies** • Introduction • Priorities of Initial approach in pre-hospital care • Scene safety • Primary assessment • Bleeding control • Extrication of victims and safe transfer •Cervical spine stabilization and C-collar application • Splinting of broken Limbs	**5**	To understand and apply the principles of initial trauma care, including scene safety, primary assessment, bleeding control, extrication techniques, cervical spine stabilization, and splinting of broken limbs, in pre-hospital emergency situations.	1,2
IV	**Triage system** • Introduction • Flow chart approach of Triage	**5**	To understand the principles of Triage, including its introduction, flowchart-based	1,2

	• Triage of Single and Multiple Casualties in Pre-Hospital setting		approach, and its application in assessing and prioritizing treatment for both single and multiple casualties in pre-hospital settings.	
V	**Medical emergencies** Introduction Victim centred approach and Management of:- • Seizures • heart attack • asthma • diabetic emergencies • emergency childbirth • Respiratory distress and failure	**4**	To understand the principles of victim-centered care and effectively manage medical emergencies including seizures, heart attacks, asthma, diabetic emergencies, emergency childbirth, and respiratory distress/failure.	1,2
VI	**Environmental Emergency** • Recognizing and caring for heat related illness such as: Heat stroke, • heat cramps, heat exhaustion, dehydration. • Recognizing and caring for cold related illness such as frostbite, • hypothermia. • Poisoning, Snake bite.	**3**	To develop the ability to recognize and provide appropriate care for individuals suffering from heat-related illnesses (heat stroke, heat cramps, heat exhaustion, dehydration), cold-related illnesses (frostbite, hypothermia), poisoning, and snake bites in emergency situations.	1,2
VII	**Safety of people in the event of fire** • Recognition of possible fire sources and emergency procedures, • Construction techniques for eliminating fire. •Types of detecting devices and extinguishing agents and systems • Devising procedures in the event of fire and react to fire danger. • Safety goals and objectives, Identifying hazards and risks	**3**	To develop the knowledge and skills necessary to ensure the safety of people and property by understanding fire sources, implementing fire prevention techniques, utilizing appropriate fire detection and suppression systems, and establishing effective emergency procedures.	1,2

REFERENCE BOOKS:

R1: Nancy Caroline's Emergency Care in the streets eight edition by Jones and Bartlett
R2: First Aid book by LC Gupta; Publisher Jaypee Brothers, 7th Edition.

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	The students will be able to recognize respiratory arrest/ cardiac arrest, and provide oxygen to the patients to sustain tissue viability	**1,8**
2	The students will be able to perform the importance of early CPR on Adult, child and infants victims	**1,8**
3	The students will be able to prevent injury from getting worse, aiding recovery, relieving pain and protecting the victims from deterioration	**1,8**
4	Importance of physiology in forestry	**1,8**
5	The students will be able to learn about the fire equipments requirements, methods of operation and getting out alive.	**1,8**

SEMESTER – III									
Course Title	**PERSONAL FINANCIAL PLANNING**								
Course code	**24UUFL202R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. The course would offer an inclusive approach to understand the relevant concepts of money, borrowing, lending, taxes and their application to financial planning. 2. Assess the personal financial planning process, the life cycle of financial plans, and methods of goal achievement. 3. Formulate a budget, record-keeping system, and tax planning strategy based on current financial goals								
CO1	Develop a cash management strategy and a plan to facilitate the home or automobile buying process								
CO2	Design a diversified investment portfolio that addresses several different investment objectives.								
CO3	Differentiate between open- and closed-end mutual funds, exchange-traded funds, and direct or indirect real estate investments.								
CO4	Create a financial plan that covers your income needs in retirement and helps protect you and your estate.								
CO5	Formulate a budget, record-keeping system, and tax planning strategy based on current financial goals								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Fundamentals of Financial Planning –** i. Functions of money; ii. Inflation- Meaning, causes, how it can be controlled; iii. process official planning, iv. Time value of money-simple and compound interest; v. Net Present Value and Future value, vi. Power of Compounding; vii. Doubling period and Rule of 72.	**6**	To understand the fundamental concepts of finance, including the functions of money, the impact of inflation, the principles of financial planning, the time value of money (simple and compound interest, NPV, and future value), the power of compounding, and the doubling period and Rule of 72.	1,2
II	**Income Tax Planning–** i. Meaning of Income, ii. Direct & Indirect Taxes, Taxable Income, various heads of Income for tax Calculation, iii. Non-taxable Income, iv. Tax evasion and tax avoidance, v. GST, Tax Planning Strategies	**6**	To understand the concepts of income, direct and indirect taxes, taxable and non-taxable income, explore tax evasion and avoidance, and learn to apply various tax planning strategies within the framework of GST.	1,2
III	**Entrepreneurial planning –** i. Meaning of Entrepreneurship, prerequisites for becoming an entrepreneur, ii. Entrepreneurship Support Systems in India, iii. Institutional support systems for entrepreneurs,	**6**	To understand the concept of entrepreneurship, its prerequisites, and to analyze the various support systems available in India, including government assistance,	1,2

	iv. Financial support systems for entrepreneurs; v. Venture Capital, Business Angels, vi. Assistant of Government, vii. Commercial Bank Loans and Overdraft.		financial institutions, venture capital, and angel investors, for successful entrepreneurial ventures.	
IV	**Planning for investing in securities market** i. Investment avenues offered by Securities Markets, Primary Market and Secondary Market, ii. Stock market- meaning, features, functions of NSE, BSE DEMAT trading account, iii. Security repository, stock brokers, Operational aspects of securities markets: placement of orders, contract note, pay-in and pay-out, trading and settlement cycle, iv. Various risks involved in investing in securities markets; Role of Financial Intermediaries; Stock indices. v. Mutual Funds- meaning concept, definition, types, importance and drawbacks of mutual funds, mutual funds in India, investing in mutual funds, vi. Systematic Investment Plan (SIP) and its advantages.	**6**	To understand and evaluate investment avenues in the securities market, including stock markets, mutual funds, and their operational aspects, while identifying and mitigating associated risks through knowledge of financial intermediaries and investment strategies like SIP.	1,2
V	**Planning for debts and Retirement** i. Consumer credit - Introduction to consumer credit; choosing a source of credit, the cost of credit alternatives, ii. Consumer Legal Protection; iii. Housing Decision: Factors and Finance; Vehicle Decisions. iv. Retirement planning - Meaning of cost of living; retirement need analysis; development of retirement plan, various retirement schemes. v. Estate Planning; Pension and Medicare Planning; Wills.	**6**	To develop a comprehensive understanding of financial planning principles, including consumer credit management, housing and vehicle financing, retirement planning strategies (including need analysis, investment options, and retirement schemes), and estate planning considerations (including pension, Medicare, and wills).	1,2

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Develop a cash management strategy and a plan to facilitate the home or automobile buying process	**7,8**
2	Design a diversified investment portfolio that addresses several different investment objectives.	**7,8**
3	Differentiate between open- and closed-end mutual funds, exchange-traded funds, and direct or indirect real estate investments.	**7,8**
4	Create a financial plan that covers your income needs in retirement and helps protect you and your estate.	**7,8**
5	Formulate a budget, record-keeping system, and tax planning strategy based on current financial goals	**7,8**

SEMESTER – III									
Course Title	**RURAL SOCIOLOGY AND GENDER INCLUSION IN AGRICULTURE**								
Course code	**24BSFD201R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. To know the intricate relationship between rural societies, gender dynamics, and agricultural practices. 2. To explore the social, economic, and cultural factors that shape rural communities, with a particular focus on gender roles, inequalities, and empowerment. 3. To understand the impact of government policies and development programs on rural communities, particularly women farmers.								
CO1	Understand the complex social structures and institutions in rural areas, including caste, class, and kinship systems.								
CO2	Analyze the traditional and evolving gender roles and relations in rural societies, particularly in agriculture.								
CO3	Identify and critically examine the gender-based inequalities prevalent in rural areas, including access to resources, decision-making power, and opportunities.								
CO4	Evaluate various rural development theories and practices, with a focus on gender-sensitive approaches.								
CO5	Assess the impact of government policies and development programs on rural communities, particularly women farmers.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Sociology and Rural sociology:** Definition and scope, its significance in agriculture extension, Rural society.	**10**	To learn about sociology and rural sociology	1,2
II	**Social Groups**, Social Stratification, Culture concept, Social Institution, Social Change & Development	**7**	To learn about Social Groups, Social Stratification	1,2
III	**Health and Nutritional Status of Women in Agriculture**, Major Causes for Poor Health and Nutritional Status Among Rural Women, Effects of Poor Health & Nutritional Status	**10**	To discuss about health and Nutritional Status of Women in Agriculture	1,2
IV	**Activities of Women in Agriculture & Allied Sectors**: Role of women in Crop production, Post Harvesting, Livestock, Fisheries, Forestry Home management, Rural Production and Food Security	**10**	To discuss about the activities of Women in Agriculture & Allied Sectors	1,2
V	**Status Of Women in Rural Families:** Measures to improve the social and economic status of rural women	**8**	To discuss about the status of Women in Rural Families	1,2

TEXT BOOKS:

T1: Norman N. Potter and Joseph H. Hotchkiss, Food Science, CBS publishers and distributors, Fifth edition, 2000

REFERENCE BOOKS:

R1: Manay Shakunthala, Nand Shadaksharaswamy M. Foods facts and Principles, New Age International (P) Ltd Publishers, Reprint 2005.
R2: Srilakshmi B. Food Science, New Age International (P) Ltd Publishers, Third edition, 2005.

OTHER LEARNING RESOURCES:

https://raubikaner.org/wp-content/themes/theme2/PDF/AGEXT-111.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the complex social structures and institutions in rural areas, including caste, class, and kinship systems.	**1,2**
2	Analyze the traditional and evolving gender roles and relations in rural societies, particularly in agriculture.	**1,2**
3	Identify and critically examine the gender- based in equalities prevalent in rural areas, including access to resources, decision-making power, and opportunities.	**1,2,4**
4	Evaluate various rural development theories and practices, with a focus on gender-sensitive approaches.	**1,2**
5	Assess the impact of government policies and development programs on rural communities, particularly women farmers.	**1,2,7**

SEMESTER – III									
Course Title	**CO-CURRICULAR ACTIVITIES**								
Course code	**24UBCC211R**	**Total credits: 0.5**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**2**	**0**	**0**	**0.5**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. Develop students' interpersonal skills, emotional intelligence, and teamwork abilities through participation in diverse co-curricular activities. 2. Foster leadership qualities and organizational skills by providing opportunities for students to take on leadership roles and 3. Manage events or projects within co-curricular activities.								
CO1	Improve Interpersonal and Teamwork Skills- Students will learn to work well with others and communicate better.								
CO2	Develop Time Management and Organizational Skills - Students will learn to manage their time and stay organized.								
CO3	Boost Creativity and Critical Thinking - Students will enhance their creative abilities and think more critically.								
CO4	Promote Physical and Mental Health - Students will improve their overall health and reduce stress.								
CO5	Encourage Social Responsibility and Civic Engagement - Students will become more aware of their role in society and contribute positively.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Based on the learner's interest they can improving interpersonal and teamwork skills, developing time management and organizational skills, boosting creativity and critical thinking, promoting physical and mental health, and encouraging social responsibility and civic engagement. They will engage in regular club activities, workshops, and competitions that align with their interests and hobbies, fostering their social and emotional development. Renowned professionals will conduct workshops to enhance students' talents. Assessments will include participation in activities, reflection essays, journals, and evaluations of their involvement in workshops and events. Through these experiences, students will learn to work well with others, communicate effectively, manage their time, stay organized, enhance creativity, think critically, improve their health, reduce stress, and contribute positively to society.	**60**	To foster holistic development by cultivating interpersonal, teamwork, time management, and organizational skills, while nurturing creativity, critical thinking, and a sense of social responsibility through engaging extracurricular activities, workshops, and mentorship from renowned professionals.	1,2

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve Interpersonal and Teamwork Skills- Students will learn to work well with others and communicate better.	**3,4,7,8**
2	Develop Time Management and Organizational Skills - Students will learn to manage their time and stay organized.	**3,4,7,8**
3	Boost Creativity and Critical Thinking - Students will enhance their creative abilities and think more critically.	**3,4,7,8**
4	Promote Physical and Mental Health - Students will improve their overall health and reduce stress.	**3,4,7,8**
5	Encourage Social Responsibility and Civic Engagement - Students will become more aware of their role in society and contribute positively.	**3,4,7,8**

SEMESTER IV									
Course Title	**INSTITUTIONAL FOOD SERVICE MANAGEMENT**								
Course code	**24BSFD211R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Spring/ IV semester of second year of the programme**								
Course Objectives	1. To introduce with catering industry and food service system. 2. To know about principles, tools and techniques of management. 3. To apply the knowledge of financial and personnel management in a food service unit								
CO1	Classify the food service system its components, and assess their functions.								
CO2	Acquire knowledge of floor planning, layout characteristics, and equipment necessary for food service facilities.								
CO3	Develop a menu plan and learn to standardize different recipes.								
CO4	Explain the food service management system								
CO5	Apply the knowledge of financial and personnel management in a food service unit								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Catering industry-**Definition of catering. Classification of food service institutions according to a. Function: Profit oriented, service oriented and public health facility oriented. b. Processing method: Conventional system, commissary system and fast food service systems. Service of food: Self service, tray service and waiter-waitress service.	**9**	Learning about functioning of food service institutions	**1,2**
II	**Floor planning and layout-**Characteristics of typical food service facilities. Plan of work areas-Receiving, storing, food preparation, cooking, serving, dining, dishwashing, pot and pan washing and garbage disposal: flow space relationship. Working heights and dimensions of work centers. Equipment–Classification, factors involved in selection, use and care of major equipment.	**10**	Learning about division and distribution of working areas in food service institutions	**1,2**
III	**Quantity food preparation-**Selection, purchasing methods and storage of foods. Menu planning – Definition, principles involved in planning and types of menus. Standardization of recipe – Definition, standard recipe format and uses. Standard portion sizes-Definition, Portioning equipments and portion control. Use of left over foods	**13**	Learning about menu planning and quality control	**1,2**
IV	**Management-**Definition, principles and techniques of effective management.	**10**	Learning about running a food institution in an	**1,2**

	Tools of management-Organization chart, work study and work improvement. Use of computers in food service establishments.		organized manner	
V	**Financial management-**Principles and methods of food cost control, factors affecting food cost, labor cost, operating cost and over head cost. Personnel management-Methods of selection, orientation, training, supervision and motivation of employees.	**12**	Learning about financial management while running a food service institution	**1,2**

TEXT BOOKS:

T1: Sethi M., Catering Management: An Integrated Approach. New Age International (P) Ltd, Publishers, Third edition, 2015.

REFERENCE BOOKS:

R1: Sethi M., Institutional Food Management. New Age International (P) Ltd, Publishers, Third edition, 2008.

OTHER LEARNING RESOURCES:

https://ebooks.inflibnet.ac.in/hsp05/chapter/classification-and-objectives-of-the-food-service/
https://egyankosh.ac.in/bitstream/123456789/33522/3/Unit-12.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Classify the food service system its components, and assess their functions.	**1**
2	Acquire knowledge of floor planning, layout characteristics, and equipment necessary for food service facilities.	**1**
3	Develop a menu plan and learn to standardize different recipes.	**1**
4	Explain the food service management system	**1**
5	Apply the knowledge of financial and personnel management in a food service unit	**1,2,8**

SEMESTER IV									
Course Title	**ADVANCE DIETETICS**								
Course code	**24BSFD222R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Spring/ IV semester of second year of the programme**								
Course Objectives	1. To study about different metabolic and systemic diseases and nutrient drug interactions. 2. To study about the different nutrient modification at different disease state. 3. To acquire knowledge of therapeutic medications for specific diet								
CO1	Learn and discuss the different aspect of dietician in healthcare sector. Acquire the knowledge of the relationship of dietician with health and develop skills required in Nutritional counseling								
CO2	Learn and apply adaptation of therapeutic diets in different disease state								
CO3	Acquired knowledge on nutritional management in infections and fever								
CO4	Apply the importance of therapeutic diet in cardiovascular disease, diabetes and gout.								
CO5	Evaluate the significance in the modifications of diet in gastrointestinal diseases. Understand different Malabsorption Syndrome								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Nutritional care for metabolic disorders- Diabetes mellitus: Types, etiology, symptoms, metabolic changes and dietary management. Gout, phenylketonuria, lactose intolerance, hypo and hyper thyroidism-Causes, symptoms and dietary management.	**10**	Learn the importance of application of therapeutic diet in different conditions.	1,2
II	Nutritional care for diseases of cardiovascular systems-Hypertension, hyperlipidaemia, atherosclerosis, coronary heart disease, congestive heart failure: Etiology, symptoms and dietary management. Relationship between dietary fat and development of cardiovascular diseases.	**9**	Understand and describe different cardiovascular disease and modify the diet according to the disease condition of the patient	1,2
III	Nutritional care for diseases of kidney and urinary tract- Nephritis, nephritic syndrome, nephrolithiasis, renal failure: Etiology, symptoms, dietary management and renal dialysis.	**8**	Understand and describe different renal diseases and modify the diet according to the disease condition of the patient	1,2
IV	Nutritional care for cancer and aids: Causative and risk factors, chronic complications, different stages of both the disorders, dietary modifications, food to be included and foods to be avoided. Food Allergy – Diagnosis and treatment. Surgery, trauma and burns- Physiological changes, nutritional care and management. Use of food exchange list in diet planning.	**10**	Develops the skills to use the knowledge of modifying the diet according to the disease condition of the patient Understand the term surgery and will be able to guide and modify the diet according to the disease condition and nutritional requirement of the patient	1,2
V	Nutritional care in eating disorders: Dietary	**8**	Describe the term dietician	1,2

	treatment and other recommendation, addictive behavior in anorexia nervosa, bulimia & alcoholism. Nutrient drug interaction. Patient education and counseling- Assessment of patient needs, establishing rapport, counseling relationship, resources and aids to counseling.		and different roles played. Understand the relationship of dietician with health and develop skills required in nutritional counseling	
VI Practical	Planning, preparation and calculation of diets for insulin dependent Diabetes mellitus. Planning snacks, desserts and beverages for diabetes. Planning, preparation and calculation of diet in cardio vascular diseases. Planning, preparation and calculation of diet in kidney failure, kidney transplant, renal complication and kidney stones. Planning, preparation and calculation of diet in cancer.	**30**	Understand, apply and assess the patient suffering from diabetes and plan the modified diet accordingly	1,2, 3,4

TEXT BOOKS:

T1: Srilakshmi B., Dietetics, New Age International (P) limited Publications, 2004.
T2: Singh J., Handbook of Nutrition and Dietetics, Lotus Press, 2012

REFERENCE BOOKS:

R1: Joshi, S. A., Nutriton and Dietetics, Tata McGraw Hill Publications, New Delhi, 2004.
R2: Srilakshmi B., Dietetics, New Age International (P) limited Publications, 2004.

OTHER LEARNING RESOURCES:

https://www.researchgate.net/publication/332318698_Counselling_Skills_for_a_Dietitian

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn and discuss the different aspect of dietician in healthcare sector. Acquire the knowledge of the relationship of dietician with health and develop skills required in Nutritional counseling	**1,8**
2	Learn and apply adaptation of therapeutic diets in different disease state	**1,2,5,8**
3	Acquired knowledge on nutritional management in infections and fever	**1,2,5,8**
4	Apply the importance of therapeutic diet in cardiovascular disease, diabetes and gout.	**1,2,5,8**
5	Evaluate the significance in the modifications of diet in gastrointestinal diseases. Understand different Malabsorption Syndrome	**1,2,5,8**

SEMESTER IV									
Course Title	**NUTRITION THROUGH LIFECYCLE**								
Course code	**24BSFD223R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ IV semester of second year of the programme**								
Course Objectives	1. To understand the physiological stages of different age groups. 2. To understand the nutritional requirements in different age groups. 3. To plan menu based on the requirements of various age groups.								
CO1	Learn the concept of balanced diet and meal planning								
CO2	Discuss the physiology and dietary requirements during pregnancy and lactation.								
CO3	Discuss the nutritional requirements during infancy and school-going children								
CO4	Describe the physiological changes in the nutritional needs of adolescents and adults								
CO5	Gain knowledge on changes during various stages of growth and development throughout lifecycle.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Balance diet and meal planning:** Definition, importance of balance diet for different age groups, important guide lines to be followed while planning a balance diet, Food Pyramid, Principles and steps involved in meal planning, factors influence meal planning, food groups.	**8**	To know about the balance diet and its requirement.	1,2
II	**Nutrition in pregnancy and lactation:** Pregnancy- Physiological stages of pregnancy, nutrition requirements and Complications of pregnancy. Lactation- Physiology of lactation, role of hormones, nutritional requirements. Meal planning for pregnant and lactating women	**10**	To learn the changes and nutritional requirement during pregnancy and lactation	1,2
III	**Nutrition during infancy:** Infancy- Growth and development, nutritional requirements, breast feeding, weaning, infant formula. Introduction of supplementary foods, weaning foods. Meal planning for infants. **Nutritional needs during childhood:** Early childhood (Toddlers and Preschoolers) - growth spurt, nutrient needs, nutritional related problems, feeding Pattern and problems School children- Nutritional requirements, Importance of snacks, school lunch. Meal planning for children	**14**	To learn the nutritional requirement during infancy and childhood	1,2
IV	**Nutrition adolescence**: Physiological and	**12**	To learn the physical and hormonal changes and	1,2

	psychological changes, body image, growth, nutrient need, food choice, eating habits, factors influencing needs and eating disorders. Meal planning for adolescents **Nutritional needs during adulthood**: Importance of balance diet, nutritional demands according to the level of activity patterns. Meal planning for adults		nutritional requirement	
V	**Nutritional needs during old age**: Process of ageing, common health problems during old age, and dietary modifications specially reference to consistency of the food. Meal planning for old age peoples.	**10**	To learn the nutritional requirement during old age	1,2

TEXT BOOKS:

T1: Robinson C. H., Lawer M. R., Chenowelth. WIC., and Garwich A. E., Normal and Therapeutic Nutrition, McMillan Publishers Co., Newyork, 17th Edition 1990.

REFERENCE BOOKS:

R1: Srilakshmi. B., Dietetics, 7th edition, Willey Eastern Ltd., New Delhi, 2014.

OTHER LEARNING RESOURCES:

https://pmc.ncbi.nlm.nih.gov/articles/PMC5104202/
https://pmc.ncbi.nlm.nih.gov/articles/PMC7926714/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn the concept of balanced diet and meal planning	**1**
2	Discuss the physiology and dietary requirements during pregnancy and lactation.	**1**
3	Discuss the nutritional requirements during infancy and school-going children	**1**
4	Describe the physiological changes in the nutritional needs of adolescents and adults	**1**
5	Gain knowledge on changes during various stages of growth and development throughout lifecycle.	**1,8**

SEMESTER – IV									
Course Title	**TECHNO PROFESSIONAL COURSE II (BAKERY SCIENCE)**								
Course code	**24BSFD225R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ IV semester of second year of the programme**								
Course Objectives	1. To provide knowledge on science behind baking. 2. To provide knowledge on basic functions of all the ingredients used in different products 3. To master in fundamental mixing methods and their applications								
CO1	Demonstrate proficient use of measuring and weighing techniques.								
CO2	Master fundamental mixing methods and their applications.								
CO3	Successfully bake a variety of basic baked goods with consistent quality								
CO4	Identify and troubleshoot common baking problems								
CO5	Apply knowledge of baking principles to create a variety of baked goods with varying levels of complexity.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Basic Baking Techniques:** Weighing and Measuring: Practice accurate weighing and measuring of ingredients using various tools (scales, measuring cups, spoons). Mixing Methods: Demonstrate and practice creaming method, rubbing-in method, whisking method. Prepare simple batters and doughs using different mixing techniques. Baking Techniques: Learn to use different types of ovens (conventional, convection). Practice baking cookies, muffins, and simple breads. Troubleshooting: Identify and troubleshoot common baking problems (e.g., overbaking, underbaking, uneven rise).	**3**	Develop fundamental baking skills like accurate measurements, Mixing methods, Baking techniques, identify and troubleshoot common baking problems	1,2,3,4
II	**Bread Making** Yeast Handling: Learn to activate yeast and understand its role in bread making. Bread Dough Preparation: Prepare basic bread dough using straight dough and sponge and dough methods. Shaping Techniques: Practice shaping bread dough into various forms (loaves, rolls, buns). Proofing: Understand the importance of proofing and control proofing conditions. Baking Bread: Bake different types of bread (white bread, whole wheat bread,	**3**	Learning about techniques of making bread	1,2,3,4

	rolls).			
III	**Cookies and Biscuits** Cookie Dough Preparation: Prepare cookie dough using various methods (creaming, mixing). Cookie Shaping: Practice different cookie shaping techniques (dropping, rolling, cutting). Baking Cookies: Bake various types of cookies (sugar cookies, chocolate chip cookies, oatmeal cookies).	**5**	To emphasize both the technical skills involved in cookie production (mixing, shaping, baking) and the understanding of the underlying principles that contribute to successful cookie making.	1,2,3,4
IV	**Cake Making** Cake Batters: Prepare different types of cake batters (sponge cake, butter cake, chiffon cake).	**5**	Learn to successfully prepare batters for sponge cake, butter cake, and chiffon cake, demonstrating an understanding of the unique ingredients and mixing methods for each type.	1,2,3,4
V	**Icing and Decoration:** Prepare basic icings (buttercream, fondant) and frost cakes. Practice simple cake decorating techniques (piping, frosting).	**5**	Learn to prepare basic buttercream and fondant icings, frost cakes evenly and neatly, and demonstrate basic cake decorating techniques such as piping and frosting.	1,2,3,4

TEXT BOOKS:

T1: Food Processing Technology: Principles and Practices" by R.P. Singh and D.K. Salunkhe

REFERENCE BOOKS:

R1: The Joy of Baking" by Shirley Corriher

OTHER LEARNING RESOURCES:

https://students.aiu.edu/submissions/profiles/resources/onlineBook/h5d3M4_Science_of_Bakery_Products.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Demonstrate proficient use of measuring and weighing techniques.	**1,8**
2	Master fundamental mixing methods and their applications.	**1,8**
3	Successfully bake a variety of basic baked goods with consistent quality	**1,8**
4	Identify and troubleshoot common baking problems	**1,8**
5	Apply knowledge of baking principles to create a variety of baked goods with varying levels of complexity.	**1,8**

SEMESTER IV									
Course Title	**FOOD TECHNOLOGY II**								
Course code	**24BSFD224R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ IV semester of second year of the programme**								
Course Objectives	1. To know about processing of dairy, extruded and irradiated food. 2. To know about preservation of various foods. 3. To learn about different packaging technology used in food industry.								
CO1	Discuss various food processing and preservation techniques								
CO2	Learn about dairy technology. Discuss different processing techniques of milk and milk products								
CO3	Gain insight on extrusion technology in food product processing								
CO4	Learn about the classification of food irradiation and it's probable uses in food processing								
CO5	Discuss packaging materials, food additives and food quality evaluation techniques in product development								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to various food processing and preservation technologies** Freezing-Introduction to refrigeration and freezing, definition, principle of freezing, changes occurring during freezing, types of freezing, thawing, changes during thawing and its effect on food. Drying and Dehydration-Definition, drying as a means of preservation, differences between sun drying and dehydration (i.e. mechanical drying), heat and mass transfer, factors affect ingrate of drying, types of driers used in the food industry.	**10**	Learning about various food processing and preservation technologies	1,2
II	**Dairy technology**- Introduction, pasteurization, homogenization, drying, packaging, standardization, recombination, reconstitution, different processing for different milk products, Co-operative Dairying, National Dairy Development Board, Operation Flood, Development in milk processing	**8**	Learning about dairy technology and its advanced processing technique	1,2
III	**Extruded foods**- introduction, classification of extruders, merits & demerits of extrusion technology, effect of Extruded foods on nutritive value of foods.	**7**	Learning about Extruded product and its processing techniques	1,2
IV	**Food Irradiation**-Introduction, kinds of ionizing radiations used in food irradiation, uses of radiation processing in food industry, concept of cold sterilization, functions, effects of food irradiation, safety	**10**	Learning about various aspect of advanced food processing	1,2

	of irradiated foods **Thermal Processing**-Concept of pasteurization, sterilization, commercial sterilization and blanching.			
V	**Packaging technology**-introduction, basic packaging materials, effects on nutritive value of foods **Food Additives**- introduction, classification, uses, merits & demerits, Fortification & Enrichment-definition & importance of fortified and enriched foods **Evaluation of Food Quality**	**9**	Learning about packing technology and food additives	1,2
VI Practical	Setting up of sensory evaluation lab and introducing the concept of organoleptic testing. Drying of food products To give the concept of shelf life of different foods (processed and unprocessed) Identification of different types of packaging materials used in the food industry Visit to different food processing industries	**30**	Learning about sensory evaluation Learning about drying process Learning about shelf life of processed and unprocessed product Learning about different packaging materials Learning about techniques of food industries	1,2,3,4

TEXT BOOKS:

T1: Food Science, Fifth Edition, Norman N. Potter, Joseph H. Hotchkiss

REFERENCE BOOKS:

R1: Rahman, M. S., Handbook of Food Preservation. MARCELDEKKER Inc. 1999

OTHER LEARNING RESOURCES:

https://www.youtube.com/watch?v=kfExSuaCq5Q
https://www.youtube.com/watch?v=yVPWcnBiFeQ
https://tn.gov/education/article/cte-cluster-agriculture-food-naturalresources.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss various food processing and preservation techniques	**1**
2	Learn about dairy technology. Discuss different processing techniques of milk and milk products	**1,8**
3	Gain insight on extrusion technology in food product processing	**1,8**
4	Learn about the classification of food irradiation and it's probable uses in food processing	**1,8**
5	Discuss packaging materials, food additives and food quality evaluation techniques in product development	**1,8**

SEMESTER – IV									
Course Title	**ENGLISH FOR EMPLOYABILITY**								
Course code	**24UBPD222R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ IV semester of second year of the programme**								
Course Objectives	1. To develop public speaking skills, including script preparation, understanding nonverbal cues, overcoming fear, and practicing speaking strategies. 2. To provide practical experience in preparing, submitting, and screening resumes and cover letters. 3. To teach email etiquette, including the structure of emails and effective drafting techniques.								
CO1	Enable students to prepare scripts, understand nonverbal cues, overcome fear, and practice public speaking strategies.								
CO2	Equip students with skills to prepare, submit, and screen resumes and cover letters.								
CO3	Teach students the different parts of an email and effective email drafting techniques.								
CO4	Prepare students for interviews by practicing commonly asked questions and participating in mock interview sessions.								
CO5	Students will understand the concept of conflict management, identify different types, and analyze its effects.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Public Speaking Skills** i**.** Preparation of Scripts and understanding Nonverbal cues of Public Speaking ii. Understanding and Overcoming Fear of Public Speaking ii. Practice strategies of Public Speaking	**7**	Students will be able to create effective speaking scripts, interpret nonverbal cues, manage public speaking anxiety, and practice effective speaking techniques.	3, 4
II	**Practical session on Resume and Cover letter** i. Preparation, submission & screening of Resume. ii. Practical session on cover letter screening session	**5**	Students will prepare, submit, and evaluate resumes and cover letters.	3
III	Email Etiquettes i.Different Parts of Email and Usage ii.Drafting emails effectively	**5**	Students will understand the structure of emails and draft them effectively.	2, 3
IV	Interview Skills (Mock sessions) i. Preparing Commonly asked Interview Questions ii. Mock Interview sessions	**7**	Students will answer common interview questions confidently and perform well in mock interviews.	3, 5
V	**Conflict Management** i. Definition ii. Type of Conflict Management iii. Effects of Conflict Management	**8**	Students will understand the concept of conflict management, identify different types, and analyze its effects.	2, 4

TEXTBOOKS:

T1: Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.
T2: Reed, James. 2016. 101 Job Interview Questions You'll Never Fear Again, Plume.
T3: Pease, Barbara. 2006. The Definitive Book of Body Language, RHUS.
T4: McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition)

REFERENCE BOOKS:

R1: Zinsser, William. (2006) On Writing Well: The Classic Guide to Writing Nonfiction Harper Perennial
R2: Taylor J. and Wright, J., IELTS Advantage Reading Skills: A step-by-step guide to a high IELTS reading score, Delta Publishing by Klett.
R3: Kelley, Thea. 2021. Get That Job: The Quick and Complete Guide to a Winning Interview, Plovercrest Press.
R4: Murphy, Raymond (2012) English Grammar in Use Book with Answers: A Self- Study and Practice Book for Intermediate Learners of English, Cambridge University Press

OTHER LEARNING RESOURCES:

https://learning.shine.com/talenteconomy/career-help/top-group-discussionskills
https://www.coursera.org/articles/conflict-management

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Enable students to prepare scripts, understand nonverbal cues, overcome fear, and practice public speaking strategies.	**3,4,7,8**
2	Equip students with skills to prepare, submit, and screen resumes and cover letters.	**3,4,7,8**
3	Teach students the different parts of an email and effective email drafting techniques.	**3,4,7,8**
4	Prepare students for interviews by practicing commonly asked questions and participating in mock interview sessions.	**3,4,7,8**
5	Students will understand the concept of conflict management, identify different types, and analyze its effects.	**3,4,7,8**

SEMESTER – IV									
Course Title	**BASIC ACCLIMATIZING SKILLS (BAS)**								
Course code	**24UULS201R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ IV semester of second year of the programme**								
Course Objectives	1. To impart knowledge of the fundamentals of Hospitality industry and its applications. 2. Students will be able to familiarize with the cooking equipments & Utensils. 3. Students will be able to handle different modes of reservations.								
CO1	Students will have basic knowledge of cooking methods.								
CO2	Students will gain the knowledge of organizing & Cleaning of Rooms.								
CO3	Students will be able to gain the travel management concept.								
CO4	Students will be able to acquire the knowledge of basic household's amenities for day-to-day use.								
CO5	Basic use of Travel & Tourism Management which will prepare students for lifelong learning								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction to Accommodation Management** • Telephone handling technique • Organizing of Rooms. • Cleaning agents. • Cleaning equipment's and uses. • Bed making Process.	**8**	Students will be able to effectively handle telephone calls, organize rooms efficiently, utilize appropriate cleaning agents and equipment, perform professional bed-making, and maintain a high standard of cleanliness and guest service	3, 4
II	**Fundamentals of Cooking** • Definition of cookery –Aim & Objectives of cooking. • Use of basic cooking equipment's • Personal Hygiene and Safety • Use of Fire & Fuels	**7**	Students will demonstrate an understanding of cookery principles, safe and hygienic practices, and the effective use of cooking equipment and fuels to achieve desired culinary results.	3
III	**Methods of Cooking** • Different Cuts. • Use of Herbs and Spices. • Basic Food and Beverage Preparation. • Regional food Habits.	**7**	Students will demonstrate knowledge of various cooking methods, including different cuts of meat, the use of herbs and spices, basic food and beverage preparation techniques, and an understanding of regional food habits	2, 3
IV	**Forms & Format's** • C –form • Reservation form • Registration form • Passport Application form • Legal Rent Agreement	**8**	Understand and utilize C-form for interstate sale of goods to claim input tax credit.	3, 5

TEXT BOOKS:

T1: Arora K (2011). Theory of cookery, Frank brothers & company (pub) pvt ltd-New Delhi.

T2: Bruce H. Axler, Carol A. Litrides (2010) Food and Beverage Service Volume 1 of Wiley Professional Restauranteur, Guides.

T3: Mohammed Zulfikar (2010) - Introductions to Tourism and Hotel Industry Introduction to Tourism and Hotel Industry. Vikas Publishing.

T4: Sudhir Andrews (2013) Food and Beverage Service: A Training Manual, Tata McGraw Hill, 2013.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will have basic knowledge of cooking methods.	**1,8**
2	Students will gain the knowledge of organizing & Cleaning of Rooms.	**1,8**
3	Students will be able to gain the travel management concept.	**1,8**
4	Students will be able to acquire the knowledge of basic household's amenities for day-to-day use.	**1,8**
5	Basic use of Travel & Tourism Management which will prepare students for lifelong learning.	**1,8**

SEMESTER – IV									
Course Title	**DIGITAL LITERACY**								
Course code	**24UUDL101R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ IV semester of second year of the programme**								
Course Objectives	1. Students will be able to identify and analyze computer hardware, software and their uses. 2. Students will be able to use MS-Office suite for various purposes. 3. Students will be able to use the Internet efficiently for required information as well as for digital financial transactions.								
CO1	Students will have basic understanding of Computer Hardware, Software and Computer handling.								
CO2	Students will be able to solve basic information management issues using MS-Office Products.								
CO3	Students will be able to efficiently search the Internet for required information.								
CO4	Students will be able to use computing technically ethically, safely, securely and legally for day-to-day use.								
CO5	Understand the fundamentals of digital payment systems and gain practical skills in creating accounts and utilizing digital payment platforms such as credit cards, debit cards, net banking, and UPI.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Fundamentals of Computer Systems** i. Components of a Computer and their functions. ii. Different Types of Computers and their Applications.	**7**	To understand the fundamental components of a computer system, their functions, and explore the diverse types of computers and their applications across various domains.	3, 4
II	**Introduction to MS-Office** i. Components of the MS-Office suite. ii. Creating documents with MS-Word. iii. Creating Presentations with MS-PowerPoint. iv. Creating Spreadsheets with MS-Excel.	**5**	To gain foundational knowledge in Microsoft Office Suite, including proficiency in creating and manipulating documents with Word, presentations with PowerPoint, and spreadsheets with Excel.	3
III	**Introduction to Internet & Cyber World** i. Introduction to Computer Networks and Internet. ii. World Wide Web, Websites and Web portals, Web browsing. iii. Web Searching, Search engines, Introduction to Google Search Engine; How to search using Keywords, topics of Interest, etc. iv. Creation and use of Email Accounts. v. Cyber Crimes.	**5**	To understand fundamental concepts of computer networks and the internet, including web browsing, searching, email usage, and basic cybersecurity awareness, particularly focusing on cybercrimes.	2, 3
IV	**Introduction to Social Media** i. The Power of social media, Relevance of	**7**	To understand the power and relevance of social media in the	3, 5

	social media in present scenario. ii. Creating accounts and using some popular social media portals and Apps like WhatsApp, Facebook, Twitter, Instagram, LinkedIn. iii. Social Media Etiquettes.		current scenario, learn to create and utilize popular social media platforms, and develop a strong understanding of appropriate social media etiquette.	
V	**Digital Payments** i. Introduction to Digital Payment Systems. ii. Creating accounts and using Digital Payment Systems like Credit Cards, Debit Cards, Net banking, UPI.	**6**	To understand the fundamentals of digital payment systems and gain practical experience in creating accounts and utilizing various digital payment methods such as credit cards, debit cards, net banking, and UPI	2, 3

TEXT BOOKS:

T1: Sinha Pradeep K. and Priti Sinha. *Computer Fundamentals: Concepts Systems & Applications*. 3rd ed. New Delhi: BPB Publications.

T2: Goel, A, 2010. Computer Fundamentals, Pearson India.

REFERENCE BOOKS:

R1: Balaguruswamy, E. 2009 Fundamentals of Computers, Tata McGraw-Hill Education.

R2: Balaguruswamy, 2014. E. Fund Of Comp & Programming (Updated Ed Sem. I, Au) Tata McGraw-Hill Education.

R3: Lawson, C. 2022. Introduction to Social Media, Oklahoma State University.

OTHER LEARNING RESOURCES:

https://www.w3schools.com
https://edu.gcfglobal.org
https://www.tutorialspoint.com
https://www.javatpoint.com/
Latest updates available in WWW.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will have basic understanding of Computer Hardware, Software and Computer handling.	**7,8**
2	Students will be able to solve basic information management issues using MS-Office Products.	**7,8**
3	Students will be able to efficiently search the Internet for required information.	**7,8**
4	Students will be able to use computing technically ethically, safely, securely and legally for day-to-day use.	**7,8**
5	Understand the fundamentals of digital payment systems and gain practical skills in creating accounts and utilizing digital payment platforms such as credit cards, debit cards, net banking, and UPI.	**7,8**

SEMESTER – IV									
Course Title	**EXTRA-CURRICULAR ACTIVITIES**								
Course code	**24UBEC221R**	**Total credits: 0.5**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**2**	**0**	**0**	**0.5**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ IV semester of second year of the programme**								
Course Objectives	1. To ascertain physical and mental development of the students and select best performers for state, national and international level competition. 2. To enhance and improve student's talents in the field of sports, yoga, music, dance, drama, etc through AdtU club activities and workshops. 3. To improve their ability to solve problems creatively and effectively.								
CO1	Enhance Leadership Skills-Students will develop leadership abilities through various activities.								
CO2	Improve Social Interaction-Students will learn to interact and build relationships with others.								
CO3	Develop Personal Interests and Hobbies- Students will explore and develop their personal interests and hobbies.								
CO4	Strengthen Problem-Solving Skills- Students will improve their ability to solve problems creatively and effectively.								
CO5	Foster Cultural Awareness- Students will gain a better understanding and appreciation of different cultures.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Based on the learner's interest they can participate in various sports, music, and co-curricular activities joining the clubs of the University (Football, Futsal; Cricket; Swimming; Basketball; Badminton; Table Tennis; athletics and other outdoor and indoor games; Dance; Music; Vocals; Photography; Drama; Literary activities); The students are encouraged to participate in regular club activities, workshops, competitions as per their interest and hobbies; Renowned skilled professionals/ personalities are invited organizing workshops to promote the talents of the students.	**60**	Students will develop and refine their interests and talents through active participation in diverse sports, music, and co-curricular clubs, benefiting from expert guidance and engaging in workshops and competitions.	1,2

REFERENCE BOOKS:

R1: "Extracurricular Activities: Essential Guides for Students" by John G. Gabriel

R2: "Developing Personal, Social and Emotional Skills through Extra-Curricular Activities" by Sally Bailey

OTHER LEARNING RESOURCES:

https://www.prospects.ac.uk/applying-for-university/university-life/the-importance-of-extra-curricular-activities

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Enhance Leadership Skills-Students will develop leadership abilities through various activities.	**3,4,7,8**
2	Improve Social Interaction-Students will learn to interact and build relationships with others.	**3,4,7,8**
3	Develop Personal Interests and Hobbies- Students will explore and develop their personal interests and hobbies.	**3,4,7,8**
4	Strengthen Problem-Solving Skills- Students will improve their ability to solve problems creatively and effectively.	**3,4,7,8**
5	Foster Cultural Awareness- Students will gain a better understanding and appreciation of different cultures.	**3,4,7,8**

SEMESTER – V									
Course Title	**CLINICAL NUTRITION I**								
Course Code	**24BSFD311R(CN)**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-Requisite**	**Nil**						
Programmes	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ V semester of third year of the programme**								
Course Objectives	1. To study about different aspect of diet modification and adaptations. 2. To study about the different nutrient modification at different disease state. 3. To understand the symptoms of different deficiency diseases.								
CO1	Understand the different aspect of food nutrients and its affect in health and wellbeing								
CO2	Learn and apply different aspect of diet modification and adaptations in diseases state								
CO3	Acquired knowledge on planning of different hospital diet								
CO4	Apply the importance of therapeutic diet in diseases condition								
CO5	Evaluate the significance in the modifications of diet in different feeding methods.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Ethics and responsibilities of Dietician, Indian Dietetic Association. Scopes.	**5**	Role of dietician	1,2
II	Principles of therapeutic diets, menu planning for specific diseases and role of diet counseling in hospital settings.	**10**	Learning of hospital diet, different, ode of feeding	1,2
III	Energy, Basal Energy Expenditure (BEE), and the nutritional requirements of the reference woman and man, including factors influencing energy expenditure, estimation methods, and the role of macronutrients and micronutrients in maintaining health.	**10**	Concisely covers the key aspects of energy, BEE, and nutritional requirements.	1,2
IV	Determination of nutritional assessment in clinical settings. Routine hospital diets: Preoperative and postoperative diets, study and review of hospital diet. Basic concepts and methods of - (a) Oral feeding (b) Tube feeding (c) Parental nutrition (d) Intravenous feeding.	**10**	To understand the principles of nutritional assessment in clinical settings, including the study and review of routine hospital diets (preoperative and postoperative), and to explore the basic concepts and methods of oral, tube, and parenteral/intravenous feeding.	1,2
V	Nutritional management in specific disease conditions.	**10**	To acquire the knowledge and skills to apply principles of nutrition in the management of specific disease conditions.	1,2
VI Practical	• Planning, preparations and calculations of nutritive value of: Routine hospital diet: Liquid diet: Clear liquid, Full fluid, Semisolid diet, Soft diet • Planning, preparations and calculations of nutritive value of: Feeds: Nasogastric (NG) feeds and Jejunostomy (JJ) feed • Menu planning for febrile conditions	**30**	To develop the ability to plan, prepare, and calculate the nutritive value of various hospital diets (routine, liquid, soft) and enteral feeds (NG, JJ), plan menus for febrile conditions, and effectively counsel patients on dietary	1,2,3,4

	• Role-play diet counseling sessions with peers or standardized patients, focusing on communication, motivational interviewing, and behavior change techniques. • Analyze case studies of patients with specific diseases (e.g., diabetes, cancer, HIV/AIDS) and develop individualized nutrition plans.		modifications through role-playing and case study analysis, emphasizing communication, motivational interviewing, and behavior change techniques.	

TEXT BOOKS

T1: Joshi, S. A., Nutrition and Dietetics, Tata McGraw Hill Publications, New Delhi, 2004.
T2: Srilakshmi B., Dietetics, New Age International (P) limited Publications, 2004

REFERENCE BOOKS

R1: Raymond, J. L., & Morrow, K. (2020). Krause and mahan's food and the nutrition care. Elsevier Health Science
R2: AntıaF.P., & P. Abraham. (2002). Clinical Dietetics and Nutrition.
R3: Shils, M.E., Olson, J.A., Shike, M. and Ross, A.C. (1999): Modern Nutrition in Health and Disease, 9th Edition, Williams and Wilkins
R4: Escott-Stump,S. (1998): Nutrition and Diagnosis Related Care, 4th Edition, Williams and Wilkins.
R5: Garrow, J. S., James, W.P.T.

OTHER LEARNING RESOURCES:

https://www.cdss.ca.gov/agedblinddisabled/res/VPTC2/9%20Food%20Nutrition%20and%20Preparation/Types_of_Therapeutic_Diets.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the different aspect of food nutrients and its affect in health and wellbeing	**1, 8**
2	Learn and apply different aspect of diet modification and adaptations in diseases state	**1,2,5,8**
3	Acquired knowledge on planning of different hospital diet	**1,2,5,8**
4	Apply the importance of therapeutic diet in diseases condition	**1,2,5,8**
5	Evaluate the significance in the modifications of diet in different feeding methods.	**1,2,5,8**

SEMESTER – V									
Course Title	**CLINICAL NUTRITION II**								
Course Code	**24BSFD312R(CN)**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-Requisite**	**Nil**						
Programmes	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ V semester of third year of the programme**								
Course Objectives	1.To review about the different biochemical metabolism reaction of the body. 2.To understand how this metabolism takes place in correlation with the nutrients of the food 3.To understand the symptoms of different deficiency diseases.								
CO1	Define and differentiate between obesity, overweight, and underweight, including their classifications and associated health risks.								
CO2	Understand the critical role of nutrition in maintaining cardiac efficiency and preventing cardiovascular diseases (CVDs) such as atherosclerosis, hyperlipidemia, and hypertension.								
CO3	Demonstrate a comprehensive understanding of diabetes mellitus, including its incidence, predisposing factors, symptoms, metabolic disturbances, diagnostic tests, dietary management, pharmacotherapy (including insulin types and hypoglycemic agents), and potential long-term complications.								
CO4	Demonstrate a comprehensive understanding of the role of nutrition in the management of renal diseases								
CO5	Understand the various causes of liver diseases, including viral infections (hepatitis), alcohol abuse, non-alcoholic fatty liver disease (NAFLD), autoimmune disorders, and genetic condition.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Obesity and underweight- causes, complication and health effects, dietary treatment and other recommendation.	**5**	Role of dietician	1,2
II	Role of nutrition in cardiac efficiency, incidence of Atherosclerosis, dietary principles, Hyperlipidenmia, Hypertension-causes and dietary treatment, Sodium restricted diet, level of sodium restriction, sources of sodium, danger of severe sodium restriction.	**10**	Learning of hospital diet, different, ode of feeding	1,2
III	Diet in Diabetes mellitus: a) Incidence and predisposing factors. b) Symptoms-types and tests for detection. c) Metabolism in diabetes d) Dietary treatment & meal management e) Hypoglycemic agent, insulin and its types. f) Complication of diabetes	**10**	Concisely covers the key aspects of energy, BEE, and nutritional requirements.	1,2
IV	Diet in Renal diseases: Basic renal function, symptoms and dietary treatment in acute and chronic glomerulonephritis, Nephrosis, renal failure, dialysis. urinary calculi-causes & treatment, acid and alkali producing and neutral foods and dietary treatment.	**10**	To understand the principles of nutritional assessment in clinical settings, including the study and review of routine hospital diets	1,2

			(preoperative and postoperative), and to explore the basic concepts and methods of oral, tube, and parenteral/intravenous feeding.	
V	Diet in diseases of the liver, gall bladder and pancreas, a) Etiology, symptoms and dietary treatment in - Jaundice, hepatitis, cirrhosis and hepatic coma. b) Role of alcohol in liver diseases. c) Dietary treatment in cholecystitis, cholelithiasis and pancreatitis. Patient education and counseling- Assessment of patient needs, establishing rapport, counseling relationship, resources and aids to counseling.	**10**	To acquire the knowledge and skills to apply principles of nutrition in the management of specific disease conditions.	1,2
VI Practical	• Planning and preparation of DASH Diet • Planning, preparation and calculation of diet in cardio vascular diseases. • Planning, preparation and calculation of diet in kidney failure, kidney transplant, renal complication and kidney stones. • Planning, preparation and calculation of nutritive value. • Planning, preparation and calculation of nutritive value of renal disorders: Renal calculi and Renal Transplantation	**30**	To develop the ability to plan, prepare, and calculate nutritionally balanced diets, specifically focusing on the DASH Diet and adapting dietary plans for individuals with cardiovascular diseases, kidney failure, kidney transplants, renal complications, and kidney stones, while accurately determining the nutritive value of these diets.	1,2,3, 4

TEXT BOOKS

T1: Joshi, S. A., Nutrition and Dietetics, Tata McGraw Hill Publications, New Delhi, 2004.
T2: Srilakshmi B., Dietetics, New Age International (P) limited Publications, 2004

REFERENCE BOOKS

R1: Raymond, J. L., & Morrow, K. (2020). Krause and mahan's food and the nutrition care. Elsevier Health Science
R2: AntıaF.P., & P. Abraham.(2002). Clinical Dietetics and Nutrition.
R3: Shils, M.E., Olson, J.A., Shike, M. and Ross, A.C. (1999): Modern Nutrition in Health and Disease, 9th Edition, Williams and Wilkins
R4: Escott-Stump,S. (1998): Nutrition and Diagnosis Related Care, 4th Edition, Williams and Wilkins.
R5: Garrow, J. S., James, W.P.T.

OTHER LEARNING RESOURCES:

https://www.cdss.ca.gov/agedblinddisabled/res/VPTC2/9%20Food%20Nutrition%20and%20Preparation/Types_of_Therapeutic_Diets.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Define and differentiate between obesity, overweight, and underweight, including their classifications and associated health risks.	**1,2,5,8**
2	Understand the critical role of nutrition in maintaining cardiac efficiency and preventing cardiovascular diseases (CVDs) such as atherosclerosis, hyperlipidemia, and hypertension.	**1,2,5,8**
3	Demonstrate a comprehensive understanding of diabetes mellitus, including its incidence, predisposing factors, symptoms, metabolic disturbances, diagnostic tests, dietary management, pharmacotherapy (including insulin types and hypoglycemic agents), and potential long-term complications.	**1,2,5,8**
4	Demonstrate a comprehensive understanding of the role of nutrition in the management of renal diseases	**1,2,5,8**
5	Understand the various causes of liver diseases, including viral infections (hepatitis), alcohol abuse, non-alcoholic fatty liver disease (NAFLD), autoimmune disorders, and genetic condition.	**1,2,5,8**

SEMESTER – V									
Course Title	**APPLIED NUTRITION I**								
Course Code	**24BSFD311R(AN)**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-Requisite**	**Nil**						
Programmes	**B.Sc. Food, Nutrition & Dietetics**								
Semester	**Fall/ V semester of third year of the programme**								
Course Objectives	1. To study about different aspect of Food Science and processing. 2. To study about the application of principles of food science in product development. 3. To acquire knowledge on evaluating product quality and sensory properties								
CO1	Reflect on the role of food trends in the new product development process								
CO2	Design a food product through the application of knowledge of food ingredients and Functional foods.								
CO3	Create and evaluate a product using the development process; Design and apply packaging								
CO4	Acquired knowledge on evaluating product quality and sensory properties								
CO5	Combine theoretical knowledge and practical skills to reproduce existing food products by ensuring.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**New food product-** Definition, classification, factors shaping new product development: social concern, health concern, impact of market place influence and technology.	**8**	Reflect on the role of food trends in the new product development Process	1,2
II	**Product development-** Steps, standardization methods. Portion size and portion control; Calculation of nutritive value and cost of production. Shelf life and storage stability evaluation procedure.	**8**	Design a food product through the application of knowledge of food ingredients and Functional foods	1,2
III	**Product evaluation-** Development of scorecard and analysis of data. Selection and training of judges. **Packaging**-Suitability, development of packages and Labeling.	**10**	Create and evaluate a product using the development process; Design and apply packaging For food products	1,2
IV	**Quality control –** Objectives, importance, functions of quality control, stages of quality control in food industry. **Food quality assurance –** Design of company quality assurance program and microbiological concerns. Managing quality in supply chain and marketing of food products.	**9**	Evaluate product quality and sensory properties	1,2
V	**Government regulations in quality control** –FAO/WHO codex Alimentarius commission, PFA, AGMARK, BIS, FPO, fair average quality (FAQ) specification for foodgrains, ISO9000 series. **HACCP–**Background, principles, benefits and limitation.	**10**	Combine theoretical knowledge and practical skills to reproduce existing food products by ensuring proper food standards	1,2

	Consumer Protection Act (CPA) **Food adulteration –** Common adulterants and tests to detect common adulterants.			
VI Practical	Introduction on developing various food products and selection of target group. Market survey and Preparation of questionnaire. Standardization of recipe, Preparation method, sensory evaluation. Shelf life, packaging, labeling, costing, storage, transportation and distribution, advertising Report writing and Presentation.	**30**	Learning about trends and innovation in food markets and developing a questionnaire Quality and sensory testing for food products; evaluate product quality and sensory properties Evaluation of food shelf life and development of food packaging for food products Combine theoretical knowledge and practical skills for established products and learning to present as a report Learn the analysis process of proximate composition	1,2,3,4

TEXT BOOKS:

T1: Rahman, M. S., Handbook of Food Preservation. MARCELDEKKER Inc. 1999

REFERENCE BOOKS:

R1: James G. Brennan, Food Processing Handbook, 2011

OTHER LEARNING RESOURCES:

https://www.fssai.gov.in/upload/uploadfiles/files/Manual_Meat_Fish_09_01_2017(1).pdf
https://www.pfndai.org/Document/Association_News/dairy_processing/Dairy_Products_Processing-_Dr_Kanade.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Reflect on the role of food trends in the new product development process	**1**
2	Design a food product through the application of knowledge of food ingredients and Functional foods.	**1**
3	Create and evaluate a product using the development process; Design and apply packaging	**1**
4	Acquired knowledge on evaluating product quality and sensory properties	**1,8**
5	Combine theoretical knowledge and practical skills to reproduce existing food products by ensuring.	**1,2**

SEMESTER – V									
Course Title	**APPLIED NUTRITION I**								
Course Code	**24BSFD312R(AN)**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-Requisite**	**Nil**						
Programmes	**B.Sc. Food, Nutrition & Dietetics**								
Semester	**Fall/ V semester of third year of the programme**								
Course Objectives	1. To study a different aspect of food standards and safety. 2. To study the different regulatory bodies of food safety and production. 3. To understand the recent trends of healthy foods in the market								
CO1	Understand the different applications of food science in food production and packaging.								
CO2	Learn about the regulatory bodies of food science and technology.								
CO3	Understand the recent trends of health foods.								
CO4	Acquire knowledge on different packaging material.								
CO5	Evaluate the significance of recent food trends								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction:** Concept of food safety, safety measures-basic concept of HACCP, Safe food handling practices and storing.	**5**	Learn different Constituents of foods	1,2
II	**Introduction to technologies used in food processing:** Hot and cold treatment. Pre and Primary Processing**.**	**10**	Learn technologies used in food processing	1,2
III	**Food additives-**various types and their effects on health. Food security-Concept, factors affecting food security. Prevention of Food Adulteration (PFA) Act.	**10**	Learn different types of quality evaluation of food	1,2
IV	**Regulating authority-** Fruit Products Order (FPO), Meat Products Order (MPO), Bureau of Indian Standards (BIS), MMPO, FSSAI, ISI, Agmark.	**10**	Learn different Regulating authority	1,2
V	Introduction to Food Packaging: Principles of Food Packaging Design. Different types of Packaging Materials. Active and Intelligent Packaging. Food Packaging Regulations and Safety	**10**	Learn different types of food packaging	1,2
VI Practical	• Introduction to different equipment in processing and preservation • Preservation by heat treatment: Sterilization, • Preservation by heat treatment: Blanching • Preservation by cold treatment: Refrigeration • Preservation by cold treatment: Freezer,deep freezing • Different methods of drying: Mechanical drying • Different methods of drying: Sun drying • Preparation of extruded products	**30**	Learning the equipment of processing and preservation techniques of heat treatment, cold treatment; Techniques of dry treatment and Techniques of extruded products	1,2,3,4

TEXT BOOKS:

T1: Rahman, M. S., Handbook of Food Preservation. MARCELDEKKER Inc. 1999

REFERENCE BOOKS:

R1: James G. Brennan, Food Processing Handbook, 2011

OTHER LEARNING RESOURCES:

https://www.fssai.gov.in/upload/uploadfiles/files/Manual_Meat_Fish_09_01_2017(1).pdf
https://www.pfndai.org/Document/Association_News/dairy_processing/Dairy_Products_Processing-_Dr_Kanade.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn about the processing technology and composition of cereals and millet.	**1**
2	Explain the processing technology and composition of pulses and legumes.	**1**
3	Acquire knowledge about the processing and quality attributes of fats and oils.	**1**
4	Learn about the classification and post-harvest changes in fruits and vegetables.	**1,8**
5	Analyze the post-mortem changes in meat and various preservation methods.	**1,2**

SEMESTER V									
Course Title	**TECHNO PROFESSIONAL COURSE III (DIET COUNSELING AND PATIENT CARE)**								
Course code	**24BSFD314R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ V semester of third year of the programme**								
Course Objectives	1. To review about various techniques used in counselling. 2. To understand the use of various types and techniques of counselling in order to motivate patients to achieve well-being 3. To understand the significance of dietitian in modifications of therapeutic diet								
CO1	Understand the principles and procedures of diet counseling and the role of the counselor.								
CO2	Give them a clear picture of influence of lifestyle on health and wellbeing.								
CO3	Analyze how acute and chronic illness affects the emotional, psychological well being and behavior of the individuals.								
CO4	Learn the techniques and skill of dietitian								
CO5	Evaluate the significance of dietitian in modifications of therapeutic diet								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Diet Counselling –Definition, counselling process-interviewing, counseling and consulting, role of the dietitian, code of ethics, limits. Techniques for obtaining relevant information: nutritional status assessment-anthropometry, clinical information, medical history and general profile, dietary assessment- diet history, 24 hr diet recall, MNA, FFQ, lifestyles, physical activity, stress Theories of counselling, approaches and techniques	**8**	Learn about the Role of a dietitian, ethical codes and responsibilities, assessment of nutritional status and techniques of counseling	1,2,3,4
II	Developing resources and nutritional aids for education and counseling Developing nutritional assessment form (for ambulatory and non-ambulatory patients) Working with Hospitalized patients and Outpatients Follow up Monitoring and Evaluation of outcome	**8**	Learn to develop counseling techniques, planning of modified diet charts according to different conditions	1,2,3,4

REFERENCE BOOKS:

R1: "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" by John W. Creswell and J. David Creswell
R2: "The Craft of Research" by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams
R3: Research Methodology: Methods and Techniques" by C.R. Kothari

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6153617/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the principles and procedures of diet counseling and the role of the counselor.	**1,2,3,8**
2	Give them a clear picture of influence of lifestyle on health and wellbeing.	**1,2,3,8**
3	Analyze how acute and chronic illness affects the emotional, psychological well being and behavior of the individuals.	**1,2,3,8**
4	Learn the techniques and skill of dietitian	**1,2,3,8**
5	Evaluate the significance of dietitian in modifications of therapeutic diet	**1,2,3,8**

SEMESTER – V									
Course Title	**TECHNO PROFESSIONAL COURSE III (COMMUNITY EXPERIENCE LEARNING)**								
Course code	**24BSFDR314R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**4**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition & Dietetics**								
Semester	**Fall/ V semester of third year of the programme**								
Course Objectives	1. To familiarize the student with concepts of community. 2. To work with community and also organizations working in the field of health and nutrition 3. To prepare audio visual material for health and nutritional awareness.								
CO1	Study the community as a concept and the dynamic formation of its structures								
CO2	Gain insight regarding the health issues faced in the community and communities understanding of their own issues.								
CO3	Prepare material for health and nutritional awareness.								
CO4	Explain various national and international health organizations								
CO5	Understand the programs in nutrition & Health								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Concept of public nutrition:** Relationship between health and nutrition. The role of public nutritionists in the fields of health care and public policy related to nutrition and health	**3**	Learning the concept of public nutrition	1,2,3 ,4
II	**Communicating with Communities:** Principles of Communication. Definitions of Communication. Functions of Communication. Types & Levels of Communication. Barriers in Communication: Collecting information on community–nutritional and health practices.	**3**	Learning about the communication	1,2,3 ,4
III	**Communication Methods:** Interpersonal and group. Steps in community activity planning: Preparing visual aids–presentations, posters, charts, information booklets etc.	**2**	Learning about different communication method	1,2,3 ,4
IV	**Traditional Media in Community Nutrition:** Role and use of theatre, folksongs, puppetry in creating awareness in the community.	**4**	Learning about community nutrition	1,2,3 ,4
V	**Policies & Programs in Nutrition & Health:** International organizations, National Organizations, Primary Health Care in India, Health Programs in India	**3**	Learning about programs in Nutrition & Health	1,2,3 ,4

TEXT BOOKS:

T1: Srilakshmi B., Community Nutrition, New Age International Pvt. Limited, First Edition, 2022.

REFERENCE BOOKS:

R1: Temple, N. J. and Steyn, N., Community Nutrition for Developing Countries Athabasca University Press and UNISA Press, 2016

R2: Park, K. Textbook of preventive and social medicine, 27th Edition, 2023.

OTHER LEARNING RESOURCES:

https://www.researchgate.net/publication/233706475_Health_Nutrition_and_Public_Policy

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Study the community as a concept and the dynamic formation of its structures	**1,2,3,5,7**
2	Gain insight regarding the health issues faced in the community and communities understanding of their own issues.	**1,2,3,5,7**
3	Prepare material for health and nutritional awareness.	**1,2,3,5,7**
4	Explain various national and international health organizations	**1,2,3,5,7**
5	Understand the programs in nutrition & Health	**1,2,3,5,7**

SEMESTER – V									
Course Title	**RESEARCH PROJECT (MINI RESEARCH)**								
Course code	**24BSFD317R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**0**	**12**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Fall/ V semester of third year of the programme**								
Course Objectives	1. To enable students to apply experimental methods to solve a given scientific task. 2. To be able to analyze research data 3. To be able to compile and document research data.								
CO1	Learn to tabulate research data								
CO2	Analyze research outcomes								
CO3	Corelate with exiting literature								
CO4	Prepare an effective dissertation report								
CO5	Able to communicate research outcome								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction, Comprehension on research search engines, Selection of Topic.	**30**	To learn to use search engines and selection of topic.	1,2,3
II	Tools for reference citation, Different methods for writing citation and references, Introduction to structure of Review and specific features of review, Plagiarism, ethnical issue in writing the review, Mapping and selection of Journal of specific knowledge of discipline and submission for publications.	**30**	To learn to write review of literature for a topic.	1,2,3

REFERENCE BOOKS:

R1: "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" by John W. Creswell and J. David Creswell
R2: "The Craft of Research" by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams
R3: Research Methodology: Methods and Techniques" by C.R. Kothari

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6153617/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn to tabulate research data	**1,2,3,5,7,8**
2	Analyze research outcomes	**1,2,3,5,7,8**
3	Corelate with exiting literature	**1,2,3,5,7,8**
4	Prepare an effective dissertation report	**1,2,3,5,7,8**
5	Able to communicate research outcome	**1,2,3,5,7,8**

SEMESTER – VI									
Course Title	**RESEARCH PROJECT PART II (DISSERTATION)**								
Course code	**24BSFD324R**	**Total credits: 5**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**0**	**30**	**0**	**5**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ VI semester of third year of the programme**								
Course Objectives	1. Apply experimental methods to solve a given scientific task, 2. Collect data for evaluation and for statistical treatment, if relevant, 3. Use relevant scientific literature.								
CO1	Develop a research proposal, formulating research questions, reviewing literature, interpreting data, and understanding the implications of research findings.								
CO2	Develop skills in crafting a concise and well-structured research proposal.								
CO3	Learn to formulate research questions, objectives, and hypotheses.								
CO4	Conduct a focused review of relevant literature related to the chosen mini research topic.								
CO5	Learn to interpret data, draw meaningful conclusions, and relate results to the research question.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Introduction, Comprehension on research search engines, Selection of Topic	**10**	To learn about methods of research	1,2
II	Tools for reference citation, Different methods for writing citation and references, Introduction to structure of Review and specific features of review, Plagiarism, ethnical issue in writing the review, Mapping and selection of Journal of specific knowledge of discipline and submission for publications	**20**	To harness ideas on data collection and interpretation	1,2

REFERENCE BOOKS:

R1: "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" by John W. Creswell and J. David Creswell
R2: "The Craft of Research" by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams
R3: "Research Methodology: A Step-by-Step Guide for Beginners" by Ranjit Kumar.

OTHER LEARNING RESOURCES:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5037944/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Develop a research proposal, formulating research questions, reviewing literature, interpreting data, and understanding the implications of research findings.	**1,2,3,4,5.6,7,8**
2	Develop skills in crafting a concise and well-structured research proposal.	**1,2,3,4,5.6,7,8**
3	Learn to formulate research questions, objectives, and hypotheses.	**1,2,3,4,5.6,7,8**
4	Conduct a focused review of relevant literature related to the chosen mini research topic.	**1,2,3,4,5.6,7,8**
5	Learn to interpret data, draw meaningful conclusions, and relate results to the research question.	**1,2,3,4,5.6,7,8**

SEMESTER – VI									
Course Title	**HERBAL MEDICINE**								
Course code	**24FSBO601R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ VI semester of third year of the programme**								
Course Objectives	1. To understand the pharmacological properties of medicinal plants. 2. To learn the methods of formulation of herbal medicine. 3. To evaluate scientific literature on herbal medicine.								
CO1	Discuss pharmacological properties of medicinal plants.								
CO2	Explain the methods of formulation of herbal medicine.								
CO3	Evaluate scientific literature on herbal medicine.								
CO4	Discuss clinical applications of herbal medicine.								
CO5	Understand the legal and ethical issues on herbal medicine.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Pharmacological Properties of Medicinal Plants:** Introduction to pharmacognosy, bioactive compounds in plants, mechanisms of action, examples of commonly used medicinal plants.	**9**	Describe the pharmacological properties and mechanisms of action of bioactive compounds in medicinal plants.	1,2
II	**Methods of Formulation of Herbal Medicine:** Extraction methods, preparation of extracts, formulation techniques (tinctures, decoctions, infusions, tablets, capsules), standardization of herbal products.	**9**	Demonstrate knowledge of different extraction and formulation techniques used in herbal medicine.	2,3
III	**Evaluation of Scientific Literature on Herbal Medicine:** Research methodologies, critical appraisal of clinical studies, systematic reviews, meta-analyses, interpretation of results.	**9**	Critically evaluate and interpret scientific literature related to herbal medicine.	4,5
IV	**Clinical Applications of Herbal Medicine:** Use of herbal medicine in treating common ailments, evidence-based applications, safety and efficacy, interaction with conventional medicines.	**9**	Discuss the clinical applications, safety, and efficacy of herbal medicines in treating various conditions.	3,4
V	**Legal and Ethical Issues in Herbal Medicine:** Regulatory frameworks, quality control, intellectual property rights, ethical considerations in research and practice, patient consent.	**9**	Understand and discuss the legal and ethical issues related to the practice and research of herbal medicine.	1,2

TEXT BOOKS:

T1: "Pharmacognosy and Phytochemistry" by Vinod D. Rangari
T2: "Textbook of Pharmacognosy" by C.K. Kokate, A.P. Purohit, and S.B. Gokhale.

T3: "Herbal Medicine: Biomolecular and Clinical Aspects" edited by Iris F.F. Benzie and Sissi Wachtel-Galor

REFERENCE BOOKS:

R1: "The Complete Guide to Herbal Medicines" by Charles W. Fetrow and Juan R. Avila
R2: "Principles and Practice of Phytotherapy: Modern Herbal Medicine" by Simon Mills and Kerry Bone
R3: "Herbal Medicine: Expanded Commission E Monographs" by Mark Blumenthal

OTHER LEARNING RESOURCES:

Coursera, YouTube

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss pharmacological properties of medicinal plants.	**1,2,5**
2	Explain the methods of formulation of herbal medicine.	**1,2,5**
3	Evaluate scientific literature on herbal medicine.	**1,2,5**
4	Discuss clinical applications of herbal medicine.	**1,2,5**
5	Understand the legal and ethical issues on herbal medicine.	**1,2,5**

SEMESTER – VI									
Course Title	**INTERNSHIP**								
Course Code	**24BSFD321R**	**Total Credits: 6**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**24**	**0**	**0**	**6**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Bachelor of Science in Food, Nutrition and Dietetics**								
Semester	**Spring/ VI semester of third year of the programme**								
Course Objectives	1. To demonstrate comprehensive knowledge of the principles of medical nutrition therapy (MNT) across various disease states 2. To identify and diagnose nutritional deficiencies, risks of malnutrition, and the impact of nutrition on disease progression. 3. To develop and implement individualized nutrition care plans based on patient-specific needs and goals.								
CO1	Understand the impact of disease on nutritional needs, the role of nutrients in disease prevention and management, and the application of evidence-based dietary guidelines.								
CO2	To accurately assess a patient's nutritional status using various methods, including nutritional history, physical examination, biochemical tests, and anthropometric measurements.								
CO3	Setting realistic dietary goals, recommending appropriate dietary interventions (e.g., meal planning, supplementation, enteral/parenteral nutrition), and providing clear and concise nutrition education to patients and their families.								
CO4	Effectively communicate with patients, families, and members of the healthcare team regarding nutrition-related issues.								
CO5	Learn to manage all aspects of food service operations, including purchasing, inventory control, production planning, and staff scheduling.								

1. **Frontpage:** Name of University, University Logo, Name of the Student, Class, Department
2. **Certificate**
3. **Acknowledgement**
4. **Contents**
5. **Introduction**
6. **Activities**

A. Activity I: Internship details

- Name of the Institution where the internship was undertaken
- Dietitian incharge under whose Supervision Internship undertaken (Name and Designation)
- Duration and date of internship
- Dietetic department profile and organization
- Posting schedule of the intern

Day/week	Posting	Activities schedule and undertaken

- Kitchen layout
- Food procurement and storage
- Schedule/timing for meal distribution
- Dietetic department menu

B. Activity II: Modified therapeutic diets and special feeding methods

C. Activity III: Clinical posting and nutritional care of patients

i. Ward posting detail

- Major disease conditions observed and Medical Nutrition Therapy recommended during ward posting

Sl. No	Ward posting	Major disease conditions observed	Recommended diets

ii. Nutrition and diet counseling

- List of educational material available
- Nutrition and diet counseling for both In and Out patients

Date/time	IPD/OPD Posting	Counseling details

Note: Separate table for IPD and OPD

D. Activity IV: Case studies

- **Disease case**

  Case problem (indicate the disease condition) Weight (kg)
  Food habits
  Occupation
  Educational qualification
  lifestyle
  Date of admission
  Date of discharge Duration of stay
  Medical diagnosis
  Past history

- **Medical history of the case**
- **Present problem**
- **Physical parameters examination**
- **Biochemical parameters**

Parameters analyzed	At the time of admission	At the time of discharge	Normal values during the treatment

- **Management and treatment details**

  i. Drug therapy (give the name of the drug/injections etc given/prescribed)

  ii. Blood glucose monitoring (record in tabular form and follow-up the patient's blood glucose level if analyzed before breakfast, before lunch and/or before dinner the period of hospitalization). (note: only for diabetes mellitus)

  iii. Dietary management of the disease condition

  iv. Nutrition/diet counseling

v. Careprognosis: (comment on the portable course and outcome with respect to patient's condition/after the disease treatment in the hospital)

vi. Case study outcome: (brief highlights how the case study helped in your understanding of the dietary management of the disease condition under study)

A. Activity V: Presentation

7. Annexure/Appendices: Abbreviations**,** Biochemical Parameters, Portion Size, Diet Sheet

Assam down town University

Curriculum and Syllabus

Master of Science
in
Food, Nutrition and Dietetics

OUTCOME BASED EDUCATION FRAMEWORK

CHOICE BASED CREDIT SYSTEM

Version: 2.2

FACULTY OF SCIENCE

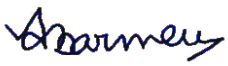
July, 2024

PREAMBLE

Assam down town University is a premier higher educational institution which offers Bachelor, Master, and Ph.D. degree programmes across various faculties. These programmes, collectively embodies the vision and mission of the university. In keeping with the vision of evolutionary changes taking place in the educational landscape of the country, the university has restructured the course curriculum as per the guidelines of National Education Policy 2020. This document contains outline of teaching and learning framework and complete detailing of the courses. This document is a guidebook for the students to choose desired courses for completing the programme and to be eligible for the degree. This volume also includes the prescribed literature, study materials, texts, and reference books under different courses as guidance for the students to follow.

Recommended by the Board of Studies (BOS) meeting of the Faculty of Science held on dated 16th & 17th July, 2024 and approved by the 51st Academic Council (AC) meeting held on dated 26/07/2024

Chairperson, Board of Studies



Member Secretary, Academic Council

Vision

To become a Globally Recognized University from North Eastern Region of India, Dedicated to the Holistic Development of Students and Making Society Better

Missions

1. Creation of curricula that address the local, regional, national, and international needs of graduates, providing them with diverse and well-rounded education.

2. Build a diverse student body from various socio-economic backgrounds, provide exceptional value-based education, and foster holistic personal development, strong academic careers, and confidence.

3. Achieve high placement success by offering students skill-based, innovative education and strong industry connections.

4. Become the premier destination of young people, desirous of becoming future professional leaders through multidisciplinary learning and serving society better.

5. Create a highly inspiring intellectual environment for exceptional learners, empowering them to aspire to join internationally acclaimed institutions and contribute to global efforts in addressing critical issues, such as sustainable development, Climate mitigation and fostering a conflict-free global society.

6. To be renowned for creating new knowledge through high quality interdisciplinary research for betterment of society.

7. Become a key hub for the growth and excellence of AdtU's stakeholders including educators, researchers and innovators

8. Adapt to the evolving needs and changing realities of our students and community by incorporating national and global perspectives, while ensuring our actions are in harmony with our foundational values and objectives of serving the community.

Programme Details

Programme Overview

M. Sc. FND offers a wide range of courses covering various basic and applied areas of nutritional sciences. The student develops an aptitude and scientific temperament to apply the technical skills in various important areas of Nutrition and Food such as Food Science, Nutritional biochemistry, Food Microbiology, Clinical Nutrition, Food Technology and Food Science. The course also offers various techno specific skills, universal ethics and elective courses considering overall development and employability scopes in research, industry and teaching sectors. The course duration is for a period of 2 years.

I. Specific Features of the Curriculum

- Experiential learning
- Constructivist approach to learn
- Practical and project-based learning

II. Eligibility Criteria:

M. Sc in FND with minimum of 45% marks or equivalent CGPA.

III. Program Educational Objectives (PEOs):

PEO1: AdtU Food Nutrition and Dietetics post graduates will be equipped to pursue lucrative careers as food analysts, public health nutritionists, food microbiologists, food product developers, food inspectors, and other related fields in both public and private sectors.
PEO2: Post graduates in Food Nutrition and Dietetics will have the academic preparation to work as certified dietitians or diet counsellors, assessing nutritional status and promoting health.
PEO3: Food Nutrition and Dietetics post graduates from AdtU will actively engage in professional efforts to uplift their status in the field of higher education/research in specialized or multidisciplinary fields while also positively impacting society and the profession. If they choose to continue further education

IV. Program Specific Outcomes (PSOs):

PSO1: Global Proficiency: Manifest global proficiency in the profession with self-paced skill development and continuous learning**.**

PSO2: Research and outreach: Encourage the pursuit of problem-solving through research, collaborate with national and international organizations that specialize in nutrition and related multi-disciplinary subjects, and raise public awareness through outreach and extension.

PSO3: Entrepreneurship: Empower competency to construct a profitable business as an entrepreneur to pursue careers in domain and multidisciplinary fields to establish a successful venture.

V. Program Outcome (PO):

PO1. Nutritional Knowledge: Apply comprehensive knowledge of food science, nutrition, dietetics, allied aspects of biological sciences, and nutrition specialization to solving complex human nutritional issues.

PO2. Problem Analysis: Identify and analyse complex nutritional problems reaching substantial conclusions using life science fundamentals and nutrition using critical thinking.

PO3. Reasoning and Research: Apply multidisciplinary knowledge and research methods including review of literature, hypotheses formulation, experimental design and analysis using modern tools and analytical techniques to provide valid conclusions.

PO4. Communication: Communicate effectively the information and nutritional intervention with individuals, peers, and society at large; prepare documents/ scientific reports and deliver presentations efficiently.

PO5. Professional Ethics: Comply with moral values, professional ethics, and their strict application in the professional practice.

PO6. Eco-Friendly Approach: Understand the impact of the formulated nutritional solutions in a socioeconomic context with eco-friendly approaches.

PO7. Teamwork and Leadership: Function effectively as an individual, and as a member or leader in multidisciplinary teams.

PO8. Lifelong Learning: Ability to engage in independent lifelong learning in the broadest context of scientific and technological advancement.

VI. Total Credits to be Earned: 89

VII. Career Prospects:

M.Sc. in Food Nutrition and Dietetics offers a range of dynamic career opportunities. Graduates can work in research and development, hospitals, and food processing industries. Roles include nutritionist, quality control analysts, and clinical researchers. Opportunities also exist in academia and education, where graduates can contribute to scientific knowledge and train future professionals.

EVALUATION METHODS

The student performance shall be evaluated through In-semester (Sessional) and semester-end examinations. A weightage of 40% or as prescribed by the programme shall be added to the score of the end-semester examination.

A. INTERNAL ASSESSMENT:

The teacher who offers the course shall be responsible for internal assessment by conducting in-semester (Sessional) examination and evaluating the performance of the students pursuing that course. The components for internal assessment are illustrated in the table given below.

S.N.	Components/ Examinations	Marks Allotted
1.	In-Sem Exam – I (ISE-I) (Written Examination)*	30
2.	In-Sem Exam – II (ISE-II) (Written Examination)*	30
3.	Assignment	10
4.	Presentation (SP)	10
5.	Quiz	5
6.	Class Performance based score*	5

are compulsory

Note: *Total Internal assessment should be out of 40*

INSTRUCTION

1. If a student fails to appear in the any of the component without any valid reason he/she shall be marked zero in that component. However, the course teacher at his discretion may arrange for the missed test on an alternate date for the absentee students after determining ground with genuine/valid reasons for the absent.
2. The report of evaluation of an activity towards the in-semester (Sessional) component of a course shall be duly notified by the concerned course teacher within a week of completion.
3. The program coordinators should upload the in-semester marks to the ERP and forward acknowledgement of all the courses of the program to the Controller of Examinations before the start of the End-semester examination.

B. SEMESTER END EXAMINATION:

Time table for end semester examination is published at least 25 days prior to the start of Examination.

I. Pre-Examination:

Eligibility Criteria for a student to appear in University Examinations:

The student shall only be allowed to appear in a University Examination, if:

i) He/ She is a registered student of the University;

ii) He/ She is of good conduct and character;

iii) He/ She has completed the prescribed Programme of study with minimum percentage of attendance as laid down in the Regulations of the Programme concerned.

Under special cases, a student may be allowed to appear for an examination without being registered in the University but the result of the said student will be kept on hold till the registration of the concerned student is completed.

II. Admit Card:

Admit card for the examination may be downloaded through ERP where the system will generate a Unique ID Cards through online.

The University shall have the right to cancel admission for examination of any candidate on valid grounds.

III. Pattern of Question Papers:

The question paper shall follow the principles of Bloom's Taxonomy.

S. N.	Level	Questions /verbs for test
1	Remember	List, Define, tell, describe, recite, recall, identify, show who, when, where, etc.
2	Understand	Describe, explain, contrast, summarize, differentiate, discuss, etc.
3	Apply	Predict, apply, solve, illustrate, determine, examine, modify
4	Analyze	Classify, outline, categorize, analyze, diagrams, illustrate, infer, etc.
5	Evaluate	Assess, summarize, choose, evaluate, recommend, justify, compare etc.
6	Create	Design, Formulate, Modify, Develop, integrate, etc.

Note: No course is to be evaluated on basis of **all 6 knowledge levels.**

The format of the question paper across all the program follow a unique pattern and the total marks is 60

Table 1: Question paper pattern for End semester examination

Sl no.	Question pattern	Total marks
1	MCQs (10 Questions)	10
2	2 Marks questions (10 Questions)	20
3	4 Marks questions (5 Questions)	20
4	10 Marks questions (1 Question)	10

IV. Examination Duration:

Each paper of 60 marks shall ordinarily be of two hours duration.

V. Practical Examinations, Viva-Voce etc.:

i) Practical examination shall be conducted in the presence of one external expert and one or more internal examiners.

ii) Viva-Voce, Oral examinations of the Project report, Dissertation etc. shall be undertaken by a Board of Examiners constituted by the respective Dean of Program with the advice of Supervisor(s).

VI. Procedure of Expulsion:

If any candidate is found to be using any unfair-means during the examination, the invigilator may cease his/her answer sheet and report it directly to the Officer-in-Charge. The Office-in-Charge of the center may take appropriate decisions as per the rules and procedure of the examination. The Officer-in-Charge may allow the students to write the exam with new answer sheet or may expel the student from appearing the paper depending on the nature of unfair-means. In case of Computer based test, the students may be directed to write an apology letter and sign in the prescribe expulsion form. The student may not be allowed to write that examination.

VII. Instruction to the Students:

(i) The students shall not bring to the Examination Hall, any electronic gadget used as a means of communication or record except electronic calculator, if required.

(ii) The students shall not receive any book or printed or hand written or photo copy (Xerox) or blank-paper from any other person while he/she is in the examination-room or in laboratory or in any other place to which he/she is allowed to have access during course of examination.

(iii) The students shall not communicate with any other candidate in the examination room or with any other person in and outside the examination-room.

(iv) The students shall not see, read or copy anything written by any other candidate, nor shall he/she knowingly or negligently permit any other candidate to see, read or copy anything written by him/her or conveyed by him/her.

(v) The students shall not write anything on the Question Paper or in other paper or materials during the examination, or pass any kind of paper to any other candidate in the examination-room, or to any person outside the room.

(vi) The students shall not disclose his/her identity to the examiner by writing his/her name or putting any sign / symbol in any part of his answer-script.

(vii) The students shall not use any abusive language or write any objectionable remark or make any appeal to examiner by writing in any part of his answer-script.

(viii) The students shall not detach any page from the answer-script or insert any authorized or unauthorized loose sheet into it. He /she shall also not insert any other answer-script / loose sheet by removing the pins of the origin answer-scripts and re-fixing it.

(ix) The students shall not resort to any disorderly conduct inside the examination-room or misbehave with the invigilator or any other examination official.

VIII. Provision for an Amanuensis (writer):

(i) A candidate may be provided with an Amanuensis (writer) to write down on dictation on his / her behalf on ground of his / her physical disability to write down by himself / herself due to accident or any other reason. The amanuensis may be provided till he / she recovers from the physical disability. The physical disability to write down by himself / herself must be supported by Medical Certificate from a competent Medical Officer.

(ii) The qualifications of the amanuensis so provided must not be equal or higher than that of the candidate. This is also to be supported by Certificate from the Faculty of Study where the Amanuensis is provided.

(iii) Such candidates are to be accommodated in a separate room under the supervision of an invigilator so that the fellow candidates are not disturbed in the process.

C. Credit Point:

It is the product of grade point and number of credits for a course, thus, CP = GP x CR

i. Credit:

A unit by which the course work is measured. It determines the number of hours of instructions required per week. 'Credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. Credits assigned for a single course always pay attention to how many hours it would take for an average learner to complete a single course successfully.

ii. Grade Point:

Grade Point is a numerical weight allotted to each Grade Letter on a 10-point scale.

iii. Letter Grade:

Letter Grade is an index of the performance of students in a said paper of a particular course. Grades are denoted by letters O, A+, A, B+, B, C, P, F and Abs. Student obtaining Grade F / Grade Abs shall be considered failed/ absent and, will be required to appear in the subsequent ESE. The UGC recommends a 10-point grading system with the following (Table: 1) Letter Grades:

(i) A Letter Grade shall signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point shall indicate the numerical weight of the Letter Grade on a 10-point scale.

(ii) There shall be 08 (eight) Letter Grades bearing specific Grade Points as listed in Table 1, where the Letter Grades 'O' to 'P' shall indicate successful completion of a course.

(iii) Apart from the 08 (eight) regular Letter Grades listed in Table 1, there shall be 03 (three) additional Letter Grades, which shall be awarded if a Course is withdrawn or spanned over the next Semester or remains incomplete as stated in Table 2.

Table 2: Letter Grades and Grade Points

Letter Grade	Grade Points	Description
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Abs	0	Absent
UFM	0	Unfair Means

iv. Grade Point Average:

a. SGPA (Semester Grade Point Average)

The SGPA of a student in a Semester shall be the weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered in that Semester, irrespective of whether he/she could or could not complete the Courses. More specifically, the calculation of SGPA shall take into account the Courses graded with Letter Grades 'O' to 'F' as given in Table 1.

$$\text{SGPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad (1.1)$$

The SGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.1) up to two decimal places, where n is the total number of Credit Courses registered by the student in that Semester, Gi is the Grade Point secured in the i^{th} registered Course and Ci is the Credit (weight) of that Course.

b. CGPA (Cumulative Grade Point Average)

(i) The CGPA of a student in a Semester of a Programme shall be the accumulated weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered and successfully completed so far starting from the enrollment in the Programme. In other words, taking into account all the Courses graded with 'O' to 'P' as given in Table 1.1, generally the CGPA of a student shall be calculated starting from the first Semester of his/her enrolled Programme, while the CGPA of a lateral-entry student shall be calculated starting from the Semester of his/her enrollment.

(ii) The CGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.2) up to two decimal places, where N is the total number of Credit Courses registered and successfully completed so far by the student, Gi is the Grade Point secured in the ith completed Course and Ci is the Credit (weight) of that Course.

$$\text{CGPA} = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i} \qquad (1.2)$$

(iii) The CGPA shall be convertible into equivalent percentage of marks using Equation Conversion of CGPA to percentage marks: = CGPA*10

D. Post-Examination

i. Transcript or Grade Card or Certificate:

A marking certificate shall be issued to all the registered students after every Semester. The Semester mark sheet will display the course details (code, title, number of credits, grade secured) along with total credit earned in that Semester.

ii. Grievance Redressal Mechanism:

Students with any dissatisfaction or grievance regarding the marks awarded in any of the Papers / Courses may appeal to the Controller of Examinations for remedial action such as Re-evaluation within 10 days of the declaration of result.

(i) A student has options to appeal for re-evaluation of his /her answer script to the Controller of Examination.

(ii) Application for re-evaluation / re-scrutiny of answer scripts shall be made in the definite proforma available with the Examination Office through the head of the respective departments within 10 days of declaration of the results of the respective examinations.

(iii) The Controller of Examination may appoint an examiner for re-evaluation and will consider and recognize the evaluation done by a University appointed examiner.

(iv) There shall be no provision for re-evaluation of the Practical Papers, Project Work, and Dissertation etc. However, the students fail in practical examination or viva voce and wish to appear again may apply to be evaluated can do so with the next schedule.

(v) After screening the application for re-evaluation, the CoE may send the answer scripts of the student to the examiners appointed by the CoE with the approval of Vice Chancellor.

(vi) The marks/grades achieved by the students after the re-evaluation shall be final and binding.

(vii) Fresh Marks – sheets / Grade Card shall be issued only if the candidate secures pass marks / passing grade in the re-evaluated paper.

(viii) Re-evaluation of answer scripts shall be deemed to be an additional facility provided to the students with a view to improving upon their results at the preceding examination result for any reason whatsoever shall not confer any right upon them for admission to next higher class which matters always be regulated in accordance with the relevant rules or regulations framed by the University.

(ix) If as a result of revaluation of the candidate attracts the provision of condonation of deficiency, the same may be applied to his/her only for fresh attempt.

INSTRUCTION TO TEACHERS AND STUDENTS

(Teaching and Learning Methods)

In all the courses the teacher has to select topics for teacher-method which should not be less than 20 percent. The approach will be direct classroom teaching through a series of lectures delivering concepts using ITC facilities, white or blackboard. Notes may also be circulated to the students; however, the students are to be involved in the preparation of the notes. The teacher will be responsible for selecting the best note for circulation. The teacher-centric methodology has recently fallen out of favour because this strategy for teaching is seen to favour passive students.

1. Student- centric / Constructivist Approach:

The topics of the courses may be selected at the start of the class and assigned one topic to each of the students for studying by themselves, prepare presentations, notes, etc., and present at respective class time after consultation and discussion with the course teachers. The teacher facilitates the learning of the students by guiding and providing input and explaining concepts. 60 percent of the course contents may be selected for this purpose. To avoid behaviour problems, teachers must lay a lot of groundwork in student-centric classrooms. Typically, it involves instilling a sense of responsibility in students. In addition, students must learn internal motivation.

a. Project-Based Learning: The teacher may select 5 percent of topics for the purpose and may conduct visits to the laboratory for experiments or field surveys. The selection of the topic may be done considering the available facility for the purpose. However, in the final semester of each of the programme the student has to undergo project-based learning at least 4 months duration. This approach will help the student to think critically, evaluate, analyze, make decisions, collaborate, and more.

b. Inquiry-Based Learning: The teacher/ students are supposed to list at least five questions in each contact hour and student solve these question or search for answer which becomes the home work for the students "question-driven" learning approach. The teacher may look for the correctness of the solution or the best possible answer and discuss in the successive class. This will help in the preparation for various competitive examination and develop a habit for search for solutions.

c. Flipped Classroom: About 10 percent of the course content has to be completed by this method. In this approach the students are asked to watch video or lecture prepared by the teacher or any video available (relevant to the course). A set of questions may be given to the students for searching answers by the students. The idea is that students should have more time in-classroom focusing on achieving these higher levels of thinking and learning. The Flipped classroom is also an acronym. The letters FLIP represent the four pillars included in this type of learning: Flexible environment, Learning culture shift, Intentional content, and Professional educator. As you can see, the second pillar refers to a culture shift from the traditional approach where students are more passive to an approach where students are active participants. As a result, this approach is also a student- centric teaching method.

d. Cooperative Learning: The remaining five percent has to be completed by cooperative learning approach. In this approach, the students are allotted problems. During library hours the students along with the teacher visit the library and search for probable solutions for the assigned problem. The same has to be done in groups so that the students discuss among themselves for the appropriate answers. Essentially, cooperative learning believes that social interactions can improve learning. In

addition, the approach recreates real-world work situations in which collaboration and cooperation are required.

The percentage categorization for the completion of a theory course

Teacher-centric or Direct Classroom Teaching: Delivery by series of lectures	20%
Student-centric Approach, Students present and deliver lectures in the presence of teacher and supervised by teacher	60%
Students visit fields or perform experiments or teachers perform demonstration	05%
Flipped Classroom approach	10%
Cooperative learning approach	05%

Inquiry-based approach has to be followed in all of the classes

The teacher has to distribute the topics to be considered for teaching by the above-mentioned approaches and prepare a lesson plan for execution and maintain a file.

SEMESTER WISE COURSE DISTRIBUTION

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester I	1.	24MSFD1101R	Advance food Science	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	2	24MSFD1102R	Biochemistry and Bio-instrumentation	**DSC Minor**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSFD1103R	Food Microbiology	**DSC Minor**	3	0	2	0	0	0	3	40	60	0	100
	4	24UMFS1101R	Fundamental of Statistics	**MDC**	1	0	2	0	0	0	2	40	60	100	200
	6	24UMPD1101R	Effective Communication (PDP)	**AEC**	0	0	4	0	0	0	2	0	0	100	100
	7	24UMEC1101	Extra-Curricular Activities	**Co and Extra-Curricular**	0	0	0	4	0	0	1	0	0	100	100
	Total										**16**				**900**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester II	1.	24MSFD1201R	Macronutrients	**DSC Major**	3	0	0	0	0	0	3	40	60	0	100
	2	24MSFD1202R	Human Physiology	**DSC Major**	3	0	0	0	0	0	3	40	60	0	100
	3	24MSFD1203R	Micronutrients	**DSC Major**	2	0	0	0	0	0	2	40	60	0	100
	4	24MSFD1204R	Public nutrition	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	5	24UMPD120R	Aptititute / Logical Course	**AEC**	2	0	0	0	0	0	2	40	60	0	100
	6	24MSFD1205R	Postgraduate Practice Teaching	**SEC**	2	0	0	0	0	0	2	0	0	100	100
	7	24FSDA1201R	Data Analysis using microsoft excel	**VAC**	2	0	4	0	0	0	2	0	0	0	100
	8	24MSFD1208R	Research methodology & Statistical Analysis	**Research**	2	0	2	0	0	0	3	40	100	100	200
	9	24MSFD1206R	Field Visit	**Field Training**	0	0	0	0	0	8	1	40	60	0	100
	10	24UMCC1201	Co-Curricular Activities	**Co-Curricular**	0	0	0	0	0	0	1	0	0	100	100
	11.	24MSFD1207R	Food Safety and Standards	**DSC-Minor**	1	0	0	0	0	0	1	40	60	0	100
	Total										**24**				**1300**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester III	1.	24MSFD2101R	Advance Nutrition	**DSC Major**	3	0	0	0	0	0	3	40	60	0	100
	2	24MSFD2102R	Applied nutrition I	**DSE Major**	3	0	2	0	0	0	4	40	60	100	200
		24MSFD2103R	Clinical Nutrition I												
	3	24MSFD2104R	Applied nutrition II	**DSE Major**	3	0	2	0	0	0	4	40	60	100	200
		24MSFD2105R	Clinical Nutrition II												
	4	24MSFD2106R	Product development and Marketing	**DSC Major**	3	0	0	0	0	0	3	40	60	0	100
	5		English (PDP)	**AEC**	0	0	4	0	0	0	2	0	0	100	100
	6		Internship	**Internship**	0	0	0	0	0	0	4	0	0	100	100
	7		Project Dissertation	**Research**	0	8	0	0	0	0	4	0	0	100	100
			Indian Knowledge Systems	**VAC**	0	0	0	0	0	0	2	0	0	100	100
	8		Field Visit	**Field Training**	0	0	0	0	0	0	1	40	60	0	100
	Total										**27**				**1100**

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester IV	**1**	24MSFD2201R	Internship	**DSC Major**	0	0	0	0	0	48	6	40	60	0	100
	7	24MSFD2202R	Research/data analysis/documentation-R4	**Research**	0	0	24	8	12	0	16	0	0	100	100
	Total										**22**				**200**
	Grand Total										**89**				**3500**

***IA: Internal Assessment, SEE: Semester End Examination,**
PE: Practical Examination

SEMESTER – I									
Course Title	**MACRONUTRIENT**								
Course code	**24MSFD1201R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ I Semester of first year of the programme**								
Course Objectives	1. To introduce the students to the basics of nutrition. 2. To study the basic food groups, cooking methods in details. 3. To learn the new concept of nutrients								
CO1	Acquire knowledge on different macronutrient								
CO2	Learn about different macronutrient deficiency and the related causes								
CO3	Understand the program and policies in connection to food and health								
CO4	Understand body composition and recommended dietary allowances for different age groups								
CO5	Gain knowledge on the sources of different nutrients								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction to Nutrition Science** - Definitions, history, and nutrition research in India. Methods of determining human nutrient needs and Description of basic terms and concepts in relation to human nutritional requirements. **Guidelines and Recommendations** - Recommended Dietary Allowances, factors affecting RDA, methods used to derive RDA, determination of RDA for different nutrients, requirements and allowances. **Body Composition** - Significance of body composition and changes through the life cycle. Methods for assessing body composition (both classical and recent) and their applications. Energy - Components of energy requirements: BMR, RMR, thermic effect of feeding, physical activity. Factors affecting energy requirements, methods of Measuring energy expenditure.	**10**	Learn about Understand body composition and recommended dietary allowances for different age groups changes through the life cycle.	1,2
II	Estimating energy requirements of individuals and groups. Regulation of energy metabolism and body weight: Control of food intake – role of leptin and other hormones	**7**	Estimating energy requirements of individuals and groups.	1,2
III	**Carbohydrates** - Review of nutritional significance of carbohydrates and changing trends in dietary intake of different types of carbohydrates and their implications. **Dietary fibre**: Types, sources, role and mechanism of action. Resistant starch, fructo-oligosaccharides, other oligosaccharides: Chemical composition and physiological significance.	**10**	Understand nutritional significance of carbohydrates	1,2

	Glycemic Index and glycemic load. Deficiency and excess of carbohydrates, its relation to human health.			
IV	**Proteins** – Metabolism of Protein, overview of role of muscle, liver and G.I. tract in protein metabolism, Nutritional requirements. **Amino acid** – Essential and Non-essential of amino acids, therapeutic applications of specific amino acids, Peptides of physiological significance. Proteins and Applied Aspects: Protein Quality.	**9**	Understand nutritional significance of Protein	1,2
V	**Lipids** – Metabolism of fat, Nutritional significance of fatty acids – SFA, MUFA, PUFA: functions and deficiency. Role of n-3 and n-6 fatty acids. Prostaglandins and trans Fatty	**9**	Understand nutritional significance of Lipid	1,2

TEXT BOOKS:

T1: Shils, M.E.; Olson, J.; Shike, M. and Roos, C. (1998): Modern Nutrition in Health and Disease. 9th edition. Williams and Williams. A Beverly Co. London.

REFERENCE BOOKS:

R1: Annual Reviews of Nutrition. Annual Review Inc, California, USA.
R2: Bodwell, C.E. and Erdman, J.W. (1988) Nutrient Interactions. Marcel Dekker Inc. New York
R3: Sumathi, R., Mudambi, Rajagopal, M.V. (1997) Fundamentals of Foods and Nutrition, New Age International (P) Ltd, Publishers, Third edition.
R4: Bamji, M. S., (2009) Textbook of Human Nutrition, Oxford, IBH Publishing (P) Ltd, 2009.

OTHER LEARNING RESOURCES:

SWAYAM, Coursera, Research articles

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Acquire knowledge on different macronutrient.	**1,2**
2	Learn about different macronutrient deficiency and the related causes	**1,2,4**
3	Understand the program and policies in connection to food and health	**1,2,4**
4	Understand body composition and recommended dietary allowances for different age groups	**1,2**
5	Gain knowledge on the sources of different nutrients.	**1,2**

SEMESTER – I									
Course Title	**HUMAN PHYSIOLOGY**								
Course code	**24MSFD1102R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ I Semester of first year of the programme**								
Course Objectives	1. To introduce the students the basics of human physiology. 2. To understand how the various physiological function of different parts of the body and there metabolism. 3. To understand the metabolism of different systems in human body.								
CO1	Understand the basics of human physiology								
CO2	Understand the functioning of the various parts of the body and the nutrient uptake from the food								
CO3	Provide knowledge on the rheological properties, its measurement and its application to food								
CO4	Gain knowledge on general organization, structure and properties of all the systems in our body								
CO5	Understand and apply the knowledge of exercise on health								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**General Physiology:** Organization of human body, cell structure and organelle, tissues and functions.	**6**	Understand basic organization of human body	1,2
II	**Blood:** Blood volume and body fluids, Composition and functions of blood, Structure and formation and function of RBC, WBC and platelets, Haemoglobin, Plasma, blood coagulation**,** Blood groups	**7**	Learn about structure, composition and functions of blood	1,2
III	**Digestive System:** General introduction, organizational plan of digestive system, Movement of G.I. Tract and functions of various components, Composition, functions and regulation of salivary, gastric, pancreatic, intestinal and biliary secretion, Functions of liver, gall bladder and pancreas, Digestion and absorption of carbohydrate, protein and fat.	**10**	Learn about Digestive System	1,2
IV	**Respiratory System:** General organization, Mechanics of respiration, Regulation of respiration, Gaseous exchange in lunge and tissues, Pulmonary ventilation, volumes and capacities, Effect of exercise on respiration, hypoxia.	**10**	Learn about Respiratory System	1,2
V	**Cardiovascular system:** General organization, structure and properties of cardiac muscles, Cardiac output, cardiac cycle, conducting system of heart, Heart sounds, regulation of H.R., pulse, blood pressure and its regulation,	**12**	Learn about Cardiovascular System	1,2

	Systemic circulation, pulmonary circulation and coronary circulation, ECG, cardio respiratory Changes during exercise.			

TEXT BOOKS:

T1: Meyer B J, Meij H S and Meyer AC., Human Physiology, AITBS Publishers and Distributors
T2: Wilson, K. J. W and Waugh, A. (1996): Rossand Wilson, Anatomy and Physiology in Health and Illness, 8th Edition, Churchill Livingstone

REFERENCE BOOKS:

R1: Ranganathan, T.S. (2004): A Textbook of Human Anatomy, Chand and Co. N.Delhi.
R2: Jain, A.K., Textbook of Physiology, Vol.I and II, Avichal Publishing Co., New Delhi.
R3: Chatterjee C.C. (1987): Human Physiology, Vol.I and II, Medical Allied Agency, Calcutta

OTHER LEARNING RESOURCES:

SWAYAM, Coursera, Research articles

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the basics of human physiology	**1,2**
2	Understand the functioning of the various parts of the body and the nutrient uptake from the food	**1,2**
3	Provide knowledge on the rheological properties, its measurement and its application to food	**1,2**
4	Gain knowledge on general organization, structure and properties of all the systems in our body	**1,2**
5	Understand and apply the knowledge of exercise on health	**1,2**

SEMESTER – I									
Course Title	**NUTRITIONAL BIOCHEMISTRY-I**								
Course code	**24MSFD1103R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ I Semester of first year of the programme**								
Course Objectives	1. To review about the different biochemical metabolism reaction of the body. 2. To understand how this metabolism takes place in correlation with the nutrients. 3. To understand different pathways involved in nutrient metabolism.								
CO1	Understand the basics metabolic reaction of the body.								
CO2	Give a clear picture of the biochemical Parameters of the body in normal and disease condition.								
CO3	Understand the concept of solutions of solid in liquid and liquid in liquid and the properties related to the concentration of solute.								
CO4	Learn about different pathways involved in nutrient metabolism								
CO5	Learn about fluid and electrolyte balance								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Carbohydrates-** Definition, classification. Structure (linear) of Monosaccharide- Glucose, fructose and galactose; Disaccharides-Maltose, lactose and sucrose; Polysaccharides- Starch and glycogen. Metabolism- Glycolytic pathway, electron transport chain and oxidative phosphorylation. Metabolism of carbohydrates: glycolysis and tricarboxylic Acid (TCA) cycle, HMP shunt.	**9**	Learn about Metabolism of carbohydrates	1,2
II	**Protein-** Definition, classification, structure, physical properties, chemical properties and utilization. Metabolism of proteins:- Transamination, deamination, decarboxylation, urea cycle. Enzymes and co-enzymes- Definition, types, classification and factors affecting velocity of enzyme catalyzed reactions. diagnostic value of serum enzymes - Creatinine kinase, Alkaline phosphatase, Acid phosphatase, LDH, SGOT, SGPT, Amylase, Lipase, Carbonic anhydrase etc.	**10**	Learn about Metabolism of protein	1,2
III	**Lipids-** Definition, classification and properties. Metabolism- Oxidation and biosynthesis of fatty acids. Ketone bodies, ketogenesis and ketosis.	**7**	Learn about Metabolism of lipid	1,2
IV	**Acid – base balance-** Acid-base balance in normal health, definition of buffers, principles of buffers, major sources of acid produced in the body, physiological buffer system and role of different buffer systems. **Fluid and electrolyte balance-**Distribution of fluids in the body, ECF, ICF, Water metabolism, Dehydration Maintenance in normal health.	**10**	Learn about acid base balance and Fluid and electrolyte balance	1,2
V	**Hormones -** Classification, general mode of action, hormones of Pituitary, Thyroid, Parathyroid, Adrenals, Reproductive Glands, Pancreas, hormonal disorders, counter regulatory hormones.	**9**	Learn about general function of hormones	1,2

TEXT BOOKS:

T1: Deb.A. C., Fundamental of Biochemistry, New Central Book Agency (P) Ltd, reprint 2004

REFERENCE BOOKS:

R1: Pattabiraman. T. N. Concise text Book of Bio-Chemistry, 2nd edition, All India Publishers and Distributors, Regd., 1998.
R2: Ambika Shanmugam, Fundamentals of biochemistry for Medical students, Karthik Printers, 7th edition, 1992.

OTHER LEARNING RESOURCES:

SWAYAM, Coursera, Research articles

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the basics metabolic reaction of the body.	**1,2,**
2	Give a clear picture of the biochemical Parameters of the body in normal and disease condition.	**1,2**
3	Understand the concept of solutions of solid in liquid and liquid in liquid and the properties related to the concentration of solute.	**1,2,3**
4	Learn about different pathways involved in nutrient metabolism	**1**
5	Learn about fluid and electrolyte balance	**1,2**

SEMESTER – I									
Course Title	**ADVANCE FOOD SCIENCE**								
Course code	**24MSFD1104R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ I Semester of first year of the programme**								
Course Objectives	1. To study different food group and their component 2. To study physical and chemical properties of food 3. To study the various cooking methods of different food groups								
CO1	Introduce student to advance food science and function of different kinds of foods, its composition and classification								
CO2	Apply the knowledge of toxic components in legumes and other food items								
CO3	Understand and apply the knowledge of food nutrient by selecting foods from different food groups in planning of diet.								
CO4	Gain home scale processing and storage skills to retain nutrients								
CO5	Develop culinary skills to satisfy sensory and nutrient needs								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Cereals chemistry: Structure, composition, nutritive value of cereals, storage and care, breakfast cereals, Characteristics of starch, use in variety of preparations Pulse chemistry: Chemical composition, Selection and variety, use in variety of preparation, nutritional aspects and cost, effect of cooking & storage on nutritive value of pulses. Toxic constituents of pulses, Lathyrism.	**10**	To learn about structure, composition and nutritive value of cereals and pulses	1,2
II	Milk & Milk Products: Composition & nutritive value, physical properties and effect of heat, nutritional importance. Milk Processing, Milk products, Substitutes, Role of milk in cookery.	**7**	To learn about composition and nutritive value of milk	1,2
III	Poultry & Fish: Composition & nutritive value, selection and storage, indication of freshness Meat: Sources of edible meat, composition & nutritive value, selection of meat, postmortem changes, changes on cooking, storage, factors effecting tenderness of meat. Egg- Structure, composition, nutritive value, tasting of freshness in eggs, uses of egg in food preparation, storage of egg Baking - Types of bake products & its nutritive value	**10**	To learn about types, composition and nutritive value of Poultry & Fish	1,2
IV	Vegetables & Fruits- Classification, composition & nutritive value, importance in human nutrition, storage, cooking of vegetables, changes in vegetables and fruits on cooking, effects of heat, acids & alkali. Phytonutrients in fruits and vegetables	**10**	To learn about types, composition and nutritive value of vegetables and fruits	1,2

	Spices and Condiments: Types, uses in Indian recipe Beverages: Coffee, tea, and cocoa, processing composition and preparation			
V	Nuts & oilseeds, Nutritive value of commonly used nuts & oil seeds in our diet, Fats& Oils- Nutritive values, types of fats & oils, role of fat in cookery. Sugar and Related Products: Nutritive value, Properties, characteristics & uses, sugar cookery, Form of sugar and liquid sweetness, Caramelization, Hydrolysis, Crystallization.	**8**	To learn about types, composition and nutritive value of Nuts & oil seeds	1,2
VI	Standardization of Cereal and pulses recipe and determine the nutritive value Standardization of egg, meat and product recipe and determine the nutritive value Standardization of vegetables, spices and fats and oil recipe and determine the nutritive value Market survey on different types of cereals and pulse (s) Market survey on different types of meat and milk products	**45**	To apply theoretical knowledge	1,2,3, 4

TEXT BOOKS:

T1: Norman N. Potter and Joseph H. Hotchkiss, Food Science, CBS publishers and distributors, Fifth edition, 2000

REFERENCE BOOKS:

R1: Manay Shakunthala, Nand Shadaksharaswamy M**.** Foods facts and Principles, New Age International (P) Ltd Publishers, Reprint 2005.

R2: Srilakshmi B. Food Science, New Age International (P) Ltd Publishers, Third edition, 2005.

OTHER LEARNING RESOURCES:

SWAYAM, Coursera, Research articles

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Introduce student to advance food science and function of different kinds of foods, its composition and classification	**1,2**
2	Apply the knowledge of toxic components in legumes and other food items	**1,2**
3	Understand and apply the knowledge of food nutrient by selecting foods from different food groups in planning of diet.	**1,2,4**
4	Gain home scale processing and storage skills to retain nutrients	**1,2**
5	Develop culinary skills to satisfy sensory and nutrient needs	**1,2,7**

SEMESTER – I									
Course Title	**FUNDAMENTAL OF STATISTICS**								
Course code	**24MSFD1201R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ I Semester of first year of the programme**								
Course Objectives	1. Help to understand the role of statistics in data analysis, decision-making, and scientific research 2. Introduce students to descriptive statistics, including measures of central tendency (mean, median, mode) and measures of dispersion (range, variance, standard deviation). 3. Teach students how to summarize and present data effectively using tables, charts, and graphs								
CO1	1. Improve understanding of Descriptive Statistics and Demography.								
CO2	2. Develop knowledge to understand the Probability theory, Distribution, and sampling methods.								
CO3	3. Develop knowledge to understand the methods for hypothesis testing and biological data analysis.								
CO4	4. Develop knowledge to understand the principles of various statistical analyses of data.								
CO5	5. Develop knowledge on R language for data analysis								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio.	**5**	Foundational Understanding of Statistical Concepts	1,2
II	Presentation: tabular and graphical, including histogram andogives. Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, skewness and kurtosis	**5**	Proficiency in Data Presentation and Analysis	1,2
III	Bivariate data: Definition scatter diagram, simple, partial and multiple correlation (3 variable only), rank correlation, simple linear regression, fitting of polynomials and exponential curves	**5**	Knowledge on Analyzing Bivariate Data and Relationships	1,2
IV	Random experiment: trial, sample point and sample space, event, Operations of Events, concepts of mutually exclusive and exhaustive events. Definition of probability: classical and relative frequency approach. Discrete probability space, Properties of probability, Independence of events, Conditional probability, total and compound Probability rules, Normal probability Distribution, Bionomial probability Distribution, Poisson Probability Distribution, Bayes'theorem and its applications.	**8**	Understanding of Probability and Distributions	1,2
V	Testing of hypothesis, parametric test: t-test, z-test, chi-square test. Non-Parametric test: One sample Kolmogorov test, wilcoxon Signed test, Mann-Whitney Test, Kruskalwalis test	**7**	Application of Hypothesis Testing and Statistical Tests	1,2

VI	1. Introduction to R - A programming language and environment for data analysis and graphics. Syntax of Rexpressions: Vectors and assignment, vector arithmetic, generating regular sequence, logical vector, character vectors, Index vectors; selecting and modifying subsets of data set 2. Data objects: Basic data objects, matrices, partition of matrices, arrays, lists, creating and using these objects; Functions-Elementary functions and summary functions, applying functions to subsets of data. Data frames: The benefits of data frames, creating data frames, combining data frames, Adding new classes of variables to data frames; Data frame attributes. matrices, partition of matrices, arrays, lists, creating and using these objects; Functions-Elementary functions and summary functions, applying functions to subsets of data. Data frames: The benefits of data frames, creating data frames, combining data frames, Adding new classes of variables to data frames; Data frame attributes. 3. Importing data files: import. Data function, read. Table function; Exporting data: export. data function, cat, write, and write. table functions, function, formatting output - options, and format functions; Exporting graphs -export. graph function. Graphics in R: creating graphs using plot function, box plot, histogram, line plot, steam and leaf plot, pie chart, bar chart, multiple plot layout, plot titles, formatting plot axes; Visualizing the multi variate data: Scatterplot, Q-Qplot, P-Pplot. 4. Performing data analysis tasks: Reading data with scan function, Exploring data using graphical tools, computing descriptive statistics, one sample tests, two sample tests, Goodness of fit tests. 5. Parametric test and Non-Parametric test	**30**	A brief knowledge on using R for data analysis and visualization	1,2, 3,4

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve understanding of Descriptive Statistics and Demography.	**1, 3, 4**
2	Develop knowledge to understand the Probability theory, Distribution, and sampling methods.	**1, 4**
3	Develop knowledge to understand the methods for hypothesis testing and Biological data analysis.	**1, 4**
4	Develop knowledge to understand the principles of various statistical analyses of data.	**1, 4**
5	Develop knowledge on R language for data analysis	**1, 4**

<table>
<tr><th colspan="10">SEMESTER – I</th></tr>
<tr><td>Course Title</td><td colspan="9">EFFECTIVE ENGLISH (Communicative English & Soft Skills)</td></tr>
<tr><td rowspan="2">Course code</td><td rowspan="2">24UMPD1101R</td><td>Total credits: 2</td><td>L</td><td>T</td><td>P</td><td>S</td><td>R</td><td>O/F</td><td>C</td></tr>
<tr><td>Total hours: 60P</td><td>0</td><td>0</td><td>4</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td>Nil</td><td>Co-requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Programme</td><td colspan="9">Master of Science in Food Nutrition and Dietetics</td></tr>
<tr><td>Semester</td><td colspan="9">Fall/ I Semester of first year of the programme</td></tr>
<tr><td>Course Objectives</td><td colspan="9">1.To introduce the types of sentences and their significance.
2.To strengthen the students' vocabulary to enhance their speaking and writing skills.
3.To familiarize the students with the importance of dress codes in various organizations.
4.To introduce the 3P's (Planning, prioritizing & performing) of Time Management.
5.To give insight into English pronunciation and into central concepts in phonetics.</td></tr>
<tr><td>CO1</td><td colspan="9">This course will enable students to analysis and identify the different types of sentences.</td></tr>
<tr><td>CO2</td><td colspan="9">Learners will be able to integrate the skills of reading and speaking in professional communication.</td></tr>
<tr><td>CO3</td><td colspan="9">Dress code Etiquette sessions will boosts their confidence and morals.</td></tr>
<tr><td>CO4</td><td colspan="9">Students will earn about the effective and efficient utilization of time.</td></tr>
<tr><td>CO5</td><td colspan="9">Introduction to Phonetics and its importance will improve the learners' pronunciation</td></tr>
<tr><td>I</td><td colspan="9">Module 1- Grammar
i. Interchange of Interrogative and Assertive Sentences, Exclamatory and Assertive Sentences
ii. Types of Tenses
iii. Common Errors
iv. Synonyms
v. Antonyms
vi. Homonyms
Module 2- Reading Skills
i. Techniques of Effective Reading
ii. Gathering ideas and information from a text The SQ3R Technique Interpret the text
Module 3-Listening Skills
i. What is listening?
ii. The Process of Listening
iii. Factors that adversely affect Listening
iv. Difference between Listening and Hearing,
v. Purpose and Importance of Effective Listening
vi. How to Improve Listening Process,
Module 4- Conflict Management
i. Definition
ii. Type of Conflict Management
iii. Effects of Conflict Management
iv. Methods to deal with Conflicts (Negative)
Module 5- Time-Management Skills
i. Introduction To Time Management,
ii. Purpose And Importance of Time Management,
iii. Basic Tips to Maintain Time.
Activity: Problem solving activity: A situation will be given to the students and they will have to tell us how to handle the situation or solve the problem.</td></tr>
</table>

TEXT BOOKS:

T1: Wren, P. C and Martin, H. 1995. *High School English Grammar and Composition*, S Chand Publishing.
T2: *English Grammar in Use*, Raymond Murphy 4th edition, CUP.
T3: Barrett, Grant. 2016. *Perfect English Grammar: The Indispensible Guide to Excellent Writing and Speaking*, Zephyros Press.

REFERENCE BOOKS:

R1: English Vocabulary in Use (Advanced), Michael McCarthy and Felicity, CUP.
R2: Effective Communication and Soft Skills, Nitin Bhatnagar, Pearsons.

OTHER LEARNING RESOURCES:

https://www.classcentral.com/report/toefl-preparation/
https://brightlinkprep.com/10-best-toefl-prep-books/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Analyse and identify the different types of sentences.	**1, 4**
2	Able to integrate the skills of reading and speaking in professional communication.	**1, 4, 7**
3	Illustrate code Etiquette sessions will boost their confidence and morals.	**4,7,8**
4	Describe about the effective and efficient utilization of time.	**4,7**
5	Explain the concept of Phonetics and its importance will improve the learners 'pronunciation	**1, 4,7**

SEMESTER – I									
Course Title	**MINI RESEARCH (R1)**								
Course code	**24MSFD1105R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**4**	**6**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ I Semester of first year of the programme**								
Course Objectives	1. Appreciate and understand the importance of importance of various research writing and review. 2. Applying the techniques and skill for writing Abstract, short communications. 3. To develop technical writing skills.								
CO1	Develop competence in writing and abstracting skill								
CO2	Learn to write literature and review								
CO3	Develop competence in Project proposal								
CO4	Acquired the knowledge to conduct scientific project								
CO5	Analyze the significant aspect of scientific project								

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Develop competence in writing and abstracting skill	**1,2**
2	Learn to write literature and review	**1,2**
3	Develop competence in Project proposal	**1,2**
4	Acquired the knowledge to conduct scientific project	**1,2,3**
5	Analyze the significant aspect of scientific project	**1,2,3**

SEMESTER – II									
Course Title	**MICRONUTRIENT**								
Course code	**24MSFD1201R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Spring/ II Semester of first year of the Programme**								
Course Objectives	1.To review the importance of micronutrients and its major metabolic rate 2.To study about the requirements and importance of different micronutrients in different stages of life 3.To understand about nutrient interactions in human body.								
CO1	Acquire knowledge on different micronutrient.								
CO2	Learn about different micronutrient deficiency and the related causes								
CO3	Understand the program and policies in connection to food and health								
CO4	Understand interaction with other nutrients								
CO5	Acquire knowledge on water and electrolyte balance								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Fat Soluble Vitamins (A, D, E and K)** Historical background, Food sources, Metabolism and functions Interaction with other nutrients, Requirements, Deficiency and toxicity.	**10**	To learn about Fat Soluble Vitamins	1,2
II	**Water Soluble Vitamins (B complex and C)** Historical background, Food sources, Metabolism and functions Interaction with other nutrients, Requirements, Deficiency and toxicity.	**10**	To learn about water Soluble Vitamins	1,2
III	**Macro Mineral** (a. Calcium and Phosphorus, b. Magnesium, c. Sodium, d. Potassium, e. Chloride) Historical background, Food sources, Metabolism and functions, Interaction with other nutrients, Requirements, Deficiency and toxicity.	**10**	To learn about macro minerals	1,2
IV	**Micro Mineral** (a. Iron, b. Copper, c. Manganese, d. Iodine, e. Fluoride, f. Zinc, g. Selenium, h. Cobalt, i. Chromium, j. Molybdneum) Historical background, Food sources, Metabolism and functions, Interaction with other nutrients, Requirements, Deficiency and toxicity	**7**	To learn about micro minerals	1,2
V	**Water** and **Electrolyte Balance**-Distribution of body water, ECF/ICF, functions, different electrolytes-their functions, thirst mechanism, water/electrolyte balance, water-Imbalance	**8**	To learn about water and electrolyte	1,2

TEXT BOOKS:

T1: Sumathi R. Mudambi, Rajagopal, M.V., Fundamentals of Foods and Nutrition, New Age International (P) Ltd, Publishers, Third edition, 1997.

REFERENCE BOOK

R1: Indian Council of Medical Research. Recommended Dietary Intakes for Indians – Latest Recommendations.
R2: Indian Council of Medical Research. Nutritive Value of Indian Foods - Latest Publication.
R3: Annual Reviews of Nutrition. Annual Review Inc, California, USA.
R4: Krause's Food & the Nutrition Care Process (Krause's Food & Nutrition Therapy) Hardcover – Illustrated, 7 July 2016.
R5: Srilakshmi, B. Nutrition Science, New Age International (P) Ltd, Publishers, 2004.
R6: Bamji, M.S., Textbook of Human Nutrition, Oxford, IBH Publishing (P) Ltd, 2009.
R7: WHO Technical Reports eries.
R8: Indian Council of Medical Research. Recommended Dietary Intakes for Indians – Latest Recommendations.

OTHER LEARNING RESOURCES:

SWAYAM, Coursera, Research articles

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Acquire knowledge on different micronutrient.	**1,2**
2	Learn about different micronutrient deficiency and the related causes	**1,2**
3	Understand the program and policies in connection to food and health	**1,2**
4	Understand interaction with other nutrients	**1,2**
5	Acquire knowledge on water and electrolyte balance	**1,2**

SEMESTER – II									
Course Title	**NUTRITIONAL BIOCHEMISTRY-II**								
Course code	**24MSFD1202R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Spring/ II Semester of first year of the Programme**								
Course Objectives	1. To review about the different biochemical metabolism reaction of the body. 2. To understand how this metabolism takes place in co-relation with the nutrients of the food 3. To understand the biochemical alterations in deficiency disorders.								
CO1	Understand the basics metabolic reaction of the body.								
CO2	Give them a clear picture of the biochemical Parameters of the body in normal and disease condition								
CO3	Understand biochemistry behind chromosomal disorders								
CO4	Gain knowledge of biochemical alteration in deficiency disorders								
CO5	Understand biochemical aspects of some vital components								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction- DNA, RNA, Genetics** **Biochemistry behind chromosomal disorders:** Down syndrome, Triple-X syndrome, Turner syndrome, trisomy18, trisomy13	**10**	Learn about Biochemistry behind chromosomal disorders	1,2
II	**Free radicals and reactive oxygen species**: types, and disease, sources, markers of oxidative stress **Antioxidants**: types and sources, antioxidant defense system, combating free radicals and reactive oxygen species	**8**	Learn about Free radicals and reactive oxygen species	1,2
III	**Enzymes and coenzymes**: types, functions, active sites, factors affecting, kinetics and inhibition, use in investigation, role of coenzymes	**10**	Learn about types and function of Enzymes and coenzymes	1,2
IV	**Biochemical alteration in deficiency disorders:** PCM/ VADD/ Anaemia, IDD, Rickets, osteomalacia, beri-beri, pellagra, scurvy	**7**	Learn about Biochemical alteration in deficiency disorders	1,2
V	**Biochemical aspects of some vital components:** Fiber, cholesterol, prostaglandins, lipoproteins, Omega-3 fa, Hb, glycocilated Hb, immonoglobulins, elastin, collagen, myosin, keratin	**10**	Learn about Biochemical aspects of some vital components	1,2
VI	**1.** Qualitative Tests for Carbohydrate **2.** Qualitative Tests of proteins **3.** Qualitative test for Lipid **4.** Qualitative determination of sugar **5.** To study the general properties of the enzyme urease and Achromatic time of salivary amylase	**40**	Plan and carry out experiments	1,2, 3,4

TEXT BOOKS:

T1: Deb. A.C., Fundamental of Biochemistry, New central book agency (P) Ltd, reprint 2004.

REFERENCE BOOK

R1: Pattabiraman. T. N. Concise text Book of Bio-Chemistry, 2nd edition, All India Publishers and Distributors, Regd., 1998.
R2: Ambika Shanmugam, Fundamentals of biochemistry for Medical students, Karthik printers, 7th edition, 1992

OTHER LEARNING RESOURCES:

SWAYAM, Coursera, Research articles

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the basics metabolic reaction of the body.	**1,2**
2	Give them a clear picture of the biochemical Parameters of the body in normal and disease condition	**1,2**
3	Understand biochemistry behind chromosomal disorders	**1,2**
4	Gain knowledge of biochemical alteration in deficiency disorders	**1,2**
5	Understand biochemical aspects of some vital components	**1,2**

SEMESTER – II									
Course Title	**PUBLIC HEALTH NUTRITION**								
Course code	**24MSFD1203R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Spring/ II Semester of first year of the Programme**								
Course Objectives	1. To study about different aspect of nutrition and health. 2. To study about the importance of child and maternal health. 3. To understand the nutritional problems and learn the programmes to combat the problems.								
CO1	Understand the different aspects of community health.								
CO2	Give them a clear picture of importance of health programs polices related to maternal and child health								
CO3	Apply the knowledge of nutrition science to human health across the life span.								
CO4	Comprehend the knowledge on nutritional problems and complications on community level								
CO5	Learn about nutritional programmes running in global as well as in India								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Nutrition and health:** Nutrition as health indicator, nutrition related problems in global as well as in India- deficiency disorders **Malnutrition:** Causes, effects of malnutrition. Prevalence, epidemiology. Hidden hunger, Vitamin deficiency- A, B1, B2, Niacin, C, D - prevalence, programmes to combat, Nutritional Anaemia, IDD and fluorosis- Prevalence, causes, symptoms and programmes to control. IMR, MMR, Mortality, morbidity rate, birth rate, sex ratio and poverty level. Health care delivery - PHC, School Health services and their role in preventing communicable diseases.	**10**	Learn about Nutrition as health indicator and malnutrition	1,2
II	**Maternal and child health:** Nutritional care in childhood, premature baby , LBW, Programmes of immunization, Nutritional requirements in pregnancy lactation, Impact of diet on outcome of pregnancy, MCH **Nutrition in emergencies:** Infant feeding, safety and hygienic measures, nutrient supplements.	**8**	Learn about Nutrition care in Pregnancy and lactation	1,2
III	**Assessment of nutritional status in the community:** Assessment, clinical symptoms of deficiency disorder. **Nutrition education:** Merits, planning, evaluation and conduct, educational techniques, aids, communication media, impact of mass media, young child feeding practices.	**10**	Learn about nutritional assessment	1,2
IV	**Nutrition and national development, national nutritional policy:** Aim, objectives, guidelines and thrust areas. PDS - Public distribution system,	**7**	Have an insight on Nutrition and national	1,2

	Agricultural planning - New strategies.		development, national nutritional policy	
V	**Nutrition intervention programmes:** Objectives, operation of feeding programmes. ICDS. **National organizations** - ICMR, NIN, NNMB, ICAR, CFTRI, NIPCCD, NHM, FSSAI. **International organizations**-FAO, WHO, UNICEF, UNESCO, World Bank.	**10**	Have an insight on Nutrition intervention programmes	1,2
VI	**1.** Conduct socio-economic survey **2.** Conduct diet survey **3.** Conduct clinical examination: Planning, conducting and Evaluating **4.** Nutrition Education Programme **5.** Impact of Government health programmes	**40**	Interpret and apply nutrition	1,2,3, 4

TEXT BOOKS:

T1: B. Srilakshmi, Nutrition Science New Age International (CP) Ltd, New Delhi, 2002.

REFERENCE BOOK:

R1: Mahtab, S. Bamji, N. Pralhadrao, Vinodini Reddy**,** Textbook of Human Nutrition, Oxford and IBIT Publishing co Pvt. Ltd, New Delhi, reprint 1999.

R2: Shukla, P. K., Nutritional problems of India, 1982.

OTHER LEARNING RESOURCES:

SWAYAM, Coursera, Research articles

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the different aspects of community health.	**1,2**
2	Give them a clear picture of importance of health programs polices related to maternal and child health	**1,2**
3	Apply the knowledge of nutrition science to human health across the life span.	**1,2**
4	Comprehend the knowledge on nutritional problems and complications on community level	**1,2,3**
5	Learn about nutritional programmes running in global as well as in India	**1,2**

SEMESTER – II									
Course Title	**FOOD MICROBIOLOGY AND FOOD SAFETY**								
Course code	**24MSFD1204R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Spring/ II Semester of first year of the Programme**								
Course Objectives	1. To study about different microbiological aspects of the food. 2. To understand the principles of food preservations and food safety. 3. To understand the positive and negative reaction of the microbes on food and human health.								
CO1	Understand the different principles of food safety.								
CO2	Give them a clear picture of role in food preservation and food spoilages.								
CO3	Apply the knowledge of microbiology on food product development								
CO4	Know about principles of Food Preservation by using different methods								
CO5	Acquire knowledge on food safety enforcement and control agencies								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Food and Microorganisms**- food as a substrate for microorganisms, important microorganisms in food microbiology, general principles underlying food spoilage. **Food Contamination-** contamination, preservation and spoilage of cereal products/ vegetables and fruits/ meat and meat products/ milk and milk products/ canned products	**10**	Learn about Food and Microorganisms	1,2
II	**Principles of Food Preservation-** asepsis, removal, anaerobic condition, preservation by high temperature/ low temperature/ drying/ food additives/ radiation	**8**	Learn about Principles of Food Preservation	1,2
III	**Foods and Enzymes Produced by Microorganism**s- productions of cultures, food fermentation, foods and enzymes from microorganisms	**10**	Learn about Foods and Enzymes Produced by Microorganisms	1,2
IV	**Food toxicity-** bacterial food borne illnesses, non-bacterial food poisoning/ infections/ intoxication, food borne disease outbreaks	**7**	Learn about Food toxicity	1,2
V	**Food Sanitation, control and Inspection-** sterilization, microbiology in food sanitation, enforcement and control agencies- national/ international/ federal/ state/ private, microbiological criteria for food	**10**	Learn about Food Sanitation, control and Inspection	1,2,3

TEXT BOOKS:

T1: Frazier, W.C, Food Microbiology, McGraw Hill Publications, New York, 4th Edition, 1998.

REFERENCE BOOK

R1: Doyle, M.P., Diez-Gonzalez, F., & Hill, C. (Eds.). (2020). *Food microbiology: fundamentals and frontiers*. John Wiley & Sons.
R2: Fields, M. L. (1979). *Fundamentals of food microbiology*. AVI Publishing Co. Inc.
R3: Matthews, K. R., Kniel, K. E., & Montville, T. J. (2017). *Food microbiology: an introduction*. John Wiley & Sons.

OTHER LEARNING RESOURCES:

SWAYAM, Coursera, Research articles

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the different principles of food safety.	**1,2,3,8**
2	Give them a clear picture of role in food preservation and food spoilages.	**1,2,3,8**
3	Apply the knowledge of microbiology on food product development	**1,2,3,8**
4	Know about principles of Food Preservation by using different methods	**1,2,3,8**
5	Acquire knowledge on food safety enforcement and control agencies	**1,2,3,8**

SEMESTER – II									
Course Title	**TECHNIQUES OF PACKAGING**								
Course code	**24MSFD1205R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Spring/ II Semester of first year of the Programme**								
Course Objectives	1. To provide comprehensive overview of the scientific and technical aspects of food packaging 2. To develop comprehensive understanding of different packaging tests. 3. To understand different types and forms of packaging.								
CO1	To provide comprehensive overview of the scientific and technical aspects of food packaging.								
CO2	Understand packaging machinery, systems, testing and regulations of packaging.								
CO3	Learn effect of various environmental factors on the stability of food Comprehend the knowledge on nutritional problems and complications								
CO4	Develop comprehensive understanding of different packaging tests								
CO5	Acquire knowledge on importance of selective packaging related to food products.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction:** Importance, definition and function of food packaging, Need of food packaging Role of packaging in extending shelf life of foods.	**3**	Learn basics of packaging	1,2,3,4
II	Types of packaging materials, Glass (construction of jars and bottles, optical, thermal and mechanical properties of glass), Metal (types of base metal sheets, construction of metal cans, lacquering), Plastics- substituted olefins, tetrafluro ethylene, PET, polyamides, polyesters.	**3**	Learn types of packaging	1,2,3,4
III	Food packaging systems, product characteristics and package requirements. Introduction of food packaging system. Different forms of packaging. Rigid, semi-rigid, flexible forms of packaging.	**3**	Learn about food packaging systems	1,2,3,4
IV	Different packaging system for-Dehydrated foods, Frozen foods, Dairy products, Fresh fruits, Vegetables, Meat, Poultry, Sea foods.	**3**	Learn about packaging system for different food	1,2,3,4
V	Package accessories and advances in Packaging technology-Introduction, Active packaging, Modified atmosphere packaging, Aseptic packaging, Packages for microwave ovens, Biodegradable plastics, Edible gums, Coatings.	**3**	Learn about packaging system for different food	1,2,3,4

TEXT BOOKS:

T1: Gordon L. Robertson, Food Packaging: Principles and Practice, Third Edition, 2013.
T2: Gordon L. Robertson, Food Packaging and Shelf Life: A Practical Guide, 2010.

REFERENCE BOOK

R1: Ruben Hernandez, Susan E. M Selke, John Culter, John D. Culter, Plastics Packaging: Properties, Processing, Applications, and Regulations, 2000.
R2: Walter Soroka, Fundamentals of Packaging Technology-Fourth Edition,

OTHER LEARNING RESOURCES:

SWAYAM, Coursera, Research articles

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	To provide comprehensive overview of the scientific and technical aspects of food packaging.	**1,2,6,7**
2	Understand packaging machinery, systems, testing and regulations of packaging.	**1,2,6,7**
3	Learn effect of various environmental factors on the stability of food Comprehend the knowledge on nutritional problems and complications	**1,2,6,7**
4	Develop comprehensive understanding of different packaging tests	**1,2,6,7**
5	Acquire knowledge on importance of selective packaging related to food products.	**1,2,6,7**

Semester II									
Course Title	**COMMUNICATION MASTERY (Communicative English & Soft Skills)**								
Course code	**24UMPD1201R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Effective English**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Spring/II Semester of first year of the programme**								
Course objectives	1. To familiarize students with the transformation of sentences and the appropriate use of prepositions. 2. To enhance the writing skills in different areas including CV and cover letter writing. 3. To convey meaning by reinforcing, substituting for, or contradicting verbal communication. 4. Productivity and performance boosting activities for professional goal achievement.								
CO1	Explain prepositions, tag questions, and idioms correctly.								
CO2	Discuss and analyze different sentence types and voices.								
CO3	Explain effective paragraphs, precis, and professional documents.								
CO4	Describe SWOT analysis, goal setting, and personal hygiene principles.								
CO5	Illustrate non-verbal communication and body language concepts.								
Unit	**Content**								
Module 1- Grammar	I. Use of Prepositions II. Tag questions III. Idioms, Phrases and Clauses IV. Simple, complex, compound sentences								
Module 2- Grammar	I. Active and Passive Voice II. Direct and Indirect Speech								
Module 3- Writing Skills	I. The Basics of Writing; avoid ambiguity and vagueness II. Paragraph Writing III. Precise Writing IV. Letter Writing V. Resume, CV and Cover Letter								
Module 4- Self-Management Skills	I. SWOT Analysis II. Self-Regulation- Goal Setting III. Personal Hygiene								
Module 5- Non- Verbal Communication- Sciences of Body Language	I. What is Non-Verbal Communication & Body Language, II. Elements of Communication, III. Types of Body Language, IV. Importance and Impact of Body Language, V. Types of Communication through Body Language, VI. Introduction to Haptic, Introduction to Kinesics VII. Introduction to Proxemics, VIII. Body Language Do's and Don'ts, Doubt Clearing Session.								
Module 6- Group Discussion (Theory)	I. Importance, II. Planning, Elements, and Skills assessed; III. Effectively disagreeing, IV. Initiating, Summarizing and Attaining the Objective								

TEXT BOOKS:

T1: Barrett, Grant. 2016. Perfect English Grammar: The Indispensible Guide to Excellent Writing and Speaking, Zephyros Press.
T2: McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition).

REFERENCE BOOK:

R1: Communication Skills Training: A Practical Guide to Improving Your Social Intelligence, Presentation and Social Speaking, Ian Tuhovsky, 2019
R2: A Textbook for AECC English Communication: Interface, Dr. Kironmoy Chetia and Pranami Bania Breez Mohan Hazarika, January 2019

OTHER LEARNING RESOURCES:

https://youtu.be/x60GHpQ8gJk
https://youtu.be/Ke_oSN-BCaY
https://youtu.be/TDPDtrLxT-c
https://www.classcentral.com/report/toefl-preparation/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Practice of grammar will polish their writing skills.	**4,2,8**
2	It will enhance their communication and interpretative skills.	**4,2,8**
3	Introduction to behavioural skills, thoughts, and emotions will enable them to behave in a conscious and productive way.	**2,4,5**
4	It will have a positive impact in their thought process and problem-solving skills.	**2,4,5**

SEMESTER – II									
Course Title	**UNIVERSAL HUMAN VALUES (UHV) + PROFESSIONAL ETHICS**								
Course code	**24UUHV2101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 15T+30P	**1**	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Winter/ II Semester of first year of the Programme**								
Course objectives	1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings 2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of Existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way 3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature								
CO1	The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.								
CO2	It is free from any dogma or value prescriptions.								
CO3	It is a process of self-investigation and self-exploration, and not of giving sermons.								
CO4	Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation.								
CO5	This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self-evolution.								

Unit No.	**Content**
I	• Understanding the need, basic guidelines, content and process for Value Education • Self Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self exploration • Continuous Happiness and Prosperity- A look at basic Human Aspirations • Right understanding, Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority • Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario • Method to fulfil the above human aspirations: understanding and living in harmony at various levels.
II	• Understanding human being as a co-existence of the sentient 'I' and the material 'Body' • Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha • Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) • Understanding the characteristics and activities of 'I' and harmony in 'I' • Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail • Programs to ensure Sanyam and Swasthya-Practice Exercises and Case Studies will be taken up in Practice Sessions.
III	• Understanding Harmony in the family – the basic unit of human interaction • Understanding values in human-human relationship; meaning of Nyaya and program for its

	fulfilment to ensure Ubhay-tripti; • Trust (Vishwas) and Respect (Samman) as the foundational values of relationship • Understanding the meaning of Vishwas; Difference between intention and competence • Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship • Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals • Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj), Universal Order (Sarvabhaum Vyawastha)- from family to world family!-Practice Exercises and Case Studies will be taken up in Practice Sessions.
IV	• Understanding the harmony in the Nature • Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature • Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all-pervasive space • Holistic perception of harmony at all levels of existence-Practice Exercises and Case Studies will be taken up in Practice Sessions.
V	• Natural acceptance of human values • Definitiveness of Ethical Human Conduct • Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order • Competence in professional ethics: • Ability to utilize the professional competence for augmenting universal human order • Ability to identify the scope and characteristics of people-friendly and eco- friendly production systems, • Ability to identify and develop appropriate technologies and management patterns for above production systems. • Case studies of typical holistic technologies, management models and production systems • Strategy for transition from the present state to Universal Human Order: • At the level of individual: as socially and ecologically responsible engineers, technologists and managers • At the level of society: as mutually enriching institutions and organizations
Guidelines and Content for Practice Sessions	**UNIT 1**: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education **PS 1:** Introduce yourself in detail. What are the goals in your life? How do you set your goals in your life? How do you differentiate between right and wrong? What have been your achievements and shortcomings in your life? Observe and analyze them. Expected outcome: the students start exploring themselves; get comfortable to each other and to the teacher and start finding the need and relevance for the course. **PS 2:** Now-a-days, there is a lot of voice about many techno-genic maladies such as energy and natural resource depletion, environmental pollution, global warming, ozone depletion, deforestation, soil degradation, etc. – all these seem to be man-made problems threatening the survival of life on Earth – What is the root cause of these maladies & what is the way out in your opinion? On the other hand, there is rapidly growing danger because of nuclear proliferation, armsrace, terrorism, criminalization of politics, large scale corruption, scams, breakdown of relationships, generation gap, depression & suicidal attempts, etc – what do you think, is the root cause of these threats to human happiness and peace – what could be the way out in your opinion?

	Expected outcome: the students start finding that technical education without study of human values can generate more problems than solutions. They also start feeling that lack of understanding of human values is the root cause of all problems and the sustained solution could emerge only through understanding of human values and value based living. Any solution brought out through fear, temptation or dogma will not be sustainable. **PS 3:** 1. Observe that each one of us has Natural Acceptance, based on which one can verify right or not right for him. Verify this in case of i) What is Naturally Acceptable to you in relationship- Feeling of respect or disrespect? ii) What is Naturally Acceptable to you – to nurture or to exploit others? Is your living the same as your natural acceptance or different? 2. Out of the three basic requirements for fulfilment of your aspirations- right understanding, relationship and physical facilities, observe how the problems in your family are related to each. Also observe how much time & effort you devote for each in your daily routine. Expected outcome: 1. The students are able to see that verification on the basis of natural acceptance and experiential validation through living is the only way to verify right or wrong, and referring to any external source like text or instrument or any other person cannot enable them to verify with authenticity; it will only develop assumptions. 2. The students are able to see that their practice in living is not in harmony with their natural acceptance most of the time, and all they need to do is to refer to their natural acceptance to remove this disharmony. 3. The students are able to see that lack of right understanding leading to lack of relationship is the major cause of problems in their family and not the lack of physical facilities in most of the cases, while they have given higher priority to earning of physical facilities in their life ignoring relationships and not being aware that right understanding is the most important requirement for any human being. **UNIT 2:** Understanding Harmony in the Human Being - Harmony in Myself! **PS 4:** List down all your desires. Observe whether the desire is related to Self (I) or Body. If it appears to be related to both, see which part of it is related to Self (I) and which part is related to Body. Expected outcome: the students are able to see that they can enlist their desires and the desires are not vague. Also they are able to relate their desires to 'I' and 'Body' distinctly. If any desire appears related to both, they are able to see that the feeling is related to I while the physical facility is related to the body. They are also able to see that 'I' and 'Body' are two realities, and most of their desires are related to 'I' and not body, while their efforts are mostly centered on the fulfilment of the needs of the body assuming that it will meet the needs of 'I' too. **PS 5:** 1. a. Observe that any physical facility you use, follows the given sequence with time : Necessary & tasteful→ unnecessary & tasteful → unnecessary & tasteless →intolerable b. In contrast, observe that any feeling in you is either naturally acceptable or not acceptable at all. If naturally acceptable, you want it continuously and if not acceptable, you do not want it any moment! 2. List down all your activities. Observe whether the activity is of 'I' or of Body or with the participation of both 'I' and Body.

	3. Observe the activities within 'I'. Identify the object of your attention for different moments (over a period of say 5 to 10 minutes) and draw a line diagram connecting these points. Try to observe the link between any two nodes. Expected outcome: 1. The students are able to see that all physical facilities they use are required for a limited time in a limited quantity. Also they are able to see that in case of feelings, they want continuity of the naturally acceptable feelings and they do not want feelings which are not naturally acceptable even for a single moment. 2. the students are able to see that activities like understanding, desire, thought and selection are the activities of 'I' only, the activities like breathing, palpitation of different parts of the body are fully the activities of the body with the acceptance of 'I' while the activities they do with their sense organs like hearing through ears, seeing through eyes, sensing through touch, tasting through tongue and smelling through nose or the activities they do with their work organs like hands, legs etc. are such activities that require the participation of both 'I' and body. 3. The students become aware of their activities of 'I' and start finding their focus of attention at different moments. Also they are able to see that most of their desires are coming from outside (through preconditioning or sensation) and are not based on their natural acceptance. **PS 6:** 1. Chalk out programs to ensure that you are responsible to your body- for the nurturing, protection and right utilisation of the body. 2. Find out the plants and shrubs growing in and around your campus. Find out their use for curing different diseases. Expected outcome: The students are able to list down activities related to proper upkeep of the body and practice them in their daily routine. They are also able to appreciate the plants wildly growing in and around the campus which can be beneficial in curing different diseases. **UNIT 3:** Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship **PS 7:** Form small groups in the class and in that group initiate dialogue and ask the eight questions related to trust. The eight questions are: 1a. Do I want to make myself happy? 2a. Do I want to make the other happy? 3a. Does the other want to make him happy? 4a. Does the other want to make me happy? What is the answer? Intention (Natural Acceptance) 1b. Am I able to make myself always happy? 2b. Am I able to make the other always happy? 3b. Is the other able to make him always happy? 4b. Is the other able to make me always happy? What is the answer? Competence Let each student answer the questions for himself and everyone else. Discuss the difference between intention and competence. Observe whether you evaluate your intention& competence as well as the others' intention & competence. Expected outcome: The students are able to see that the first four questions are related to our Natural Acceptance i.e. Intention and the next four to our Competence. They are able to note that the intention is always correct, only competence is lacking! We

	generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention as a result we conclude that I am a good person and other is a bad person. **PS 8:** 1. Observe on how many occasions you are respecting your related ones (by doing the right evaluation) and on how many occasions you are disrespecting by way of under-evaluation, over-evaluation or otherwise evaluation. 2. Also observe whether your feeling of respect is based on treating the other as yourself or on differentiations based on body, physical facilities or beliefs. Expected outcome: The students are able to see that respect is right evaluation, and only right evaluation leads to fulfilment in relationship. Many present problems in the society are an outcome of differentiation (lack of understanding of respect), like gender biasness, generation gap, caste conflicts, class struggle, dominations through power play, communal violence, clash of isms, and so on so forth. All these problems can be solved by realizing that the other is like me as he has the same natural acceptance, potential and program to ensure a happy and prosperous life for him and for others though he may have different body, physical facilities or beliefs. **PS 9:** 1. Write a note in the form of story, poem, skit, essay, narration, dialogue to educate a child. Evaluate it in a group. 2. Develop three chapters to introduce 'social science- its need, scope and content' in the primary education of children Expected outcome: The students are able to use their creativity for educating children. The students are able to see that they can play a role in providing value education for children. They are able to put in simple words the issues that are essential to understand for children and comprehensible to them. The students are able to develop an outline of holistic model for social science and compare it with the existing model. **UNIT 4:** Understanding Harmony in the Nature and Existence - Whole existence as Co-existence **PS 10:** List down units (things) around you. Classify them in four orders. Observe and explain the mutual fulfilment of each unit with other orders. Expected outcome: The students are able to differentiate between the characteristics and activities of different orders and study the mutual fulfilment among them. They are also able to see that human beings are not fulfilling to other orders today and need to take appropriate steps to ensure right participation(in terms of nurturing, protection and right utilization) in the nature. **PS 11:** 1. Make a chart for the whole existence. List down different courses of studies and relate them to different units or levels in the existence. 2. Choose any one subject being taught today. Evaluate it and suggest suitable modifications to make it appropriate and holistic. Expected outcome: The students feel confident that they can understand the whole existence; nothing is a mystery in this existence. They are also able to see the interconnectedness in the nature, and point out how different courses of study relate to the different units and levels. Also they are able to make out how these courses can be made appropriate and holistic. **UNIT 5:** Implications of the above Holistic Understanding of Harmony at all Levels of Existence **PS 12:**

	Choose any two current problems of different kind in the society and suggest how they can be solved on the basis of natural acceptance of human values. Suggest steps you will take in present conditions. Expected outcome: The students are able to present sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them. **PS 13:** 1. Suggest ways in which you can use your knowledge of Technology/ Engineering/ Management for universal human order, from your family to the world family. 2. Suggest one format of humanistic constitution at the level of nation from your side. Expected outcome: The students are able to grasp the right utilization of their knowledge in their streams of Technology/Engineering/ Management to ensure mutually enriching and recyclable productions systems. **PS 14:** The course is going to be over now. Evaluate your state before and after the course in terms of a. Thought b. Behaviour and c. Work d. Realization Do you have any plan to participate in the transition of the society after graduating from the institute? Write a brief note on it. Expected outcome: The students are able to sincerely evaluate the course and share with their friends. They are also able to suggest measures to make the course more effective and relevant. They are also able to make use of their understanding in the course for a happy and prosperous society.

TEXT BOOKS:

T1**:** R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2

REFERENCE BOOK

R1: PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers. Lucknow. Reprinted 2008.
R2: Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986,1991
R3: Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
R4: Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, limits to Growth, Club of Rome's Report, Universe Books.
R5: Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati.
R6: A Nagraj, 1998, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.
R7: E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
R8: A.N. Tripathy, 2003, Human Values, New Age International Publishers

OTHER LEARNING RESOURCES:

Value Education websites, http://uhv.ac.in, http://www.uptu.ac.in
Story of Stuff, http://www.storyofstuff.com
Al Gore, An Inconvenient Truth, Paramount Classics, USA
Charlie Chaplin, Modern Times, United Artists, USA
IIT Delhi, Modern Technology – the Untold Story

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.	**5,6,7,8**
2	It is free from any dogma or value prescriptions.	**5,6,7,8**
3	It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it, based on their Natural Acceptance and subsequent Experiential Validation.	**5,6,7,8**
4	This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self-evolution.	**5,6,7,8**
5	This self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs.	**5,6,7,8**

SEMESTER – II									
Course Title	**Research Methodology and Statistical Analysis**								
Course code	**24UMRM1201R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 15T+60S	**1**	**0**	**0**	**4**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Spring/ II Semester of first year of the programme**								
Course objectives	1. The course aims to enhances the students' a broad understanding of research methodology, includingtheoryofscienceandqualitativeandquantitativemethodsinresearch. 2. The course seeks to enhance the students' skills for developing critical thinking through research literature review in different domain. Consequently, it aims to develop skills for preparation of a research proposal for a master' thesis project/Mini research. 3. To develop Students competency in planning, conducting, evaluating and presenting a research project.								
CO1	Students will have basic knowledge of Research methods.								
CO2	Students will gain the knowledge of Research Methodology.								
CO3	Students will be able to gain the Skill questionnaire development.								
CO4	Students will be able to acquire the knowledge of basic Report/dissertation Procedure.								
CO5	Knowledge on different IPR rights								

Unit no.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Research Methodology- An Introduction-meaning and objectives of research, motivation in research, types and significance of research, criteria of good research. Defining the Research Problems-definition of research problem, necessity of defining research problem	**2**	Knowledge on fundamental concepts of research methodology, including the meaning and objectives of research	1,2
II	Research Design- meaning and need of research design, features of a good design, different research designs, Sampling Design- steps in sampling design, Sample Size determination, criteria for selecting a sampling design, different types of sampling design, Experimental Design, Principles of Design of Experiment, One – way ANOVA, Two-Way ANOVA, CRD, RBD, LSD, 22, 23 Factorial Design	**4**	Able to understand and apply the fundamental principles of research design, including the meaning and necessity of research design	1,2
III	Types of data, sources of data collection, tools of data collection, Nominal, ordinal, interval and ratio – Attitude scale construction and measurement, rating scales, semantic differential (SD), Use of scale in statistical analysis, Schedules for interviews preparation and standardization, development of survey instruments and item analysis for the questionnaire	**3**	A good knowledge on different types of data and identify various sources and tools for data collection	1,2

IV	Planning and organizing research report, Format of research report, Different steps of writing report, lay out of the research report , How to organize thesis/Dissertation, mechanics of writing research report, standard methods of quoting- presenting the result, written and oral reports, Uses of abstract, format of research report, presentation of statistics - tabular and graphic references and uses of references, Bibliography and presentation of bibliography	**3**	Able to organize and write a comprehensive research report	1,2
V	Intellectual property right (IPR), Introduction and the need for IPR, IPR in India and worldwide, Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications, Patentable and non-patentable, patenting life, Filing of a patent application, The different layers of the international patent system, Case studies on Basmati rice, Turmeric, and Neem patents	**3**	Knowledge on importance of Intellectual Property Rights (IPR) both in India and globally	1,2
Practical	Laboratory using R Software: 1 Analysis of One way ANOVA; 2 Analysis of Two way ANOVA; 3 Analysis of CRD 4 Analysis of RBD 5 Analysis of 22 and 23 Factorial Experiment 6 Simulation-I using R (Bernoulli, Binomial, Poisson and Geometric distribution.). 7 Simulation-II using R (Exponential and Normal distribution). 8 Simple random Sampling 9 Stratified Random Sampling	**60**	Knowledge on various statistical experiments and simulations using R	1,2,3,4

REFERENCE BOOK

R1: Boyle JS. Styles of ethnography. In: JM Morse, editor. Critical issues in qualitative research methods.
R2: Thousand Oaks, CA: Sage, 1994:159–85.
R3: Coughlan M., Cronin P. and Ryan F. (2007). Step-by-step guide to critiquing research. Part 1: quantitative research. British journal of Nursing 16 (11).
R4: Creswell, JW. (1998). Qualitative Inquiry and Research Design Choosing Among Five Traditions.
R5: Thousand Oaks, CA: Sage Publications.
R6: Crotty, M. (1998). The Foundations of social research: Meaning and perspective in the research process. London: Sage.
R7: Denzin, NK. (1978) Sociological Methods. New York: McGraw-Hill.
R8: Hanson WE, JW Creswell, VL Plano Clark, KS Petska and JD Creswell. Mixed Methods Research
R9: Designs in Counseling Psychology. Journal of Counseling Psychology, 2005, Vol. 52, No. 2, 224–
R10: 235 http://www.preciousheart.net/chaplaincy/Auditor_Manual/13casesd.pdf
R11: 7 Johnson & Christensen. (2004). Educational Research: Quantitative, qualitative and mixes approaches, 2nd Ed. Boston: Allyn & Bacon

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will have basic knowledge of Research methods.	**2,3**
2	Students will gain the knowledge of Research Methodology.	**2,3**
3	Students will be able to gain the Skill questionnaire development. Students will be able to acquire the knowledge of basic Report/dissertation Procedure.	**2,3**

SEMESTER – III										
Course Title	**PERSONAL FINANCIAL PLANNING**									
Course Code	**24UUFL1202R**	**Total Credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
		Total Hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**1**	
Pre- Requisite	**Introduction to Financial Budgeting And Planning**	**Co-requisite**	**Nil**							
Programmes	**Master of Science in Food Nutrition and Dietetics**									
Semester	**Fall/ III Semester of second year of the program**									
Course Objectives	1. The course would offer an inclusive approach to understand the relevant concepts of money, borrowing, lending, taxes and their application to financial planning. 2. Assess the personal financial planning process, the life cycle of financial plans, and methods of goal achievement. 3. Formulate a budget, record-keeping system, and tax planning strategy based on current financial goals.									
CO1	Explain the cash management and buying plan for homes or automobiles.									
CO2	Discuss a diversified investment portfolio for different objectives.									
CO3	Compare mutual funds, ETFs, and real estate investment options.									
CO4	Develop a financial plan for retirement and estate protection.									
CO5	Describe financial products and strategies for long-term goals									

Unit no.	Content	Contact Hour	Learning Outcome	KL
I	**Unit 1- Fundamentals of Financial Planning –** i. Functions of money; ii. Inflation- Meaning, causes, how it can be controlled; iii. process official planning, iv. Time value of money-simple and compound interest; v. Net Present Value and Future value, vi. Power of Compounding; vii. Doubling period and Rule of 72.	**6**	Students will be able to comprehend the fundamentals of financial planning.	2,3
II	**Unit 2- Income Tax Planning**– i. Meaning of Income, ii. Direct & Indirect Taxes, Taxable Income, various heads of Income for tax Calculation, iii. Non-taxable Income, iv. Tax evasion and tax avoidance, v. GST, Tax Planning Strategies.	**6**	Students will be able to understand and utilize the basic aspects of income tax and GST.	1,2
III	**Unit 3- Entrepreneurial planning** – i. Meaning of Entrepreneurship, prerequisites for becoming an entrepreneur, ii. Entrepreneurship Support Systems in India, iii. Institutional support systems for entrepreneurs, iv. Financial support systems for entrepreneurs; v. Venture Capital, Business Angels, vi. Assistant of Government, vii. Commercial Bank Loans and Overdraft.	**6**	Students will be able to understand the concept, scope and pre-requisites of entrepreneurship.	1,2
IV	**Unit 4-Planning for investing in securities market –** i. Investment avenues offered by Securities Markets,. Primary Market and Secondary Market, ii. Stock market- meaning, features, functions of NSE, BSE DEMAT trading account,	**6**	Students will be able to analyze and interpret the different dimensions of stock market investment.	3,4

	iii. Security repository, stock brokers, Operational aspects of securities markets: placement of orders, contract note, pay-in and pay-out, trading and settlement cycle, iv. Various risks involved in investing in securities markets; Role of Financial Intermediaries; Stock indices. v. Mutual Funds- meaning concept, definition, types, importance and drawbacks of mutual funds, mutual funds in India, investing in mutual funds, vi. Systematic Investment Plan (SIP) and its advantages.			
V	**Unit 5- Planning for debts and Retirement** i. Consumer credit - Introduction to consumer credit; choosing a source of credit, the cost of credit alternatives, ii. Consumer Legal Protection; iii. Housing Decision: Factors and Finance; Vehicle Decisions. iv. Retirement planning - Meaning of cost of living; retirement need analysis; development of retirement plan, various retirement schemes, v. Estate Planning; Pension and Medicare Planning; Wills.	**6**	Students will be able to evaluate the aspects of retirement planning to formulate effective strategic financial plans.	1,2,3

TEXT BOOKS:

T1: Sinha Pradeep K. and Priti Sinha. Computer Fundamentals: Concepts Systems & The Million-Dollar Financial Advisor: Powerful Lessons and Proven Strategies from Top Producers by David J. Mullen Jr

T2: Personal Finance and Planning by Dr. Rajni

T3: Peaceful Personal Finance: A Short Read on the Basics of Personal Finance and Planning Kindle Edition by Hema Singh

T4: Be Your Own Financial Advisor: Financial Planning, Investment Options, Risk Management, Tax Management, Succession Planning Kindle Edition y Sushil Bali

T5: The Dumb Things Smart People Do with Their Money: Thirteen Ways to Right Your Financial Wrongs Kindle Edition y Jill Schlesinger

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the cash management and buying plan for homes or automobiles.	**5**
2	Discuss a diversified investment portfolio for different objectives.	**1**
3	Compare mutual funds, ETFs, and real estate investment options.	**2, 5**
4	Develop a financial plan for retirement and estate protection.	**1**
5	Describe financial products and strategies for long-term goals	**5**

SEMESTER – III									
Course Title	**CLINICAL NUTRITION I**								
Course code	**24UMRM1201R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ III Semester of second year of the program**								
Course Objectives	1. To study about different aspect of diet modification and adaptations. 2. To study about the different nutrient modification at different disease state. 3. To learn planning and modification of diet in normal and different disease conditions.								
CO1	Understand the different aspect of food nutrients and its affect in health and wellbeing								
CO2	Learn and apply different aspect of diet modification and adaptations in diseases state								
CO3	Acquired knowledge on planning of different hospital diet								
CO4	Apply the importance of therapeutic diet in diseases condition								
CO5	Evaluate the significance in the modifications of diet in different feeding methods.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to clinical therapy-** Introduction, Role of dietician in health care. Patient Care and Counselling.	**5**	Role of dietician	1,2
II	**Adaptation of therapeutic diets:** Introduction to therapeutic diets, Types of dietary adaptation for therapeutic needs, Normal nutrition- a base of therapeutic diet, Diet prescription and constructing therapeutic diets **Routine Hospital Diets:** Normal or general diets, Liquid diets, soft diets. **Mode of Feeding:** Oral feeding, tube or enteral feeding, Peripheral vein feeding, Total parenteral nutrition.	**10**	Learning of hospital diet, different , mode of feeding	1,2
III	**Nutritional management in infections and fever:** Typhoid, Pneumonia and Tuberculosis **Nutritional care in weight management:** Introduction, underweight, overweight and obesity, PCOS.	**10**	Different types of diet for infections, weight management	1,2
IV	**Nutrional management in cardiovascular diseases:** Dyslipidemia, Atherosclerosis, Hypertension, Myocardial Infarction, Angina Pectoris, Chronic Heart Failure, Rheumatic heart disease, Stroke. **Nutrional management in diabetes mellitus and gout**	**10**	Diet modifications for CVD, Diabetes.	1,2
V	**Nutritional management in gastro intestinal diseases:** Diarrhoea, Constipation, Gastritis, Peptic Ulcer, Gall bladder and biliary disorders, pancreatitis. **Malabsorption Syndrome**- Celiac disease, Steatorrhoea, Lactose Intolerance, Tropical	**10**	Therapeutic diet for gastrointestinal diseases	

	spruce, Crohns disease, Irritable bowel disease.			
VI (Practical)	1. Planning, preparations and calculations of nutritive value of: Routine hospital diet: Liquid diet: Clear liquid, Full fluid, Semisolid diet, Soft diet 2. Planning, preparations and calculations of nutritive value of: Feeds: Nasogastric (NG) feeds and Jejunostomy (JJ) feed 3. Planning, preparations and calculations of nutritive value of: Cardiovascular diseases: Hyperlipidemia and Hypertension 4. Planning, preparations and calculations of nutritive value of: Gastrointestinal tract: Diarrhoea and Constipation 5. Planning, preparations and calculations of nutritive value of: Gastrointestinal tract: Peptic ulcer and gastritis 6. Planning, preparations and calculations of nutritive value of: Gastrointestinal tract: Celiac disease and Crohn's disease 7. Planning, preparations and calculations of nutritive value of: Gastrointestinal tract: Diabetes mellitus 8. Planning, preparations and calculations of nutritive value of: Gastrointestinal tract: Gout	**16**	Learn different types of hospital diet, Feeding method, diet for CVD, Gastrointestinal disorder, peptic ulcer, Celiac disease and Crohn's disease, diabetes mellitus, gout	1,2

TEXT BOOKS:

T1: Joshi, S. A., Nutrition and Dietetics, Tata McGraw Hill Publications, New Delhi, 2004.
T2: Srilakshmi B., Dietetics, New Age International (P) limited Publications, 2004

REFERENCE BOOKS:

R1: Raymond, J. L., & Morrow, K. (2020). Krause and Mahan's food and the nutrition care. Elsevier Health Science
R2: Antıa F.P., & P. Abraham. (2002) Clinical Dietetics and Nutrition.
R3: Shils, M. E., Olson, J. A., Shike, M. and Ross, A. C**.** (1999): Modern Nutrition in Health and Disease, 9th Edition, Williams and Wilkins
R4: Escott-Stump, S. (1998): Nutrition and Diagnosis Related Care, 4th Edition, Williams and Wilkins.
R5: Garrow, J. S., James, W.P.T.

OTHER LEARNING RESOURCES:

Courseera, swayam

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the different aspect of food nutrients and its affect in health and wellbeing	**1,2**
2	Learn and apply different aspect of diet modification and adaptations in diseases state	**1,2**
3	Acquired knowledge on planning of different hospital diet	**1,2**
4	Apply the importance of therapeutic diet in diseases condition	**1,2**
5	Evaluate the significance in the modifications of diet in different feeding methods.	**1,2**

SEMESTER – III									
Course Title	**APPLIED NUTRITION I**								
Course code	**24MSFD2105R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ III Semester of second year of the program**								
Course Objectives	1.To study about different aspect of Food Science and processing. 2.To study about the application of principles of food science in product development. 3.To learn different techniques of food adultration testing.								
CO1	Understand the different application of food science in food production and packaging .								
CO2	Give them a clear picture of recent trends and advancement in food science and technology.								
CO3	Learn different food standard and regulations governed by Indian govt								
CO4	Develop nutrients dense food products								
CO5	Analyze different techniques and skill for detecting food adulteration.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Role of macronutrients:** Role of fiber in lipid metabolism, colon function, blood glucose level and G.I tract functions – Disadvantages of Dietary fiber, Role of saturated fat, cholesterol, lipoprotein and Triglycerides and EFA in the diet	**5**	Role of dietician	1,2,3
II	**Standards for foods:** Milk and milk products, Fruits and vegetables, Beverages and Fleshy foods.	**10**	Learning of hospital diet, different, mode of feeding	1,2
III	**Food regulations-Standards and quality control :** Principles of quality control- Raw material process Control and product inspections. **Food laws and consumerism:** Definition, Consumer protection, Consumer Education, Legal modes of protection and Machinery for redressal of consumer grievances.	**10**	Different types of diet for infections, weight management	1,2
IV	**Product development:** Designing new product-types and drawing force, Need for product development, stages of product development, Success in product development, Consumer research, Role of sensory evaluation in consumer product acceptance.	**10**	Diet modifications for CVD, Diabetes.	1,2,4
V	**Food adulteration and hygiene:** Definition, Common adulterants in different foods, Methods of detecting adulterated foods, Food Sensitivity	**10**	Therapeutic diet for gastrointestinal diseases	1,2,3,4
VI (Practical)	1. Introduction to different equipments used in food processing industries 2. Evaluation of proximate composition- moisture 3. Evaluation of proximate composition- protein	**16**	Knowledge of different equipment, Learn the analysis process of proximate composition, Sensory	1,2,3,4

	4. Evaluation of proximate composition- total ash 5. Evaluation of proximate composition-fats 6. Evaluation of proximate composition-Fiber 7. Introduction to sensory analysis and uses of sensory tests: Establishing sensory panels, Recognition tests for 4 basic tastes, odour and aroma., Analytical tests: (i) Difference, (ii) Ranking, (iii) Descriptive, (iv) Scoring and (v) Rating 8. Standardization and storage studies of developed food products and using different packaging properties.		evaluation, Storage studies by packaging materials	

TEXT BOOKS:

T1: Norman N. Potter and Joseph H. Hotchkiss, Food Science, CBS publishers and distributors, Fifth edition, 2000

REFERENCE BOOKS:

R1: Manay, S. and Shadaksharaswami, M., Foods: Facts and Principles, New Age Publishers, 2004

R2: B. Srilakshmi, Food science, New Age Publishers, 2002

OTHER LEARNING RESOURCES:

Courseera, swayam

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the different application of food science in food production and packaging .	**1,2**
2	Give them a clear picture of recent trends and advancement in food science and technology.	**1,2**
3	Learn different food standard and regulations governed by Indian govt	**1,2**
4	Develop nutrients dense food products	**1,2**
5	Analyze different techniques and skill for detecting food adulteration.	**1,2**

SEMESTER – III									
Course Title	**CLINICAL NUTRITION II**								
Course code	**24MSFD2108R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ III Semester of second year of the program**								
Course Objectives	1.To review about the different biochemical metabolism reaction of the body. 2.To understand how this metabolism takes place in correlation with the nutrients of the food 3. To plan meal for different conditions.								
CO1	Understand the different aspect of food nutrients and interactions.								
CO2	Understand and apply different aspect of diet modification and adaptations in metabolic and systemic diseases state								
CO3	Analyse and understand different diet for inborn error metabolism								
CO4	Acquired knowledge on the planning diet for different conditions								
CO5	Apply therapeutic diet for extreme nutrient required patients.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Nutrient and drug interaction:** Effect of Nutrition on Drug, Drug Effects on Nutritional Status, Drug and Drug Interaction	**5**	Learn the importance of Nutrient and drug interaction	1,2
II	**Nutritional management in cancer, Aids, hematological disorders and burns**	**10**	Learn different types of diet for AIDS	1,2
III	**Nutritional management in hepatic disorders:** Viral Hepatitis, Liver Cirrhosis, Hepatic encephalopathy or Hepatic coma **Nutritional management in pulmonary disorders:** Asthma, COPD, Bronchitis, Pneumonia	**10**	Learn different types of diet modification for liver and pulmonary diseases.	1,2
IV	**Nutritional management in renal diseases:** Acute and Chronic renal diseases, Nephrotic Syndrome, Renal calculi, ESRD, Renal Transplantation	**10**	Learn different types of diet modification for renal diseases	1,2
V	**Nutritional management in neurological and mental disorders:** Eating disorders, Alzheimer's disease, Parkinson's disease, Nutritional and holistic care for neurological and mental disorder. **Inborn Errors of Metabolism**	**10**	Learn different Types of diet modification for neurological disorders	1,2
VI (Practical)	1. Planning, preparation and calculation of nutritive value of hepatic disorders: Viral Hepatitis, Liver Cirrhosis 2. Planning, preparation and calculation of nutritive value of hepatic disorders: Hepatic encephalopathy or hepatic coma 3. Planning, preparation and calculation of nutritive value of pulmonary disorders: Asthma, COPD, Bronchitis, Pneumonia	**16**	Learn diet modifications of liver disorders, Learn diet modifications of Nephrotic disorder	1,2

	4. Planning, preparation and calculation of nutritive value of renal disorders: Nephrotic syndrome, Dialysis 5. Planning, preparation and calculation of nutritive value of renal disorders: Renal calculi and Renal Transplantation 6. Planning, preparation and calculation of nutritive value of cancer 7. Planning, preparation and calculation of nutritive value of AIDS 8. Planning, preparation and calculation of nutritive value of anemia, burns			

TEXT BOOKS:

T1: Srilakshmi. B., Dietetics, New Age International (P) Ltd, Publishers, 2014
T2: Mahan, L.K. and Escott-Stump, S. (2000): Krause's Food Nutrition and Diet Therapy, 10th Edition, W.B. Saunders Ltd.

REFERENCE BOOKS:

R1: Srilakshmi. B., Dietetics, New Age International (P)Ltd, Publishers, 2014
R2: Robinson C. H., Lawer M. R., Chenowelth.WIC., and Garwich A. E., Normal and therapeutic nutrition, McMillan Publishers Co., New York, XVII Edition, 1986.
R3: Mahan, L.K. and Escott-Stump, S. (2000): Krause's Food Nutrition and Diet Therapy, 10th Edition, W.B. Saunders Ltd.
R4: Escott-Stump, S. (1998): Nutrition and Diagnosis Related Care, 4th Edition, Williams and Wilkins
R5: Raymond, J.L., & Morrow, K. (2020). Krause and mahan's food and the nutrition care. Elsevier Health Science
R6: Antıa F.P., & P. Abraham. (2002) Clinical Dietetics and Nutrition.

OTHER LEARNING RESOURCES:

Courseera, swayam

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the different aspect of food nutrients and interactions.	**1,2,3**
2	Understand and apply different aspect of diet modification and adaptations in metabolic and systemic diseases state	**1,2,3**
3	Analyse and understand different diet for inborn error metabolism	**1,2,3**
4	Acquired knowledge on the planning diet for different conditions	**1,2,3**
5	Apply therapeutic diet for extreme nutrient required patients.	**1,2,3**

SEMESTER – III									
Course Title	**APPLIED NUTRITION II**								
Course code	**24MSFD2107R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ III Semester of second year of the program**								
Course Objectives	1. To study a different aspect of food standards and safety. 2. To study the different regulatory bodies of food safety and production. 3. To study the advanced methods of food processing.								
CO1	Understand the different applications of food science in food production and packaging.								
CO2	Give them a clear picture of regulatory bodies of food science and technology.								
CO3	Understand the recent trends of health foods.								
CO4	Acquired knowledge on different packaging material.								
CO5	Evaluate the significance of recent food trends								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction:** Aim and Objectives of Food Science and Technology **Constituents of Food:** Chemical, Physical and Nutritional Alterations Occurring in Foods During Processing and Storage **Enzymes of importance in food processing:** Carbohydrates, Proteases, lipases, Oxidoreductases, Hydrolases.	**5**	Learn different Constituents of foods	1,2
II	**Introduction to advanced technologies used in food processing:** Agglomeration, agitation, air classification, Membrane technology (reverse osmosis and ultra Filtration), high pressure, surface heat exchanger, ohmic resistance heating, super critical extraction. **Pre and Primary Processing:** Some Basic Concepts **Fermentation, Semi Processed Foods, Instant Foods**	**10**	Learn technologies used in food processing	1,2
III	**Quality Evaluation of Food:** Requirement for conducting sensory tests, Types of tests, limitation of sensory evaluation. Objective methods of evaluation of food.	**10**	Learn different types of quality evaluation of food	1,2,4
IV	**Food Trends:** Changing food trends and consumer behavior in, Purchasing foods, Lifestyle changes: economic, socio-cultural, Psychological influences and marketing influences.	**10**	Learn different Food Trends	1,4,5
V	**Food Packaging:** Food packaging-Principles in the development of safe and protective packing, Packaging materials (metals, glass, paper and plastics) use of packaging in extending shelf life of unprocessed foods (modified	**10**	Learn different types of food packaging	1,2,3, 4

	atmosphere packaging, Biodegradable Plastics). **Food Safety:** Food Toxins, Food Standards			
VI (Practical)	1. Introduction to different equipment in processing and preservation 2. **Preservation by heat treatment:** Sterilization, 3. **Preservation by heat treatment :** Blanching 4. **Preservation by cold treatment :** Refrigeration 5. **Preservation by cold treatment:** Freezer, deep freezing 6. **Different methods of drying:** Mechanical drying 7. **Different methods of drying :** Sun drying 8. **Preparation of extruded products**	**16**	Learning the equipment of processing and preservation, Techniques of heat treatment, Techniques of cold treatment, Techniques of dry treatment, Techniques of extruded products	1,2,3, 4

TEXTBOOKS:

T1: Norman N. Potter and Joseph H. Hotchkiss (1999) Food Science, Springer

T2: G. Subbulakshmi and Shobha U Udipi (2006) Food Processing and Preservation. New age publishers; First edition (1 January 2006)

REFERENCE BOOKS:

R1: Norman N. Potter and Joseph H. Hotchkiss (1999) Food Science, Springer

R2: Fields, M. L. (1979). *Fundamentals of food microbiology*. AVI Publishing Co.Inc.

R3: Matthews, K.R.,Kniel, K.E., & Montville,T.J. (2017). *Food microbiology: an introduction*. John Wiley & Sons.

OTHER LEARNING RESOURCES:

Courseera, swayam

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the different applications of food science in food production and packaging.	**1,2**
2	Give them a clear picture of regulatory bodies of food science and technology.	**1,2**
3	Understand the recent trends of health foods.	**1,2**
4	Acquired knowledge on different packaging material.	**1,2**
5	Evaluate the significance of recent food trends	**1,2**

SEMESTER – III									
Course Title	**CORPORATE COMPETENCY (Communicative English & Soft Skills)**								
Course code	**24UMPD2101R**	**Total credits: 2** **Total hours: 60P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ III Semester of second year of the programme**								
Course Objectives	1. To acquaint students with the various tools of an effective presentation. 2. To acquire the speaking skill instruct, influence, engage, educate, or appease the listeners. 3. To increase proficiency, presentability and quality of resume and provide guidance for self- promotion and self-evaluation in social media. 4. To prepare and train the students for the campus drives & walking interviews.								
CO1	It will prepare the learners to speak with greater control and charisma in front of others.								
CO2	It will have a positive impact in their thought process and problem-solving skills.								
CO3	It will arm the students with all the necessary tools and skill sets to prepare professional resume. They will learn to highlight and assess themselves in social media.								
CO4	It will impart in them techniques to solve critical problems in an interview, develop strategies to crack interviews, improve their communication skills, boost their confidence								
CO5	It will prepare the learners to speak with greater control and charisma in front of others.								

Unit-No.	**Content**
I	**Module 1-Presentation Skills** i. Introduction ii. Essential characteristics of a good presentation iii. Preparation of a good presentation
II	**Module 2-Public Skills** i. Fear of Public Speaking, ii. Understanding and Overcoming Fear of Public Speaking, iii. Confidence and Control, iv. Physiology and Stress - Control/Process, v. Tips for Presentations and Public Speaking, vi. Tips for Using Visual Aids in Presentations, vii. Process for Preparing and Creating Presentations, viii. Delivering Presentations Successfully, Doubt Clearing and Summary of Main Points
III	**Module 3-Practical session on Resume, Curriculum Vitae, Writing cover letter & LinkedIn Profile** i. Preparation, submission & screening of Resume. ii. Practical session on cover letter screening session iii. Creating a profile on LinkedIn How to utilize it
IV	**Module 4-Leadership & Management Skills** i. Concepts of Leadership, ii. Leadership Styles, iii. Manager VS Leader, iv. How to be an Effective Leader, v. Mock/Practice Session, vi. Doubt Clearing Session.

V	**Module 5-Research Paper–Writing Skills** i. How to write a research paper Key point in Research Work
VI (Practical)	**Module 6- Interview Skills & Dress code Ethics** i. Types of the interview-telephonic, virtual & face to face ii. Online interview, personal interview, iii. Panel interview, iv. Group interview, v. JAM session, vi. Types of interview questions-traditional/common interview questions, vii. Case interview questions, viii. General Strategies for answering questions, ix. Marketing your skills and experiences, x. Preparation before the interview, xi. How to dress up for an interview, xii. How to maintain eye contact and positive body language, xiii. How to be presentable, xiv. Interview dos and don'ts, xv. Introduction to Dress Code Ethics, xvi. Purpose and Importance xvii.How to Make 'FIRST IMPRESSION' What to Wear During Interviews or Any Other Formal Meetings–Male & Female
VII	**Module 7- Mock Interview** i. Practical Mock Interview, ii. Feedback-Receiving Feedback, iii. Giving Feedback, iv. Advantages of Effective Feedback, v. How to deal with negative feedback.

TEXTBOOKS:

T1: Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.

T2: McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition)

REFERENCE BOOKS:

R1: Garg. Manoj Kr. (2018) *English Communication: Theory and Practice*

OTHER LEARNING RESOURCES:

https://brightlinkprep.com/10-best-toefl-prep-books/
https://files.eric.ed.gov/fulltext/EJ1132742.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	It will have a positive impact in their thought process and problem-solving skills.	**5**
2	It will arm the students with all the necessary tools and skill sets to prepare professional resume. They will learn to highlight and assess themselves in social media.	**2**
3	It will impart in them techniques to solve critical problems in an interview, develop strategies to crack interviews, improve their communication skills, boost their confidence	**5**
4	It will prepare the learners to speak with greater control and charisma in front of others.	**5**
5	It will have a positive impact in their thought process and problem-solving skills.	**5,6,8**

SEMESTER – III									
Course Title	**ADVANCE NUTRITION**								
Course code	**24MSFD2101R**	**Total credits: 2** **Total hours: 30T**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			2	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ III Semester of second year of the program**								
Course Objectives	1. To study about different concepts of advance nutrition and nutritional requirement in special conditions. 2. To study about the recent trends in nutrient modifications and their applications. 3. To understand the role of different nutraceuticals and their functions.								
CO1	Understand the efficacy and importance of functional and bioactive components.								
CO2	Understand and apply nutritional knowledge in various aspects like sports nutrition, space nutrition, sea voyage, emergency care etc.								
CO3	Acquired knowledge on recent advances in nutrition.								
CO4	Deliver in depth knowledge on and metabolic role of various nutrients and their interactions in human nutrition.								
CO5	Analyze the pharmacological actions of nutrients and their implications.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Concept of advanced nutrition:** Application of Nutrition Principles; Scope and Limitation of Food, Nutrition and Dietetics; Current advancements in nutrition.	**5**	Learn the concept of Nutrition and its principles	1,2
II	**Food additives**: Functions and uses in processed food products. Chemical, technological and toxicological aspects. **Food fortification and Food enrichment**: Objectives, principles and nutritional aspects. **Epigenetics and Nutrigenomics: specific food modulating nutrigenomics (lycopene, omega3)** **Nutritional requirements for special conditions:** Special nutritional needs for space, military, emergency care and sea voyage.	**10**	Acquired knowledge of food additive	1,2
III	**Immuno-nutrition:** Concept, Definition, Importance, Scope, Different immune-nutrients and their uses in different physiological conditions.	**10**	Acquired knowledge of immune- nutrients	1,2
IV	**Neutraceuticals**: Definition and types, Efficacy and Safety, Dietary and resistant fibre, Probiotics, Prebiotics and Symbiotic, Antioxidant and Pro-Oxidant Aspects. **Functional and bioactive components of foods:** Definition, chemistry, sources, bioavailability and perspective of food applications for: polyphenols, phytosterols, pigments (lycopenes, carotenoids), organo-sulphur compounds.	**10**	Acquired knowledge of Functional and bioactive components of foods	1,2
V	**Nutritional requirements for special conditions:** special nutrition needs for space, military, emergency care, sea voyage.	**10**	Acquired knowledge of Nutritional requirements for special conditions	1,2

TEXT BOOKS:

T1**:** Sareen S Gropper, Advanced Nutrition and Human Metabolism, 1990
T2**:** Goldberg, Functional Foods: Designer foods, Pharma foods, Nutraceuticals, Chapman & Hall, New York, 1994

REFERENCE BOOKS:

R1: Norman N. Potter and Joseph H. Hotchkiss (1999) Food Science, Springer
R1: Raffaele Caterina, Al Sareen S Gropper, Advanced Nutrition and Human Metabolism, 1990
R2: Goldberg, Functional Foods: Designer foods, pharma foods, Nutraceuticals, Chapman & Hall, New York, 1994 fredo Martinez, Martin Kohlmeier, Principles of Nutrigenetics and Nutrigenomics, 2019, Elsevier

OTHER LEARNING RESOURCES:

Courseera, swayam

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand the efficacy and importance of functional and bioactive components.	**1,2**
2	Understand and apply nutritional knowledge in various aspects like sports nutrition, space nutrition, sea voyage, emergency care etc.	**1,2**
3	Acquired knowledge on recent advances in nutrition.	**1,2**
4	Deliver in depth knowledge on and metabolic role of various nutrients and their interactions in human nutrition.	**1,2**
5	Analyze the pharmacological actions of nutrients and their implications.	**1,2**

SEMESTER – III									
Course Title	**PRODUCT DEVELOPMENT AND MARKETING**								
Course code	**24MSFD2102R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ III Semester of second year of the program**								
Course Objectives	1.To understand the steps in food product development. 2.To know about the concept of entrepreneurship. 3.To study about role and responsibilities of entrepreneur.								
CO1	Explain the concept of entrepreneurship								
CO2	Learn about entrepreneurship motivation								
CO3	Explore world of entrepreneurs								
CO4	Analyze difference between successful and failed entrepreneurs								
CO5	Understand the values and attitudes of successful entrepreneurs								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Introduction on developing various food products and selection of target group. Market survey and Preparation of questionnaire.	**2**	Learn to developed novel food product	3,5
II	Standardization of recipe, Preparation method, sensory evaluation.	**2**	Formulate Questionnaire	1,2
III	Shelf life, packaging, labeling, costing, storage, transportation and distribution, advertising	**2**	Standardization method & Different packaging material	1,2,3
IV	Transportation and distribution of the developed product Survey and selling of the developed product	**2**	Skill of marketing	1,4
V	Report writing and Presentation.	**2**	Documentation	1,5

TEXT BOOKS:

T1: Manimala, M. J. Entrepreneurship Theory at the Crossroads: Paradigms and Praxis, 2005

REFERENCE BOOKS:

R1: Earle M. and Earle, R. 2007. Case studies in food product development. Woodhead Publishing Ltd., Abington, Cambridge, UK.

R2: Frewer, Land Trijp, H. 2007. Understanding consumers of food products. Woodhead Publishing Ltd., Abington, Cambridge, UK.

OTHER LEARNING RESOURCES:

Courseera, swayam

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the concept of entrepreneurship	**5,7,8**
2	Learn about entrepreneurship motivation	**5,7,8**
3	Explore world of entrepreneurs	**5,7,8**
4	Analyze difference between successful and failed entrepreneurs	**5,7,8**
5	Understand the values and attitudes of successful entrepreneurs	**5,7,8**

SEMESTER – III									
Course Title	**RESEARCH ETHICS**								
Course Code	**24UMRE2101R**	**Total Credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 15T	**1**	**0**	**0**	**0**	**0**	**0**	**1**
Pre-Requisite	**NA**	**Co-Requisite**	**NA**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ III Semester of second year of the program**								
Course Objectives	1. To install a sense of integrity in data collection, analysis, and reporting, and to emphasize the need of honesty, transparency and accountability in research practices. 2. To address issue related to authorship, publication ethics, peer review, and the importance of avoiding research misconduct like data fabrication, falsification and plagiarism. 3. To develop critical thinking and ethical decision- making skills to navigate complex research scenarios, balancing scientific progress with respect for ethical norms.								
CO1	Describe and apply research ethics theories and methods.								
CO2	Explain research ethics issues such as responsibility, vetting, and misconduct.								
CO3	Illustrate arguments and results in ethical research inquiries.								
CO4	Identify and apply procedures for sampling, data collection, and reporting.								
CO5	Apply ethical principles to research design and evaluation								

Unit no.	**Content**
I	**ETHICS:** Introduction to the course and each other; an introduction to moral theory. Ethics: definition, moral philosophy, nature of moral judgements and reactions. Research regulation; self – regulation; research ethics. Honesty, candor, compromise and integrity. Data ownership and stewardship; conflicts of interest; collaboration. Human and Non-Human subjects. Research and researchers in society.
II	**SCIENTIFIC CONDUCT-** Ethics with respect to science and research. Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data
III	**PUBLICATION ETHICS**- Publication ethics: definition, introduction and importance. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.
IV	**OPEN ACCESS PUBLISHING-**Open access publications and initiatives**.** SHERPA/RoME0 online resource to check publisher copyright & self-archiving policies. Software tool to identify predatory publications developed by SPPU**.** Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.
V	**PUBLICATION MISCONDUCT** Group Discussions; Subject specific ethical issues, FFP, authorship. Conflicts of interest. Complaints and appeals: examples and fraud from India and abroad. Software tools; Use of plagiarism software like Turnitin, Urkund and other open source software tools. **DATABASES AND RESEARCH METRICS**–Databases: Indexing databases. Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, I 10 index, altmetrics.

TEXT BOOKS:

T1: Bird, A (2006). Philosophy of Science. Routledge.
T2: Maclntyre, Alasdair (1967) A Short History of Ethics. London.
T3: Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019)

REFERENCE BOOKS:

R1: On Being a Scientist: A Guide of Responsible Conduct in Research: National Academy of Science, National Academy of Engineering and Institute of Medicine Third Edition, National academics Press. (2009).
R3: George R, (2011). Sociological Theory, Rawat Publication, New Delhi, India.
R3: George R, (2019). Post Modern Social Theory, Rawat Publication, New Delhi, India.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe and apply research ethics theories and methods.	**6**
2	Explain research ethics issues such as responsibility, vetting, and misconduct.	**6**
3	Illustrate arguments and results in ethical research inquiries.	**5, 6**
4	Identify and apply procedures for sampling, data collection, and reporting.	**2, 3, 4**
5	Apply ethical principles to research design and evaluation	**4**

SEMESTER – III									
Course Title	**MINI RESEARCH (REVIEW OF LITERATURE-R3)**								
Course code	**24MSFD2103R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**6**	**4**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ III Semester of second year of the programme**								
Course Objectives	1. Appreciate and understand the importance of various research writing and review. 2. Applying the techniques and skill for writing abstract, short communications. 3. To learn technical writing and how to review literature.								
CO1	Develop competence in writing and abstracting skill								
CO2	Learn to write literature and review								
CO3	Develop competence in Project proposal								
CO4	Acquired the knowledge to conduct scientific project								
CO5	Analyze the significant aspect of scientific project								

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Develop competence in writing and abstracting skill	**3**
2	Learn to write literature and review	**3**
3	Develop competence in Project proposal	**3**
4	Acquired the knowledge to conduct scientific project	**3**
5	Analyze the significant aspect of scientific project	**3**

SEMESTER – IV									
Course Title	**INTERNSHIP**								
Course code	**24MSFD2201R**	**Total credits: 6**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**24**	**0**	**0**	**6**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ IV Semester of second year of the program**								
Course Objectives	1. To gain hands on experience of working in various institutions related to the area of Food and Nutrition. 2. To learn the inter-relationship and intra-relationship between the employee 3. To understand management in work place								
CO1	Extend field experience to apply therapeutic intervention strategies in hospital/ industry setup								
CO2	Apply therapeutic knowledge and acquire practical skills in the field of expertise								
CO3	Evaluate and manage hospitalized patients with nutrition intervention strategies								
CO4	Analyze thoughtful assessments and plans for evaluation and management in the work environment								
CO5	Identify the scope of exposure and employment opportunities in relevant field.								

Hospital internship will be continued in the downtown hospital for 60 days.

1. **Front page**: Name of University, University Logo, Name of the Student, Class, Department
2. **Certificate**
3. **Acknowledgement**
4. **Contents**
5. **Introduction**
6. **Activities**

A. Activity I: Internship details

- Name of the Institution where the internship was undertaken
- Dietitian incharge under whose Supervision Internship undertaken (Name and Designation)
- Duration and date of internship
- Dietetic department profile and organization
- Posting schedule of the intern

Day/week	Posting	Activities schedule and undertaken

- Kitchen layout
- Food procurement and storage
- Schedule/timing for meal distribution
- Dietetic department menu

B. Activity II: Modified therapeutic diets and special feeding methods

C. Activity III: Clinical posting and nutritional care of patients

i. Ward posting detail

- Major disease conditions observed and Medical Nutrition Therapy recommended during ward posting

Sl. No	Ward Posting	Major disease conditions observed	Recommended diets

ii. Nutrition and diet counselling

- List of educational material available
- Nutrition and diet counselling for both In and Out patients

Date/Time	IPD/OPD Posting	Counselling details

Note: Separate table for IPD and OPD

D. Activity IV: Case studies

-Disease case

Case problem (indicate the disease condition)

-Patient profile

Patient name
Age
Weight (kg)
Food habits Occupation
Educational qualification lifestyle
Date of admission
Date of discharge
Duration of stay
Medical diagnosis
Past history

Medical history of the case

- **Present problem**
- **Physical parameters examination**
- **Biochemical parameters**

Parameters analyzed	At the time of admission	At the time of discharge	Normal values during the treatment

Management and treatment details

i. Drug therapy (give the name of the drug/injections etc given/prescribed)
ii. Blood glucose monitoring (record in tabular form and follow-up the patient's blood glucose level if analyzed before breakfast, before lunch and/or before dinner the period of hospitalization). (note: only for diabetes mellitus)
iii. Dietary management of the disease condition
iv. Nutrition/diet counselling
v. Care prognosis:(comment on the portable course and outcome with respect to patient's condition/after the disease treatment in the hospital)

vi. Case study outcome: (brief highlights how the case study helped in your understanding of the dietary management of the disease condition under study)

E. Activity V: Presentation

7. Annexure/Appendices: Abbreviations**,** Biochemical Parameters, Portion Size, Diet Sheets etc

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Extend field experience to apply therapeutic intervention strategies in hospital/industry setup	**1,2,5,7**
2	Apply therapeutic knowledge and acquire practical skills in the field of expertise	**1,2,5,7**
3	Evaluate and manage hospitalized patients with nutrition intervention strategies	**1,2,5,7**
4	Analyze thoughtful assessments and plans for evaluation and management in the work environment	**1,2,5,7**
5	Identify the scope of exposure and employment opportunities in the relevant field	**1,2,5,7**

SEMESTER – IV									
Course Title	**RESEARCH/ DATA ANALYSIS/ DOCUMENTATION**								
Course code	**24MSFD2202R**	**Total credits: 12**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**20**	**4**	**6**	**0**	**12**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Food Nutrition and Dietetics**								
Semester	**Fall/ IV Semester of second year of the program**								
Course Objectives	1. Appreciate and understand the importance of importance of various research writing and review 2. Learning to write Abstract and short communication 3. To learn techniques of research, tabulation and documentation of research work								
CO1	Develop competence in writing and abstracting skill								
CO2	Learn to write literature and review								
CO3	Develop competence in Project proposal								
CO4	Acquired the knowledge to conduct scientific project								
CO5	Analyze the significant aspect of scientific project								
Unit-No.	**Content**								
I	Introduction Review of literature Materials and methods Results and Discussion Summary Annexure/Appendices Presentation of the research work								

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Develop competence in writing and abstracting skill	**3**
2	Learn to write literature and review	**3**
3	Develop competence in Project proposal	**3**
4	Acquired the knowledge to conduct scientific project	**3**
5	Analyze the significant aspect of scientific project	**3**

ASSAM DOWN TOWN UNIVERSITY

Curriculum and Syllabus

Master of Science

in

Biotechnology

OUTCOME BASED EDUCATION FRAMEWORK

CHOICE BASED CREDIT SYSTEM

Version: 2.1

FACULTY OF SCIENCE

July, 2023

PREAMBLE

Assam down town University is a premier higher educational institution which offers Bachelor, Master, and Ph.D. degree programmes across various faculties. These programmes, collectively embodies the vision and mission of the university. In keeping with the vision of evolutionary changes taking place in the educational landscape of the country, the university has restructured the course curriculum as per the guidelines of National Education Policy 2020. This document contains outline of teaching and learning framework and complete detailing of the courses. This document is a guidebook for the students to choose desired courses for completing the programme and to be eligible for the degree. This volume also includes the prescribed literature, study materials, texts, and reference books under different courses as guidance for the students to follow.

Recommended by the Board of Studies (BOS) meeting of the Faculty of Science held on dated 16th & 17th July, 2024 and approved by the 51st Academic Council (AC) meeting held on dated 26/07/2024

Chairperson, Board of Studies

Member Secretary, Academic Council

Vision

To become a Globally Recognized University from North Eastern Region of India, Dedicated to the Holistic Development of Students and Making Society Better

Mission

1. Creation of curricula that address the local, regional, national, and international needs of graduates, providing them with diverse and well-rounded education.

2. Build a diverse student body from various socio-economic backgrounds, provide exceptional value-based education, and foster holistic personal development, strong academic careers, and confidence.

3. Achieve high placement success by offering students skill-based, innovative education and strong industry connections.

4. Become the premier destination of young people, desirous of becoming future professional leaders through multidisciplinary learning and serving society better.

5. Create a highly inspiring intellectual environment for exceptional learners, empowering them to aspire to join internationally acclaimed institutions and contribute to global efforts in addressing critical issues, such as sustainable development, Climate mitigation and fostering a conflict-free global society.

6. To be renowned for creating new knowledge through high quality interdisciplinary research for betterment of society.

7. Become a key hub for the growth and excellence of AdtU's stakeholders including educators, researchers and innovators

8. Adapt to the evolving needs and changing realities of our students and community by incorporating national and global perspectives, while ensuring our actions are in harmony with our foundational values and objectives of serving the community.

Programme Details

Programme Overview

M Sc. Biotechnology offers a wide range of courses covering various basic and applied areas of life sciences. The student develops an aptitude and scientific temperament to apply the technical skills in various important areas of Biotechnology such as Immunology, Agricultural Biotechnology, Medical Biotechnology, Plant Biotechnology, and Molecular Biology. The course also offers various techno specific skills, universal ethics and elective courses considering overall development and employability scopes in research, industry and teaching sectors. The course duration is for a period of 2 years.

I. Specific Features of the Curriculum

- Experiential learning
- Constructivist approach to learn
- Practical and project based learning

II. Eligibility Criteria:

BSc in any area of life sciences with minimum of 45% marks or equivalent CGPA.

III. Program Educational Objectives (PEOs):

PEO-1: Students will demonstrate expertise in the field of modern biotechnology through a dynamic, research-focused curriculum tailored to meet the demands of both academic and industrial settings.

PEO-2: Students will expand their career prospects in industries and laboratory environments, globally through hands-on experiences in cutting-edge laboratories and dissertation projects that encourage the development of global competencies.

PEO-3: Students will equipped with leadership qualities that enable them to safeguarding the product of their intellect, staying updated on emerging trends and adapting to industry demands required by national and international organizations.

IV. Program Specific Outcomes (PSOs):

PSO1: Interdisciplinary Knowledge: Able to understand the concept of life sciences and apply the knowledge for empowerment to address challenges within the domains of biotechnology enabling employment opportunities in the relevant field.

PSO2:Research & Innovation: Should have the ability to promote a multidisciplinary approach for research exploration and collaboration with professionals across diverse disciplines of life science.

PSO3: Entrepreneurial Ability Development: Execute innovative ideas within the field of biological research and development by employing scientific methodologies to gain in-depth knowledge, ultimately contributing to entrepreneurial developments.

V. Program Outcome (PO):

PO1: Biotechnology Knowledge: Apply comprehensive knowledge of basic sciences, classical and applied life sciences, process technology, computational biology, biostatistics, and analytical techniques in rendering biological interventions to solve biotechnological problems.

PO2: **Problem Analysis:** Identify, formulate, review literature, design and evaluate complex biological problems by applying critical thinking to draw sustainable and strategic solutions.

PO3:Solution Design: Design solutions for complex life science problems and develop systems and processes for holistic socioeconomic development.

PO4: **Investigation and Research:** Conduct research applying comprehensive knowledge and scientific methods, data analyses and interpretation to provide conclusions.

PO5: Communication: Communicate effectively with peers, stakeholders and community, and able to prepare documents, scientific reports and impactful presentations.

PO6: Professional Ethics and Values: Comply with human values, ethics and norms of scientific practice in the profession.

PO7: Environment and Sustainability: Evaluate the impact of formulated biotechnological solutions in socio-economic and environmental contexts, and redesign it for sustainable global development.

PO8: Leadership &Teamwork: Work independently, and as a member/ leader in diverse teams, and in multidisciplinary settings

PO9: Lifelong Learning: Ability to engage in independent and life-long learning in the broadest context of scientific and technological advances.

VI. Total Credits to be Earned: 89

VII. Career Prospects:

M.Sc. in Biotechnology offers a range of dynamic career opportunities. Graduates can work in research and development, pharmaceuticals, and agricultural biotech. Roles include lab technicians, quality control analysts, and clinical researchers. Additionally, graduates can pursue careers in regulatory affairs, ensuring compliance with biotech regulations, or work in environmental biotech, focusing on sustainable solutions. Opportunities also exist in academia and education, where graduates can contribute to scientific knowledge and train future professionals.

EVALUATION METHODS

The student performance shall be evaluated through In-semester (Sessional) and semester-end examinations. A weightage of 40% or as prescribed by the programme shall be added to the score of the end-semester examination.

A. INTERNAL ASSESSMENT:

The teacher who offers the course shall be responsible for internal assessment by conducting in-semester (sessional) examination and evaluating the performance of the students pursuing that course. The components for internal assessment are illustrated in the table given below.

SN	Components/ Examinations	Marks Allotted
1.	In-Sem Exam – I (ISE-I) (Written Examination)*	30
2.	In-Sem Exam – II (ISE-II) (Written Examination)*	30
3.	Assignment	10
4.	Presentation (SP)	10
5.	Quiz	5
6.	Class Performance based score*	5

are compulsory

Note: *Total Internal assessment should be out of 40*

INSTRUCTIONS

1. If a student fails to appear in the any of the component without any valid reason he/she shall be marked zero in that component. However, the course teacher at his discretion may arrange for the missed test on an alternate date for the absentee students after determining ground with genuine/valid reasons for the absent.
2. The report of evaluation of an activity towards the in-semester (sessional) component of a course shall be duly notified by the concerned course teacher within a week of completion.
3. The program coordinators should upload the in-semester marks to the ERP and forward acknowledgement of all the courses of the program to the Controller of Examinations before the start of the End-semester examination.

B. SEMESTER END EXAMINATION:

Time table for end semester examination is published at least 25 days prior to the start of Examination.

I. Pre-Examination:

Eligibility Criteria for a student to appear in University Examinations:

The student shall only be allowed to appear in a University Examination, if:

i) He/ She is a registered student of the University;

ii) He/ She is of good conduct and character;

iii) He/ She has completed the prescribed Programme of study with minimum percentage of attendance as laid down in the Regulations of the Programme concerned.

Under special cases, a student may be allowed to appear for an examination without being registered in the University but the result of the said student will be kept on hold till the registration of the concerned student is completed.

II. Admit Card:

Admit card for the examination may be downloaded through ERP where the system will generate a Unique ID Card online.

The University shall have the right to cancel admission for examination of any candidate on valid grounds.

III. Pattern of Question Papers:

The question paper shall follow the principles of Bloom's Taxonomy.

S. N.	Level	Questions /verbs for test
1	Remember	List, Define, tell, describe, recite, recall, identify, show who, when, where, etc.
2	Understand	Describe, explain, contrast, summarize, differentiate, discuss, etc.
3	Apply	Predict, apply, solve, illustrate, determine, examine, modify
4	Analyze	Classify, outline, categorize, analyze, diagrams, illustrate, infer, etc.
5	Evaluate	Assess, summarize, choose, evaluate, recommend, justify, compare etc.
6	Create	Design, Formulate, Modify, Develop, integrate, etc.

Note: No course is to be evaluated on basis of **all 6 knowledge levels.**

The format of the question paper across all the program follow a unique pattern and the total marks is 60

Table 1: Question paper pattern for End semester examination

Sl no	Question pattern	Total marks
1	MCQs (10 Questions)	10
2	2 Marks questions (10 Questions)	20
3	4 Marks questions (5 Questions)	20
4	10 Marks questions (1 Question)	10

IV. Examination Duration:

Each paper of 60 marks shall ordinarily be of two hours duration.

V. Practical Examinations, Viva-Voice etc.:

i) Practical examination shall be conducted in the presence of one external expert and one or more internal examiners.

ii) Viva-Voce, Oral examinations of the Project report, Dissertation etc. shall be undertaken by a Board of Examiners constituted by the respective Dean of Program with the advice of Supervisor(s).

VI. Procedure of Expulsion:

If any candidate is found to be using any unfair-means during the examination, the invigilator may cease his/her answer sheet and report it directly to the Officer-in-Charge. The Office-in-Charge of the center may take appropriate decisions as per the rules and procedure of the examination. The Officer-in-Charge may allow the students to write the exam with new answer sheet or may expel the student from appearing the paper depending on the nature of unfair-means. In case of Computer based test, the students may be directed to write an apology letter and sign in the prescribe expulsion form. The student may not be allowed to write that examination.

VII. Instruction to the Students:

(i) The students shall not bring to the Examination Hall, any electronic gadget used as a means of communication or record except electronic calculator, if required.

(ii) The students shall not receive any book or printed or hand written or photo copy (Xerox) or blank-paper from any other person while he/she is in the examination-room or in laboratory or in any other place to which he/she is allowed to have access during course of examination.

(iii) The students shall not communicate with any other candidate in the examination room or with any other person in and outside the examination-room.

(iv) The students shall not see, read or copy anything written by any other candidate, nor shall he/she knowingly or negligently permit any other candidate to see, read or copy anything written by him/her or conveyed by him/her.

(v) The students shall not write anything on the Question Paper or in other paper or materials during the examination, or pass any kind of paper to any other candidate in the examination-room, or to any person outside the room.

(vi) The students shall not disclose his/her identity to the examiner by writing his/her name or putting any sign / symbol in any part of his answer-script.

(vii) The students shall not use any abusive language or write any objectionable remark or make any appeal to examiner by writing in any part of his answer-script.

(viii) The students shall not detach any page from the answer-script or insert any authorized or unauthorized loose sheet into it. He /she shall also not insert any other answer-script / loose sheet by removing the pins of the origin answer-scripts and re-fixing it.

(ix) The students shall not resort to any disorderly conduct inside the examination-room or misbehave with the invigilator or any other examination official.

VIII. Provision for an Amanuensis (writer):

(i) A candidate may be provided with an Amanuensis (writer) to write down on dictation on his / her behalf on ground of his / her physical disability to write down by himself / herself due to accident or any other reason. The amanuensis may be provided till he / she recovers from the physical disability. The physical disability to write down by himself / herself must be supported by Medical Certificate from a competent Medical Officer.

(ii) The qualifications of the amanuensis so provided must not be equal or higher than that of the candidate. This is also to be supported by Certificate from the Faculty of Study where the Amanuensis is provided.

(iii) Such candidates are to be accommodated in a separate room under the supervision of an invigilator so that the fellow candidates are not disturbed in the process.

C. Credit Point:

It is the product of grade point and number of credits for a course, thus, CP = GP x CR

i. Credit:

A unit by which the course work is measured. It determines the number of hours of instructions required per week. 'Credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. Credits assigned for a single course always pay attention to how many hours it would take for an average learner to complete a single course successfully.

ii. Grade Point:

Grade Point is a numerical weight allotted to each Grade Letter on a 10-point scale.

iii. Letter Grade:

Letter Grade is an index of the performance of students in a said paper of a particular course. Grades are denoted by letters O, A+, A, B+, B, C, P, F and Abs. Student obtaining Grade F / Grade Abs shall be considered failed/ absent and, will be required to appear in the subsequent ESE. The UGC recommends a 10-point grading system with the following (Table: 1) Letter Grades:

(i) A Letter Grade shall signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point shall indicate the numerical weight of the Letter Grade on a 10-point scale.

(ii) There shall be 08 (eight) Letter Grades bearing specific Grade Points as listed in Table 1, where the Letter Grades 'O' to 'P' shall indicate successful completion of a course.

(iii) Apart from the 08 (eight) regular Letter Grades listed in Table 1, there shall be 03 (three) additional Letter Grades, which shall be awarded if a Course is withdrawn or spanned over the next Semester or remains incomplete as stated in Table 2.

Table 2: Letter Grades and Grade Points

Letter Grade	Grade Points	Description
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Abs	0	Absent
UFM	0	Unfair Means

iv. Grade Point Average:

a. SGPA (Semester Grade Point Average)

The SGPA of a student in a Semester shall be the weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered in that Semester, irrespective of whether he/she could or could not complete the Courses. More specifically, the calculation of SGPA shall take into account the Courses graded with Letter Grades 'O' to 'F' as given in Table 1.

$$\text{SGPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad (1.1)$$

The SGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.1) up to two decimal places, where n is the total number of Credit Courses registered by the student in that Semester, Gi is the Grade Point secured in the i^{th} registered Course and Ci is the Credit (weight) of that Course.

b. CGPA (Cumulative Grade Point Average)

(i) The CGPA of a student in a Semester of a Programme shall be the accumulated weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered and successfully completed so far starting from the enrollment in the Programme. In other words, taking into account all the Courses graded with 'O' to 'P' as given in Table 1.1, generally the CGPA of a student shall be calculated starting from the first Semester of his/her enrolled Programme, while the CGPA of a lateral-entry student shall be calculated starting from the Semester of his/her enrollment.

(ii) The CGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.2) up to two decimal places, where N is the total number of Credit Courses registered and successfully completed so far by the student, Gi is the Grade Point secured in the ith completed Course and Ci is the Credit (weight)of that Course.

$$\text{CGPA} = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i} \qquad (1.2)$$

(iii) The CGPA shall be convertible into equivalent percentage of marks using Equation Conversion of CGPA to percentage marks: = CGPA*10

D. Post-Examination

i. Transcript or Grade Card or Certificate:

A marking certificate shall be issued to all the registered students after every Semester. The Semester mark sheet will display the course details (code, title, number of credits, grade secured) along with total credit earned in that Semester.

ii. Grievance Readdressal Mechanism:

Students with any dissatisfaction or grievance regarding the marks awarded in any of the Papers / Courses may appeal to the Controller of Examinations for remedial action such as Re-evaluation within 10 days of the declaration of result.

(i) A student has options to appeal for re-evaluation of his /her answer script to the Controller of Examination.

(ii) Application for re-evaluation / re-scrutiny of answer scripts shall be made in the definite proforma available with the Examination Office through the head of the respective departments within 10 days of declaration of the results of the respective examinations.

(iii) The Controller of Examination may appoint an examiner for re-evaluation and will consider and recognize the evaluation done by a University appointed examiner.

(iv) There shall be no provision for re-evaluation of the Practical Papers, Project Work, and Dissertation etc. However, the students fail in practical examination or viva voce and wish to appear again may apply to be evaluated can do so with the next schedule.

(v) After screening the application for re-evaluation, the CoE may send the answer scripts of the student to the examiners appointed by the CoE with the approval of Vice Chancellor.

(vi) The marks/grades achieved by the students after the re-evaluation shall be final and binding.

(vii) Fresh Marks – sheets / Grade Card shall be issued only if the candidate secures pass marks / passing grade in the re-evaluated paper.

(viii) Revaluation of answer scripts shall be deemed to be an additional facility provided to the students with a view to improving upon their results at the preceding examination result for any reason whatsoever shall not confer any right upon them for admission to next higher class which matters always be regulated in accordance with the relevant rules or regulations framed by the University.

(ix) If as a result of revaluation of the candidate attracts the provision of condonation of deficiency, the same may be applied to his/her only for fresh attempt.

INSTRUCTION TO TEACHERS AND STUDENTS

(Teaching and Learning Methods)

In all the courses the teacher has to select topics for teacher-method which should not be less than 20 percent. The approach will be direct classroom teaching through a series of lectures delivering concepts using ITC facilities, white or blackboard. Notes may also be circulated to the students; however, the students are to be involved in the preparation of the notes. The teacher will be responsible for selecting the best note for circulation. The teacher-centric methodology has recently fallen out of favour because this strategy for teaching is seen to favour passive students.

1. Student- centric / Constructivist Approach:

The topics of the courses may be selected at the start of the class and assigned one topic to each of the students for studying by themselves, prepare presentations, notes, etc., and present at respective class time after consultation and discussion with the course teachers. The teacher facilitates the learning of the students by guiding and providing input and explaining concepts. 60 percent of the course contents may be selected for this purpose. To avoid behaviour problems, teachers must lay a lot of groundwork in student-centric classrooms. Typically, it involves instilling a sense of responsibility in students. In addition, students must learn internal motivation.

a. Project-Based Learning: The teacher may select 5 percent of the topics for the purpose and may conduct visits to the laboratory for experiments or field surveys. The selection of the topic may be done considering the available facility for the purpose. However, in the final semester of each of the programme the student has to undergo project-based learning at least 4 months duration. This approach will help the student to think critically, evaluate, analyze, make decisions, collaborate, and more.

b. Inquiry-Based Learning: The teacher/ students are supposed to list at least five questions in each contact hour and student solve these question or search for answer which becomes the home work for the students "question-driven" learning approach. The teacher may look for the correctness of the solution or the best possible answer and discuss in the successive class. This will help in the preparation for various competitive examination and develop a habit for search for solutions.

c. Flipped Classroom: About 10 percent of the course content has to be completed by this method. In this approach the students are asked to watch video or lecture prepared by the teacher or any video available (relevant to the course). A set of questions may be given to the students for searching answers by the students. The idea is that students should have more time in-classroom focusing on achieving these higher levels of thinking and learning. The Flipped classroom is also an acronym. The letters FLIP represent the four pillars included in this type of learning: Flexible environment, Learning culture shift, Intentional content, and Professional educator. This approach is also a student-centric teaching method.

d. Cooperative Learning: The remaining five percent has to be completed by cooperative learning approach. In this approach, the students are allotted problems. During library hours the students along with the teacher visitthe library and search for probable solutions for the assigned problem. The same has to be done in groups so that the students discuss among themselves for the appropriate answers. Essentially, cooperative learning believes that social interactions can improve learning. In addition, the approach recreates real-world work situations in which collaboration and cooperation are required.

Teacher-centric or Direct Classroom Teaching: Delivery by series of lectures	20%
Student-centric Approach, Students present and deliver lectures in the presence of teacher and supervised by teacher	60%
Students visit fields or perform experiments or teachers perform demonstration	05%
Flipped Classroom approach	10%
Cooperative learning approach	05%

Inquiry-based approach has to be followed in all of the classes

The teacher has to distribute the topics to be considered for teaching by the above-mentioned approaches and prepare a lesson plan for execution and maintain a file.

SEMESTER WISE COURSE DISTRIBUTION

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester I	1	24MSBT1101R	Cell biology	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	2	24MSBT1102R	Biochemistry	**DSC Minor**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSBT1103R	Bioinstrumentation	**DSC Minor**	3	0	2	0	0	0	4	40	60	100	200
	4	24UMFS1101R	Fundamental of Statistics	**MDC**	2	0	0	0	0	0	2	40	60	0	100
	5	24UMPD1101R	Effective Communication	**AEC**	0			0	0	0	2	0	0	100	100
	6	24UMCC1101	Extra-curricular	**Co and extra-Curricular**	0	0	0	0	0	0	1	0	0	100	100
	Total										**17**				**900**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester II	1	24MSBT1201R	Immunology	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	2	24MSBT1202R	Molecular biology, Genomics and Genetic Engineering	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSBT1203R	Microbiome and Microbial Technology	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	4	24UMPD1201R	Advanced communication	**AEC**	2	0	0	0	0	0	2	0	0	100	100
	5	24MSBT1204R	Postgraduate Practice Teaching	**SEC**	1	0	0	0	0	0	1	0	0	100	100
	6	24MSBT2105R	Research Methodology and Statistical Analysis	**SEC**	2	0	2	0	0	0	3	40	60	100	200
	7	24FSDA1201R	Data analysis using Microsoft excel	**VAC**	0	0	4	0	0	0	2	0	0	100	100
	8	24MSBT1205R	Field Visit	**Field Training**	0	0	0	0	0	8	1	0	0	0	100
	9	24UMCC1201	Co-curricular	**Co and extra-Curricular**	0	0	0	0	0	0	1	0	0	100	100
	Total										**22**				**1300**

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester III	1	24MSBT2101R	Bioinformatics	**DSC Major**	2	0	2	0	0	0	3	40	60	100	200
	2		English (PDP)	**AEC**	0	0	4	0	0	0	2	0	0	100	100
	3	24MSBT2102R	Internship	**Internship**	0	0	0	0	0	0	4	0	0	100	100
	4	24MSBT2103R	Field Visit	**Field Training**	0	0	0	0	0	0	1	40	60	0	100
	5	24MSBT2104R	Research Project I	**Research/ Industry Internship**	0	0	8	0	0	0	4	0	0	100	100
	6	24MSBT2105R	Indian knowledge system	**VAC**	0	0	0	0	0	0	2	0	0	100	100
	Discipline specific Elective (Any three subjects to be selected)														
	7	24MSBT2106R	Plant and Animal Biotechnology	**DSE**	3	0	2	0	0	0	4	40	60	100	200
	8	24MSBT2107R	Bioprocess and Fermentation Technology	**DSE**	3	0	2	0	0	0	4	40	60	100	200
	9	24MSBT2108R	Medical Biotechnology	**DSE**	3	0	2	0	0	0	4	40	60	100	200
	10	24MSBT2109R	Food Biotechnology	**DSE**	3	0	2	0	0	0	4	40	60	100	200
	Total										**28**				**1300**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester IV	1	24MSBT2201R	Research project II	**Research/ Industry Internship**	0	0	32	0	0	0	16	0	0	100	100
	Discipline specific Elective (Any two subjects to be selected)														
	2	24MSBT2202R	Agriculture Biotechnology	**DSE**	3	0	0	0	0	0	3	40	60	0	100
	3	24MSBT2203R	Environmental Biotechnology	**DSE**	3	0	0	0	0	0	3	40	60	0	100
	4	24MSBT2203R	Organic farming	**DSE**	3	0	0	0	0	0	3	40	60	0	100
	Total										**22**				**300**
	Grand Total										**89**				**3800**

***IA: Internal Assessment, SEE: Semester End Examination, PE: Practical Examination**

SEMESTER – I									
Course Title	**Bioinstrumentation**								
Course code	**24MSBT111R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Biotechnology**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To impart knowledge about the working of different Biomedical Instruments. 2. Basic working principle of different instruments. 3. Working principle of chromatography, centrifugation								
CO1	Discuss Chromatography techniques including history, classification, principles, operation, analysis and application.								
CO2	Define Centrifugation techniques, classification, principles, operation and its application.								
CO3	Explain and investigate Electrophoresis, its categorization, underlying principle, operational methods, pH meter functionality, dialysis, and blotting methodologies.								
CO4	Discuss radioisotope dating principles, including detection, measurement, isotopes, radiation, units and decay.								
CO5	Develop the comprehensive understanding of principles, and practical application skills in various spectroscopic methods for scientific analysis.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Chromatography:** History; Classification; Types, principles, operation, application & analysis (Paper, Column, Adsorption column, Partition, Thin layer, Ion exchange, quantitative Ion exchange, and Gel Chromatography):	10	Able to describe, illustrate and explain the chromatography and their applications	1,2
II	**Centrifugation:** Types; Application; Principle; rotors; density gradient & analytical centrifugation.	5	Able to describe, illustrate and explain the centrifuge	1,2
III	**Gel Electrophoresis:** Application; Types; Principle; pH meter (Principle); Dialysis, **Blotting technique:** Southern, Western, & Northern blot	8	Able to describe, illustrate and explain the electrophoresis	1,2
IV	**Radio- isotope dating technique:** Introduction, nature, detection & measurement of radioactivity, radioisotopes & radiation, units, radioactive decay.	7	Able to describe, illustrate and explain the radio isotopes.	1,2
V	**Spectroscopic techniques:** Introduction, Principle and application of spectroscopy	10	Able to describe, illustrate and explain the spectroscope	1,2
Practical	Operation of molecules from given sample by 1. Paper chromatography 2. Column chromatography 3. Thin layer chromatography 4. Separation of DNA and protein molecules by gel electrophoresis	30	Able to use various instruments for analysis	1,2,3,4

Text Books

T1. Upadhyay. Biophysical chemistry: principle and technique. 12th edition.Himalaya Publishing House Pvt. Ltd; 2017.

Reference Books

R1. Kakkar. Atomic and Molecular Spectroscopy. 1st edition. Cambridge English; 2017.
R2. Evans. Handbook of Chromatography.2nd Edition, Will ford Press; 2019.
R3. Holme and Peck. Analytical biochemistry.3rd edition. Longman, 1983.

Other Learning Resources:

https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/chromatography

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss Chromatography techniques including history, classification, principles, operation, analysis and application.	**1,4, 5**
2	Define Centrifugation techniques, classification, principles, operation and its application.	**1, 4, 5**
3	Explain and investigate Electrophoresis, its categorization, underlying principle, operational methods, pH meter functionality, dialysis, and blotting methodologies.	**1,4, 5, 7**
4	Discuss radioisotope dating principles, including detection, measurement, isotopes, radiation, units and decay.	**1, 7**
5	Develop the comprehensive understanding of principles, and practical application skills in various spectroscopic methods for scientific analysis.	**1,9**

SEMESTER – I									
Course title	**Biochemistry**								
Course code	**24MSBT112R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	Nil	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Fall/I Semester of First Year of the Program**								
Course objectives	1. To study the structure of biomolecules, such as proteins, nucleic acids, carbohydrates and lipids 2. To know the functions and interactions of biomolecules, which will provide the knowledge of the structure of cells and the various functions performed by them which are associated with life? 3. To study the metabolic pathways of biomolecules like carbohydrate, amino acids etc.								
CO1	Improve the concept of chemical interactions and molecular organization of micro and macromolecules								
CO2	Understand the composition, structure and function of the biomolecules								
CO3	Enhance the understanding on metabolism and physiology of cell.								
CO4	Analyse the concepts of secondary metabolites for human benefits.								
CO5	Prepare the base for understanding courses such as molecular biology and cellular functioning at molecular level.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Concept of biomolecules (composition, structure and functions):** Carbohydrates, Proteins, Lipids, Nucleic acids, Vitamins and Minerals.	**10**	Knowledge on the concept of biomolecules, differentiating the various biomolecules with thorough understanding on their types and functions	1,2
II	**Bioenergetics:** Concept of thermodynamics (entropy, enthalpy and free energy), reaction kinetics: Substrate phosphorylation and oxidative phosphorylation, **Enzymology:** Principle of catalysis, enzyme and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, Importance of enzymes in diagnosis and therapy.	**10**	Demonstrate the fundamental knowledge of bioenergetics and enzyme and its kinetics for understanding of metabolism and learning its applications in clinical and therapeutics.	1,2
III	**Metabolism of biomolecules:** **Carbohydrate metabolism**: Glycolysis and its regulation, Gluconeogenesis, Glycogenolysis TCA cycle, Pentose phosphate pathway, glyoxalate pathway. **Lipid metabolism**: oxidation of saturated and unsaturated fatty acid, odd chain fatty acid, regulation of fatty acid metabolism.	**10**	Build knowledge of the biochemical pathways of synthesis and degradation of the carbohydrate and lipids with its regulatory concept	1,2
IV	**Amino acid metabolism**: Transamination, Deamination and its types, urea cycle **Nucleotide metabolism**: biosynthesis and degradation of purines and pyrimidines	**8**	Understandthe amino acid and nucleotide synthesis and degradation with its biochemical and regulatory concept	1,2,3
V	**Heme Metabolism and Photosynthesis and Secondary metabolites:** Heme synthesis and degradation**,** Photosynthesis: Structure of chloroplast, light reaction and dark reaction, Brief concept on the secondary metabolites	**7**	Learn the synthesis and breakdown of heme, gain knowledge on the mechanism of photosynthesis and apply the concept of secondary	1,2,3, 4

	(Flavonoids, terpenoids, phenolic acids and alkaloids)		metabolites for mankind.	
Practical	Buffers: Preparation of acetate buffer, citrate buffer, tris buffer, phosphate buffer; Estimation of protein by Lowry's/Bradford method. Estimation of reducing sugar by DNS method. Estimation of RNA by orcinol method. Estimation of DNA by diphenyl amine method, Extraction and estimation of chlorophyll. Determination of total activity of amylase. Determination of total activity of protease, Qualitative analysis for protein, carbohydrate and its types, amino acid.	**30**	To apply the practical knowledge of biochemistry in variousfields	1,2,3, 4

Text books:
T1. U Satyanarayana.Biochemistry.13th edition.Elsevier Health Sciences;2017.
Reference books:
R1. David L. Nelson, Michael Cox. Leininger Principles of Biochemistry.7th Edition.WH Freeman; 2017.
R2. Rodwell et al. Harper's Illustrated Biochemistry.29th edition.McGraw Hill; 2012.
R3. Voet and Voet.Biochemistry.3rd edition.John Wiley & Sons, 2004.
Other learning resources: https://pubmed.ncbi.nlm.nih.gov/34809432/

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve the concept of chemical interactions and molecular organization of micro and macromolecules	**1,3**
2	Understand the composition, structure and function of the biomolecules	**1, 4**
3	Enhance the understanding on metabolism and physiology of cell.	**1,3,4**
4	Analyse the concepts of secondary metabolites for human benefits.	**1, 2, 7**
5	Prepare the base for understanding courses such as molecular biology and cellular functioning at molecular level.	**1, 9.**

SEMESTER -I									
Course Title	**Cell Biology**								
Course code	**24MSBT113R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
programme	**Bachelor of Science in Biotechnology**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To make students understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles 2. To define how the cellular components are used to generate and utilize energy in cells 3. Familiarize the cellular components underlying mitotic cell division.								
CO1	Improve understanding on the membrane structure and its functioning								
CO2	Improve understanding on structural organization of cell and its organelles.								
CO3	Describe and able to understand the process of cell division								
CO4	Able to understand the how the cell communicates for functioning of the cell.								
CO5	Prepare the base for understanding advance courses in Biological Sciences.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Membrane Structure and Function: (Structure of a model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes)	7	Knowledge of structure of cell membrane and function	1,2
II	Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure and function of cytoskeleton and its role in motility)	10	To learn the basic structural organisation of intracellular organelles	1,2
III	Cell Division and Cell Cycle (Mitosis and Meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle)	10	To understand the basics of how a cell divides and its importance in cell cycle.	1,2
IV	Cell signalling: (Ligands and their receptors, cell surface receptor, signalling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signalling pathways, bacterial and plant two-component systems, light signalling pathways in plants, bacterial chemotaxis and quorum sensing)neurotransmission and its regulation	8	To know about the communications and signalling mechanisms in cells	1,2
V	Cellular communication: (Regulation of haematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins,)	10	Knowledge on Basic regulatory mechanisms of cell	1,2
Practical	1. Staining and microscopic observation of various stages of Mitosis of given sample(s). 1. Staining and microscopic observation of various stages in Meiosis of given sample(s).	30	Describe, illustrate and explain and apply staining techniques and carry out microscopic examination.	1,2,3,4

Text Books

T1: Alberts B, Johnson A, Lewis J, et al. Molecular Biology of the Cell. 4th edition. New York: Garland Science; 2002.

Reference Books

R1: Cooper GM. The Cell: A Molecular Approach. 2nd edition. Sunderland (MA): Sinauer Associates; 2000.

R2: Ambrose and Dorothy. Cell Biology.2nd Edition.MEasty, ELBS Publications; 1970.

R3: Sharp, Lester W. Fundamentals of Cytology.1st edition.Mc Graw Hill Company; 1943.

Other Learning Resources:https://www.ncbi.nlm.nih.gov/books/NBK9839/?term=cell%20Biolpgy

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve understanding on the membrane structure and its functioning	**1, 3**
2	Improve understanding on structural organization of cell and its organelles.	**1, 3**
3	Describe and able to understand the process of cell division	**1, 4**
4	Able to understand the how the cell communicates for functioning of the cell.	**1, 3**
5	Explain the Cellular communication, involving haematopoiesis regulation, cell adhesion, gap junctions, extracellular matrix, and integrins, ensures proper tissue structure and function	**1, 3, 4, 7**

SEMESTER-I									
Course Title	**Microbiome and Microbial Techniques**								
Course code	**24MSBT114R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course objectives	1.Introduction to Basic Microbiology and microbiome. 2.To develop and use critical thinking and problem-solving skills through the use of case studies and reviews of scientific literature. 3.To discuss the historical perspectives important in the development of microbiology along with the current diversity in the field. 4.To discuss and perform the various techniques associated with microbiology								
CO1	Explain the evolution of the field and focus on prokaryotic cell structure and functions								
CO2	Discuss the methods for culturing microorganisms.								
CO3	Elaborate the approaches for diversity study								
CO4	Explain the role of microorganisms in the field of Environment.								
CO5	Describe diversity of microbes								

Unit-No.	Content	CH	Learning Outcome	KL
I	Microbiome, Concept of Microorganism & structure. Eukaryotic and Prokaryotic cell, Bacterial Structure and types, Gram positive and Gram-negative bacteria, Actinomycetes, Introduction to characteristics of fungi, molds and yeasts, Hyphae and Body of Fungus, Major polysaccharide components of fungal cell wall, Cell wall components of Fungi. Concept of microbial secondary metabolites: Antibiotics, Probiotics.	7	Knowledge on the basic structure of bacterial cells, difference between gram negative and gram-positive bacteria, introduction to fungi and its cell wall components	1,2
II	Physical and chemical methods of sterilization: Sterilization by dry heat, moist heat, Chemical agents- Alcohol, Ethyl alcohol, Isopropyl alcohol, Aldehyde, Formaldehyde, Bacteriocidal, bacteriostatic. Effect of dyes, Gases. Staining technique: Gram staining, Aerobic and anaerobic culture, mixed culture and pure culture. Techniques of pure culture isolation: Streak plate, Pour plate, Spread plate methods. Definition of media, Peptone, & nutrient broth, types of media, uses of different types of media, transport media, Serial dilution technique, Colony Forming Units (CFU) and it's calculation, Preservation and maintenance of pure culture	10	Knowledge on physical, chemical techniques of sterilization, isolation, technique and media and staining preparation, preservation of culture	1,2
III	Culture-dependent approaches for microbial diversity study, advantages, limitations, Exploration of Unculturable bacteria: Culture independent molecular methods studying of unculturablebacteria, expand the knowledge about bacterial growth requirements, met-genome concept. Microbial dysbiosis	10	Knowledge on difference between culture dependent and culture independent molecular methods, Bacterial growth requirement.	1,2
IV	Gut microbial flora & its role, normal microflora of skin, Eyes, urogenital tract. Human microbiome & immunity	8	Knowledge on different types of microbial flora present on different parts of body	1,2

V	Diversity of microbes in terrestrial ecosystem, Microbes in extreme environments – thermophiles, psychrophiles, barophiles, acidophiles, alkaliphiles and halophiles, Microbial interactions: Competition, ammensalism, parasitism, mutualism, commensalism, synergism, Endophytism, Plant endophytes relation	10	Knowledge on Microbial diversity in terrestrial ecosystem and their resistance towards the extreme environments.	1,2
Practical	1. Laboratory Safety, preparation for experiment, and laboratory waste management. 2. Principle, operation and measurement of pH of a given sample 3. Principle and operation of Hot air oven, Autoclave, Laminar airflow and centrifuge. 4. Isolation of microbes from given sample by serial dilution techniques and estimation of the CFU (Pour plate and streak plate techniques also be learned) 5. Staining (gram, acid fast, endospore or any appropriate staining) of the given microbial sample and observation under microscope.	30	Describe, illustrate and explain and apply laboratory safety rules, set a microbiological experiment for microbial isolation, prepare slides by applying staining techniques and observe them under microscope.	1,2,3,4

Text books:

T1. Michael J. Pelczar; E.C.S. Chan. Microbiology (An Application Based Approach). 12th edition.Tata McGraw Hill; 2010.

Reference books

R1. L.E.J.R. Casida. Industrial Microbiology.2nd edition. New AGE International Publisher, 2019

R2. P. S. Bisen. Frontiers in microbial technology.1st edition. C.B.S. Publishers and Distributors; 1994

R3. Alan T. Bull. Biotechnology: International Trends and Perspectives, Issue 7. Organisation for Economic Co-operation and Development, 1982.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the evolution of the field and focus on prokaryotic cell structure and functions	**1, 4**
2	Discuss the methods for culturing microorganisms.	**1, 3, 4**
3	Elaborate the approaches for diversity study.	**1, 4, 7**
4	Explain the role of microorganisms in the field of Environment.	**1, 2, 7**
5	Describe diversity of microbes	**1, 4, 7**

SEMESTER - I									
Course Title	**Fundamental of Statistics**								
Course code	**24UMFS111R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course objectives	1. Help to understand the role of statistics in data analysis, decision-making, and scientific research 2. Introduce students to descriptive statistics, including measures of central tendency (mean, median, mode) and measures of dispersion (range, variance, standard deviation). 3. Teach students how to summarize and present data effectively using tables, charts, and graphs								
CO1	Improve understanding of Descriptive Statistics and Demography.								
CO2	Develop knowledge to understand the Probability theory, Distribution, and sampling methods.								
CO3	Develop knowledge to understand the methods for hypothesis testing and biological data analysis.								
CO4	Develop knowledge to understand the principles of various statistical analyses of data.								
CO5	Develop knowledge on R language for data analysis								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Statistical Methods**: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio.	5	Foundational Understanding of Statistical Concepts	1,2
II	**Presentation**: tabular and graphical, including histogram and ogives. Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, skewness and kurtosis.	5	Proficiency in Data Presentation and Analysis	1,2
III	**Bivariate data**: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, fitting of polynomials and exponential curves.	5	Knowledge on Analyzing Bivariate Data and Relationships	1,2
IV	**Random experiment**: trial, sample point and sample space, event, Operations of Events, concepts of mutually exclusive and exhaustive events. Definition of probability: classical and relative frequency approach. Discrete probability space, Properties of probability, Independence of events, Conditional probability, total and compound probability rules, Normal probability Distribution, Binomial probability Distribution, Poisson Probability Distribution, Bayes' theorem and its applications.	8	Understanding of Probability and Distributions	1,2
V	**Testing of hypothesis**, parametric test: t-test, z-test, chi-square test. Non-Parametric test: One sample Kolmogorov test, Wilcoxon Signed test, Mann-Whitney Test, Kruskalwails test.	7	Application of Hypothesis Testing and Statistical Tests	1,2
Practical	1.Introduction to R - A programming language and environment for data analysis and graphics. Syntax of R expressions: Vectors and assignment, vector arithmetic, generating regular sequence,	30	A brief knowledge on using R fordata analysis and visualization	1,2, 3,4

	logical vector, character vectors, Index vectors; selecting and modifying subsets of dataset 2.Data objects: Basic data objects, matrices, partition of matrices, arrays, lists, creating and using these objects; Functions- Elementary functions and summary functions, applying functions to subsets of data. Data frames: The benefits of data frames, creating data frames, combining data frames, Adding new classes of variables to data frames; Data frame attributes. 3.Importing data files: import. Data function, read table function; Exporting data: export. data function, cat, write, and write. Table functions, function, formatting output - options, and format functions; Exporting graphs -export. Graph function. Graphics in R: creating graphs using plo function, box plot, histogram, line plot, steam and leaf plot, pie chart, bar chart, multiple plot layout, plot titles, formatting plot axes; Visualizing the multivariate data: Scatter plot, Q-Q plot, P-Pplot. 4.Performing data analysis tasks: Reading data with scan function, exploring data using graphical tools, computing descriptive statistics, one sample tests, two sample tests, Goodness of fit tests. 5.Parametric test and non-parametric test			

Text books:

T1: Methods in Biostatistics by K S Negi, ISBN:9789374735053,4th Edition, Year:2023, AITBS Publishers, INDIA

Reference books

R1; "Introduction to the Practice of Statistics" by David S. Moore, George P. McCabe, and Bruce A. Craig

R2: "Statistics" by David Freedman, Robert Pisani, and Roger Purves

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve understanding of Descriptive Statistics and Demography.	**1, 4**
2	Develop knowledge to understand the Probability theory, Distribution, and sampling methods.	**1, 4**
3	Develop knowledge to understand the methods for hypothesis testing and Biological data analysis.	**1, 4**
4	Develop knowledge to understand the principles of various statistical analyses of data.	**1, 4**
5	Develop knowledge on R language for data analysis	**1, 4, 9**

SEMESTER - I									
Course Title	**MINI RESEARCH (REVIEW OF LITERATURE-R1)**								
Course code	**24MSBT115R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**0**	**4**	**6**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course objectives	To develop students scientific writing skill								
CO1	Employ databases and library resources to gather original research, books, and articles effectively								
CO2	Summarize and differentiate between various types of reviews, specifically analytical and descriptive reviews.								
CO3	Identify research topics and employ appropriate methods for collecting and filtering information.								
CO4	Critically analyze the demonstrations and findings of previous authors to comprehend their contributions and insights.								
CO5	Compose a detailed review that explains the prospects and future directions of the chosen study.								

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Employ databases and library resources to gather original research, books, and articles effectively	1, 2, 3, 4
2	Summarize and differentiate between various types of reviews, specifically analytical and descriptive reviews.	1, 2, 3, 4
3	Identify research topics and employ appropriate methods for collecting and filtering information.	1, 2, 3, 4
4	Critically analyze the demonstrations and findings of previous authors to comprehend their contributions and insights.	1, 2, 3, 4
5	Compose a detailed review that explains the prospects and future directions of the chosen study.	1, 2, 3, 4,6

SEMESTER - I									
Course Title	**EFFECTIVE ENGLISH (Communicative English & Soft Skills)**								
Course code	**24UMPD111R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course objectives	1. To introduce the types of sentences and their significance. 2. To strengthen the students' vocabulary to enhance their speaking and writing skills. 3. To familiarize the students with the importance of dress codes in various organizations. 4. Tointroducethe3P's (Planning, prioritizing & performing) of Time Management. 5. To give insight into English pronunciation and into central concepts in phonetics.								
CO1	This course will enable students to analysis and identify the different types of sentences.								
CO2	Learners will be able to integrate the skills of reading and speaking in professional communication.								
CO3	Dress code Etiquette sessions will boost their confidence and morals.								
CO4	Students will learn about the effective and efficient utilization of time.								
CO5	Introduction to Phonetics and its importance will improve the learners 'pronunciation								

Sl No	**Content**	**Learning Outcome**
MODULES	**Module 1- Grammar** Interchange of Interrogative and Assertive Sentences, Exclamatory and Assertive Sentences, Types of Tenses, Common Errors, Synonyms, Antonyms, Homonyms	Identify and understand the structure of interrogative and assertive sentences. Transform and enhance grammatical accuracy and sentence formation skills.
	Module 2- Reading Skills Techniques of Effective Reading, gathering ideas and information from a text The SQ3R Technique Interpret the text	Develop strategies for faster reading with better comprehension and improve the ability to recall and organize textual information systematically .
	Module 3-Listening Skills What is listening? The Process of Listening, Factors that adversely affect Listening, Difference between Listening and Hearing, Purpose and Importance of Effective Listening, How to Improve Listening Process,	Understand the fundamental aspects and importance of listening. It also helps to enhance interpersonal and professional communication by practicing listening skills.
	Module 4- Conflict Management Definition**,** Type of Conflict Management**,** Effects of Conflict Management**,** Methods to deal with Conflicts (Negative)	Learn strategies to manage and resolve conflicts effectively to encourage a positive environment by turning conflicts into opportunities for growth.
	Module 5- Time-Management Skills Introduction To Time Management, Purpose and Importance of Time Management, Basic Tips to Maintain Time.	Enhance productivity and stress management through effective time allocation and planning. It helps to understand the importance of time management in achieving personal and professional goals.
	Activity: Problem solving activity: A situation will be given to the students and they will have to tell us how to handle the situation or solve the problem.	

Text books:

T1: Wren, P.C and MartinH. 1995. High School English Grammar and Composition, S Chand Publishing.
T2: English Grammar in Use, Raymond Murphy 4th edition, CUP.

T3: Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.

Reference books:

R1; English Vocabulary in Use (Advanced), Michael McCarthy and Felicity, CUP.

R2: Effective Communication and Soft Skills, Nitin Bhatnagar, Pearsons.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Analyse and identify the different types of sentences.	**1, 5**
2	Able to integrate the skills of reading and speaking in professional communication.	**1, 5, 9**
3	Illustrate code Etiquette sessions will boost their confidence and morals.	**5, 6, 9**
4	Describe about the effective and efficient utilization of time.	**5, 9**
5	Explain the concept of Phonetics and its importance will improve the learners 'pronunciation	**1, 5, 9**

SEMESTER - II									
Course Title	**Immunology**								
Course code	**24MSMB121R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course objectives	1. To make students understand the Immune system and its components, immune response, antigen, antibody, immunity, Hypersensitivity, Autoimmunity etc. 2. To make students learn various immunological concepts. 3. To make skilled students in diagnostic techniques.								
CO1	Describe the immune system and its components and their mode of action in defense mechanisms.								
CO2	Outline antigen and antibody structure, types, and properties including the processes of monoclonal and polyclonal antibody production								
CO3	Apply the knowledge of different immunological diagnostics tests, their principle, and interpretations aiding in the detection of the underlying cause of the diseases.								
CO4	Interpret transplantation and cancer immunology findings and their role in research.								
CO5	Discuss immunological disorders like autoimmunity and hypersensitivity, their prevention strategies, and management								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Introduction to immunology** – Definition, history, scope of immunology. Overview of the immune system-cells and organs of the immune system. Immune response- Humoral and cell mediated immune response. Immunity- types of immunity- Innate and acquired immunity, APC.	**7**	Knowledge of Immune system, Immunity, immune response	**1,2**
II	**Antigens** – General features, haptens, adjuvants, epitopes. Antibody – Structure, types, antibody mediated effector functions – opsonisation, antibody activated complement, ADCC, isotypes, allotypes, idiotypes, **Antibody production and purification** – production of monoclonal antibodies, immunotoxins, abzymes, extraction of antibodies. Expression of immunoglobulin genes- antibody diversity, class switching of Immunoglobulins	**10**	Knowledge on antigens and their properties and antibodies and their types along with their production and purification process	**1,2**
III	**Antigen-antibody interaction** – principle and application – RIA, ELISA, Western blotting, Immunofluorescence, Complement system – classical and alternative pathway, functions	**10**	Theoretical and practical knowledge on principle and process of different immunological diagnostic tests	**1,2**
IV	**HLA** – Theories of antibody formation, HLA typing, MHC, T cell receptors, Transplantation immunology – Graft rejection, immune suppressive therapy, immune tolerance, clinical transplantation Immune effectors – Cytokines, IL and functions, cell mediated cytotoxicity, NK cells, TNF, Interferons, Inflammation, leukocyte activation, and migration	**8**	Knowledge on transplantation immunology and immune effectors.	**1,2**

V	Hypersensitivity and types, Autoimmunity, Cancer and immune system – tumour antigen, tumour evasion and immunotherapy of cancer, AIDS – primary and secondary immunodeficiency. Vaccines and its types	**10**	Knowledge on Hypersensitivity, Autoimmunity, cancer immunology, immunodeficiency and vaccines	**1,2**
Practical	Precipitation Reaction: i. Double Diffusion Reaction ii. Single Diffusion Reaction iii. Ouchterlony immunodiffusion iv. Immunoelectrodiffusion Agglutination Reaction: (Qualitative and quantitative) WIDAL, ASO, VDRL, RPR, CRP Blood grouping and Rh typing, ELISA	**30**	Able to operate ELISA, RIA	**1,2, 3,4**

Text books

T1. Punt et al. Kuby Immunology 18th Edition. W H Freeman &Co (Sd); 2018.

Reference books

R1. Abbas.Cellular and Molecular Immunology.10th edition.Elsevier; 2021.

R2. Martin et al. Roitt's Essential Immunology (Essentials).13th edition.Wiley-Blackwell, 2017.

R3. Westwood.Practical Immunology.4th edition.Wiley-Blackwell; 2002.

Other learning resources:

https://pubmed.ncbi.nlm.nih.gov/28830733/

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the immune system and its components and their mode of action in defense mechanisms.	**1, 2**
2	Outline antigen and antibody structure, types, and properties including the processes of monoclonal and polyclonal antibody production	**1, 4**
3	Apply the knowledge of different immunological diagnostics tests, their principle, and interpretations aiding in the detection of the underlying cause of the diseases.	**1, 4**
4	Interpret transplantation and cancer immunology findings and their role in research.	**1, 4**
5	Discuss immunological disorders like autoimmunity and hypersensitivity, their prevention strategies, and management.	**1, 2, 3**

SEMESTER - II									
Course Title	**MOLECULAR BIOLOGY,GENOMICS AND GENETIC ENGINEERING**								
Course code	**24MSBT122R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course objectives	1. To teach in depth about genome and its arrangement in eukaryotes and microbes. 2. To teach the central dogma of life (replication, transcription, translation and post transcriptional modifications) with the best possible teaching tools (explanation/power point presentation/seminar/assignment) and with utmost attention. 3. Important topics like mutation, DNA damage and repair are explained.								
CO1	Explain the fundamental of genomics concepts such as genome, DNA structure, RNA, proteins and the central dogma.								
CO2	Explain the methods for mapping genomes, describe markers, linkage analysis with different types of organisms, physical mapping, and basics of genome sequencing, shotgun sequencing.								
CO3	Compare prokaryotic and eukaryotic genomes, including the presence of extra chromosomal DNA and examine the vital function of DNA binding proteins in gene expression and regulation.								
CO4	Illustrate the dynamics of genome access, encompassing aspects such as euchromatin, heterochromatin, chromosome painting, nucleosome modifications, histone acetylation, DNA modifications, DNA methylation-induced gene silencing, and gene regulation in both prokaryotes and eukaryotes.								
CO5	Discuss the mutation causes, types of DNA mutation and DNA repair mechanisms, crucial for maintaining genetic stability and impacting human health.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Introduction to genomics, definitions of genome, DNA structure and composition, RNA and the transcriptome, proteins and the proteome, the central dogma	7	Introductory knowledge and refreshing the existing understanding	1,2
II	Mapping of genomes, markers for genetic mapping, the basis to genetic mapping, linkage analysis with different types of organisms, physical mapping, basics of genome sequencing, shotgun sequencing	10	Sequencing techniques in detail followed by linkage mapping	1,2
III	Genomes of prokaryotes and eukaryotes, extra chromosomal DNA, role of DNA binding proteins in genome expression: methods for studying DNA binding proteins and their attachment sites, special features of DNA binding proteins, interaction between DNA and its binding proteins	10	Knowledge on DNA replication in prokaryotes and eukaryotes with special emphasis on the proteins and enzymes involved .	1,2
IV	Accessing the genome: euchromatin and heterochromatin, chromosome painting, nucleosome modifications and genome expression, histone modification, acetylation, DNA modifications and genome expression, gene silencing by DNA methylation, gene regulation in prokaryotes and eukaryotes	8	Genome organisation is discussed in detail with various post translational events along with regulatory mechanisms	1,2
V	Introduction to genetic engineering, Different DNA manipulating enzymes, methods for isolating DNA, vectors for bacteria, plant and animals, expression vectors, DNA libraries, application of genetic engineering.	10	By the end of this course, students will understand genetic engineering techniques, use vectors, evaluate expression vectors, and propose innovative applications.	1,2

Practical	Isolation of genomic DNA., Isolation of plasmid DNA, Polymerase chain reaction, Endonuclease digestion of DNA and analysis of DNA fragments by agarose electrophoresis.	30	Knowledge on extraction of DNA and plasmid from biological samples followed by their in vitro amplification and studying RFLP profile	1,2, 3,4

Text books

T1. Watson et al. The Molecular Biology of the Gene.7th edition.Pearson Publication; 2013.

Reference books

R1. Alberts et al. The Molecular Biology of the Cell.7th Edition. WW Norton & Co, 2022.

R2. Rastogi.Cell and Molecular Biology.4th edition.New Age International Private Limited; 2020.

R3. Som. Practical Manual of Molecular Biology.1st edition.KAAV Publications, 2018.

Other learning resources:

https://pubmed.ncbi.nlm.nih.gov/28830733/

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the fundamental of genomics concepts such as genome, DNA structure, RNA, proteins and the central dogma.	**1, 9**
2	Explain the methods for mapping genomes, describe markers, linkage analysis with different types of organisms, physical mapping, and basics of genome sequencing, shotgun sequencing.	**1, 4**
3	Compare prokaryotic and eukaryotic genomes, including the presence of extra chromosomal DNA and examine the vital function of DNA binding proteins in gene expression and regulation.	**1, 2**
4	Illustrate the dynamics of genome access, encompassing aspects such as euchromatin, heterochromatin, chromosome painting, nucleosome modifications, histone acetylation, DNA modifications, DNA methylation-induced gene silencing, and gene regulation in both prokaryotes and eukaryotes.	**1, 4**
5	Discuss thegenetic engineering techniques, including DNA manipulation, vector use, and DNA libraries, and explore their applications.	**1, 2, 7**

SEMESTER - II									
Course Title	**Bioinformatics**								
Course code	**24MSBT123R**	**Total credits: 3** **Total hours: 30T+30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			2	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course objectives	1. To search and retrieve biological information from different biological databases. 2. Knowledge on computational database management system and its application in Biology 3. A basic idea on the structural biology using computer.								
CO1	A basic concept on Bioinformatics and its significance in the field of biological data analysis								
CO2	Knowledge on database management system and its application in Biology								
CO3	A good knowledge on sequence submission tools as well as biological search engines								
CO4	Knowledge on sequence alignment and analysis.								
CO5	Learn the concept of computer aided drug designing								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Introduction to Bioinformatics, Scope and Applications of Bioinformatics, Introduction to various molecular data and databases, Importance of Computers/IT in the field of Biology. Flatfileformats. Biological Database and its Types - General Introduction of Biological Databases: Nucleotide sequence databases (NCBI, DDBJ, and EMBL). Protein sequence databases (SWISS-PROT, PIR, GenPept), Specialized Genome databases: (SGD, TIGR etc). Structure databases (CATH, SCOP, and PDB, NDB, MMDB)	7	Knowledge on bioinformatics and its relation with molecular biology and its application.	1,2
II	Database Management System: Basic Concept of DBMS, Concepts of Entities, Attribute, Keys, Relationship. Three level architecture of a DBMS, Structure of a DBMS, Advantages & Disadvantages of a DBMS.File Based System, Traditional System, DBMS types Hierarchical, Network, Relational Data Model etc	6	Formation of a database and its application in biology	1,2
III	Bioinformatics Database search engines: Text-based search engines (Entrez, DBGET /Link DB). Sequence similarity-based search engines (BLAST and FASTA). Motif-based search engines (ScanProsite and eMOTIF). Structure similarity-based search engines (Combinatorial Extension, VAST and DALI). Proteomics tools: - ExPASy server, EMBOSS.	7	Knowledge on different bioinformatics search engines and their applications in retrieving data	1,2
IV	Pairwise sequence alignments: Sequence similarity, identity, and homology. Global and local alignment, BLAST and PSI-Blast, Application of Blast tool, Multiple sequence alignments and Application of multiple sequence alignment.	5	A good knowledge on sequence alignment and its application	1,2
V	Computer assisted drug design- concept, methods and practical approaches, various computational methods applied to design the drugs, CADD software demonstration. Protein homology modeling	5	A brief knowledge on drug designing through computer as well as protein 3D modelling	1,2
Practical	Data retrieval from different biological database	30	Knowledge on	1,2,3,4

	Sequence alignment through BLAST Protein homology modeling Phylogenetic Analysis through MEGA software Demonstration of Drug designing		different biological databases and sequence alignment tool.	

Text books

T1. Harisha S. Fundamental of Bioinformatics.3rd edition.Dreamtech Press, 2019.

Reference books

R1. Sharma T. R. Genome Analysis and Bioinformatics: A Practical Approach (English) (Paperback). 1st edition.Dreamtech Press; 2019.

R2. Orengo C.A. et al. Bioinformatics: Genes, proteins and computers. 1st edition.Taylor & Francis, 2002.

R3. Kangueane P., Mathura V. Bioinformatics: A Concept-Based Introduction. 1st edition.Springer-Verlag New York Inc. 2009.

Other learning resources:

https://pubmed.ncbi.nlm.nih.gov/28830733/

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	A basic concept on Bioinformatics and its significance in the field of biological data analysis	**1, 4, 9**
2	Knowledge on database management system and its application in Biology	**1, 4, 5**
3	A good knowledge on sequence submission tools as well as biological search engines	**1, 4, 5**
4	Knowledge on sequence alignment and analysis.	**1, 4**
5	Learn the concept of computer aided drug designing	**1, 3, 4**

SEMESTER - II									
Course Title	**Concepts of Organic Cultivation (Generic Elective)**								
Course code	**24MSBT124R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Offered by Program of Biotechnology for students of other Faculty of Studies**								
Semester	**Fall/Spring/II, IV(UG)/II, III (PG) Semesters other than Faculty of Science**								
Course objectives	1. Introduction to Concept of Organic cultivation 2. To discuss the Organic Farming System (OFS), its importance and benefits. 3. To discuss the methods associated with organic farming – mulching, crop rotation, tillage, bio-fertilizer etc.								
CO1	Explain the OF, its principles and benefits for health and society.								
CO2	Discuss the relation between OF and natural processes such as nutrient cycles.								
CO3	Explain cultural, mechanical, and biological methods for crop protection and manage organic production for various crops.								
CO4	Illustrate crop protection strategies, including biopesticides and organic methods for key crops, and understand yolk functions.								
CO5	Discuss the soil less farming system.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Introduction** to Organic Farming (OF); Development of OF; Principles and Types of OF; Biodynamic Farming; Need and Benefits of OF; Conventional Farming (CF) Vs (OF); Scope of OF.	7	Understand organic farming, its types, principles, benefits and scope.	1,2
II	**OF System**; Soil and Soil tillage, Choice of crop/ varieties, Propagation – Seed , planting material and seed treatments, Crop rotation, Intercropping, Water Management, Green Manuring, Mulching, Composting, Vermicomposting, Organic Manure, Biofertilizer	8	Describe illustrate and explain the organic farming system	1,2
III	**Crop Protection:** Cultural and Mechanical method; Biopesticides and Botanical Pesticides, Bio-control agents, Weed Management	5	Describe and explain the various ways for protecting plants	1,2
IV	**Organic crop production** of Rice, Zinzer, Turmeric, Banana and Vegetables Yolk-its function and significances	5	Describe and explain the organic production of crop plants	1,2
V	**Concept on modern organic farming methods** – Hydroponics, Aquaponics, Hydroponics	5	Describe and explain the modern methods of agriculture	1,2

Text books

T1. J. M. Fortier. The Market Gardener – A successful Grower's Handbook for Small- Scale OF. 1st edition.New Society Publishers, 2014.

Reference books

R1. A. L. Hansen. Organic Farming Manual: A Comprehensive Guide To Starting And Running A Certified Organic Farm. 1st edition.Storey Publishing LLC, 2010.

R2. C. SarathChandran et al. Organic Farming: New Advances Towards Sustainable Agriculture Systems, 1st edition, Springer; 2019.

R3. D. Nandwani (eds). Organic Farming for Sustainable Agriculture.1st edition, Springer; 2016.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the OF, its principles and benefits for health and society.	**1, 2, 3, 4**
2	Discuss the relation between OF and natural processes such as nutrient cycles.	**2, 7**
3	Explain cultural, mechanical, and biological methods for crop protection and manage organic production for various crops.	**3, 4, 7**
4	Illustrate crop protection strategies, including biopesticides and organic methods for key crops, and understand yolk functions.	**3, 4, 7**
5	Discuss the soil less farming system	**3, 5**

SEMESTER - II									
Course Title	**Techno Professional Skills - I**								
Course code	**24MSBT125R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Biotechnology**								
Semester	**Spring/II semester of first year of the programme**								
Course objectives	1. To develop proficiency in different techniques involving microbiology, cell biology. 2. To enable students to interpret morphologies of microorganisms and chromosomes. 3. To make skilled students in microbiological and molecular biology experiments.								
CO1	Explain polytene chromosomes in Drosophila for chromosomal analysis.								
CO2	Discuss meiosis in grasshopper testis or onion buds to understand cell division.								
CO3	Perform various staining techniques for microbial analysis.								
CO4	Apply IMVIC tests for bacterial differentiation.								
CO5	Prepare buffers, conduct agarose gel electrophoresis, and use streaking methods for microbial culture.								

Unit-No.	Content	CH	Learning Outcome	KL
I	1. Study of polytene chromosome in Drosophila. 2. Study of meiosis in grasshopper testis/ onion flower bud 3. Staining techniques: • Capsule stain • Spore stain • Acid fast stain • Negative staining 4. IMVIC test 5. Different Streaking methods for pure culture preparation 6. Isolation of fungi and their characterization from different sources 7. Preparation of different buffer system 8. Agarose gel electrophoresis	30	Understand the cellular organization and functions	1,2, 3,4

Text books

T1. Aneja.Experiments in microbiology, brand petrology, tissue culture, and microbial biotechnology.6th Edition, New Age international publication; 2022.

Reference books

R1. Brown. Benson's Microbiological Applications Laboratory Manual in General Microbiology. 10th edition.McGraw-Hill Education, 2006.
R2. Atlas.Handbook of Microbiological Media, 4th edition. ASM press, 2010.
R3. Mishra et al. Cell Biology.12th Edition.Mahaveer Publications, 2020.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1.	Explain polytene chromosomes in Drosophila for chromosomal analysis.	**1, 2, 4**
2.	Discuss meiosis in grasshopper testis or onion buds to understand cell division.	**1, 2, 3**
3.	Perform various staining techniques for microbial analysis.	**1, 5**
4.	Apply IMVIC tests for bacterial differentiation.	**1, 2, 5**
5.	Prepare buffers, conduct agarose gel electrophoresis, and use streaking methods for microbial culture.	**1, 2, 5**

SEMESTER - II									
Course Title	**MINI RESEARCH (REVIEW OF LITERATURE-R2)**								
Course code	**24MSBT127R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**0**	**4**	**6**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course objectives	To develop students scientific writing skill								
CO1	Employ databases and library resources to gather original research, books, and articles effectively								
CO2	Summarize and differentiate between various types of reviews, specifically analytical and descriptive reviews.								
CO3	Identify research topics and employ appropriate methods for collecting and filtering information.								
CO4	Critically analyze the demonstrations and findings of previous authors to comprehend their contributions and insights.								
CO5	Compose a detailed review that explains the prospects and future directions of the chosen study.								

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Employ databases and library resources to gather original research, books, and articles effectively	1, 2, 3, 4
2	Summarize and differentiate between various types of reviews, specifically analytical and descriptive reviews.	1, 2, 3, 4
3	Identify research topics and employ appropriate methods for collecting and filtering information.	1, 2, 3, 4
4	Critically analyze the demonstrations and findings of previous authors to comprehend their contributions and insights.	1, 2, 3, 4
5	Compose a detailed review that explains the prospects and future directions of the chosen study.	1, 2, 3, 4,6

SEMESTER - II									
Course Title	**Research Methodology and Statistical Analysis**								
Course code	**24UMRM121R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours:15T+60S	**1**	**0**	**0**	**4**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
programme	**Master of Science in Biotechnology**								
Semester	**Spring/II semester of First year of the programme**								
Course objectives	1. The course aims to enhances the students' a broad understanding of research methodology, includingtheoryofscienceandqualitativeandquantitativemethodsinresearch. 2. The course seeks to enhance the students' skills for developing critical thinking through research literature review in different domain. Consequently, it aims to develop skills for preparation of a research proposal for a master' thesis project/Mini research. 3. To develop Students competency in planning, conducting, evaluating and presenting a research project.								
CO1	Students will have basic knowledge of Research methods.								
CO2	Students will gain the knowledge of Research Methodology.								
CO3	Students will be able to gain the Skill questionnaire development.								
CO4	Students will be able to acquire the knowledge of basic Report/dissertation Procedure.								
CO5	Knowledge on different IPR rights								

Unit no	**Content**	**CH**	**Learning Outcome**	**KL**
I	Research Methodology- An Introduction-meaning and objectives of research, motivation in research, types and significance of research, criteria of good research. Defining the Research Problems- definition of research problem, necessity of defining research problem	2	Knowledge on fundamental concepts of research methodology, including the meaning and objectives of research	1,2
II	Research Design- meaning and need of research design, features of a good design, different research designs, Sampling Design- steps in sampling design, Sample Size determination, criteria for selecting a sampling design, different types of sampling design, Experimental Design, Principles of Design of Experiment, One – way ANOVA, Two- Way ANOVA, CRD, RBD, LSD, 22, 23 Factorial Design	4	Able to understand and apply the fundamental principles of research design, including the meaning and necessity of research design	1,2
III	Types of data, sources of data collection, tools of data collection, Nominal, ordinal, interval and ratio – Attitude scale construction and measurement, rating scales, semantic differential (SD), Use of scale in statistical analysis, Schedules for interviews preparation and standardization, development of survey instruments and item analysis for the questionnaire	3	A good knowledge on different types of data and identify various sources and tools for data collection	1,2
IV	Planning and organizing research report, Format of research report, Different steps of writing report, lay out of the research report, How to organize thesis/Dissertation, mechanics of writing research report, standard methods of	3	Able to organize and write a comprehensive research report	1,2

	quoting- presenting the result, written and oral reports, Uses of abstract, format of research report, presentation of statistics - tabular and graphic references and uses of references, Bibliography and presentation of bibliography			
V	Intellectual property right (IPR), Introduction and the need for IPR, IPR in India and worldwide, Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications, Patentable and non-patentable, patenting life, Filing of a patent application, The different layers of the international patent system, Case studies on Basmati rice, Turmeric, and Neem patents	3	Knowledge on importance of Intellectual Property Rights (IPR) both in India and globally	1,2
Practical	Laboratory using R Software: 1 Analysis of One-way ANOVA; 2 Analysis of Two-way ANOVA; 3 Analysis of CRD 4 Analysis of RBD 5 Analysis of 22 and 23 Factorial Experiment 6 Simulation-I using R (Bernoulli, Binomial, Poisson and Geometric distribution.). 7 Simulation-II using R (Exponential and Normal distribution). 8 Simple random Sampling 9 Stratified Random Sampling	60	Knowledge on various statistical experiments and simulations using R	1,2,3,4

Text books

T1: Methods in Biostatistics by K S Negi, ISBN:9789374735053,4th Edition, Year:2023, AITBS Publishers, INDIA

Reference books

R1. Johnson & Christensen. (2004). Educational Research: Quantitative, qualitative and mixes approaches, 2nd Ed. Boston: Allyn& Bacon.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will have basic knowledge of Research methods.	**2, 4, 9**
2	Students will gain the knowledge of Research Methodology.	**2, 4, 9**
3	Students will be able to gain the Skill questionnaire development.	**2, 4, 5**
4	Students will be able to acquire the knowledge of basic Report/dissertation Procedure.	**4, 5**
5	Knowledge on different IPR rights	**6, 7**

SEMESTER - II									
Course Title	**UNIVERSAL HUMAN VALUES (UHV) + PROFESSIONAL ETHICS**								
Course code	**24UUHV101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours:15T+30P	**1**	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Biotechnology**								
Semester	**Winter/II semester of First year of the programme**								
Course objectives	1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings 2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of Existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way 3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature								
CO1	The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.								
CO2	It is free from any dogma or value prescriptions.								
CO3	It is a process of self-investigation and self-exploration, and not of giving sermons.								
CO4	Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation.								
CO5	This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self-evolution.								
Unit	**Content**								
I	• Understanding the need, basic guidelines, content and process for Value Education • Self-Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration • Continuous Happiness and Prosperity- A look at basic Human Aspirations • Right understanding, Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority • Understanding Happiness and Prosperity correctly- A critical appraisal of the currentscenario • Method to fulfil the above human aspirations: understanding and living in harmony at various levels.								
II	• Understandinghumanbeingasaco-existenceofthesentient'I'andthematerial'Body' • Understanding the needs of Self ('I') and 'Body' - *Sukh*and*Suvidha* • Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) • Understanding the characteristics and activities of 'I' and harmony in'I' • Understanding the harmony of I with the Body: *Sanyam*and *Swasthya*; correctappraisal of Physical needs, meaning of Prosperity in detail • Programs to ensure *Sanyam*and *Swasthya*-Practice Exercises and Case Studies will be taken up in PracticeSessions.								
III	Understanding Harmony in the family – the basic unit of human interaction Understanding values in human-human relationship; meaning of Nyaya and programfor its fulfilment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship Understanding the meaning of Vishwas; Difference between intention and competence Understanding the meaning of Samman, Difference Between respect and differentiation; the other salient values in relationship Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals								

	Visualizing a universal harmonious order in society- Undivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha)- from family to world family! -Practice Exercises and Case Studies will be taken up in Practice Sessions.
IV	• Understanding the harmony in theNature • Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation innature • Understanding Existence as Co-existence (*Sah-astitva*) of mutually interacting unitsin all-pervasive space • Holistic perception of harmony at all levels of existence-Practice Exercises and Case Studies will be taken up in PracticeSessions.
V	• Natural acceptance of human values • Definitiveness of Ethical Human Conduct • Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order • Competence in professional ethics: ➢ Ability to utilize the professional competence for augmenting universal human order ➢ Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, ➢ Ability to identify and develop appropriate technologies and management patterns for above production systems. • Case studies of typical holistic technologies, management models and production systems • Strategy for transition from the present state to Universal HumanOrder: ➢ At the level of individual: as socially and ecologically responsible engineers, technologists and managers ➢ At the level of society: as mutually enriching institutions and organizations
Guidelines and Content for Practice Sessions	UNIT 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education PS 1: Introduce yourself in detail. What are the goals in your life? How do you set your goals in your life? How do you differentiate between right and wrong? What have been your achievements and shortcomings in your life? Observe and analyze them. Expected outcome: the students start exploring themselves; get comfortable to each other and to the teacher and start finding the need and relevance for the course. PS 2: Now-a-days, there is a lot of voice about many techno-genic maladies such as energy and natural resource depletion, environmental pollution, global warming, ozone depletion, deforestation, soil degradation, etc. – all these seem to be man-made problems threatening the survival of life on Earth – What is the root cause of these maladies & what is the way out in your opinion? On the other hand, there is rapidly growing danger because of nuclear proliferation, arms race, terrorism, criminalization of politics, large scale corruption, scams, breakdown of relationships, generation gap, depression & suicidal attempts, etc – what do you think, is the root cause of these threats to human happiness and peace – what could be the way out in your opinion? Expected outcome: the students start finding that technical education without study of human values can generate more problems than solutions. They also start feeling that lack of understanding of human values is the root cause of all problems and the sustained solution could emerge only through understanding of human values and value based living. Any solution brought out through fear, temptation or dogma will not be sustainable. PS 3: 1. Observe that each one of us has Natural Acceptance, based on which one can verify right or not right for him. Verify this in case of i) What is Naturally Acceptable to you in relationship- Feeling of respect or disrespect? ii) What is Naturally Acceptable to you – to nurture or to exploit others? Is your living the same as your natural acceptance or different? 2. Out of the three basic requirements for fulfilment of your aspirations- right understanding, relationship and physical facilities, observe how the problems in your family are related to each. Also observe how much time & effort you devote for each in your daily routine.

	Expected outcome: 1. The students are able to see that verification on the basis of natural acceptance and experiential validation through living is the only way to verify right or wrong, and referring to any external source like text or instrument or any other person cannot enable them to verify with authenticity; it will only develop assumptions. 2. The students are able to see that their practice in living is not in harmony with their natural acceptance most of the time, and all they need to do is to refer to their natural acceptance to remove this disharmony. 3. The students are able to see that lack of right understanding leading to lack of relationship is the major cause of problems in their family and not the lack of physical facilities in most of the cases, while they have given higher priority to earning of physical facilities in their life ignoring relationships and not being aware that right understanding is the most important requirement for any human being. UNIT 2: Understanding Harmony in the Human Being - Harmony in Myself! PS 4: List down all your desires. Observe whether the desire is related to Self (I) or Body. If it appears to be related to both, see which part of it is related to Self (I) and which part is related to Body. Expected outcome: the students are able to see that they can enlist their desires and the desires are not vague. Also they are able to relate their desires to 'I' and 'Body' distinctly. If any desire appears related to both, they are able to see that the feeling is related to I while the physical facility is related to the body. They are also able to see that 'I' and 'Body' are two realities, and most of their desires are related to 'I' and not body, while their efforts are mostly centered on the fulfilment of the needs of the body assuming that it will meet the needs of 'I' too. PS 5: 1. a. Observe that any physical facility you use, follows the given sequence with time : Necessary & tasteful→ unnecessary & tasteful → unnecessary & tasteless →intolerable b. In contrast, observe that any feeling in you is either naturally acceptable or not acceptable at all. If naturally acceptable, you want it continuously and if not acceptable, you do not want it any moment! 2. List down all your activities. Observe whether the activity is of 'I' or of Body or with the participation of both 'I' and Body. 3. Observe the activities within 'I'. Identify the object of your attention for different moments (over a period of say 5 to 10 minutes) and draw a line diagram connecting these points. Try to observe the link between any two nodes. **Expected outcome:** 1. The students are able to see that all physical facilities they use are required for a limited time in a limited quantity. Also they are able to see that in case of feelings, they want continuity of the naturally acceptable feelings and they do not want feelings which are not naturally acceptable even for a single moment. 2. the students are able to see that activities like understanding, desire, thought and selection are the activities of 'I' only, the activities like breathing, palpitation of different parts of the body are fully the activities of the body with the acceptance of 'I' while the activities they do with their sense organs like hearing through ears, seeing through eyes, sensing through touch, tasting through tongue and smelling through nose or the activities they do with their work organs like hands, legs etc. are such activities that require the participation of both 'I' and body. 3. The students become aware of their activities of 'I' and start finding their focus of attention at different moments. Also they are able to see that most of their desires are coming from outside (through preconditioning or sensation) and are not based on their natural acceptance. PS 6: 1. Chalk out programs to ensure that you are responsible to your body- for the nurturing, protection and right utilisation of the body. 2. Find out the plants and shrubs growing in and around your campus. Find out their use

	for curing different diseases. Expected outcome: The students are able to list down activities related to proper upkeep of the body and practice them in their daily routine. They are also able to appreciate the plants wildly growing in and around the campus which can be beneficial in curing different diseases. UNIT 3: Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship PS 7: Form small groups in the class and in that group initiate dialogue and ask the eight questions related to trust. The eight questions are: 1a. Do I want to make myself happy? 2a. Do I want to make the other happy? 3a. Does the other want to make him happy? 4a. Does the other want to make me happy? What is the answer? Intention (Natural Acceptance) 1b. Am I able to make myself always happy? 2b. Am I able to make the other always happy? 3b. Is the other able to make him always happy? 4b. Is the other able to make me always happy? What is the answer? Competence Let each student answer the questions for himself and everyone else. Discuss the difference between intention and competence. Observe whether you evaluate your intention& competence as well as the others' intention & competence. Expected outcome: The students are able to see that the first four questions are related to our Natural Acceptance i.e. Intention and the next four to our Competence. They are able to note that the intention is always correct, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention as a result we conclude that I am a good person and other is a bad person. PS 8: 1. Observe on how many occasions you are respecting your related ones (by doing the right evaluation) and on how many occasions you are disrespecting by way of under- evaluation, over-evaluation or otherwise evaluation. 2. Also observe whether your feeling of respect is based on treating the other asyourself or on differentiations based on body, physical facilities or beliefs. Expected outcome: The students are able to see that respect is right evaluation, and only right evaluation leads to fulfilment in relationship. Many present problems in the society are an outcome of differentiation (lack of understanding of respect), like gender biasness, generation gap, caste conflicts, class struggle, dominations through power play, communal violence, clash of isms, and so on so forth. All these problems can be solved by realizing that the other is like me as he has the same natural acceptance, potential and program to ensure a happy and prosperous life for him and for others though he may have different body, physical facilities or beliefs. PS 9: 1. Write a note in the form of story, poem, skit, essay, narration, dialogue to educate a child. Evaluate it in a group. 2. Develop three chapters to introduce 'social science- its need, scope and content' in the primary education of children Expected outcome: The students are able to use their creativity for educating children. The students are able to see that they can play a role in providing value education for children. They are able to put in simple words the issues that are essential to understand for children and comprehensible to them. The students are able to develop an outline of holistic model for social science and compare it with the existing model. UNIT 4: Understanding Harmony in the Nature and Existence - Whole existence as Co-existence PS 10: List down units (things) around you. Classify them in four orders. Observe and explain the mutual fulfilment of each unit with other orders. Expected outcome: The students are able to differentiate between the characteristics and activities of different orders and study the mutual fulfilment among them. They are alsoable to

	see that human beings are not fulfilling to other orders today and need to take appropriate steps to ensure right participation(in terms of nurturing, protection and right utilization) in the nature. PS 11: 1.Make a chart for the whole existence. List down different courses of studies andrelate them to different units or levels in the existence. 2.Choose any one subject being taught today. Evaluate it and suggest suitablemodifications to make it appropriate and holistic. Expected outcome: The students feel confident that they can understand the whole existence; nothing is a mystery in this existence. They are also able to see the interconnectedness in the nature, and point out how different courses of study relate to the different units and levels. Also they are able to make out how these courses can be made appropriate and holistic. UNIT 5: Implications of the above Holistic Understanding of Harmony at all Levels ofExistence PS 12: Choose any two current problems of different kind in the society and suggest how they can be solved on the basis of natural acceptance of human values. Suggest steps you will take in present conditions. Expected outcome: The students are able to present sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them. PS 13: 1.Suggest ways in which you can use your knowledge of Technology/Engineering/Management for universal human order, from your family to the world family. 2.Suggest one format of humanistic constitution at the level of nation from your side. Expected outcome: The students are able to grasp the right utilization of their knowledgein their streams of Technology/Engineering/ Management to ensure mutually enriching and recyclable productions systems. PS 14: The course is going to be over now. Evaluate your state before and after the coursein terms of a. Thoughtb. Behaviour andc. Workd. Realization Do you have any plan to participate in the transition of the society after graduating from theinstitute? Write a brief note on it. Expected outcome: The students are able to sincerely evaluate the course and share with their friends. They are also able to suggest measures to make the course more effectiveand relevant. They are also able to make use of their understanding in the course for a happy and prosperous society.

Text book

1. R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values an professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2

Reference

R1:B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
R2: PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
R3: Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986,1991

Other Learning Resources

1. Value Education websites, http://uhv.ac.in, http://www.uptu.ac.in
2. Story of Stuff, http://www.storyofstuff.com
3. Al Gore, An Inconvenient Truth, Paramount Classics, USA
4. Charlie Chaplin, Modern Times, United Artists, USA
5. IIT Delhi, Modern Technology – the Untold Story

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.	**1, 2, 3, 4, 7**
2	It is free from any dogma or value prescriptions.	**1, 3, 4**
3	It is a process of self-investigation and self-exploration, and not of giving sermons.	**1, 2, 3**
4	Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation.	**1, 3, 5**
5	This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self-evolution.	**3, 8**

SEMESTER - II									
Course Title	**COMMUNICATION MASTERY (Communicative English & Soft Skills)**								
Course code	**24UMPD121R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Effective English**	**Co-requisite**	**Nil**						
programme	**Master of Science in Biotechnology**								
Semester	**Spring/II semester of First year of the programme**								
Course objectives	1. To familiarize students with the transformation of sentences and the appropriate use of prepositions. 2. To enhance the writing skills in different areas including CV and cover letter writing. 3. To convey meaning by reinforcing, substituting foror contradictingverbal communication. 4. Productivity and performance boosting activities for professional goal achievement.								
CO1	Explain prepositions, tag questions, and idioms correctly.								
CO2	Discuss and analyze different sentence types and voices.								
CO3	Explain effective paragraphs, precis, and professional documents.								
CO4	Describe SWOT analysis, goal setting, and personal hygiene principles.								
CO5	Illustrate non-verbal communication and body language concepts.								
Unit	**Content**								
Module 1- Grammar	I. Use of Prepositions II. Tag questions III. Idioms, Phrases and Clauses IV. Simple, complex, compound sentences								
Module 2- Grammar	I. Active and Passive Voice II. Direct and Indirect Speech								
Module 3- Writing Skills	I. The Basics of Writing; avoid ambiguity and vagueness II. Paragraph Writing III. Precis Writing IV. Letter Writing V. Resume, CV and Cover Letter								
Module 4- Self-Management Skills	I. SWOT Analysis II. Self-Regulation- Goal Setting III. Personal Hygiene								
Module 5- Non- Verbal Communication-Sciences of Body Language	I. What is Non-Verbal Communication & Body Language, II. Elements of Communication, III. Types of Body Language, IV. Importance and Impact of Body Language, V. Types of Communication through Body Language, VI. Introduction to Haptic, Introduction to Kinesics VII. Introduction to Proxemics, VIII. Body Language Do's and Don'ts, Doubt Clearing Session.								
Module 6- Group Discussion (Theory)	I. Importance, II. Planning, Elements, and Skills assessed; III. Effectively disagreeing, IV. Initiating, Summarizing and Attaining the Objective								

Text book

1. Barrett, Grant. 2016.Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.
2. McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition).

Reference books

1. Communication Skills Training: A Practical Guide to Improving Your Social Intelligence, Presentation and Social Speaking, Ian Tuhovsky,2019

2. A Textbook for AECC English Communication: Interface, Dr. KironmoyChetia and PranamiBaniaBreez Mohan Hazarika, January2019.

Other Learning Resources:

1. https://youtu.be/x60GHpQ8gJk
2. https://youtu.be/Ke_oSN-BCaY
3. https://youtu.be/TDPDtrLxT-c
4. https://www.classcentral.com/report/toefl-preparation/

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain prepositions, tag questions, and idioms correctly.	**5**
2	Discuss and analyze different sentence types and voices.	**2, 5**
3	Explain effective paragraphs, precis, and professional documents.	**3, 5**
4	Describe SWOT analysis, goal setting, and personal hygiene principles.	**5**
5	Illustrate non-verbal communication and body language concepts.	**5**

SEMESTER III									
Course Title	**Techno-Professional Skills II (Biofertilizer production)**								
Course Code	**24MSBT215R**	**Total Credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 60p	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-Requisite	**Cell Biology, Biochemistry**	**Co-Requisite**	**NA**						
Programme	**MSc. Biotechnology**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	1. Appreciate the agronomic importance of beneficial micro-organisms 2. To make students learn and formulate biofertilizers 3. Produce and apply biofertilizers in a pilot scale								
CO1	Explain the Importance of biofertilizers in plant development.								
CO2	Describe mass cultivation and inoculation.								
CO3	Explain the importance of Azolla as a biofertilizers.								
CO4	Describe the importance of phosphate in biofertilizers.								
CO5	Apply the knowledge on the use of Fungi and Mycorrhiza.								

Unit no	Content	CH	Learning outcome	KL
I	Biofertilizers– Introduction, scope. A general account of plant growth promoters and regulators – Cyanobacterial Biofertilizer: Algalization – mass cultivation of cyanobacterial biofertilizers	**10**	Importance of biofertilizers in plant development	1,2
II	Nitrogen fixing Bacteria: Isolation, characterization, identification, mass cultivation and inoculation method of Rhizobium and Azospirillum. Mechanism of nitrogen fixation (free-living and symbiotic) - Biochemistry and molecular basis of nitrogen fixation.	**10**	Knowledge about mass cultivation and inoculation.	1,2
III	Azolla – Structure and Morphology – Mass cultivation method and Application. Economic and Ecological importance of Azolla.	**10**	Importance of Azolla	1,2
IV	Phosphate solubilizing Bacteria: Isolation, characterization, identification, mass cultivation and inoculation method of Phosphobacteria. Biochemistry of Phosphate solubilization and mobilization. Carrier based inoculum production methods and Field application References	**10**	Importance of phosphate in biofertilizers	1,2
V	Mycorrhizal fungi as biofertilizers - Introduction, scope. A general account of Ecto, Endo and Arbuscular mycorrhizae (AM). Isolation and method of inoculation of Arbuscular mycorrhizae (AM), Legume - AM interactions	**10**	Importance of Fungi, Mycorrhiza	1,2

Text Books

T1: A text book of microbiology, second reprint. S. Chand and Company Ltd., New Delhi. Ann Larkin Hansen, 2010,

Reference Books

R1. Kannaiyan, S. 2002 Biotechnology of Biofertilizers. Narosa publishing house, New Delhi.Dubey, R.C. 2001.
R2. Dubey, R. C. 2008. A Textbook of Biotechnology. S. Chand & Co., New Delhi.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the Importance of biofertilizers in plant development.	**1, 2, 9**
2	Describe mass cultivation and inoculation.	**1, 2, 3**
3	Explain the importance of Azolla as a biofertilizers.	**1, 2, 9**
4	Describe the importance of phosphate in biofertilizers.	**1, 2, 9**
5	Apply the knowledge on the use of Fungi and Mycorrhiza.	**1, 9**

SEMESTER - III									
Course Title	**Research Ethics**								
Course Code	**24UMRE211R**	**Total Credits:1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours:60	**0**	**0**	**0**	**4**	**0**	**0**	**1**
Pre-Requisite	**NA**	**Co-Requisite**	**NA**						
Programme	**MSc. Biotechnology**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	1. This course aims to lay a foundation for empirical research. 2. To make students aware of relevant guidelines, policies, and codes relating to ethical research. 3. To make students learn ethical theories and concepts.								
CO1	Describe and apply research ethics theories and methods.								
CO2	Explain research ethics issues such as responsibility, vetting, and misconduct.								
CO3	Illustratearguments and results in ethical research inquiries.								
CO4	Identify and apply procedures for sampling, data collection, and reporting.								
CO5	Apply ethical principles to research design and evaluation								
Unit no	**Content**								
I	**ETHICS:** Introduction to the course and each other; an introduction to moral theory. Ethics: definition, moral philosophy, nature of moral judgements and reactions. Research regulation; self – regulation; research ethics. Honesty, candor, compromise and integrity. Data ownership and stewardship; conflicts of interest; collaboration. Human and non-human subjects. Research and researchers in society.								
II	**SCIENTIFICCONDUCT-** Ethics with respect to science and research. Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data								
III	**PUBLICATION ETHICS**- Publication ethics: definition, introduction and importance. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.								
IV	**OPEN ACCESS PUBLISHING-**Open access publications and initiatives**.** SHERPA/RoME0 online resource to check publisher copyright & self-archiving policies. Software tool to identify predatory publications developed by SPPU**.** Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.								
V	**PUBLICATION MISCONDUCT** Group Discussions; Subject specific ethical issues, FFP, authorship. Conflicts of interest. Complaints and appeals: examples and fraud from India and abroad. Software tools; Use of plagiarism software like Turnitin, Urkund and other open-source software tools. **DATABASES AND RESEARCH METRICS–**Databases: Indexing databases. Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, I 10 indexes, altimetric.								

Text Books

Bird, A(2006). Philosophy of Science. Routledge.
Macintyre, Alasdair (1967) A Short History of Ethics.London.
Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance(2019)

Reference Books

National Academy of Science, National Academy of Engineering and Institute of Medicine (2009). On Being a Scientist: A Guide of Responsible Conduct in Research: Third Edition, National academicsPress
George R, (2011). Sociological Theory, Rawat Publication, New Delhi, India.George R,(2019).Post Modern Social Theory, Rawat Publication, New Delhi, India.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe and apply research ethics theories and methods.	**6**
2	Explain research ethics issues such as responsibility, vetting, and misconduct.	**6**
3	Illustratearguments and results in ethical research inquiries.	**5, 6**
4	Identify and apply procedures for sampling, data collection, and reporting.	**2, 3, 4**
5	Apply ethical principles to research design and evaluation	**4, 9**

SEMESTER - III									
Course Title	**CORPORATE PROFICIENCY**								
Course Code	**24UMPD211R**	**Total Credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours:60	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-Requisite	**Communication Mastery**	**Co-Requisite**	**NA**						
Programmes	**MSc. Biotechnology**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	1. To acquaint students with the various tools of an effective presentation. 2. To acquire the speaking skill, instruct, influence, engage, educate, or appease the listeners. 3. To increase proficiency, present ability and quality of resume and provide guidance for self- promotion and self-evaluation in social media. 4. To prepare and train the students for the campus drives & walking interviews.								
CO1	Able to speak with greater control and charisma in front of others.								
CO3	Discuss the positive impact in their thought process and problem-solving skills.								
CO3	Illustrate with all the necessary tools and skill sets to prepare professional resume.								
CO4	Discuss the highlights and assess themselves in social media.								
CO5	Explain the impart in them techniques to solve critical problems in an interview, develop strategies to crack interviews, improve their communication skills, boost their confidence								
Unit no	**Content**								
I	**Module 1- Presentation Skills** i. Introduction ii. Essential characteristics of a good presentation iii. Preparation of a good presentation								
II	**Module 2- Public Skills** i. Fear of Public Speaking, ii. Understanding and Overcoming Fear of Public Speaking, iii. Confidence and Control, iv. Physiology and Stress - Control/Process, v. Tips for Presentations and Public Speaking, vi. Tips for Using Visual Aids in Presentations, vii. Process for Preparing and Creating Presentations, viii. Delivering Presentations Successfully, ix. Doubt Clearing and Summary of Main Points								
III	**Module 3- Practical session on Resume, Curriculum Vitae, Writing cover letter & LinkedIn Profile** i. Preparation, submission & screening of Resume. ii. Practical session on cover letter screening session iii. Creating a profile on LinkedIn iv. How to utilize it **Module 4- Leadership & Management Skills** i. Concepts of Leadership, ii. Leadership Styles, iii. Manager VS Leader, iv. How to be an Effective Leader, v. Mock/ Practice Session, vi. Doubt Clearing Session.								
IV	**Module 5- Research Paper – Writing Skills** i. How to write a research paper ii. Key point in Research Work **Module 6- Interview Skills & Dress code Ethics** i. Types of the interview- telephonic, virtual & face to face ii. Online interview, personal interview, iii. Panel interview,								

	iv. Group interview, v. JAM session, vi. Types of interview questions-traditional/common interview questions, vii. Case interview questions, viii. General Strategies for answering questions, ix. Marketing your skills and experiences, x. Preparation before the interview, xi. How to dress up for an interview, xii. How to maintain eye contact and positive body language, xiii. How to be presentable, xiv. Interview dos and don'ts, xv. Introduction to Dress Code Ethics, xvi. Purpose and Importance xvii. How to Make „FIRSTIMPRESSION" xviii. What to Wear During Interviews or Any Other Formal Meetings – Male &Female
V	**Module 7- Mock Interview** i. Practical Mock Interview, ii. Feedback- Receiving Feedback, iii. Giving Feedback, iv. Advantages of Effective Feedback, v. How to deal with negative feedback.

Text Books

T1.Barrett,Grant.2016.Perfect English Grammar: TheIndispensable Guide to Excellent Writing and Speaking, Zephyros Press.

T2.McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition).

Reference Books

Garg. Manoj Kr. (2018)English Communication: Theory and Practice

Other Learning Resources: https://brightlinkprep.com/10-best-toefl-prep-books/

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Able to speak with greater control and charisma in front of others.	**5**
2	Discuss the positive impact in their thought process and problem-solving skills.	**2**
3	Illustrate with all the necessary tools and skill sets to prepare professional resume.	**5**
4	Discuss the highlights and assess themselves in social media.	**5**
5	Explain the impart in them techniques to solve critical problems in an interview, develop strategies to crack interviews, improve their communication skills, boost their confidence	**5, 6, 8**

SEMESTER - III									
Course Title	**MINI RESEARCH (SURVEY/EXPERIMENTS-R3)**								
Course code	**24MSBT217R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**0**	**4**	**6**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course objectives	To develop students scientific method								
CO1	To design an experiment using scientific method								
CO2	Apply the knowledge of sampling methods in sample collection.								
CO3	To store and work on the sample through various parametric assays.								
CO4	To structurize data and perform statistical analyses.								
CO5	To interpret and discuss the findings.								

<table>
<tr><th colspan="10">SEMESTER - III</th></tr>
<tr><th>Course Title</th><th colspan="9">PERSONALFINANCIALPLANNING</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">24UUFL202R</th><th>TotalCredits:1</th><th>L</th><th>T</th><th>P</th><th>S</th><th>R</th><th>O/F</th><th>C</th></tr>
<tr><th>TotalHours:30p</th><td>0</td><td>0</td><td>2</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><th>Pre- Requisite</th><th>Introduction to Financial Budgeting And Planning</th><th>Co-Requisite</th><th colspan="7">NIL</th></tr>
<tr><th>Programmes</th><th colspan="9">Master of Science in Biotechnology</th></tr>
<tr><th>Semester</th><th colspan="9">Fall/ 3rd Semester of 2nd year of the program</th></tr>
<tr><th>Course Objectives</th><td colspan="9">1. The course would offer an inclusive approach to understand the relevant concepts of money, borrowing, lending, taxes and their application to financial planning.
2. Assess the personal financial planning process, the life cycle of financial plans, and methods of goal achievement.
3. Formulate a budget, record-keeping system, and tax planning strategy based on current financial goals.</td></tr>
<tr><th>CO1</th><td colspan="9">Explain the cash management and buying plan for homes or automobiles.</td></tr>
<tr><th>CO2</th><td colspan="9">Discuss a diversified investment portfolio for different objectives.</td></tr>
<tr><th>CO3</th><td colspan="9">Compare mutual funds, ETFs, and real estate investment options.</td></tr>
<tr><th>CO4</th><td colspan="9">Develop a financial plan for retirement and estate protection.</td></tr>
<tr><th>CO5</th><td colspan="9">Describe financial products and strategies for long-term goals</td></tr>
<tr><th>Unit no</th><th colspan="9">Content</th></tr>
<tr><th>I</th><td colspan="9">Unit 1- Fundamentals of Financial Planning –
i. Functions of money;
ii. Inflation- Meaning, causes, how it can be controlled;
iii. process official planning,
iv. Time value of money-simple and compound interest;
v. Net Present Value and Future value,
vi. Power of Compounding;
vii. Doubling period and Rule of 72.</td></tr>
<tr><th>II</th><td colspan="9">Unit 2- Income Tax Planning–
i. Meaning of Income,
ii. Direct & Indirect Taxes, Taxable Income, various heads of Income for tax Calculation,
iii. Non-taxable Income,
iv. Tax evasion and tax avoidance,
v. GST, Tax Planning Strategies.</td></tr>
<tr><th>III</th><td colspan="9">Unit 3- Entrepreneurial planning –
i. Meaning of Entrepreneurship, prerequisites for becoming an entrepreneur,
ii. Entrepreneurship Support Systems in India,
iii. Institutional support systems for entrepreneurs,
iv. Financial support systems for entrepreneurs;
v. Venture Capital, Business Angels,
vi. Assistant of Government,
vii. Commercial Bank Loans and Overdraft.</td></tr>
<tr><th>IV</th><td colspan="9">Unit 4-Planning for investing in securities market –
i. Investment avenues offered by Securities Markets, Primary Market and Secondary Market,
ii. Stock market- meaning, features, functions of NSE, BSE DEMAT trading account,
iii. Security repository, stock brokers, Operational aspects of securities markets: placement of orders, contract note, pay-in and pay-out, trading and settlement cycle,
iv. Various risks involved in investing in securities markets; Role of Financial Intermediaries; Stock indices.
v. Mutual Funds- meaning concept, definition, types, importance and drawbacks of mutual funds, mutual funds in India, investing in mutual funds,
vi. Systematic Investment Plan (SIP) and its advantages.</td></tr>
<tr><th>V</th><td colspan="9">Unit 5- Planning for debts and Retirement</td></tr>
</table>

	i. Consumer credit - Introduction to consumer credit; choosing a source of credit, the cost of credit alternatives, ii. Consumer Legal Protection; iii. Housing Decision: Factors and Finance; Vehicle Decisions. iv. Retirement planning - Meaning of cost of living; retirement need analysis; development of retirement plan, various retirement schemes, v. Estate Planning; Pension and Medicare Planning; Wills.

Text Books:

1. Sinha Pradeep K. and Priti Sinha. Computer Fundamentals: Concepts Systems &The Million-Dollar Financial Advisor: Powerful Lessons and Proven Strategies from Top Producers by David J. Mullen Jr

2. Personal Finance and Planning by Dr. Rajni

3. Peaceful Personal Finance: A Short Read on the Basics of Personal Finance and Planning Kindle Edition by Hema Singh

4. Be Your Own Financial Advisor: Financial Planning, Investment Options, Risk Management, Tax Management, Succession Planning Kindle Edition y Sushil Bali

5. The Dumb Things Smart People Do with Their Money: Thirteen Ways to Right Your Financial Wrongs Kindle Edition y Jill Schlesinger

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the cash management and buying plan for homes or automobiles.	**5**
2	Discuss a diversified investment portfolio for different objectives.	**9**
3	Compare mutual funds, ETFs, and real estate investment options.	**2, 5, 9**
4	Develop a financial plan for retirement and estate protection.	**9**
5	Describe financial products and strategies for long-term goals	**5**

SEMESTER - III									
Course Title	**Plant and Animal Biotechnology**								
Course Code	**24MSBT211R**	**Total Credits: 4Total Hours: 45t+30p**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**2**	**0**	**0**	**0**	**4**
Pre-Requisite	**Cell Biology, Biochemistry, Molecular Biology**	**Co-Requisite**	**NA**						
Programme	**MSc. Biotechnology**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	1. Introduction to the best use of Plant Cell Culture media as well as maintenance of aseptic condition. 2. To describe the plant cell, its characteristic organelles as well as the composition, structure and properties of the plant cell wall, and its practical possibilities 3. Introduction to the best use of Animal Cell Culture media as well as maintenance of aseptic condition. 4. Elucidation of various cell to cell interaction; adhesion, motility and metabolic co-operation.								
CO1	Explain the advanced genetic modification techniques used in both plants and animals.								
CO2	Acquire and demonstrate the skills in plant and animal tissue culture, cloning, and propagation methods.								
CO3	Describe the knowledge of biotechnology to enhance crop yield, improve resistance to pests and diseases, and optimize agricultural practices.								
CO4	Discuss the knowledge of biotechnology in medicine and healthcare, particularly in the context of animal biotechnology.								
CO5	Explain the ethical issues related to plant and animal biotechnology.								

Unit No	**Content**	**CH**	**Learning Outcome**	**KL**
I	Cell and tissue culture: Introduction to cell and Tissue Culture Laboratory facilities, Tissue culture media (composition and preparation) Callus and suspension cultures: initiation and maintenance of callus and suspension cultures; single cell clones.	10	To learn the basics of plant tissue culture	1,2
II	Tissue and micropropagation, regeneration, production of haploids, protoplast culture and somatic hybridization. Cloning in plants - Ti plasmid organization. Concept of transgenic plants Bt cotton and other plant applications.	8	To harness ideas on embryogenesis and organogenesis	1,2
III	Various techniques of animal cell and tissue culture: Culture media, growth factors, laboratory facilities. Characteristics of cells in culture: Contact inhibition, anchorage dependence, cell-cell communication etc.; Cell senescence; cell and tissue response to trophic factors. Primary culture, immortal cells, cell lines. d) Maintenance of cell lines in the laboratory.	8	To get the basic knowledge on the different techniques of animal cell culture	1,2
IV	rDNA products: Brief idea about recombinant DNA products in medicine (insulin, somatostatin, vaccines), Concept of Gene therapy, Production of recombinant vaccines – hepatitis. Concept of transgenic animals In vitro fertilization and embryo transfer in	10	To apply knowledge of DNA manipulation on the improvement of plant traits	1,2,3,4

	humans and farm animals. Transgenic animals			
V	PR proteins, nematode resistance, marker-assisted selection – strategies for introducing genes of biotic and abiotic stress resistance in plants. Ethical issues of plant and animal biotechnology	9	To learn the applications of biotechnology in the field of plant science	1,2,3,4
Practical	Establishing a plant cell culture (both in solid and liquid media) – seed germination, callus culture, suspension cell culture, regeneration from callus cells. Cell count by hemocytometer. Artificial seed.	30	To apply the practical knowledge of plant biotechnology in various fields	1,2,3,4

Text Books

1.Biotechnology by U. Satyanarayan.
2.Biotechnology; Expanding Horizon by B.D. Singh.
3.Biotechnology; S.S.Purohit

Reference Books

Ravishankar G.A. and Venkataraman L.V. (197) Biotechnology Applications of plant Tissue & culture. Oxford & IBH Publishing Co, Pvt. Ltd.
Bhan (1998) Tissue Culture, Mittal Publications, New Delhi.
Islan A.C (1996) Plant Tissue Culture, Oxford & IBH Publishing Co. Pvt. Ltd.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the advanced genetic modification techniques used in both plants and animals.	**1, 2, 3**
2	Acquire and demonstrate the skills in plant and animal tissue culture, cloning, and propagation methods.	**1, 2, 3, 4**
3	Describe the knowledge of biotechnology to enhance crop yield, improve resistance to pests and diseases, and optimize agricultural practices.	**1, 2, 3**
4	Discuss the knowledge of biotechnology in medicine and healthcare, particularly in the context of animal biotechnology.	**1, 2, 7**
5	Explain the ethical issues related to plant and animal biotechnology.	**1, 2, 7**

SEMESTER - III									
Course Title	**Medical Biotechnology**								
Course Code	**24MSBT212R**	**Total Credits: 4** **Total Hours:45T+30p**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**2**	**0**	**0**	**0**	**4**
Pre-Requisite	**Molecular biology**	**Co-Requisite**	**NA**						
Programmes	**MSc. Biotechnology**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	1. To introduce the students about human genome project, concept of gene therapy, stems cells and various diseases. 2. To study the detail about diagnosis, treatment, control measurement of various diseases. 3. To study Nano biotechnology and its application in drug delivery.								
CO1	Explain Human Genome Project and its importance in the field medical science.								
CO2	Discuss gene therapy focusing on disease-associated genes and ethical consideration contributions to this field addressing genetic diseases.								
CO3	Describe the concept of stem cells and its properties.								
CO4	Describe Cancer Biology, explores and demonstrate microbial diseases, providing insights into infection modes, control measures for a holistic view of human health.								
CO5	Illustrate the concept of nano materials, their synthesis, and applications in biosensors, drug delivery, gene therapy, and cancer therapy.								

Unit no	**Content**	**CH**	**Learning outcome**	**KL**
I	Human genome Project-Introduction, history, techniques, ethics, application.	10	To learn the basics and scopes of medical biotechnology	1,2
II	Gene therapy- Introduction, genes responsible for disease, Principle, types, gene targeted for gene therapy, SCID, Humanized antibody, plasminogen activator, ethics, importance	8	To harness ideas on recent trends in the field of medical biotechnology	1,2
III	Stem Cells: Introduction, Types of Stem Cells, Sources of Stem Cells Properties of Stem Cells	8	To get the basic knowledge of stem cell therapy	1,2
IV	Cancer Biology: Introduction, Types of Tumours, Predisposing factors for cancer, Cellular changes involved in Tumour formation, Methods of Tumour detection, Treatment of cancer – Chemotherapy and Radiotherapy. Microbial diseases in Human – mode of infection, symptoms, epidemiology and control measures	10	To learn about cancer, diagnosis and therapies related to it.	1,2,
V	Nanobiotechnology- introduction, Type of nano material, Synthesis of nano material, Nano Biosensor, Drug Delivery, Gene therapy, Drug Delivery, Cancer Therapy, Risk Potential of Nano Material. Molecular detection of presymptomatic genetic disease, its importance in health care, pre-natal diagnosis and genetic manipulation	9	To learn about the techniques for the detection of different diseases	1,2,3,4
Practical	Study of Mycobacterium tuberculosis by AFB staining method. Diagnosis of venereal disease by using VDRL test. Study of Salmonella typhi by using Widal test	30	To apply the practical knowledge of detection of different diseases	1,2,3,4

Text Books

T1: Medical Biotechnology, V. Rao p. Nallari, Oxford University Press

Reference Books

R1: Human Molecular Genetics 2nd Edition by Strachan & Read, Wiley and sons' publication.

R2: Medical Microbiology, Credic A Mims (2004) 3rd Edition, Mosgy Inc. Publication

R3: Nano biotechnology, Subbiah Balaji, Neha Publishers & Distributors

R4: Nano biotechnology: Concepts, Applications & Perspectives, Niemeyer C M, Wiley India Pvt. Ltd.-New Delhi.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain Human Genome Project and its importance in the field medical science.	**1, 2, 4, 6**
2	Discuss gene therapy focusing on disease-associated genes and ethical consideration contributions to this field addressing genetic diseases.	**1, 2, 3, 5**
3	Describe the concept of stem cells and its properties.	**1, 2**
4	Describe Cancer Biology, explores and demonstrate microbial diseases, providing insights into infection modes, control measures for a holistic view of human health.	**1, 2, 3, 4**
5	Illustrate the concept of nano materials, their synthesis, and applications in biosensors, drug delivery, gene therapy, and cancer therapy.	**1, 2, 3, 4**

SEMESTER - III									
Course Title	**Bioprocess and Fermentation Technology**								
Course Code	**24MSBT213R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-Requisite	**Biochemistry, Cell Biology, Microbiology**	**CO-REQUISITE**	**NA**						
Programme	**MSc. Biotechnology**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	1.To teach bacterial strain improvement techniques, inoculation procedures, media preparation, types and make up of bioreactors. 2. To teach the industrial production of Agar, Alcohols, Organic Acids, Amino Acids, Antibiotics, SCP, Vitamins, Enzymes. 3. To impart knowledge on upstream and downstream bioprocess technology								
CO1	Describe the historical development in Bioprocess Engineering, key inventions and discoveries and its application in different fields.								
CO2	Explain the design structure, function, and operation of bioreactors including, functional operations and specialised variation in designs of bioreactors.								
CO3	Illustrate the formulation strategies of fermentation media and different source of nutrients for fermentation media.								
CO4	Outline the techniques of downstream processing and different isolation and purification methods of biotechnological products.								
CO5	Summarize the different fermentation processes involved in fermented foods and HACCP concept and explain effective safety measures in producing fermented foods.								

Unit no	**Content**	**CH**	**Learning outcome**	**KL**
I	Introduction to BPE, History, application, Inoculum production for bacterial and fungal process, Screening selection and strain improvement	7	By the end of this module, students will understand Bioprocess Engineering (BPE), its history, applications, and techniques for inoculum production and strain improvement in microbial processes	1, 2
II	Bioreactors: Introduction, basic design, function, body construct, Temperature control, aeration, Baffles, Agitation systems Sterilization of fermentor, air supply and medium, Aseptic inoculation and sampling methods, Specialized bioreactor, Fluidized bed bioreactor, packed bed bioreactors, Photo bioreactor	10	Understand Bioprocess Engineering (BPE), its history, applications, and techniques for inoculum production and strain improvement in microbial processes.	1,2
III	Media: Fermentation media, natural and synthetic media, Media formulation strategies, Sources of Carbon, Nitrogen, Vitamins, minerals, Buffers, Precursor, inhibitors, inducer, Antifoam agents, Solid state fermentation.	8	Understand fermentation media, including natural and synthetic types, media formulation strategies, and the sources and roles of carbon, nitrogen, vitamins, minerals, buffers, precursors, inhibitors, inducers, antifoam agents, and solid-state fermentation.	1,2

IV	Downstream process: Introduction, Objective, criteria, cell disruption, precipitation, filtration, Centrifugation, Liquid-Liquid extraction, Membrane filtration, Chromatography, Drying device, Crystallization, Packing and Quality assurance. Immobilization: Definition, concept, Process of immobilization, Enzyme and whole cell immobilization, application, Food spoilage: Introduction, types, spoilage due to bacteria, fungi, yeast, food processing principle, methods, Canning, Packing, Sterilization, Pasteurization	12	Understand downstream processing, immobilization techniques, and the causes and prevention of food spoilage, along with food processing methods like canning, packing, sterilization, and pasteurization.	1,2
V	Fermented food: Sausages, olives, Bread, Idli, Acidophilus milk, importance of fermented food, HACCP concept	8	Understand the fermentation processes in sausages, olives, bread, idli, and acidophilus milk, and the importance of fermented foods, including HACCP for food safety.	1,2
Practical	Production of acetic acid, citric acid, lactic acid	30		1,2,3,4

Text Books

T1: Stanbury, P. F, Whitaker, A and Hal. S. J(1997), Principle of fermentation technology-Elsevier Science Limited, Aditya Book(P) ltd, New Delhi.

T2: Crueger&Crueger (2004) Industrial Microbiology. 3rd edition.Panima Books, New Delhi

Reference Books

R1: Prescott and Dunn (1984), Industrial Microbiology, Mc Graw Hill New York.

R2: Casida Jr L.E(1997), Industrial Microbiology, New Age International Pvt Ltd.

R3: Fraiser W.C and West off D.C(1998) Food Microbiology, Tata Mc Graw Hill Publication, New Delhi

R4:Mc NeilBand Harvey I.M. (1990) Fermantation, a practical approach. IRL Press, New York

R5: Doyle, MP et al, Food microbiology, ASM Press, Washington D.C.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the historical development in Bioprocess Engineering, key inventions and discoveries and its application in different fields.	**1, 2**
2	Explain the design structure, function, and operation of bioreactors including, functional operations and specialised variation in designs of bioreactors.	**1, 2, 3**
3	Illustrate the formulation strategies of fermentation media and different source of nutrients for fermentation media.	**1, 2**
4	Outline the techniques of downstream processing and different isolation and purification methods of biotechnological products.	**1, 2**
5	Summarize the different fermentation processes involved in fermented foods and HACCP concept and explain effective safety measures in producing fermented foods.	**1, 2, 3, 9**

SEMESTER - III									
Course Title	**FOOD BIOTECHNOLOGY**								
Course Code	**24MSBT214R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours:45p+30p	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-Requisite	**Molecular biology, microbiology**	**Co-Requisite**	**NA**						
Programmes	**MSc. Biotechnology**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	1. Describe the applications and current situation of Biotechnology in relation to foods. 2. Knowledge on advantages and limitations of novel food products obtained through biotechnological approaches. 3. Apply the role of microorganisms and enzymes for the production and transformation of foods and most recent advances in foods made of/with genetically modified organisms.								
CO1	Explain the basic principles of fermentation.								
CO2	Describe selected fermentation systems.								
CO3	Discuss the mechanism of enzyme action and classification.								
CO4	Develop the skill to link food chemistry with industry.								
CO5	Develop entrepreneurship skills related to food biotechnology.								

Unit no	Content	CH	Learning outcome	KL
I	Food biotechnology: Introduction, historical development	3	Understand the introduction and historical development of food biotechnology.	1,2
II	Enhancing the nutritional quality of foods-manipulation of sucrose and starch content: manipulation of fatty acid composition of oils, enriching with protein content, increasing the content of methionine and lysine in feed storage proteins increasing the levels of vitamins and minerals.	10	Learn methods to enhance the nutritional quality of foods through manipulation of sucrose, starch, fatty acids, protein, vitamins, minerals, and amino acids.	1,2
III	Removal or minimizing the anti-nutritional factors and toxic molecules from food-phytate, oxalic acids, neurotoxins etc., decreasing the contents of pesticides, herbicides and heavy metals-use of bio-insecticides, development of herbicide resistant plant etc.	12	Gain knowledge of techniques to remove or minimize anti-nutritional factors, toxins, pesticides, herbicides, and heavy metals from food.	1,2
IV	Increasing the shelf life of the fruits Development of food value, metabolites-food colors, food Flavors, food additives, sweeteners etc. Animal biotechnology for increasing meat quality and meet production.	12	Explore methods to increase the shelf life and develop metabolites such as food colors, Flavors, additives, and sweeteners.	1,2
V	Probiotics in foods: methods of incorporation and types of probiotics	8	Understand animal biotechnology for improving meat quality and production.	1,2
Practical	Isolation of probiotics microorganisms from different sources	30	Learn about probiotics in foods, including methods of incorporation and types of probiotics used	1,2, 3,4

Text Books

T1: Food Biotechnology - 2nd Edition - Martin Wiedmann

Reference Books

R1: Bio enhancement and Fortification of Foods for a Healthy Diet. Octavio Paredes-López, Oleksandr Shevchenko, Viktor Stabnikov, Volodymyr Ivanov. August 08, 2022

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the basic principles of fermentation.	**1**
2	Describe selected fermentation systems.	**1, 2**
3	Discuss the mechanism of enzyme action and classification.	**1, 2**
4	Develop the skill to link food chemistry with industry.	**1, 3**
5	Develop entrepreneurship skills related to food biotechnology.	**1, 2, 3, 9**

SEMESTER - III									
Course Title	**MINI RESEARCH (SURVEY/EXPERIMENTS-R4)**								
Course code	**24MSBT224R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**0**	**4**	**6**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course objectives	To develop students' scientific method								
CO1	To design an experiment using scientific method								
CO2	Apply the knowledge of sampling methods in sample collection.								
CO3	To store and work on the sample through various parametric assays.								
CO4	To structurize data and perform statistical analyses.								
CO5	To interpret and discuss the findings.								

SEMESTER IV									
Course Title	**ORGANIC FARMING**								
Course code	**24MSBT221R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours:45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Biotechnology**								
Semester	**Spring/IV Semester**								
Course objectives	1. Introduction to Concept of Organic cultivation 2. To discuss the Organic Farming System (OFS), its importance and benefits. 3. To discuss the methods associated with organic farming – mulching, crop rotation, tillage, bio-fertilizer etc								
CO1	Explain organic Farming, its principles, scope and benefits for the health and society.								
CO2	Illustrate the relation between organic farming and natural processes such as nutrient cycles, soil preparation and choice of crop varieties, planting material and seed treatment.								
CO3	Discuss crop protection methods, analyse scenarios, propose strategies and evaluate effectiveness, preparing to innovate in pest and weed management.								
CO4	Explain the organic production of rice, zinzer, turmeric, banana and vegetables.								
CO5	Describe the concept of soil less farming system.								

Unit-No.	Content	CH	Learning Outcome	KL
I	**Introduction** to Organic Farming (OF); Development of OF; Principles and Types of OF; Biodynamic Farming; Need and Benefits of OF; Conventional Farming (CF) Vs (OF); Scope of OF.	10	Understand organic farming, its types, principles, benefits and scope.	1,2
II	**OF System**; Soil and Soil tillage, Choice of crop/ varieties, Propagation – Seed, planting material and seed treatments, Crop rotation, Intercropping, Water Management, Green Manuring, Mulching, Composting, Vermicomposting, Organic Manure, Biofertilizer	8	Describe illustrate and explain the organic farming system	1,2
III	**Crop Protection:** Cultural and Mechanical method; Biopesticides and Botanical Pesticides, Bio-control agents, Weed Management	8	Describe and explain the various ways for protecting plants	1,2
IV	**Organic crop production** of Rice, Zinzer, Turmeric, Banana and Vegetables Yolk-its function and significances	10	Describe and explain the organic production of crop plants	1,2
V	**Concept on modern organic farming methods** – Hydroponics, Aquaponics, Hydroponics	9	Describe and explain the modern methods of agriculture	1,2
Practical	1. Prepare organic manure/ compost using given substrates. 2. Isolate, culture and identify microbes which may be used as a biofertilizer. 3. Apply any organisms obtained in (2) above and analyse their potentiality	30	Apply knowledge of organic farming	1,2, 3,4

Text books

T1. J. M. Fortier. The Market Gardener – A successful Grower's Handbook for Small- Scale OF. 1st edition.New Society Publishers, 2014.

Reference books

R1. A. L. Hansen. Organic Farming Manual: A Comprehensive Guide To Starting And Running A Certified Organic Farm. 1st edition.Storey Publishing LLC, 2010.

R2. C. SarathChandran et al. Organic Farming: New Advances Towards Sustainable Agriculture Systems, 1st edition, Springer; 2019.

R3. D. Nandwani (eds). Organic Farming for Sustainable Agriculture.1st edition, Springer; 2016.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain organic Farming, its principles, scope and benefits for the health and society.	**1**
2	Illustrate the relation between organic farming and natural processes such as nutrient cycles, soil preparation and choice of crop varieties, planting material and seed treatment.	**1, 2**
3	Discuss crop protection methods, analyse scenarios, propose strategies and evaluate effectiveness, preparing to innovate in pest and weed management.	**2, 3**
4	Explain the organic production of rice, zinzer, turmeric, banana and vegetables.	**1**
5	Describe the concept of soil less farming system.	**1**

SEMESTER - IV									
Course Title	**Environmental Biotechnology**								
Course code	**24MSBT222R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours:45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Biotechnology**								
Semester	**Spring/IV Semester**								
Course objectives	1. The course aims to provide an advanced understanding of all aspects of climate change, biodiversity and environmental management, pollution and control, population dynamics, ecosystems and urbanization. 2. Modern-day technology and human actions are slowly ruining and draining the planet's ecosystem and natural resources. The study of environmental science helps to enlighten the world about global issues, such as forest denudation and dynamite fishing. 3. Applying knowledge gained through environmental science is the only way to solve these problems so that the environment can be preserved. Ultimately, environmental science is necessary to save the environment from destruction and all of its dependents from extinction.								
CO1	Understand the concept of climate changes and their management.								
CO2	Explain biodiversity and their conservation.								
CO3	Illustrate various alternative fuels and their production.								
CO4	Discuss microbial biodiversity and its role in biogeochemical cycles, linking microorganisms' eco-physiological aspects to terrestrial ecosystem function.								
CO5	Describe environmental problems and solutions.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
1	Energy- Introduction, Renewable and non-renewable energy, resources and maintenance	6	To understand the basics of renewable energy	1,2
2	Pollution- Introduction, sources and management of soil, air and water pollution, Water as an important natural resources, Importance of water management, waste water characteristic, treatment, Aerobic process- Activated sludge method, Oxidation ditch, Trickling filter, Oxidation pond Anaerobic digestion- Anaerobic filter, Membrane bioreactors, treatment of dairy effluents, treatment of distillery effluents, treatment of tannery effluents, treatment of textile effluents, treatment of sugar industry effluents, CEPT, reverse osmosis and ultra filtration	6	To learn about pollution and water management	1,2
3	Biomagnification- xenobiotic compounds and their sources Bioremediation-concept and principle, bioremediation of xenobiotics, soil, water contaminated with hydrocarbon and surfactants, Bio mining, Bioleaching, biosorption and bioaccumulation of heavy metals, Bio monitoring (Bio indicators), Phytoremediation Biofilm, Organ chloride compounds in Bleach plant effluents (Reduction)	6	To learn about biomagnification, phytoremediation	1,2
4	Solid waste management: introduction, sources, Management, waste as a source of energy, Degradation of plant fibre, cell wall, lignin, Pulping of wood and pitch problem, Production of oil and fuel from wood waste.	6	To learn about applications of environmental biotechnology	1,2

	Biotechnological approach to solve slime problem.			
5	Biogas production- methanol production and byproducts of sugar industry, composting and wormiculture, Global environmental Problems- Ozone depletion, its impact on the environment, Greenhouse effect, acid rain. Biodiversity- Status and conversation, biotechnological approach in conservation of biodiversity, GMO and its impact on the environment.	5	To learn about applications of environmental biotechnology	1,2
Practical	Extraction of enzymes from waste using microbial cultures,Visit to industrial wastewater treatment plants	30	To apply the knowledge of environmental biotechnology	1,2, 3,4

Text books

T1: Environmental biotechnology, Kumar, Arvind, 2004

Reference books

R1: Introduction to Environmental Biotechnology A.K.Chatterji, 2007

R2: Introduction to Environmental Science & Technology Dr. S. Amal Raj, First Edition, 2005

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss the concept of climate changes and their management.	**1**
2	Explain biodiversity and their conservation.	**2**
3	Illustrate various alternative fuels and their production.	**3**
4	Discuss microbial biodiversity and its role in biogeochemical cycles, linking micro-organisms eco-physiological aspects to terrestrial ecosystem function.	**4**
5	Describe environmental problems and solutions.	**5, 4**

SEMESTER - IV									
Course Title	**Agriculture Biotechnology**								
Course code	**24MSBT223R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Biotechnology**								
Semester	**Spring/IV Semester**								
Course objectives	1. To introduce the students about Bio pesticides, Biofertilizersetc. 2. To studypost-harvest modification and stress management by plants. 3. To study the detail about seed certification process.								
CO1	Explain and apply the concept of Bio pesticides, biofertilizers to get better yield.								
CO2	Describe the concept of Post harvest modification to maximize the storage of food/ vegetables.								
CO3	Explain the various steps involve in seed certification.								
CO4	Discuss the principles and techniques of genetic engineering used to enhance abiotic stress tolerance in plants and to induce male sterility.								
CO5	Illustrate the potential applications of biotechnology in agriculture, including genetic modification, crop improvement, and sustainable farming practices.								

Unit no	Content	CH	Learning Outcome	KL
1	Agricultural biotechnology-scopes and application	7	To understand the basics of agriculture biotechnology	1,2
2	Biofertilizers-Definition, Types (bacterial, fungal, phosphate solubilizers, BGA,Plants-Azolla); Kind of association, Mode of application and merits, current practices & production of biofertilizers	8	To learn about biofertilizers	1,2
3	Biopesticides- Introduction, types (bacterial-Bacillus thruingiensis, Viral –NPV, fungal-Trichoderma), Mode of action, factors influencing, Genes involved and target pests; Biological approach in pest management, Use of antisense RNA technology for extending self-life of fruits and flower, Importance of JH &JH analogs in pest controll	10	To learn about biopesticides	1,2
4	Post-harvest management, Assessment of postharvest losses due to storage pests; Environmental factors and storage pests in stored perishables, cereals and grain legumes; Major groups of post-harvest pests (insects, mites and rodents)Management practices of economically important post-harvest pest; Application of Biotechnology in post-harvest management	12	To learn about post-harvest management	1,2
5	Genetic engineering for abiotic stress, Male sterile plant, method of inducing male sterility, Bar star and barnase system	8	To learn about applications of biotechnology in agriculture	1,2,3
Practical	Preparation and formulation of microbial biopesticide (bacteria, fungi and viruses), In vitro evaluation of medicinal plants against pathogenic microbes, Preparation and formulation of microbial biopesticide (bacteria, fungi and viruses), In vitro evaluation of medicinal plants against pathogenic microbes. Study of root/stem nodule& study of VAM, Vermicomposting Mushroom cultivation	30	To apply the knowledge of agriculture biotechnology	1,2, 3,4

Text books

T1: Corporate Crops: Biotechnology, Agriculture, and the Struggle for Control (English) (Paperback) by Gabriela, University of Texas Press

Reference books

R1: Biotechnology in Agriculture: Utilization of Molecular markers\nin Mango (Mangiferaindica L.) (English) (Paperback) by Ahmed Mansour, Omayma M Mahmoud Ismail, VdmVerlag Dr. Muller Aktiengesellschaft& Co. Kg

R2: Environmental Science and Engineering 2nd Edition (English) 2nd Edition (Paperback) by J. Glynn Henry, W. Gary Heinke, Phi Learning Pvt. Ltd.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss and apply the concept of Bio pesticides, biofertilizers to get better yield.	**1, 3,**
2	Apply the concept of Post harvest modification to maximize the storage of food/ vegetables.	**3**
3	Explain the various steps involve in seed certification.	**4**
4	Describe the principles and techniques of genetic engineering used to enhance abiotic stress tolerance in plants and to induce male sterility.	**1, 2**
5	Apply the potential applications of biotechnology in agriculture, including genetic modification, crop improvement, and sustainable farming practices.	**1, 2, 3**

Assam down town University

Curriculum and Syllabus

Master of Science

in

Botany

OUTCOME BASED EDUCATION FRAMEWORK
CHOICE BASED CREDIT SYSTEM
Version: 2.2

FACULTY OF SCIENCE

July, 2024

PREAMBLE

Assam down town University is a premier higher educational institution which offers Bachelor, Master, and Ph.D. degree programmes across various faculties. These programmes, collectively embodies the vision and mission of the university. In keeping with the vision of evolutionary changes taking place in the educational landscape of the country, the university has restructured the course curriculum as per the guidelines of National Education Policy 2020. This document contains outline of teaching and learning framework and complete detailing of the courses. This document is a guidebook for the students to choose desired courses for completing the programme and to be eligible for the degree. This volume also includes the prescribed literature, study materials, texts, and reference books under different courses as guidance for the students to follow.

Recommended by the Board of Studies (BOS) meeting of the Faculty of Science held on dated 16th & 17th July, 2024 and approved by the 51st Academic Council (AC) meeting held on dated 26/07/2024

Chairperson, Board of Studies

Member Secretary, Academic Council

Vision

To become a Globally Recognized University from North Eastern Region of India, Dedicated to the Holistic Development of Students and Making Society Better

Missions

1. Creation of curricula that address the local, regional, national, and international needs of graduates, providing them with diverse and well-rounded education.

2. Build a diverse student body from various socio-economic backgrounds, provide exceptional value-based education, and foster holistic personal development, strong academic careers, and confidence.

3. Achieve high placement success by offering students skill-based, innovative education and strong industry connections.

4. Become the premier destination of young people, desirous of becoming future professional leaders through multi disciplinary learning and serving society better.

5. Create a highly inspiring intellectual environment for exceptional learners, empowering them to aspire to join internationally acclaimed institutions and contribute to global efforts in addressing critical issues, such as sustainable development, Climate mitigation and fostering conflict-free global society.

6. To be renowned for creating new knowledge through high quality inter disciplinary research for betterment of society.

7. Become a key hub for the growth and excellence of AdtU's stake holders including educators, researchers and innovators

8. Adapt to the evolving needs and changing realities of our students and community by incorporating national and global perspectives, while ensuring our actions are in harmony with our foundational values and objectives of serving the community.

Programme Details

Programme Overview

M.Sc. in Botany is a 2-year post graduate programme which deals with basic and advanced study on plants and develops understanding and knowledge for applying on to the agricultural, horticultural, floricultural and environment & forest sectors. Botany is one of the multi-disciplinary fields with great demand in various applications in the field of research and development. After completion of this course, students may opt for various higher studies like M.Phil, and PhD which will improve the chances for better jobs.

I. Specific Features of the Curriculum

- Experiential learning
- Constructivist approach to learn
- Practical and project based learning

II. Eligibility Criteria:

B.Sc. in Botany/Life Science/ Biological Science/Allied subject related to Botany.

III. Program Educational Objectives (PEOs):

PEO1: AdtU Botany Postgraduates will be prepared for successful careers in both government and private sectors as botanists, angiosperm taxonomists, pathologists, plant microbiologists, ecologists and in allied areas.

PEO2: The Postgraduates will be academically prepared to become botanist and will contribute effectively to the growth of the profession.

PEO3: The Postgraduates will engage in professional activities to enhance their stature and simultaneously contribute to the profession and society at large and be successful in higher education in botany or interrelated disciplines if perused.

IV. Program Specific Outcomes (PSOs):

PSO1: **Experiential Learning:** Demonstrate expertise in applied botany for sustainable community and societal outcomes.

PSO2 **Innovation and Entrepreneurship:** Ability to critically analyze research problems with proper gap analysis and design projects in the field of plant science to find appropriate innovative solutions.

PSO3: **Global Competency:** Demonstrate global competency through empowering lifelong learning and contributing to technological advancement in botanical science.

V. Program Outcome (PO):

PO1: **Disciplinary Knowledge:** Apply comprehensive knowledge of basic sciences, biostatistics, biosciences and specialization in plant sciences to resolve complex agricultural, ecological and botanical challenges.

PO2: **Problem Solving:** Identify, formulate, analyse, and evaluate complex botanical problems by applying critical thinking and drawing a conclusive solution.

PO3: **Investigation and Research:** Apply research competency to design hypotheses and experiments using modern tools and techniques, and analyse and interpret the data to arrive at logical conclusions in the area of plant biology.

PO4: **Communication:** Effectively communicate information among the scientific community and society and be able to prepare documents and reports, and deliver impactful presentations.

PO5: **Professional Codes and Ethics:** Comply with values, professional codes and ethics in the profession.

PO6: **Environment and Sustainability:** Understand the impact of the suggested solutions in a socio-environmental context, and redesign it for better ecological balance and environmental sustainability.

PO7: **Leadership and Teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO8: **Lifelong Learning:** Able to engage in lifelong learning independently in the broadest context of scientific and technological advancement.

VI. Total Credits to be Earned: 88

VII. Career Prospects:

M.Sc. in Botany offers a range of dynamic career opportunities. Graduates can work in research and development, Agricultural, Horticultural, Floricultural and Environment & forest sectors. Roles include Environmental Impact Assessment for complex ecological and environmental problems to meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. Additionally, graduates can pursue careers in contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to application of plant resources in human welfare. Skill based courses like Mushroom Cultivation, Bio fertilizer etc. appropriately trained personnel for the promotion of mushroom production. Opportunities also exist in academia and education, where graduates can contribute to scientific knowledge and train future professionals.

EVALUATION METHODS

The student performance shall be evaluated through In-semester (Sessional) and semester-end examinations. A weight age of 40% or as prescribed by the programme shall be added to the score of the end semester examination.

A. INTERNAL ASSESSMENT:

The teacher who offers the course shall be responsible for internal assessment by conducting in-semester (sessional) examination and evaluating the performance of the students pursuing that course. The components for internal assessment are illustrated in the table given below.

SN	Components/ Examinations	Marks Allotted
1.	In-Sem Exam – I (ISE-I) (Written Examination)*	30
2.	In-Sem Exam – II (ISE-II) (Written Examination)*	30
3.	Assignment	10
4.	Presentation (SP)	10
5.	Quiz	5
6.	Class Performance based score*	5

are compulsory

Note: *Total Internal assessment should be out of 40*

INSTRUCTION

1. If a student fails to appear in the any of the component without any valid reason he/she shall be marked zero in that component. However, the course teacher at his discretion may arrange for the missed test on an alternate date for the absentee students after determining ground with genuine/valid reasons for the absent.

2. The report of evaluation of an activity towards the in-semester (sessional) component of a course shall be duly notified by the concerned course teacher within a week of completion.

3. The program coordinators should upload the in-semester marks to the ERP and forward acknowledgement of all the courses of the program to the Controller of Examinations before the start of the End-semester examination.

B. SEMESTER END EXAMINATION:

Time table for end semester examination is published at least 25 days prior to the start of Examination.

I. Pre-Examination:

Eligibility Criteria for a student to appear in University Examinations:

The student shall only be allowed to appear in a University Examination, if:

i) He/ She is a registered student of the University;

ii) He/ She is of good conduct and character;

iii) He/ She has completed the prescribed Programme of study with minimum percentage of attendance as laid down in the Regulations of the Programme concerned.

Under special cases, a student may be allowed to appear for an examination without being registered in the University but the result of the said student will be kept on hold till the registration of the concerned student is completed.

II. Admit Card:

Admit card for the examination may be downloaded through ERP where the system will generate a Unique ID Cards through online.

The University shall have the right to cancel admission for examination of any candidate on valid grounds.

III. Pattern of Question Papers:

The question paper shall follow the principles of Bloom's Taxonomy.

Table

S. N.	Level	Questions /verbs for test
1	Remember	List, Define, tell, describe, recite, recall, identify, show who, when, where, etc.
2	Understand	Describe, explain, contrast, summarize, differentiate, discuss etc.
3	Apply	Predict, apply, solve, illustrate, determine, examine, modify
4	Analyze	Classify, outline, categorize, analyze, diagrams, illustrate, infer, etc.
5	Evaluate	Assess, summarize, choose, evaluate, recommend, justify, compare etc.
6	Create	Design, Formulate, Modify, Develop, integrate, etc.

Note: No course is to be evaluated on basis of **all 6 knowledge levels.**

The format of the question paper across all the program follow a unique pattern and the total marks is 60

Table 1: Question paper pattern for End semester examination

Sl no	Question pattern	Total marks
1	MCQs (10 Questions)	10
2	2 Marks questions (10 Questions)	20
3	4 Marks questions (5 Questions)	20
4	10 Marks questions (1 Question)	10

IV. Examination Duration:

Each paper of 60 marks shall ordinarily be of two hours duration.

V. Practical Examinations, Viva-Voice etc.:

i) Practical examination shall be conducted in the presence of one external expert and one or more internal examiners.

ii) Viva-Voice, Oral examinations of the Project report, Dissertation etc. shall be undertaken by a Board of Examiners constituted by the respective Dean of Program with the advice of Supervisor(s).

VI. Procedure of Expulsion:

If any candidate is found to be using any unfair-means during the examination, the

invigilator may cease his/her answer sheet and report it directly to the Officer-in-Charge. The Office-in-Charge of the center may take appropriate decisions as per the rules and procedure of the examination. The Officer-in-Charge may allow the students to write the exam with new answer sheet or may expel the student from appearing the paper depending on the nature of unfair-means. In case of Computer based test, the students may be directed to write an apology letter and sign in the prescribe expulsion form. The student may not be allowed to write that examination.

VII. Instruction to the Students:

(i) The students shall not bring to the Examination Hall, any electronic gadget used as a means of communication or record except electronic calculator, if required.

(ii) The students shall not receive any book or printed or hand written or photo copy (Xerox) or blank-paper from any other person while he/she is in the examination-room or in laboratory or in any other place to which he/she is allowed to have access during course of examination.

(iii) The students shall not communicate with any other candidate in the examination room or with any other person in and outside the examination-room.

(iv) The students shall not see, read or copy anything written by any other candidate, nor shall he/she knowingly or negligently permit any other candidate to see, read or copy anything written by him/her or conveyed by him/her.

(v) The students shall not write anything on the Question Paper or in other paper or materials during the examination, or pass any kind of paper to any other candidate in the examination-room, or to any person outside the room.

(vi) The students shall not disclose his/her identity to the examiner by writing his/her name or putting any sign / symbol in any part of his answer-script.

(vii) The students shall not use any abusive language or write any objectionable remark or make any appeal to examiner by writing in any part of his answer-script.

(viii) The students shall not detach any page from the answer-script or insert any authorized or unauthorized loose sheet into it. He /she shall also not insert any other answer-script / loose sheet by removing the pins of the origin answer-scripts and re-fixing it.

(ix) The students shall not resort to any disorderly conduct inside the examination-room or misbehave with the invigilator or any other examination official.

VIII. Provision for an Amanuensis (writer):

(i) A candidate may be provided with an Amanuensis (writer) to write down on dictation on his / her behalf on ground of his / her physical disability to write down by himself / herself due to accident or any other reason. The amanuensis may be provided till he / she recovers from the physical disability. The physical disability to write down by himself / herself must be supported by Medical Certificate from a competent Medical Officer.

(ii) The qualifications of the amanuensis so provided must not be equal or higher than that of the candidate. This is also to be supported by Certificate from the Faculty of Study where the Amanuensis is provided.

(iii) Such candidates are to be accommodated in a separate room under the supervision of an invigilator so that the fellow candidates are not disturbed in the process.

C. Credit Point:

It is the product of grade point and number of credits for a course, thus, CP = GP x CR

i. Credit:

A unit by which the course work is measured. It determines the number of hours of instructions required per week. 'Credit' refers to the weight age given to a course, usually in terms of the number of instructional hours per week assigned to it. Credits assigned for a single course always pay attention to how many hours it would take for an average learner to complete a single course successfully.

ii. Grade Point:

Grade Point is a numerical weight allotted to each Grade Letter on a 10-point scale.

iii. Letter Grade:

Letter Grade is an index of the performance of students in a said paper of a particular course. Grades are denoted by letters O, A+, A, B+, B, C, P, F and Abs. Student obtaining Grade F / Grade Abs shall be considered failed/ absent and, will be required to appear in the subsequent ESE. The UGC recommends a 10-point grading system with the following (Table: 1) Letter Grades:

(i) A Letter Grade shall signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point shall indicate the numerical weight of the Letter Grade on a 10-point scale.

(ii) There shall be 08 (eight) Letter Grades bearing specific Grade Points as listed in Table 1, where the Letter Grades 'O' to 'P' shall indicate successful completion of a course.

(iii) Apart from the 08 (eight) regular Letter Grades listed in Table 1, there shall be 03 (three) additional Letter Grades, which shall be awarded if a Course is withdrawn or spanned over the next Semester or remains incomplete as stated in Table 2.

Table 2: Letter Grades and Grade Points

Letter Grade	Grade Points	Description
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Abs	0	Absent
UFM	0	Unfair Means

iv. Grade Point Average:

a. SGPA (Semester Grade Point Average)

The SGPA of a student in a Semester shall be the weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered in that Semester, irrespective of whether he/she could or could not complete the Courses. More specifically, the calculation of SGPA shall take into account the Courses

graded with Letter Grades 'O' to 'F' as given in Table 1.

$$\text{SGPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad (1.1)$$

The SGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.1) up to two decimal places, where n is the total number of Credit Courses registered by the student in that Semester, Gi is the Grade Point secured in the i^{th} registered Course and Ci is the Credit (weight) of that Course.

b. CGPA (Cumulative Grade Point Average)

(i) The CGPA of a student in a Semester of a Programme shall be the accumulated weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered and successfully completed so far starting from the enrollment in the Programme. In other words, taking into account all the Courses graded with 'O' to 'P' as given in Table 1.1, generally the CGPA of a student shall be calculated starting from the first Semester of his/her enrolled Programme, while the CGPA of a lateral-entry student shall be calculated starting from the Semester of his/her enrollment.

(ii) The CGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.2) up to two decimal places, where N is the total number of Credit Courses registered and successfully completed so far by the student, Gi is the Grade Point secured in the ith completed Course and Ci is the Credit (weight) of that Course.

$$\text{CGPA} = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i} \qquad (1.2)$$

(iii) The CGPA shall be convertible into equivalent percentage of marks using Equation Conversion of CGPA to percentage marks: = CGPA*10

D. Post-Examination

i. Transcript or Grade Card or Certificate:

A marking certificate shall be issued to all the registered students after every Semester. The Semester mark sheet will display the course details (code, title, number of credits, grade secured) along with total credit earned in that Semester.

ii. Grievance Readdress Mechanism:

Students with any dissatisfaction or grievance regarding the marks awarded in any of the Papers / Courses may appeal to the Controller of Examinations for remedial action such as Re-evaluation within 10 days of the declaration of result.

(i) A student has options to appeal for re-evaluation of his /her answer script to the Controller of Examination.

(ii) Application for re-evaluation / re-scrutiny of answer scripts shall be made in the definite proforma available with the Examination Office through the head of the respective departments within 10 days of declaration of the results of the respective examinations.

(iii) The Controller of Examination may appoint an examiner for re-evaluation and will consider and recognize the evaluation done by a University appointed examiner.

(iv) There shall be no provision for re-evaluation of the Practical Papers, Project Work, and Dissertation etc. However, the students fail in practical examination or viva voce and wish to appear again may apply to be evaluated can do so with the next schedule.

(v) After screening the application for re-evaluation, the CoE may send the answer scripts of the student to the examiners appointed by the CoE with the approval of Vice Chancellor.

(vi) The marks/grades achieved by the students after the re-evaluation shall be final and binding.

(vii) Fresh Marks – sheets / Grade Card shall be issued only if the candidate secures pass marks / passing grade in the re-evaluated paper.

(viii) Revaluation of answer scripts shall be deemed to be an additional facility provided to the students with a view to improving upon their results at the preceding examination result for any reason whatsoever shall not confer any right upon them for admission to next higher class which matters always be regulated in accordance with the relevant rules or regulations framed by the University.

(ix) If as a result of revaluation of the candidate attracts the provision of condonation of deficiency, the same may be applied to his/her only for fresh attempt.

INSTRUCTION TO TEACHERS AND STUDENTS

(Teaching and Learning Methods)

In all the courses the teacher has to select topics for teacher-method which should not be less than 20 percent. The approach will be direct class room teaching through series of lectures delivering concepts using ITC facilities, white or black board. Notes may also be circulated to the students however; the students are to be involved in preparation of the notes. The teacher will be responsible in selecting the best note for circulation. The teacher- centric methodology has recently fallen out of favour because this strategy for teaching is seen to favour passive students.

1. Student- centric / Constructivist Approach:

The topics of the courses may be selected at the start of the class and assigned one topic to each of the student for studying by themselves, prepare presentations, notes etc., and present at respective class time after consultation and discussion with the course teachers. The teacher facilitate the learning of the students by guiding and providing input and explaining concepts. 60 percent of the course contents may be selected for this purpose. To avoid behavior problems, teachers must lay a lot of groundwork in student- centric classrooms. Typically, it involves instilling a sense of responsibility in students. In addition, students must learn internal motivation.

a. Project-Based Learning: The teacher may select 5 percent of topics for the purpose and may conduct visit to the laboratory for experiments or field and survey. The selection of the topic may be done considering the available facility for the purpose. However, in the final semester of each of the programme the student has to undergo a project-Based learning at least 4 months duration. This approach will help the student to think critically, evaluate, analyze, make decisions, collaborate, and more.

b. Inquiry-Based Learning: The teacher/ students are supposed to list at least five questions in each contact hour and student solve these question or search for answer which becomes the home work for the students "question-driven" learning approach. The teacher may look for the correctness of the solution or the best possible answer and discuss in the successive class. This will help in the preparation for various competitive examination and develop a habit for search for solutions.

c. Flipped Classroom: About 10 percent of the course content has to be completed by this method. In this approach the students are asked to watch video or lecture prepared by the teacher or any video available (relevant to the course). A set of questions may be given to the students for searching answers by the students. The idea is that students should have more time in-classroom focusing on achieving these higher levels of thinking and learning. The Flipped classroom is also an acronym. The letters FLIP represent the four pillars included in this type of learning: Flexible environment, Learning culture shift, Intentional content, and Professional educator. As you can see, the second pillar refers to a culture shift from the traditional approach where students are more passive to an approach where students are active participants. As a result, this approach is also a student- centric teaching method.

d. Cooperative Learning: The remaining five percent has to be completed by cooperative learning approach. In this approach the students are allotted with problems. During the library hours the student along with the teacher visits library search probable solution for the assigned problem. The same has to be done in group so that the students discuss among themselves for the appropriate answers. Essentially, cooperative learning believes that social

interactions can improve learning. In addition, the approach recreates real-world work situations in which collaboration and cooperation are required.

The percentage categorization for the completion of a theory course

Teacher- centric or Direct Classroom Teaching: Delivery by series of lectures	20%
Student- centric Approach, Student present and deliver lectures in presence of teacher and supervised by teacher	60%
Student visit fields or perform experiments or teacher perform demonstration	05%
Flipped Classroom approach	10%
Cooperative learning approach	05%

Inquiry based approach has to be followed in all of the classes

Teacher has to distribute the topics to be considered for teaching by the above-mentioned approaches and prepare lesson plan for execution and maintain a file.

SEMESTER WISE COURSE DISTRIBUTION

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester I	1	24MSBO1101R	Plant Ecology and Phytogeography	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	2	24MSBO1102R	Plant Diversity	**DSC Minor**	2	0	2	0	0	0	3	40	60	100	200
	3	24MSBO1103R	Plant and climate change	**DSC Minor**	1	0	2	0	0	0	2	40	60	100	200
	4	24MSBO1104R	Floral morphology, Embryology and Palynology	**DSC Minor**	2	0	2	0	0	0	3	40	60	100	200
	5	24UMFS1101R	Fundamental of Statistics	**MDC**	1	0	2	0	0	0	2	40	60	100	200
	6	24UMPD1101R	English (PDP)	**AEC**	0		4	0	0	0	2	0	0	100	100
	7	24UMCC1101R	Co-curricular	**Co and extra-Curricular**	0		0	0	0	0	1	0	0	100	100
			Total								**17**				**1200**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester II	1	24MSBO1201R	Plant taxonomy and systamatics	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	2	24MSBO1202R	Microbiology and plant Pathology	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSBO1203R	Plant Physiology and Biochemistry	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	4	24UMPD1201R	Aptitude / Logical Course	**AEC**	0	0	4	0	0	0	2	40	60	0	100
	5	24MSBO1205R	Postgraduate Practice Teaching	**SEC**	1	0	0	0	0	0	1	0	0	100	100
	6	24MSBO1206R	Research methodology and statistical analysis	**SEC**	2	0	2	0	0	0	3	40	60	100	200
	7	24FSDA1201R	Data analysis using Microsoft excel	**VAC**	0	0	4	0	0	0	2	0	0	100	100
	8	24MSBO1204R	Field Visit	**Field Training**	0	0	0	0	0	0	1	40	60	0	100
	9	24UMEC1201R	Extra-curricular	**Co and Extra Curricular**	0	0	0	0	0	0	1	0	0	100	100
	Total										**22**				**1300**

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester III	1.	24MSBO2101R	Plant molecular biology and biotechnology	**DSC Major**	2	0	2	0	0	0	3	40	60	100	200
	2	24MSBO2102R	Bioinstrumentation	**DSC Major**	2	0	2	0	0	0	3	40	60	100	200
	3	24MSBO2103R	Plant cell, genetics and plant breeding	**DSC Major**	2	0	2	0	0	0	3	40	60	100	200
	4	24MSBO2104R	Plant anatomy, microtechnique and evolution	**DSC Major**	2	0	2	0	0	0	3	40	60	100	200
	5	24MSBO2105R	Gardening and nursery technology	**DSC Major**	1	0	2	0	0	0	2	40	60	100	200
	7	24MSBO2106R	Internship	**Internship**	0	0	0	0	0	0	4	0	0	100	100
	8	24MSBO2107R	Project dissertation	**Research**	0	0	8	0	0	0	4	0	0	100	100
	9	24MSBO2109R	Field Visit	**Field Training**	0	0	0	0	0	8	1	40	60	0	100
	10	24UMPD2101R	English (PDP)	**AEC**	0	0	4	0	0	0	2	0	0	100	100
	11		Indian Knowledge System	**VAC (Online)**	0	0	0	0	0	0	2	0	0	100	100
	Total										**27**				**1500**

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester IV	1	24MSBO2203R	Project dissertation	**Research**	0	0	24	8	12	0	16	0	0	100	100
	Elective course: Student has to take any one special paper														
	Group1ElectivePaper: Angiosperm Taxonomy														
	2	24MSBO2201R	Angiosperm Taxonomy-I	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSBO2202R	Angiosperm Taxonomy-II	**DSC Major**	2	0	0	0	0	0	2	40	60	0	100
	Group1IElectivePaper: Microbiology														
	2	24MSBO2201R	Microbiology-I	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSBO2202R	Microbiology-II	**DSC Major**	2	0	0	0	0	0	2	40	60	0	100
	Group1IIElectivePaper: Plant Ecology														
	2	24MSBO2201R	Plant Ecology-I	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSBO2202R	Plant Ecology-II	**DSC Major**	2	0	0	0	0	0	2	40	60	0	100
	Group1IIElectivePaper: Plant Physiology and Biochemistry														
	2	24MSBO2201R	Plant Physiology and Biochemistry-I	**DSC Major (Elective)**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSBO2202R	Plant Physiology and Biochemistry-II	**DSC Major (Elective)**	2	0	0	0	0	0	2	40	60	0	100
	Total										**22**				**400**
	Grand Total										**88**				**4400**

***IA: Internal Assessment, SEE: Semester End Examination, PE: Practical Examination**

SEMESTER – I									
Course Title	**Plant Diversity-I**								
Course code	**24MSBO111R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. Introduce the concept of diversity, life cycle pattern of vascular and non-vascular cryptogams. 2. To make learner understand about the Phylogeny and economic values of vascular and non-vascular cryptogams. 3. To impart various application of lower cryptogams for human welfare.								
CO1	Describe the characteristics of algae, identify, classify and their economic importance.								
CO2	Describe the characteristics, identify, classify fungi and lichen, and their economic importance.								
CO3	Describe the characteristics, identify, classify Bryophytes, and their economic importance.								
CO4	Describe the characteristics, identify, classify pteridophyte and their economic importance.								
CO5	Illustrate the industrial, agricultural and environmental aspects of algae and fungi.								

Unit-No.	Content	CH	Learning Outcome	KL
I	**ALGAE:** General account of Algae, Phylogenetic relationship, Classification of algae (Lee). Study of different classes of algae as per the classification of Lee (1989), Economic importance of algae.	8	Able to describe and explain about the different classes of algae and their economic importance.	1,2
II	**FUNGI:** General account of fungi, Evolution and Phylogeny, Classification of fungi (Alexopoulos and Mims). Study of different classes of fungi as per the classification of Alexopoulos and Mims (1979), Economic importance fungi. **LICHEN**: General account of lichen, structure and reproduction, Classification, Economic importance Lichen.	12	Able to describe and explain about the fungi and lichens and their economic importance.	1,2
III	**BRYOPHYTES:** General account of Bryophytes, Classification of Bryophytes (Reimer), Study of different classes of Bryophytes as the classification of Reimer, Economic importance bryophytes.	10	Able to describe and explain about the different classes of bryophytes and their economic importance.	1,2
IV	**PTERIDOPHYTES:** General account of Pteridophytes, Classification of Pteridophytes (Smith), Study of different classes of Pteridophytes as per the classification of Smith (1955), Economic importance Pteridophytes.	10	Able to describe and explain about the different classes of pteridophytes and their economic importance.	1,2
V	**APPLIED CRYPTOGAMS:** Algal biotechnology: algal biofuels, algal bio fertilizer, Algal culture, Bioremediation Fungal Biotechnology: Production of organic acid, Secondary metabolites, Single Cell Protein	5	Able to describe and explain about the different applications of algae and fungi.	1,2
Practical	1. Study of range of thallus organization and reproductive structures of algae with the help of suitable representatives. 2. Study of morphological, anatomical and reproductive features of some fungi growing in Assam.	30	Able to explain and demonstrate different groups of lower cryptogams	1,2,3,4

	3. Study of morphological and anatomical features of some lichens growing in Assam. 4. Study of some important genera of Bryophytes and Pteridophytes available in NE India with respect to their morphology, anatomy and reproductive structures.			

Text Books

T1. Textbook of Algae. B. P Sarabhai, C.KArora, Anmol Publishing Pvt. Ltd. New Delhi.
T2. Phycology (4th Edition) R.L. Lee, Cambridge University Press.
T3. Algae-An introduction to Phycology-CV and enHoek, DGMann, HMJanes, Cambridge University Press, 1995.
T4. HandBookofMicroalgalculture.EdbyA.Richmond.BlackwellPublishingHouse.
T5. Algae-Anatomy, Biochemistry and Biotechnology-L.Barsanti & P.Gualtieri.
Taylor & Francis.

Reference Books

R1. Hand Book of Microalg alculture. Ed by A.Richmond. Blackwell Publishing House, 2003.
R2. Algae-Anatomy,BiochemistryandBiotechnology-L.Barsanti&P.Gualtieri.Taylor&Francis,2006

Other Learning Resources:

https://www.sciencedirect.com/journal/algal-research

https://www.sciencedirect.com/topics/immunology-and-microbiology/lichen-organism

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the characteristics of algae, identify, classify and their economic importance.	**1, 3,4, 6**
2	Describe the characteristics, identify, classify fungi and lichen, and their economic importance.	**1, 3, 4, 6**
3	Describe the characteristics, identify, classify Bryophytes, and their economic importance.	**1, 3, 4, 6**
4	Describe the characteristics, identify, classify pteridophyte and their economic importance.	**1, 3, 4, 6**
5	Illustrate the industrial, agricultural and environmental aspects of algae and fungi.	**2, 3, 4, 6**

SEMESTER – I									
Course Title	**Plant Diversity-II**								
Course code	**24MSBO111R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To understand the geological time scale and types of fossils. 2. To make learner understand about the Phylogeny and economic values of gymnosperms and angiosperms. 3. To understand, explain and demonstrate the methods of plant exploration techniques.								
CO1	Explain Geological Time-scale, fossils, and its role in oil exploration.								
CO2	Describe the characteristics, identify, classify gymnosperms, and their economic importance.								
CO3	Describe the characteristics, identify, classify Angiosperm based on their floral morphology.								
CO4	Discuss the method for classifying plants, ICN principles and taxa concept.								
CO5	Demonstrate the method to prepare and maintenance of herbarium.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Geological Time-scale fossilization and Fossil types: Compressions, incrustation, casts, molds, petrifactions, coal balls and compactions, carbon dating-–Role of fossilin oil exploration. Salient features and affinities of fossil gymnosperms- Pro-Gymnosperms, Pteridos permales, Bennettitales, Pentoxylales, Cordaitales	10	Able to describe and explain about the geological time scale and different types of fossils.	1, 2
II	Classification of Gymnosperms (Sporne, 1965). Comparative study of vegetative, anatomy and reproductive structure of Cycadales, Ginkgoales, Taxales, Coniferales, Ephedrales & Gnetales Economic importance of Gymnosperm. Living fossils Affinities of Gymnosperms with Angiosperms and Pteridophytes.	8	Able to describe and explain about the gymnosperms and their economic importance.	1, 2
III	Origin and evolution of Angiosperms; In florescence and flowers; Co-evolution of flower and pollinators; Morphology of stamens and carpels; staminodia; nectaries; types of ovaries, morphology of in feriorovary; placent a and placentation. Role of morphology and anatomy in plant taxonomy.	10	Able to describe and explain about the evolution and morphology of Angiospermic flower.	1, 2
IV	Systems of Classification: Linnaeus, Bentham and Hooker, Takhtajan, Bessydicta, APGI, II, III systems–Merits and demerits. International code of Botanical Nomenclature, Botanical Gardens and Botanical survey of India. International Code of Nomenclature (ICN). History, Principles and major rules of nomenclature. concept of taxa, species, genus and family, in traspecific categories.	10	Able to describe and explain about the different classification systems of angiosperms.	1, 2
V	Methods of Plant exploration; Management of herbaria, major herbariain India and the World, Specimen preparation for herbarium, Role of herbariain taxonomy. Charcteristic feature, Phylogeny, and botanical description of importance of selected order-Fabales, Rubiales, Lamiales, Malpighiales, Liliales & Poales	7	Able to describe and explain about the methods of plant exploration.	1, 2

Practical	1. Study of some important genera of gymnosperms available in NE India with respect to their morphology, anatomy and reproductive structures. 2. Study of Angios permic flowers as well as stem and leaf with analytical drawings. 3. Collectionandpreparationofherbariumspecimens ofcommonplantsforfamiliarizationofherbariumte chniques. 4. Botanical description and identification upto the rank of species.	30	Able to explain and demonstrate gymnosperms and angiosperms.	1, 2, 3, 4

Text Books

T1. A Textbook of Botany: Angiosperms. B.P. Pandey; S.Chand Publishers Introduction to Embryophyta–Pteridophytes, Parihar, N.S. 2005. Central Book Dep, Allahabad.

T2. Palaeobotany. Shirpad N. Agashe. 1995. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.

Reference Books

R1. Plant Systematics, Gurucharan Singh, 2017. Oxford & IBH Publishing company (P) Ltd, New Delhi.

R2. Taxanomy of Angiosperms. Pandey. B.P. 2009. S.Chand & Co. Ltd. New Delhi.

Other Learning Resources:

https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/fossil-plant

https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/gymnosperm

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain Geological Time-scale, fossils, and its role in oil exploration.	**1, 3, 6**
2	Describe the characteristics, identify, classify gymnosperms, and their economic importance.	**1, 3, 4**
3	Describe the characteristics, identify, classify Angiosperm based on their floral morphology.	**1, 3, 6**
4	Discuss the method for classifying plants, ICN principles and taxa concept.	**1, 3, 4**
5	Demonstrate the method to prepare and maintenance of herbarium.	**2, 3, 4, 6**

SEMESTER – I									
Course Title	**Plant ecology and phytogeography**								
Course code	**24MSBO111R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To study about physical and biotic environment and its interactions. 2. To study about environment pollution and the effects of pollution on plants and ecosystems. 3. To study about Population and Community Ecology, Ecological succession. 4. To study about the concept of phytogeography, different routes and barriers to plant migration, centers of origin, different Phytogeographical regions of India and the Biodiversity significance of NE region.								
CO1	Explain the factors influencing environment.								
CO2	Explain population and community ecology.								
CO3	Describe ecosystem structure and function.								
CO4	Explain the principle and approaches used for conservation.								
CO5	Describe principle, objectives, and dynamism of phytogeography, demonstrate phytogeography of India.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**The Environment**: Physical environment, biotic environment, Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Laws of limiting factor Environmental pollution: Origin of pollution, types of pollutants, kinds of sources of air, soil and water pollution, parameters to assess the pollution level, effects of pollution on plants and eco systems, global warming and environmental change, Green house gas, acid rain.	10	Able to understand about the ecosystem, environment and global warming.	1, 2
II	**Population Ecology and Community Ecology:** Charactersofpopulationecology,density,Size ofpopulation,Spatialdistribution,agestructure, natality,mortality,bioticpotential,populationd ynamics,growthrate ofpopulation,competitionandco-existence,SpeciesInteractions,CommunityEc ology:Natureofcommunities;communitystruc tureand Species diversity.	8	Able to describe and explain about the population and community ecology.	1, 2
III	**Ecosystem Ecology**: Ecosystem structure; ecosystem function; energy flow and Biogeochemical cycles in Ecosystem: Atmospheric cycles, mineral cycling (C, N, S, P); Structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (freshwater, marine, estuarine), Ecological succession.	10	Able to explain about the structure and function of ecosystems.	1, 2
IV	**Conservation Biology**: Principles of conservation, major approaches to management, Indian case studies on conservation /management strategy (Project	10	Able to describe and explain about nature and its conservation strategies.	1, 2

	Tiger, Project Elephant, Biosphererereserves), biodiversity: status, monitoring and documentation in situconservation, ex-situconservation, protectedare as in India, sanctuaries, national parks, biosphererereserves. Botanicalgardens, fieldgenebanks, seed banks, invitrorepositories, cryobanks etc.			
V	**Phytogeography:** Definition, principles and objectives of Phytogeography, Descriptive and Dynamic Phytogeography, Continuous and discontinuous plant distribution in India; Routes and barriers to plantmigration, Centers of origin (Primary and secondary centers'); Endemism Types; Endemism in Indian flora; Age and Areahypothesis, Phytogeographical regions of India. The biodiversity significance of NE region.	7	Able to describe and explain about phytogeography and endemism.	1, 2
Practical	1. Determination of minimum size, number of quadrates necessary to study herbaceous communities. 2. Determination of abundance, density, frequency of plant communities by quadrate method. 3. Preparation of a map of India showing biogeographical zones.	30	Able to explain and demonstrate minimum size of quadrate for population study and determine the results upon field study.	1, 2, 3, 4

Text Books

T1. A Textbook of Plant Ecology by R.S. Ambasht

T2. Palaeobotany. Shirpad N. Agashe. 1995. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.

Reference Books

R1. Ecology Environmental Science and Conservation by J.S. Singh, S.R. Gupta & S.P.Singh.

R2. Bharucha, F.R.-A textbook of plantgeography. Oxford UniPress.

Other Learning Resources:

https://www.sciencedirect.com/journal/perspectives-in-plant-ecology-evolution-and-systematics

https://link.springer.com/journal/11258

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the factors influencing environment.	1, 3, 6
2	Explain population and community ecology.	1, 2, 3, 6
3	Describe ecosystem structure and function.	1, 3, 6
4	Explain the principle and approaches used for conservation.	1, 3, 6, 7
5	Describe principle, objectives, and dynamism of phytogeography, demonstrate phytogeography of India.	1, 3

SEMESTER – I									
Course Title	**Bioinstrumentation**								
Course code	**24MSBT111R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. Working principle of chromatography, centrifugation, PCR, microscopy, gel electrophoresis etc. 2. To understand the different types of chromatography, microscopy etc. 3. Application of Electrophoresis, Blotting and Microscopic Techniques etc.								
CO1	Students will understand and differentiate between various chromatographic methods.								
CO2	Students will gain comprehensive knowledge of the types, principles, and applications of gel electrophoresis, PCR, blotting technique and microscopy.								
CO3	Understanding on different separation techniques using centrifugation.								
CO4	Understanding of Radio-Isotope Dating and its applications.								
CO5	Students will understand spectroscopic methods.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Chromatography:** History; Classification; Types, principles, operation, application & analysis (Paper, Column, Adsorption column, Partition, Thin layer, Ion exchange, quantitative Ion exchange, and Gel Chromatography):	7	Able to describe, illustrate and explain the chromatography and their applications	1,2
II	**Gel Electrophoresis:** Application; Types; Principle; pH meter (Principle); Dialysis, **PCR**: Introduction, types and application. **Blotting technique:** Southern, Western, & Northern blot. **Microscopy**: Introduction, types and application.	8	Able to describe, illustrate and explain the electrophoresis, PCR, blotting technique and microscopy.	1,2
III	**Centrifugation:** Types; Application; Principle; rotors; density gradient & analytical centrifugation.	5	Able to describe, illustrate and explain the centrifuge	
IV	**Radio- isotope dating technique:** Introduction, nature, detection & measurement of radioactivity, radioisotopes & radiation, units, radioactive decay.	5	Able to describe, illustrate and explain the radio isotopes.	1,2
V	**Spectroscopic techniques:** Introduction, Principle and application of spectroscopy.	5	Able to describe, illustrate and explain the spectroscope	1,2

Text Books

T1. Upadhyay. Biophysical chemistry: principle and technique. 12th edition. Himalaya Publishing House Pvt. Ltd; 2017.

Reference Books

R1. Kakkar. Atomic and Molecular Spectroscopy. 1st edition. Cambridge English.
R2. Evans. Handbook of Chromatography. 2nd Edition, Willford Press.
R3. Holme and Peck. Analytical biochemistry. 3rd edition. Longman.

Other Learning Resources:

https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/chromatography

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will understand and differentiate between various chromatographic methods.	**3**
2	Students will gain comprehensive knowledge of the types, principles, and applications of gel electrophoresis, PCR, blotting technique and microscopy.	**3**
3	Understanding on different separation techniques using centrifugation.	**3**
4	Understanding of Radio-Isotope Dating and its applications.	**2**
5	Students will understand spectroscopic methods.	**2**

SEMESTER – I									
Course Title	**Field study-I**								
Course code	**24MSBT111R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	**1.** To give the students the field knowledge of habit, habitat of different plant groups. 2. Collection of wild plants from their habitat for preparation of herbarium. 3. Floristic study of a particular area and preparation of field reports.								
CO1	Illustrate the methods of plant specimen collection and preservation.								
CO2	Summarize strategies for plant specimen sample collection.								
CO3	Explain the methods of management and maintenance of the preserved plant specimens.								
CO4	Identify and preserve plant species of different plant groups.								
CO5	Write comprehensive report on the field exploration.								

Practical	**Content**	**CH**	**Learning Outcome**	**KL**
	1. Fieldtrip/excursion to the neighbouring states of Assam (5-7 days) for the collection and preservation of plant specimens like algae, fungi, lichen, bryophytes, pteridophytes, gymnosperms and angiosperms from their habitat. 2. Preservation of the collected specimens from field by herbarium technique. 3. Preservation of the collected algae, fungi specimens from field by preservatives. 4. Preparation and submission of field report and herbarium.	60	Able to describe, illustrate and explain the habit and habitats of different plant groups. Also able to describe, illustrate and explain the method of collection and preservation of specimens.	1,2

Text Books

T1. Payel Paul, Siyanda Dear, Dr. Monoranjan Chowdhury . Herbarium Technique: First Edition. Orange Books Publication Pvt. Ltd; 2020.

Reference Books

R1. Handbook of Field and Herbarium Methods, Rao, R R & S K Jain, 2016.

Other Learning Resources:

https://www.sciencedirect.com/science/article/pii/S0169534722002956
https://www.researchgate.net/publication/349640811_Herbarium_Technique

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Illustrate the methods of plant specimen collection and preservation.	**1**
2	Summarize strategies for plant specimen sample collection.	**3**
3	Explain the methods of management and maintenance of the preserved plant specimens.	**4,5**
4	Identify and preserve plant species of different plant groups.	**3**
5	Write comprehensive report on the field exploration.	**4,5**

SEMESTER – I									
Course Title	**MINI RESEARCH (REVIEW OF LITERATURE-R1)**								
Course code	**24MSBT114R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**0**	**4**	**6**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Botany**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course objectives	To develop students scientific writing skill								
CO1	Develop competence in writing and abstracting skills.								
CO2	Evaluate and understand technical writing skill.								
CO3	Comprehend different methods and techniques of research.								

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Employ databases and library resources to gather original research, books, and articles effectively	2
2	Summarize and differentiate between various types of reviews, specifically analytical and descriptive reviews.	2
3	Identify research topics and employ appropriate methods for collecting and filtering information.	2
4	Critically analyze the demonstrations and findings of previous authors to comprehend their contributions and insights.	3
5	Compose a detailed review that explains the prospects and future directions of the chosen study.	3

SEMESTER – I									
Course Title	**Fundamentals of Statistics**								
Course code	**24UMFS111R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Botany**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course objectives	1. Help to understand the role of statistics in data analysis, decision-making, and scientific research 2. Introduce students to descriptive statistics, including measures of central tendency (mean, median, mode) and measures of dispersion (range, variance, standard deviation). 3. Teach students how to summarize and present data effectively using tables, charts, and graphs.								
CO1	Improve understanding of Descriptive Statistics and Demography.								
CO2	Develop knowledge to understand the Probability theory, Distribution, and sampling methods.								
CO3	Develop knowledge to understand the methods for hypothesis testing and biological data analysis.								
CO4	Develop knowledge to understand the principles of various statistical analyses of data.								
CO5	Develop knowledge on R language for data analysis.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Statistical Methods**: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio.	5	Foundational Understanding of Statistical Concepts	1,2
II	**Presentation**: tabular and graphical, including histogram and ogives. Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, skewness and kurtosis.	5	Proficiency in Data Presentation and Analysis	1,2
III	**Bivariate data**: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, fitting of polynomials and exponential curves.	5	Knowledge on Analyzing Bivariate Data and Relationships	1,2,3
IV	**Random experiment**: trial, sample point and sample space, event, Operations of Events, concepts of mutually exclusive and exhaustive events. Definition of probability: classical and relative frequency approach. Discrete probability space, Properties of probability, Independence of events, Conditional probability, total and compound probability rules, Normal probability Distribution, Binomial probability Distribution, Poisson Probability Distribution, Bayes' theorem and its applications.	8	Understanding of Probability and Distributions	1,2,3
V	**Testing of hypothesis**, parametric test: t-test, z-test, chi-square test. Non-Parametric test: One sample Kolmogorov test, Wilcoxon Signed test, Mann-Whitney Test, Kruskal wails test.	7	Application of Hypothesis Testing and Statistical Tests	1,2,3
Practical	1. Introduction to R - A programming language and environment for data analysis and graphics. Syntax of R expressions: Vectors and assignment, vector arithmetic, generating regular sequence, logical vector, character vectors, Index vectors; selecting and modifying subsets of dataset 2. Data objects: Basic data objects, matrices, partition	30	A brief knowledge on using R for data analysis and visualization	1,2,3,4

	of matrices, arrays, lists, creating and using these objects; Functions- Elementary functions and summary functions, applying functions to subsets of data. Data frames: The benefits of data frames, creating data frames, combining data frames, Adding new classes of variables to data frames; Data frame attributes. 3. Importing data files: import. data function, read. table function; Exporting data: export. data function, cat, write, and write. table functions, function, formatting output - options, and format functions; Exporting graphs -export. graph function. Graphics in R: creating graphs using plot function, box plot, histogram, line plot, steam and leaf plot, pie chart, bar chart, multiple plot layout, plot titles, formatting plot axes; Visualizing the multivariate data: Scatter plot, Q-Q plot, P-P plot. 4. Performing data analysis tasks: Reading data with scan function, exploring data using graphical tools, computing descriptive statistics, one sample tests, two sample tests, Goodness of fit tests. 5.Parametric test and non-parametric test			

Text books:

T1: Methods in Biostatistics by K S Negi, ISBN: 9789374735053, 4th Edition, Year:2023, AITBS Publishers, INDIA

Reference books

R1; "Introduction to the Practice of Statistics" by David S. Moore, George P. McCabe, and Bruce A. Craig

R2: "Statistics" by David Freedman, Robert Pisani, and Roger Purves

Other learning resources:

https://www.sciencedirect.com/journal/computational-statistics-and-data-analysis

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve understanding of Descriptive Statistics and Demography.	**2**
2	Develop knowledge to understand the Probability theory, Distribution, and sampling methods.	**2**
3	Develop knowledge to understand the methods for hypothesis testing and biological data analysis.	**2**
4	Develop knowledge to understand the principles of various statistical analyses of data.	**2**
5	Develop knowledge on R language for data analysis	**3**

SEMESTER – I									
Course Title	**EFFECTIVE ENGLISH (Communicative English & Soft Skills)**								
Course code	**24UMPD111R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Botany**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course objectives	1. To introduce the types of sentences and their significance. 2. To strengthen the students' vocabulary to enhance their speaking and writing skills. 3. To familiarize the students with the importance of dress codes in various organizations. 4. Tointroducethe3P's (Planning, prioritizing & performing) of Time Management. 5. To give insight into English pronunciation and into central concepts in phonetics.								
CO1	This course will enable students to analysis and identify the different types of sentences.								
CO2	Learners will be able to integrate the skills of reading and speaking in professional communication.								
CO3	Dress code Etiquette sessions will boost their confidence and morals.								
CO4	Students will learn about the effective and efficient utilization of time.								
CO5	Introduction to Phonetics and its importance will improve the learners 'pronunciation.								

Unit	**Content**	**Contact Hour**	**Learning Out Come**	**KL**
MODULES	**Grammar** Interchange of Interrogative and Assertive Sentences, Exclamatory and Assertive Sentences, Types of Tenses, Common Errors, Synonyms, Antonyms, Homonyms		1. Identify and understand the structure of interrogative and assertive sentences. Transform and enhance grammatical accuracy and sentence formation skills.	
	Reading Skills Techniques of Effective Reading, gathering ideas and information from a text The SQ3R Technique Interpret the text		2. Develop strategies for faster reading with better comprehension and improve the ability to recall and organize textual information systematically.	
	Listening Skills What is listening? The Process of Listening, Factors that adversely affect Listening, Difference between Listening and Hearing, Purpose and Importance of Effective Listening, How to Improve Listening Process,		3. Understand the fundamental aspects and importance of listening. It also helps to enhance interpersonal and professional communication by practicing listening skills.	
	Conflict Management Definition**,** Type of Conflict Management**,** Effects of Conflict Management**,** Methods to deal with Conflicts (Negative)		4. Learn strategies to manage and resolve conflicts effectively to encourage a positive environment by turning conflicts into opportunities for growth.	
	Time-Management Skills Introduction To Time Management, Purpose and Importance of Time Management, Basic Tips to Maintain Time.		5. Enhance productivity and stress management through effective time allocation and planning. It helps to understand the importance of time management in achieving personal and professional goals.	
	Activity: Problem solving activity: A situation will be given to the students and they will have to tell us how to handle the situation or solve the problem.			

Text books:

T1: Wren, P.C and Martin, H. 1995. High School English Grammar and Composition, S Chand Publishing.
T2: English Grammar in Use, Raymond Murphy 4th edition, CUP.
T3: Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.

Reference books:

R1; English Vocabulary in Use (Advanced), Michael McCarthy and Felicity, CUP.
R2: Effective Communication and Soft Skills, Nitin Bhatnagar, Pearsons.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	This course will enable students to analysis and identify the different types of sentences.	**2**
2	Learners will be able to integrate the skills of reading and speaking in professional communication.	**3**
3	Dress code Etiquette sessions will boost their confidence and morals.	**3**
4	Students will learn about the effective and efficient utilization of time.	**2**
5	Introduction to Phonetics and its importance will improve the learners 'pronunciation	**2**

SEMESTER – I									
Course Title	**MOOCS-I**								
Course code	**24MSCE111R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Botany**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course objectives	As per the course opted.								
Course outcomes	As per the course opted.								
Course description	As per the online material available								

Teaching Objective	As per the course opted
Learning Outcomes/Course Outcome	As per the course opted

Course content:
As per the online material available.

Reference:
https://www.coursera.org/programs/assam-downtown-university-on-coursera rzqtn?currentTab=CATALOG

SEMESTER – II									
Course Title	**Plant cell, Genetics and Plant Breeding**								
Course code	**24MSBO121R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course Objectives	1. Introduce the basic concepts of genetics, helping students to develop their analytical, quantitative and problem- solving skills from classical to molecular genetics. 2. To provide insight into structure and functions of chromosomes, chromosome mapping, polyploidy and cytogenetic aspects of crop evolution. 3. To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.								
CO1	Describe the structure, function and biogenesis of cell and its organelles.								
CO2	Explain structure and function of chromatin, DNA condensation, plant cytoskeletal genes, cell cycle and apoptosis.								
CO3	Describe chromosome structure, its involvement in sex determination, aberrations and its impact on crop evolution.								
CO4	Explain the structure, regulation of prokaryotic and eukaryotic gene and its function.								
CO5	Describe hybridization, inbreeding, disease resistance, transgenes and practice backcross methods of plant breeding.								

Unit-No.	Content	CH	Learning Outcome	KL
I	Structure, functions and biogenesis of cell wall and plasma membrane. Structure and function of cytoplasmic cell organelles and biopolymers. Nucleus: Nuclear envelope, nuclear pore complex, trafficking between nucleus and cytoplasm.	10	Knowledge of structure of cell and its organelles.	1,2
II	Chromatin structure in eukaryotes, condensation and packaging of DNA in prokaryotes. Structure and function of plant cytoskeletal genes and gene products. Cell cycle and apoptosis.	8	To learn the basic structural organisation of chromatin and genes.	1,2
III	Chromosome: Structure and nomenclature, centromere and telomere. Sex determination: mechanisms, sex chromosomes, Chromosomal aberrations: Duplications, deficiencies/ deletions, inversions, interchanges/ translocations. Role of chromosomal aberrations in crop evolution. Ploidy changes: Haploids, polyploids and aneuploids.	10	To know about the chromosome and its behaviour.	1,2
IV	Fine structure of gene. Prokaryotic gene regulation. Mendelian and Non-Mendelian Inheritance. Chromosome theory of inheritance. Eukaryotic Genome: Evolution, structure and organization. Gene regulation. Recombination in Eukaryotes. Linkage and crossing over: basic concepts, linkage maps, correlation of genetic and physical maps, Post translational modifications of eukaryotes.	10	To understand the basics of gene structure and post transcriptional modifications.	1,2
V	Objectives and scope of plant breeding, hybridization in self and cross-pollinated crops, genetic basis of inbreeding depression and heterosis. Breeding for disease and insect resistance, transgenes and transgenic plants. Alien gene transfer through chromosome.	7	Able to describe and explain about the methods of plant breeding and its different applications.	1,2

	Transfer of gene through individual chromosome for distant hybridization. Back Cross methods of plant breeding.			
Practical	1. Preparation of stains and staining techniques for chromosome analysis. 2. Chromosome analysis, study of chromosome behaviour inmitosis and meiosis. 3. Karyotyping of dicot (mitosis)	30	Describe, illustrate and explain and apply staining techniques and carry out microscopic examination.	1,2,3,4

Text Books

T1. Genetics, B.D. Singh, Kalyani Publishers.

T2. Introduction to Genetic Analysis, 9th edition by Griffiths et al.

T3. Principles of Genetics by Snustad etal (2004).

Reference Books

R1. Concepts of Genetics, Klug, Cummings and Spencer.

R2. An Introduction to Plant Breeding, Jack Brown &Peter Caligiri.

R3. Fundamentals of Plant Breeding, Kuckuck, Hermann, Kobabe.

Other Learning Resources:

https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/chromosome

https://link.springer.com/journal/10577

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the structure, function and biogenesis of cell and its organelles.	**1,3**
2	To provide insight into structure and functions of chromosomes, chromosome mapping, polyploidy and cytogenetic aspects of crop evolution.	**1,2**
3	Describe chromosome structure, its involvement in sex determination, aberrations and its impact on crop evolution.	**1,4**
4	Explain the structure, regulation of prokaryotic and eukaryotic gene and its function.	**1,2**
5	Describe hybridization, inbreeding, disease resistance, transgenes and practice backcross methods of plant breeding.	**1,4**

SEMESTER – II									
Course Title	**Microbiology and Plant Pathology**								
Course code	**24MSBO122R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course Objectives	1. The course deals with the introduction, distribution/ diversity of microbes in soil, water, air, milk and its application in the field of agriculture, industry. 2. To make learner understand the method of isolation of microorganisms and their growth in the laboratory condition and also various culture techniques and instruments used for microbiological studies. 3. To impart the concept of symptomology and epidemiology of different plant disease.								
CO1	Describe about diversity of microorganisms.								
CO2	Demonstrate the method of isolation, pure culture, preservation of microbes and design to estimate microbial growth.								
CO3	Describe application of microorganisms in agriculture, fermented food, dairy, bio-waste management.								
CO4	Explain innate and acquired responses, antibodies, cells and tissues of immune system, serological reactions and sero diagnostics.								
CO5	Describe symptomatology, epidemiology and host-pathogen relationships, defense mechanisms, and strategies for plant disease control.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Microbial diversity- 'Species' and 'Strain' concept in microbiology, ICN for virus, bacteria and other microbes, microbiome concept, ecological significance of microbes, microbiology of soil, air, water and milk.	10	Knowledge of microbial diversity and ecology.	1,2
II	Microbial techniques-Isolation of microbes, pureculture, preservation, types of culture, growth, media sterilization and disinfection, sterilization techniques, population estimation (directs pore count, CFU, spectrophotometric method), pure culture and visualization techniques, culture preservation and maintenance.	10	To learn about the microbial techniques.	1,2
III	Applied microbiology- Application of microbes in the field of agriculture, fermented foods and dairy products, industry and bio-waste management.	7	To know about the applications of microbiology in different sectors.	1,2
IV	Immunology- Immunity, Innate and acquired immunity, antibodies, cells and tissues of the immune system, immune diseases, serological reactions and sero-diagnostics, cancer biology.	8	To understand the basics of immunology and cancer biology.	1,2

V	Plant Pathology-Symptomatology and epidemiology, methods of studying plant diseases, stages in disease development, recognition and entry processes of different pathogens like Bacteria and fungi in plant host cells, host-pathogen relationship, Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR), Control of plant diseases.	10	Able to describe and explain about the disease caused by different microbial agents in plants.	1,2
Practical	1. Isolation and pure culture of microbes from soil, air, water and disease plant materials. 2. Identification and characterization of isolated pure cultures. 3. Estimation of bacterial growth by spectrophotometric method and counting of cells. 4. Study of plant pathogenic fungi from diseased specimens (symptoms, causal organism and their morphological & reproductive characters.	30	Describe, illustrate and explain and apply microbial and plant pathogenic techniques and carry out microscopic examination.	1,2, 3,4

Text Books

T1. Microbiology-Pelzer, Chan, Krieg Tata McGraw Hill Publications. 5th Edition.

T2. Prescotts Microbiology, Dorothy Wood, Joanne Willey, Kathleen Sandman.12th Edition.

Reference Books

R1. P D Sharma, Microbiology and Plant Pathology, Rastogi Publication.

R2. P Chakraborty, A Textbook of Microbiology, New Central Book Agency 3rd Edition (2013)

Other Learning Resources

https://www.sciencedirect.com/journal/microbiologicalresearch

https://www.sciencedirect.com/special-issue/10DQJXMVLPT

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe about diversity of microorganisms.	**1, 3, 4**
2	Demonstrate the method of isolation, pure culture, preservation of microbes and design to estimate microbial growth.	**1, 3, 6**
3	Describe application of microorganisms in agriculture, fermented food, dairy, bio-waste management.	**2, 3, 4, 5, 6**
4	Explain innate and acquired responses, antibodies, cells and tissues of immune system, serological reactions and sero diagnostics	**1, 2, 3**
5	Describe symptomatology, epidemiology and host-pathogen relationships, defense mechanisms, and strategies for plant disease control.	**1, 3, 4, 6**

SEMESTER – II									
Course Title	**Plant physiology and biochemistry**								
Course code	**24MSBO123R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course Objectives	1. This course aims to educate student on concepts of proteins, enzymes. 2. Basic plant signaling mechanisms, sensory photobiology. 3. The course further deals with physiology of plant hormones, reproduction, enzymology metabolism, photosynthesis and respiration.								
CO1	Describe membrane transport mechanism and environmental stress on plants.								
CO2	Explain mechanism of electron transport system during photosynthesis and pathway of photorespiration and respiration.								
CO3	Describe plant hormones, enzymes, regulation of enzymes and Enzyme Kinetics.								
CO4	Explain structure of protein and role of thermodynamics in plants.								
CO5	Describe signal transduction in Bacteria and plants.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Membrane transport and trans location of water and solute. Stress physiology: Waterstress, heat Stress, coldstress. Flooding and ROS formation and oxidative stress (Uniport, Symport, Anti port channels, Pressure flow model, Polymert rapping mode).	10	Knowledge of plant transport and stress biology.	1, 2
II	Photosynthesis: Light harvesting system, Mechanisms of electron transport, photo protective mechanisms, CO_2 fixation-C3, C4 and CAM pathways. Respiration and photo respiration: Citric acid cycle; plant mitochondrial electron transport and ATP synthesis, alternate oxidase, photo respiratory path way.	10	To learn about the plant photosynthesis reactions.	1, 2
III	Plant hormones: Biosynthesis, storage, break down and translocation. Mechanism of action of plants hormones. Enzyme and regulation, Enzyme kinetics and other growth regulators, Derivation of Michaelis Menten equation.	7	To know about the biosynthesis and applications of plant hormones.	1, 2
IV	Protein structure and protein synthesis (folding, ticketing, degradation, purification, detection and functional characterization), Application of principles of thermodynamics in biology. Nitrate and ammonium as similation, amino acid biosynthesis complex, Translational proof - reading, Translational inhibitors and Post-Translational modification of proteins.	8	To understand the protein structure and functions.	1, 2
V	Signal Transduction: Overview second messengers, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, specific signalling, mechanisms and their regulation. Specific signalling. Mechanismin bacteria and plants.	10	Able to describe and explain about the signal transduction in plants.	1, 2
Practical	1. Determination of water potential using gravimetric method. 2. Extraction of carbohydrates from plant	30	Describe, illustrate and explain and apply plant physiological and biochemical reactions.	1, 2, 3,

	materials and estimation of reducing and non-Reducing sugars. 3. Extraction and estimation of proteins from plant materials by Lowry's method using BSA standard curve. 4. Extraction of chloroplast pigments and quantitative estimation with determination of cholorophy ll a/b ratio and total chlorophy ll in C3, C4 and CAM plants.			4

Text Books

T1. Buchanan B.B, Gruissem W. and Jones R. L (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA

T2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley &Sons, U.S.A. 4th Edition.

Reference Books

R1. Bajracharya, D., (1999).Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

Other Learning Resources

https://www.sciencedirect.com/journal/journal-of-plant-physiology

https://www.sciencedirect.com/topics/medicine-and-dentistry/plant-physiology

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe membrane transport mechanism and environmental stress on plants.	1,2.6
2	Explain mechanism of electron transport system during photosynthesis and pathway of photorespiration and respiration.	1,3,8
3	Describe plant hormones, enzymes, regulation of enzymes and Enzyme Kinetics.	1,2,3
4	Explain structure of protein and role of thermodynamics in plants.	1,3,8
5	Describe signal transduction in Bacteria and plants.	1,3,8

SEMESTER - II									
Course Title	**Techno Professional Skills –I (Mushroom Cultivation)**								
Course code	**24MSBO124R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course objectives	1. To create awareness about the Mushroom among the people. 2. To strengthen the promotion of mushroom cultivation by establishing a well-equiped laboratory and offices. 3. To know and explore the cultivation in Assam.								
CO1	Describe the method of producing mushroom spawn and the cultivation process for mushrooms, including substrate preparation, inoculation, and environmental conditions required for successful growth.								
CO2	Illustrate the techniques involved in fungal culture for mushroom spawn production, such as agar plate methods, liquid culture techniques, and spawn generation using grain or sawdust.								
CO3	Explain the techniques for cultivating mushrooms, including methods for maintaining optimal humidity, temperature, and light conditions, as well as managing pests and diseases.								
CO4	Describe the management of spent mushroom substrate, including strategies for composting or vermicomposting to recycle organic waste and improve soil fertility.								
CO5	Explain the commercial aspects of mushroom production, including market analysis, business planning, and strategies for developing entrepreneurship in the mushroom industry.								
Practical	**Content**		**CH**	**Learning Outcome**					**KL**
	1. Laboratory techniques for production of mushroom spawn Staining techniques: 2. Method for cultivation of mushroom. 3. Utilization of mushroom spent (waste). 4. Hands on training on commercial cultivation process of mushroom (field/ industry visit).		**60**	Understand the cellular organization and functions					1,2, 3,4

Text books

T1. Mushroom Cultivation Technology by Joy Sarkar, Krishnendu Acharya, Anirban Roy (Author). Publisher: Techno World.

T2. Handbook of Mushrooms 4th Edition by Bahl N, Oxford & Ibh Publishing

Reference books

R1. Mushroom Cultivation by Parveen Garg, Publisher: B.R. Publishing Corporation, ISBN:9788193031421.

R2. Mushrooms: A Manual for Cultivation by S. Biswas, M. Datta, S. V. Ngachan, PHILearning

Other Learning Resources:

https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/mushroom-growing

https://www.sciencedirect.com/science/article/pii/S2666833521000769

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the method of producing mushroom spawn and the cultivation process for mushrooms, including substrate preparation, inoculation, and environmental conditions required for successful growth.	**1.2.3**
2	Illustrate the techniques involved in fungal culture for mushroom spawn production, such as agar plate methods, liquid culture techniques, and spawn generation using grain or sawdust.	**1,2,3,4**
3	Explain the techniques for cultivating mushrooms, including methods for maintaining optimal humidity, temperature, and light conditions, as well as managing pests and diseases.	**2,3,6**
4	Describe the management of spent mushroom substrate, including strategies for composting or vermicomposting to recycle organic waste and improve soil fertility.	**2,3,7**
5	Explain the commercial aspects of mushroom production, including market analysis, business planning, and strategies for developing entrepreneurship in the mushroom industry.	**3,4,7**

SEMESTER -II									
Course Title	**Mini Research (Research gap analysis-R2)**								
Course code	**24MSBO125R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/f**	**C**
		Total hours:60	**0**	**0**	**0**	**4**	**12**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course objectives	1.To determine whether the objectives of review of literature gap analysis have been met, if not what steps can be taken accordingly.								
CO1	Create and implement a plan to bridge the gap								
CO2	Find the gap and evaluate solutions.								
CO3	Identify the ideal future state/action plan								
CO4	To analyse the current state/work of research								
CO5	To implement the strategies to meet the research gap under supervision.								

Text books

1. T1. Multiple Stressors: Literature Review and Gap Analysis (WERF Research Report Series) by S.M. Swanson.

SEMESTER – II									
Course Title	**Open elective- Coursera**								
Course code	**24MSBO126R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course objectives	As per the course opted.								
Course outcomes	As per the course opted.								
Course description	As per the online material available								

Teaching Objective	As per the course opted
Learning Outcomes/Course Outcome	As per the course opted

Course content:
As per the online material available.

Reference:
https://www.coursera.org/programs/assam-downtown-university-on-coursera rzqtn?currentTab=CATALOG

SEMESTER – II									
COURSE TITLE	**Research Methodology and Statistical Analysis**								
Course code	**24UMRM121R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/f**	**C**
		Total hours:15T+60S	**1**	**0**	**0**	**4**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course objectives	1. The course aims to enhances the students' a broad understanding of research methodology, including theory of science and qualitative and quantitative methods in research. 2. The course seeks to enhance the students' skills for developing critical thinking through research literature review in different domain. Consequently, it aims to develop skills for preparation of a research proposal for a master' thesis project/Mini research. 3. To develop Students competency in planning, conducting, evaluating and presenting a research project.								
CO1	Students will have basic knowledge of Research methods.								
CO2	Students will gain the knowledge of Research Methodology.								
CO3	Students will be able to gain the Skill questionnaire development.								
CO4	Students will be able to acquire the knowledge of basic Report/dissertation Procedure.								
CO5	Knowledge on different IPR rights								

Unit no	**Content**	**CH**	**Learning Outcome**	**KL**
I	Research Methodology- An Introduction- meaning and objectives of research, motivation in research, types and significance of research, criteria of good research. Defining the Research Problems- definition of research problem, necessity of defining research problem	2	Understand research methodology, motivations, types, significance, good research criteria, and defining research problems.	1,2
II	Research Design- meaning and need of research design, features of a good design, different research designs, Sampling Design- steps in sampling design, Sample Size determination, criteria for selecting a sampling design, different types of sampling design, Experimental Design, Principles of Design of Experiment, One – way ANOVA, Two- Way ANOVA, CRD, RBD, LSD, 22, 23 Factorial Design	4	Master research design principles, sampling methods, experimental design, and various ANOVA and factorial designs.	1,2
III	Types of data, sources of data collection, tools of data collection, Nominal, ordinal, interval and ratio– Attitude scale construction and measurement, rating scales, semantic differential (SD), Use of scale in statistical analysis, Schedules for interviews preparation and standardization, development of survey instruments and item analysis for the questionnaire	3	Learn data types, collection methods, scales, survey instruments, and statistical analysis for research questionnaires.	1,2
IV	Planning and organizing research report, Format of research report, Different steps of writing report, lay out of the research report, how to organize thesis/Dissertation, mechanics of writing research report, standard methods of quoting- presenting the result, written and oral reports, Uses of abstract, format of research report, presentation of statistics - tabular and graphic references and uses of references, Bibliography and presentation of bibliography	3	Master research report planning, formatting, writing, presentation, quoting methods, and bibliography preparation.	1,2
V	Intellectual property right (IPR), Introduction and the need for IPR, IPR in India and	3	Understand IPR concepts, global and Indian frameworks,	1,2

	worldwide, Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications, Patentable and non-patentable, patenting life, Filing of a patent application, The different layers of the international patent system, Case studies on Basmati rice, Turmeric, and Neem patents		patents, trademarks, and key case studies.	
Practical	Laboratory using R Software: 1 Analysis of One-way ANOVA; 2 Analysis of Two-way ANOVA; 3 Analysis of CRD 4 Analysis of RBD 5 Analysis of 22 and 23 Factorial Experiment 6 Simulation-I using R (Bernoulli, Binomial, Poisson and Geometric distribution.). 7 Simulation-II using R (Exponential and Normal distribution). 8 Simple random Sampling 9 Stratified Random Sampling	60	Conduct and analyze ANOVA, CRD, RBD, factorial experiments, simulations, and sampling using R software.	1,2,3,4

Text books

T1. Jerome L. Myers, Arnold D. Well, Robert F. Lorch, Jr. Research design and statistical analysis, 3rd edition.

Reference books

R1. Johnson & Christensen. (2004). Educational Research: Quantitative, qualitative and mixes approaches, 2nd Ed. Boston: Allyn & Bacon.

https://www.sciencedirect.com/journal/statistical-methodology

https://www.sciencedirect.com/journal/computational-statistics-and-data-analysis

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will have basic knowledge of Research methods.	**2**
2	Students will gain the knowledge of Research Methodology.	**3**
3	Students will be able to gain the Skill questionnaire development.	**3**
4	Students will be able to acquire the knowledge of basic Report/dissertation Procedure.	**1**
5	Knowledge on different IPR rights	**2**

SEMESTER – II									
Course Title	**UNIVERSAL HUMAN VALUES (UHV) + PROFESSIONAL ETHICS**								
Course code	**24UUHV101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours:15T+30P	**1**	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course objectives	1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings 2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of Existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way 3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.								
CO1	The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.								
CO2	It is free from any dogma or value prescriptions.								
CO3	It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation.								
CO4	This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self- evolution								
CO5	This self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs.								
Unit	**Content**								
I	• Understanding the need, basic guidelines, content and process for Value Education • Self-Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration • Continuous Happiness and Prosperity- A look at basic Human Aspirations • Right understanding, Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority. • Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario • Method to fulfil the above human aspirations: understanding and living in harmony at various levels.								
II	• Understandinghumanbeingasaco-existenceofthesentient'I'andthematerial 'Body' • Understanding the needs of Self ('I') and 'Body' - *Sukh* and *Suvidha* • Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) • Understanding the characteristics and activities of 'I' and harmony in'I' • Understanding the harmony of I with the Body: *Sanyam* and *Swasthya*; correct appraisal of Physical needs, meaning of Prosperity in detail • Programs to ensure *Sanyam* and *Swasthya*-Practice Exercises and Case Studies will be taken up in Practice Sessions.								
III	• Understanding Harmony in the family – the basic unit of human interaction • Understanding values in human-human relationship; meaning of Nyaya and program for its fulfilment to ensure Ubhay-tripti; • Trust (Vishwas) and Respect (Samman) as the foundational values of relationship • Understanding the meaning of Vishwas; Difference between intention and competence. • Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship • Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals • Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj),								

	Universal Order (Sarvabhaum Vyawastha)- from family to world family! -Practice Exercises and Case Studies will be taken up in Practice Sessions.
IV	• Understanding the harmony in the Nature • Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature • Understanding Existence as Co-existence (*Sah-astitva*) of mutually interacting units in all-pervasive space • Holistic perception of harmony at all levels of existence-Practice Exercises and Case Studies will be taken up in Practice Sessions.
V	• Natural acceptance of human values • Definitiveness of Ethical Human Conduct • Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order • Competence in professional ethics: ➢ Ability to utilize the professional competence for augmenting universal human order ➢ Ability to identify the scope and characteristics of people-friendly and eco- friendly production systems, ➢ Ability to identify and develop appropriate technologies and management patterns for above production systems. • Case studies of typical holistic technologies, management models and production systems • Strategy for transition from the present state to Universal Human Order: ➢ At the level of individual: as socially and ecologically responsible engineers, technologists and managers ➢ At the level of society: as mutually enriching institutions and organizations
Guidelines and Content for Practice Sessions	UNIT 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education PS 1: Introduce yourself in detail. What are the goals in your life? How do you set your goals in your life? How do you differentiate between right and wrong? What have been your achievements and shortcomings in your life? Observe and analyze them Expected outcome: the students start exploring themselves; get comfortable to each other and to the teacher and start finding the need and relevance for the course. PS 2: Now-a-days, there is a lot of voice about many techno-genic maladies such as energy and natural resource depletion, environmental pollution, global warming, ozone depletion, deforestation, soil degradation, etc. – all these seem to be man-made problems threatening the survival of life on Earth – What is the root cause of these maladies & what is the way out in your opinion? On the other hand, there is rapidly growing danger because of nuclear proliferation, arms race, terrorism, criminalization of politics, large scale corruption, scams, breakdown of relationships, generation gap, depression & suicidal attempts, etc – what do you think, is the root cause of these threats to human happiness and peace – what could be the way out in your opinion? Expected outcome: the students start finding that technical education without study of human values can generate more problems than solutions. They also start feeling that lack of understanding of human values is the root cause of all problems and the sustained solution could emerge only through understanding of human values and value based living. Any solution brought out through fear, temptation or dogma will not be sustainable. PS 3: 1. Observe that each one of us has Natural Acceptance, based on which one can verify right or not right for him. Verify this in case of i) What is Naturally Acceptable to you in relationship- Feeling of respect or disrespect? ii) What is Naturally Acceptable to you – to nurture or to exploit others? Is your living the same as your natural acceptance or different? 2. Out of the three basic requirements for fulfilment of your aspirations- right understanding, relationship and physical facilities, observe how the problems in your family are related to each. Also observe how much time & effort you devote for each in your daily routine. Expected outcome: 1. The students are able to see that verification on the basis of natural acceptance and experiential validation through living is the only way to verify right or wrong, and referring to any

	external source like text or instrument or any other person cannot enable them to verify with authenticity; it will only develop assumptions. 2. The students are able to see that their practice in living is not in harmony with their natural acceptance most of the time, and all they need to do is to refer to their natural acceptance to remove this disharmony. 3. The students are able to see that lack of right understanding leading to lack of relationship is the major cause of problems in their family and not the lack of physical facilities in most of the cases, while they have given higher priority to earning of physical facilities in their life ignoring relationships and not being aware that right understanding is the most important requirement for any human being. UNIT 2: Understanding Harmony in the Human Being - Harmony in Myself! PS 4: List down all your desires. Observe whether the desire is related to Self (I) or Body. If it appears to be related to both, see which part of it is related to Self (I) and which part is related to Body. Expected outcome: the students are able to see that they can enlist their desires and the desires are not vague. Also they are able to relate their desires to 'I' and 'Body' distinctly. If any desire appears related to both, they are able to see that the feeling is related to I while the physical facility is related to the body. They are also able to see that 'I' and 'Body' are two realities, and most of their desires are related to 'I' and not body, while their efforts are mostly centered on the fulfilment of the needs of the body assuming that it will meet the needs of 'I' too. PS 5: 1. a. Observe that any physical facility you use, follows the given sequence with time : Necessary & tasteful→ unnecessary & tasteful → unnecessary & tasteless →intolerable b. In contrast, observe that any feeling in you is either naturally acceptable or not acceptable at all. If naturally acceptable, you want it continuously and if not acceptable, you do not want it any moment! 2. List down all your activities. Observe whether the activity is of 'I' or of Body or with the participation of both 'I' and Body. 3. Observe the activities within 'I'. Identify the object of your attention for different moments (over a period of say 5 to 10 minutes) and draw a line diagram connecting these points. Try to observe the link between any two nodes. Expected outcome: 1. The students are able to see that all physical facilities they use are required for a limited time in a limited quantity. Also they are able to see that in case of feelings, they want continuity of the naturally acceptable feelings and they do not want feelings which are not naturally acceptable even for a single moment. 2. the students are able to see that activities like understanding, desire, thought and selection are the activities of 'I' only, the activities like breathing, palpitation of different parts of the body are fully the activities of the body with the acceptance of 'I' while the activities they do with their sense organs like hearing through ears, seeing through eyes, sensing through touch, tasting through tongue and smelling through nose or the activities they do with their work organs like hands, legs etc. are such activities that require the participation of both 'I' and body. 3. The students become aware of their activities of 'I' and start finding their focus of attention at different moments. Also they are able to see that most of their desires are coming from outside (through preconditioning or sensation) and are not based on their natural acceptance. PS 6: 1. Chalk out programs to ensure that you are responsible to your body- for the nurturing, protection and right utilisation of the body. 2. Find out the plants and shrubs growing in and around your campus. Find out their use for curing different diseases. Expected outcome: The students are able to list down activities related to proper upkeep of the body and practice them in their daily routine. They are also able to appreciate the plants wildly growing in and around the campus which can be beneficial in curing different diseases. UNIT 3: Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship PS 7: Form small groups in the class and in that group initiate dialogue and ask the eight questions related to trust. The eight questions are:

	1a. Do I want to make myself happy? 2a. Do I want to make the other happy? 3a. Does the other want to make him happy? 4a. Does the other want to make me happy? What is the answer? Intention (Natural Acceptance) 1b. Am I able to make myself always happy? 2b. Am I able to make the other always happy? 3b. Is the other able to make him always happy? 4b. Is the other able to make me always happy? What is the answer? Competence Let each student answer the questions for himself and everyone else. Discuss the difference between intention and competence. Observe whether you evaluate your intention& competence as well as the others' intention & competence. Expected outcome: The students are able to see that the first four questions are related to our Natural Acceptance i.e. Intention and the next four to our Competence. They are able to note that the intention is always correct, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention as a result we conclude that I am a good person and other is a bad person. PS 8: 1. Observe on how many occasions you are respecting your related ones (by doing the right evaluation) and on how many occasions you are disrespecting by way of under- evaluation, over-evaluation or otherwise evaluation. 2. Also observe whether your feeling of respect is based on treating the other as yourself or on differentiations based on body, physical facilities or beliefs. Expected outcome: The students are able to see that respect is right evaluation, and only right evaluation leads to fulfilment in relationship. Many present problems in the society are an outcome of differentiation (lack of understanding of respect), like gender biasness, generation gap, caste conflicts, class struggle, dominations through power play, communal violence, clash of isms, and so on so forth. All these problems can be solved by realizing that the other is like me as he has the same natural acceptance, potential and program to ensure a happy and prosperous life for him and for others though he may have different body, physical facilities or beliefs. PS 9: 1. Write a note in the form of story, poem, skit, essay, narration, dialogue to educate a child. Evaluate it in a group. 2. Develop three chapters to introduce 'social science- its need, scope and content' in the primary education of children Expected outcome: The students are able to use their creativity for educating children. The students are able to see that they can play a role in providing value education for children. They are able to put in simple words the issues that are essential to understand for children and comprehensible to them. The students are able to develop an outline of holistic model for social science and compare it with the existing model. UNIT 4: Understanding Harmony in the Nature and Existence - Whole existence as Co-existence PS 10: List down units (things) around you. Classify them in four orders. Observe and explain the mutual fulfilment of each unit with other orders. Expected outcome: The students are able to differentiate between the characteristics and activities of different orders and study the mutual fulfilment among them. They are also able to see that human beings are not fulfilling to other orders today and need to take appropriate steps to ensure right participation(in terms of nurturing, protection and right utilization) in the nature. PS 11: 1. Make a chart for the whole existence. List down different courses of studies and relate them to different units or levels in the existence. 2. Choose any one subject being taught today. Evaluate it and suggest suitable modifications to make it appropriate and holistic. Expected outcome: The students feel confident that they can understand the whole existence; nothing is a mystery in this existence. They are also able to see the interconnectedness in the nature, and point out how different courses of study relate to the different units and levels. Also they are

	able to make out how these courses can be made appropriate and holistic. UNIT 5: Implications of the above Holistic Understanding of Harmony at all Levels of Existence PS 12: Choose any two current problems of different kind in the society and suggest how they can be solved on the basis of natural acceptance of human values. Suggest steps you will take in present conditions. Expected outcome: The students are able to present sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them. PS 13: 1. Suggest ways in which you can use your knowledge of Technology/Engineering/Management for universal human order, from your family to the world family. 2. Suggest one format of humanistic constitution at the level of nation from your side. Expected outcome: The students are able to grasp the right utilization of their knowledge in their streams of Technology/Engineering/ Management to ensure mutually enriching and recyclable productions systems. PS 14: The course is going to be over now. Evaluate your state before and after the course in terms of a. Thought b. Behavior and c. Work d. Realization Do you have any plan to participate in the transition of the society after graduating from the institute? Write a brief note on it. Expected outcome: The students are able to sincerely evaluate the course and share with their friends. They are also able to suggest measures to make the course more effective and relevant. They are also able to make use of their understanding in the course for a happy and prosperous society.

Text book

T1: R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2

Reference

R1: B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
R2. PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Purblisher.
R3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986,1991
R4: Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
R5:Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III,1972, limits to Growth, Club of Rome's Report, Universe Books.
R6. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) KrishiTantra Shodh, Amravati.
R7. A Nagraj, 1998, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.
R8. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
R9. A.N. Tripathy, 2003, Human Values, New Age International Publishers.

Other Learning Resources

1.Value Education websites, http://uhv.ac.in, http://www.uptu.ac.in
2.Story of Stuff, http://www.storyofstuff.com
3.Al Gore, An Inconvenient Truth, Paramount Classics, USA
4.Charlie Chaplin, Modern Times, United Artists, USA
5.IIT Delhi, Modern Technology – the Untold Story

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.	**2**
2	It is free from any dogma or value prescriptions.	**2**
3	It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation.	**1**
4	This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self-evolution.	**0**
5	This self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs.	**0**

Semester-II									
Course Title	**COMMUNICATION MASTERY (Communicative English & Soft Skills)**								
Course code	**24UMPD121R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/f**	**C**
		Total hours: 15T+30P	**1**	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**22UMPD111R Effective English**	**Co-requisite**	**Nil**						
programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course objectives	1. To familiarize students with the transformation of sentences and the appropriate use of prepositions. 2. To enhance the writing skills in different areas including CV and cover letter writing. 3. To convey meaning by reinforcing, substituting for, or contradicting verbal communication. 4. Productivity and performance boosting activities for professional goal achievement.								
CO1	Practice of grammar will polish their writing skills.								
CO2	It will enhance their communication and interpretative skills.								
CO3	Introduction to behavioural skills, thoughts, and emotions will enable them to behave in a conscious and productive way.								
CO4	It will have a positive impact in their thought process and problem-solving skills.								

Unit	Content
Module 1- Grammar	I. Use of Prepositions II. Tag questions III. Idioms, Phrases and Clauses **IV.** Simple, complex, compound sentences
Module 2- Grammar	I. Active and Passive Voice **II.** Direct and Indirect Speech
Module 3- Writing Skills	I. The Basics of Writing; avoid ambiguity and vagueness II. Paragraph Writing III. Precis Writing IV. Letter Writing **V.** Resume, CV and Cover Letter
Module 4- Self-Management Skills	I. SWOT Analysis II. Self-Regulation- Goal Setting **III.** Personal Hygiene
Module 5- Non- Verbal Communication- Sciences of Body Language	I. What is Non-Verbal Communication & Body Language, II. Elements of Communication, III. Types of Body Language, IV. Importance and Impact of Body Language, V. Types of Communication through Body Language, VI. Introduction to Haptic, Introduction to Kinesics VII. Introduction to Proxemics, **VIII.** Body Language Do's and Don'ts, Doubt Clearing Session.
Module 6- Group Discussion (Theory)	I. Importance, II. Planning, Elements, and Skills assessed; III. Effectively disagreeing, IV. Initiating, Summarizing and Attaining the Objective

Text book

T1. Barrett, Grant. 2016.Perfect English Grammar: The Indispensible Guide to Excellent Writing and Speaking, Zephyros Press.

T2. McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition).

Reference books

R1. Communication Skills Training: A Practical Guide to Improving Your Social Intelligence, Presentation and Social Speaking, Ian Tuhovsky,2019

R2. A Textbook for AECC English Communication: Interface, Dr. Kironmoy Chetia and Pranami Bania Breez Mohan Hazarika, January2019.

Other Learning Resources:
https://youtu.be/x60GHpQ8gJk
https://youtu.be/Ke_oSN-BCaY
https://youtu.be/TDPDtrLxT-c
https://www.classcentral.com/report/toefl-preparation/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain prepositions, tag questions, and idioms correctly.	**5**
2	Discuss and analyze different sentence types and voices.	**2, 5**
3	Explain effective paragraphs, precis, and professional documents.	**3, 5**
4	Describe SWOT analysis, goal setting, and personal hygiene principles.	**5**
5	Illustrate non-verbal communication and body language concepts.	**5**

SEMESTER – II									
Course Title	**MOOCS-II**								
Course code	**24MSCE121R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30 T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course objectives	As per the course opted.								
Course outcomes	As per the course opted.								
Course description	As per the online material available								

Teaching Objective	As per the course opted
Learning Outcomes/Course Outcome	As per the course opted

Course content:
As per the online material available.

Reference:
https://www.coursera.org/programs/assam-downtown-university-on-coursera rzqtn?currentTab=CATALOG

SEMESTER – III									
Course Title	**MOOCS-III**								
Course code	**24MSCE211R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Botany**								
Semester	**Fall/ III Semester of 2nd year of the program**								
Course objectives	As per the course opted.								
Course outcomes	As per the course opted.								
Course description	As per the online material available								

Teaching Objective	As per the course opted
Learning Outcomes/Course Outcome	As per the course opted

Course content:
As per the online material available.

Reference:
https://www.coursera.org/programs/assam-downtown-university-on-coursera rzqtn?currentTab=CATALOG

SEMESTER – III									
Course Title	**MOOCS - IV**								
Course code	**24MSCE212R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours:	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Botany**								
Semester	**Fall/ III Semester of 2nd year of the program**								
Course objectives	As per the course opted.								
Course outcomes	As per the course opted.								
Course description	As per the online material available								

Teaching Objective	As per the course opted
Learning Outcomes/Course Outcome	As per the course opted

Course content:

As per the online material available.

Reference:

https://www.coursera.org/programs/assam-downtown-university-on-coursera rzqtn?currentTab=CATALOG

Semester III									
Course title	**Techno-Professional Skills II (Bio fertilizer production)**								
Course code	**24MSBT211R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	Nil	**Co-requisite**	**NA**						
Programme	**MSc. Botany**								
Semester	**Fall/ III Semester of 2nd year of the program**								
Course Objectives	1. Appreciate the agronomic importance of beneficial micro-organisms. 2. Formulate, produce and apply Bio fertilizers in a pilot scale.								
CO1	Isolate nitrogen-fixing, phosphate-solubilizing bacteria, and mycorrhizal fungi cultures.								
CO2	Apply biofertilizers effectively in paddy fields, agriculture, and floriculture applications.								
CO3	Gain practical skills in commercial biofertilizer production through industry visits.								

Unit no	**Content**	**CH**	**Learning outcome**	**KL**
I	Isolation of pure culture of Nitrogen fixing, Phosphate solubilizing bacteria and mycohhrizal fungi	**10**	Isolate pure cultures of nitrogen-fixing bacteria, phosphate-solubilizing bacteria, and mycorrhizal fungi.	1,2
II	Application of biofertilizer on paddy field, agricultural land and floriculture.	**10**	Apply biofertilizers in paddy fields, agriculture, and floriculture effectively.	1,2
III	Hand on training on commercial production of biofertilizer (industry visit)	**10**	Learn commercial biofertilizer production techniques through hands-on industry training visits.	1,2

Text Books

T1: A text book of microbiology, second reprint. S. Chand and Company Ltd., New Delhi. Ann Larkin Hansen 2010,

Reference Books

R1. Kannaiyan, S. 2002 Biotechnology of Bio fertilizers. Narosa publishing house, New Delhi. Dubey, R.C. 2001.
R2. Dubey, R. C. 2008. A Textbook of Biotechnology. S. Chand & Co., New Delhi.

Other learning resources:

https://www.sciencedirect.com/science/article/pii/S2666517421000742
https://www.sciencedirect.com/topics/earth-and-planetary-sciences/biofertilizer

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES5

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the Importance of biofertilizers in plant development.	**1, 2, 8**
2	Describe mass cultivation and inoculation.	**1, 2, 3**
3	Explain the importance of Azolla as a biofertilizers.	**1, 2, 8**
4	Describe the importance of phosphate in biofertilizers.	**1, 2, 8**
5	Apply the knowledge on the use of Fungi and Mycorrhiza.	**1, 8**

SEMESTER – III									
Course Title	**Open elective (Coursera)**								
Course code	**24MSBO217R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Botany**								
Semester	**Fall/ III Semester of 2nd year of the program**								
Course objectives	As per the course opted.								
Course outcomes	As per the course opted.								
Course description	As per the online material available								

Teaching Objective	As per the course opted
Learning Outcomes/Course Outcome	As per the course opted

Course content:
As per the online material available.

Reference:
https://www.coursera.org/programs/assam-downtown-university-on-coursera rzqtn?currentTab=CATALOG

Semester-III									
Course title	**Research Ethics**								
Course code	**24UMRE211R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 15T	**1**	**0**	**0**	**0**	**0**	**0**	**1**
Pre-requisite	**NA**	**Co-requisite**	**NA**						
programme	**MSc. Botany**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	This course aims to lay a foundation for empirical research and make students aware of relevant guidelines, policies, and codes relating to ethical research, as well as to provide, via a study of ethical theories, concepts.								
CO1	To be able to describe and apply theories and methods in ethics and research ethics								
CO2	To acquire an overview of important issues in research ethics, like responsibility for research, ethical vetting, and scientific misconduct.								
CO3	To acquire skills of presenting arguments and results of ethical inquiries.								
CO4	To be able to Identify the concepts and procedures of sampling, data collection, analysis and reporting								

Unit no	Content	Learning OutCome
I	**ETHICS:** Introduction to the course and each other; an introduction to moral theory. Ethics: definition, moral philosophy, nature of moral judgements and reactions. Research regulation; self – regulation; research ethics. Honesty, candor, compromise and integrity. Data ownership and stewardship; conflicts of interest; collaboration. Human and non-human subjects. Research and researchers in society.	Understand and apply key ethical principles and moral theories in research contexts, critically evaluate issues related to research ethics.
II	**SCIENTIFICCONDUCT-** Ethics with respect to science and research. Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data	Understand and apply ethical principles related to scientific conduct, demonstrate intellectual honesty and research integrity, recognize and prevent scientific misconduct
III	**PUBLICATION ETHICS**- Publication ethics: definition, introduction and importance. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.	Understand the importance of publication ethics, recognize best practices and standards
IV	**OPEN ACCESS PUBLISHING-**Open access publications and initiatives**.** SHERPA/RoME0 online resource to check publisher copyright & self-archiving policies. Software tool to identify predatory publications developed by SPPU**.** Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.	Understand the concept and significance of open access publishing
V	**PUBLICATION MISCONDUCT** Group Discussions; Subject specific ethical issues, FFP, authorship. Conflicts of interest. Complaints and appeals: examples and fraud from India and abroad. Software tools; Use of plagiarism software like Turnitin, Urkund and other open-source software tools. **DATABASES AND RESEARCH METRICS–**Databases: Indexing databases. Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, I 10 indexes, altmetrics.	Gain proficiency in navigating indexing and citation databases

Text Books

T1. Bird, A (2006). Philosophy of Science. Routledge.

T2. Maclntyre, Alasdair (1967) A Short History of Ethics.London.

T3. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019)

Reference Books

R1. National Academy of Science, National Academy of Engineering and Institute of Medicine (2009). On Being a Scientist: A Guide of Responsible Conduct in Research: Third Edition, National academics Press

R2. George R, (2011). Sociological Theory, Rawat Publication, New Delhi, India. GeorgeR, (2019). Post Modern Social Theory, Rawat Publication, New Delhi, India.

Other learning resources:

https://researcheracademy.elsevier.com/uploads/2018-02/ethics_a5_booklet_update260617_web.pdf

https://researcheracademy.elsevier.com/publication-process/ethics

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe and apply research ethics theories and methods.	**6**
2	Explain research ethics issues such as responsibility, vetting, and misconduct.	**6**
3	Illustrate arguments and results in ethical research inquiries.	**5, 6**
4	Identify and apply procedures for sampling, data collection, and reporting.	**2, 3, 4**
5	Apply ethical principles to research design and evaluation	**4,8**

Semester- III									
Course title	**Personal financial planning**								
Course code	**24UUFL202R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**1**
Pre- requisite	22UUFL201R Introduction to Financial Budgeting And Planning	**Co-requisite**	Nil						
Programmes	Bachelor of Business Administration/Bachelor of Hotel Management and Catering Technology/Bachelor of Business Administration (I)/Bachelor of Business Administration (Industry Integrated)/Bachelor of Social Work/Bachelor of Arts in Sociology/Bachelor of **Master of Science in Botany**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	1. The course would offer an inclusive approach to understand the relevant concepts of money, borrowing, lending, taxes and their application to financial planning. 2. Assess the personal financial planning process, the life cycle of financial plans, and methods of goal achievement. 3. Formulate a budget, record-keeping system, and tax planning strategy based on current financial goals.								
CO1	Explain the cash management and buying plan for homes or automobiles.								
CO2	Discuss a diversified investment portfolio for different objectives.								
CO3	Compare mutual funds, ETFs, and real estate investment options.								
CO4	Develop a financial plan for retirement and estate protection.								
CO5	Describe financial products and strategies for long-term goals								

Unit no	Content	Contact Hour	Learning Outcome	KL
I	**Unit 1- Fundamentals of Financial Planning –** Functions of money; Inflation- Meaning, causes, how it can be controlled; process official planning, Time value of money- simple and compound interest; Net Present Value and Future value, Power of Compounding; Doubling period and Rule of 72.	6	Students will be able to comprehend the fundamentals of financial planning.	2,3
II	**Unit 2- Income Tax Planning**– Meaning of Income, Direct & Indirect Taxes, Taxable Income, various heads of Income for tax Calculation, Non-taxable Income, iv. Tax evasion and tax avoidance, v. GST, Tax Planning Strategies.	6	Students will be able to understand and utilise the basic aspects of income tax and GST.	1,2
III	**Unit 3- Entrepreneurial planning** – i. Meaning of Entrepreneurship, prerequisites for becoming an entrepreneur, ii. Entrepreneurship Support Systems in India, iii. Institutional support systems for entrepreneurs, iv. Financial support systems for entrepreneurs;	6	Students will be able to understand the concept, scope and prerequisites of entrepreneurship.	1,2

	v. Venture Capital, Business Angels, vi. Assistant of Government, vii. Commercial Bank Loans and Overdraft. v. Venture Capital, Business Angels, vi. Assistant of Government, vii. Commercial Bank Loans and Overdraft.			
IV	**Unit 4-Planning for investing in securities market –** i. Investment avenues offered by Securities Markets,. Primary Market and Secondary Market, ii. Stock market- meaning, features, functions of NSE,BSE DEMAT trading account, iii. Security repository, stock brokers, Operational aspects of securities markets: placement of orders, contract note, pay-in and pay-out, trading and settlement cycle, iv. Various risks involved in investing in securities markets; Role of Financial Intermediaries; Stock indices. v. Mutual Funds- meaning concept, definition, types, importance and drawbacks of mutual funds, mutual funds in India, investing in mutual funds, vi. Systematic Investment Plan (SIP) and its advantages.	6	Students will be able to analyze and interpret the different dimensions of stock market investment.	3,4
V	**Unit 5- Planning for debts and Retirement** i. Consumer credit - Introduction to consumer credit; choosing a source of credit, the cost of credit alternatives, ii. Consumer Legal Protection; iii. Housing Decision: Factors and Finance; Vehicle Decisions. iv. Retirement planning - Meaning of cost of living; retirement need analysis; development of retirement plan, various retirement schemes, v. Estate Planning; Pension and Medicare Planning; Wills.	6	Students will be able to evaluate the aspects of retirement planning to formulate effective strategic financial plans.	1,2,3

Text Books:

1. Sinha Pradeep K. and Priti Sinha. Computer Fundamentals: Concepts Systems &The Million-Dollar Financial Advisor: Powerful Lessons and Proven Strategies from Top Producers by David J. Mullen Jr
2. Personal Finance and Planning by Dr. Rajni
3. Peaceful Personal Finance: A Short Read on the Basics of Personal Finance and Planning Kindle Edition by Hema Singh
4. Be Your Own Financial Advisor: Financial Planning, Investment Options, Risk Management, Tax

Management, Succession Planning Kindle Edition y Sushil Bali
5. The Dumb Things Smart People Do with Their Money: Thirteen Ways to Right Your Financial Wrongs Kindle Edition y Jill Schlesinger

Other learning resources:

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the cash management and buying plan for homes or automobiles.	**5**
2	Discuss a diversified investment portfolio for different objectives.	**9**
3	Compare mutual funds, ETFs, and real estate investment options.	**2, 5, 9**
4	Develop a financial plan for retirement and estate protection.	**9**
5	Describe financial products and strategies for long-term goals	**5**

Semester- III									
Course title	**Corporate proficiency**								
Course code	**24UMPD211R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	22UMPD121R Communication Mastery	**Co-requisite**	**NA**						
Programmes	**MSc. Botany**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	1. To acquaint students with the various tools of an effective presentation. 2. To acquire the speaking skill, instruct, influence, engage, educate, or appease the listeners. 3. To increase proficiency, present ability and quality of resume and provide guidance for self- promotion and self-evaluation in social media. 4. To prepare and train the students for the campus drives & walking interviews.								
CO1	It will prepare the learners to speak with greater control and charisma in front of others.								
CO2	It will have a positive impact in their thought process and problem-solving skills.								
CO3	It will arm the students with all the necessary tools and skill sets to prepare professional resume.								
CO4	They will learn to highlight and assess themselves in social media.								
CO5	It will impart in them techniques to solve critical problems in an interview, develop strategies to crack interviews, improve their communication skills, boost their confidence								

Unit no	Content
I	**Module 1- Presentation Skills** i. Introduction ii. Essential characteristics of a good presentation iii. Preparation of a good presentation
II	**Module 2- Public Skills** i. Fear of Public Speaking, ii. Understanding and Overcoming Fear of Public Speaking, iii. Confidence and Control, iv. Physiology and Stress - Control/Process, v. Tips for Presentations and Public Speaking, vi. Tips for Using Visual Aids in Presentations, vii. Process for Preparing and Creating Presentations, viii. Delivering Presentations Successfully, ix. Doubt Clearing and Summary of Main Points
III	**Module 3- Practical session on Resume, Curriculum Vitae, Writing cover letter & LinkedIn Profile** i. Preparation, submission & screening of Resume. ii. Practical session on cover letter screening session iii. Creating a profile on LinkedIn iv. How to utilize it **Module 4- Leadership & Management Skills** i. Concepts of Leadership, ii. Leadership Styles, iii. Manager VS Leader, iv. How to be an Effective Leader, v. Mock/ Practice Session, vi. Doubt Clearing Session.
IV	**Module 5- Research Paper – Writing Skills** i. How to write a research paper

	ii. Key point in Research Work **Module 6- Interview Skills & Dress code Ethics** i. Types of the interview- telephonic, virtual & face to face ii. Online interview, personal interview, iii. Panel interview, iv. Group interview, v. JAM session, vi. Types of interview questions-traditional/common interview questions, vii. Case interview questions, viii. General Strategies for answering questions, ix. Marketing your skills and experiences, x. Preparation before the interview, xi. How to dress up for an interview, xii. How to maintain eye contact and positive body language, xiii. How to be presentable, xiv. Interview dos and don'ts, xv. Introduction to Dress Code Ethics, xvi. Purpose and Importance xvii. How to Make, FIRST IMPRESSION‟ xviii. What to Wear During Interviews or Any Other Formal Meetings – Male &Female
V	**Module 7- Mock Interview** i. Practical Mock Interview, ii. Feedback- Receiving Feedback, iii. Giving Feedback, iv. Advantages of Effective Feedback, v. How to deal with negative feedback.

Text Books

T1. Barrett, Grant. 2016. Perfect English Grammar: The Indispensible Guide to Excellent Writing and Speaking, Zephyros Press.

T2. McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition).

Reference Books

R1. Garg. Manoj Kr. (2018) English Communication: Theory and Practice

Other Learning Resources:

https://brightlinkprep.com/10-best-toefl-prep-books/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	It will prepare the learners to speak with greater control and charisma in front of others.	**5**
2	It will have a positive impact in their thought process and problem-solving skills.	**2**
3	It will arm the students with all the necessary tools and skill sets to prepare professional resume.	**5**
4	They will learn to highlight and assess themselves in social media.	**5**
5	It will impart in them techniques to solve critical problems in an interview, develop strategies to crack interviews, improve their communication skills, boost their confidence	**5, 6, 8**

SEMESTER - III									
Course Title	**Mini Research (Survey/experiments-R3)**								
Course code	**24MSBO212R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/f**	**C**
		Total hours: 60P	**0**	**0**	**0**	**4**	**12**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course objectives	1. To determine whether the objectives of review of literature gap analysis have been met, if not what steps can be taken accordingly.								
CO1	Create and implement a plan to bridge the gap								
CO2	Find the gap and evaluate solutions.								
CO3	Identify the ideal future state/action plan								
CO4	To analyse the current state/work of research								
CO5	To implement the strategies to meet the research gap under supervision.								

SEMESTER – III									
Course Title	Floral morphology, Embryology and Palynology								
Course code	**24MSBO213R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. To understand the origin and evolution of different parts of flowering plants. 2. Knowledge on developmental biology. 3. Understand the pollen structure and its application.								
CO1	Describe the morphology of a flower, including advanced and primitive structures, and explain flower development stages.								
CO2	Explain the structure and function of microsporangium, mega sporangium, pollen development (microsporogenesis), and sporogenesis.								
CO3	Describe endosperm types, the relationship between endosperm and embryo, and explain embryo culture techniques.								
CO4	Explain the applications of tissue culture techniques in plants, including micro propagation, genetic modification, somatic embryogenesis, disease eradication, and conservation.								
CO5	Describe palynology, including pollen and spore morphology, chemistry, and techniques for analyzing pollen and spore morphology using microscopy and staining methods.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Flower-**Morphology of flower, inflorescence. Primitive and Advanced structure of stamen and carpel, homologies of Development of flower. –evolution of flower and pollinator, Staminodia, Nectaris.	10	Able to describe and explain about the flower and its development.	1,2
II	**Microsporangium**–Structure and function of wall layers, Microsporogenesis, role of Callose and tape tum in pollen development, Pollen wall morphogenesis, Microspore /pollen mitosis, Division of generative cells, heterogeneity in sperms, Pollen fertility and male sterility, Pollen storage and germination.	8	Knowledge about microsporangia and megasporangia.	1,2
III	**Post-fertilization changes inembryosac**-Endospermty pesand their development, Endosperm haustoria and their function, Embryogenesis in Monocot and dicotangiosperms, Structure, Cytology and function of suspensor, Physiological and Morphogenetical relationship of endosperm and embryo, Embryoculture.	10	Able to describe and explain about the post fertilization changes takes place in embryosac.	1,2
IV	**Plant Tissue culture**: History, Basic aspects of plant tissue culture, Types of plant tissue culture, and Methods of Sterilisation, Nutrient Medium (MS and White), Explant, Types of explants, Cellular Totipotency, Differentiation, Morphogenesis Organogenesis, Somatic Embryogenesis, Micropropogation, e.g., Banana,	10	Able to describe and explain about the different tissue cultural techniques.	1,2
V	**Palynology-**Branches of palynology. Spore, pollen morphology, Wall chemistry, exineornamentation, Evolution of aperture types, Application of neopalynology and palaeopalynology. Aeropalynology	7	To understand the pollen and its applications.	1,2

	and pollen Allergy, melissopalynology.			
Practical	1. Study of types of ovules and anther and stages of embryo (Globular type and heart shaped) 2. Micro propagation of important crops through tissue culture technique. 3. Study of pollen grains thtough Acetolysis technique	30	Able to explain and demonstrate, flower analysis and embryological and palynological study.	1,2, 3,4

Text Books

T1. Shivanna KR and Johri BM (1985) The Angiosperm Pollen: Structure and Function. New Delhi, India: Wiley-Eastern.

T2. Introduction to Embryology: P.Maheswari.

Reference Books

R1. Studies in Botany (Vol-I), J.N.Mitra, D.Mitra and S.K.Chowdhuri, Moulik publishing, Kolkata.

R2. Bhojwani and Bhatnagar. Embryology of Angiospems.

Other Learning Resources:

https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/embryo-plant

https://www.sciencedirect.com/journal/review-of-palaeobotany-and-palynology

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the morphology of a flower, including advanced and primitive structures, and explain flower development stages.	**1,2,3**
2	Explain the structure and function of micro sporangium, mega sporangium, pollen development (micro sporogenesis), and sporogenesis.	**1,3,6**
3	Describe endosperm types, the relationship between endosperm and embryo, and explain embryo culture techniques.	**1,2,4**
4	Explain the applications of tissue culture techniques in plants, including micro propagation, genetic modification, somatic embryogenesis, disease eradication, and conservation.	**1,3,7**
5	Describe palynology, including pollen and spore morphology, chemistry, and techniques for analyzing pollen and spore morphology using microscopy and staining methods.	**1,3,4**

SEMESTER – III										
Course Title	Economic botany, ethnobotany and pharmacognosy									
Course code	**24MSBO214R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. To give knowledge about the different aspects of economic botany. 2. To uplift the knowledge of the students about the conventional use of medicinal plant. 3. To give knowledge to the students about development of new drugs for safe and more rational use of herbal preparations.								
CO1	Student scan able to know the economically used plants.								
CO2	Describe and classify the economically important plants according to their use.								
CO3	Documentation of Ethno botanically used plants along with the type of use.								
CO4	Understand the need for development of new drugs for safe and more rational use of herbal preparations.								
CO5	Develop laboratory skill in testing of herbal drugs and new commercial products.								

Unit-No.	Content	CH	Learning Outcome	KL
I	**Introduction to Economic Botany:** Different aspects of economic botany, Role of plants in relation to human welfare, Importance of forestry, their Utilization and commercial aspects, Centre of origin of cultivated plants Indian centre of wild plant geneticre sources. Botany and uses of fodder and aromatic plants, Ornamental plants, Alcoholic beverage, Plants used for pollution control: Methods of control and examples. Mineral indicating plants.	10	Able to describe and explain about the economically important plants and their utility.	1, 2
II	**Classification of Economic Plants:** Classification of economically important plants, Cereals and Millets, Pulses and Legumes, Vegetables, Fruits, Beverage-yielding plants, Drug-yielding plants, Narcotic-yielding plants, Fiber-yielding plants, Timber-yielding plants and Bamboos, Rubber-yielding plants, Oil-yielding plants, Sugar-yielding plants, Mushroom cultivation etc.	8	Knowledge about economic plants' groups.	1, 2
III	**Ethnobotany:** Introduction to Ethnobotany, Different branches of Ethnobotany, Importance and Impact of Ethnobotany inherbal-medicine industry, Role of ethno medicine and its scope in modern times, Role of	10	Able to describe and explain about the role and scope of ethno botany.	1, 2

	Ethnobotany in conservation and sustain able development, Centres of Ethno botanical studies in India, Use of some ethno medicinal plants by the ethnic communities of North East India. Wild and edible mushrooms of North-East India.			
IV	**Pharmacognosy:** Pharmacognosy and its importance, History of Pharmacognosy, Pharmaceutical Aids, pharmacologically active constituents: Carbohydrates, Proteins, Enzymes, Fixedoil, Fats and Waxes-Lipids, Volatileoils, Alkaloids, Resins, Tannins, Glycosides, Antibiotics etc, Adulteration, drug evaluation and pharmacopoeial strandards.	10	Able to describe and explain about the different active constituents of drugs derievd from plants.	1, 2
V	**Classification of Drugs:** Systems of classification of drugs from natural origin, Types of Plant drug and their Pharmacognostic study) Rhizome and Root drugs: Cyperrusrotundus, Ipecac, Raulvolfia, Satavari,With ania Ginger, Turmeric etc) Leaf drugs: Datura, Senna, Azadirachta, Andrographis Clitoriaetcd) Bark drugs: Terminaliaarjuna, Cinnamon, Cinchona, Holorrhenae) Flower drugs: Saffronf) Seed drugs: Black piper, Mucunag) Fruit drugs: Cumin, Coriandrum, Amla etc) Whole plant drugs: *Catheranthusroseus.*	7	To understand development of drugs from plants.	1, 2
Practical	1. Morphological and anatomical studies on economically important plants/parts of Rice, Jute, Rauvolfia, Ocimum, Tea, Sugarcane. 2. Organoleptic and microscopic evaluation of the following drug plants: *Datura* /*Senna*/ *Azadirachta* (Leaf drug) *Zingiber*/ *Cyperrus rotundus* (Rhizome & Root drug) *Coriandrum*/ *Trachyspermum*/ *Foeniculum*/ *Cuminum* (Fruitdrug) *Cinnamon*/ *Cinchona* (Bark drug)	30	Able to explain and demonstrate, different economically important plant parts and pollens.	1, 2, 3, 4

Text Books

T1. Textbook of Economic Botany, Sunidhi Miglani**.**

Reference Books

R1. Economic Botany, B.P. Pandey, SChand.

R2. BrunetonJ., 1999. Pharmacognosy, Phytochemistry, Medicinal Plants, Intercept Ltd., Paris. 2. Dewick P.M., 2002. Medicinal Natural Products: A biosynthetic approach, John Wiley & Sons Ltd.

R3. Pharmacognosy,J.S.Qadry.

Other Learning Resources:

https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/economic-botanyhttps://link.springer.com/journal/12231

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students can able to know the economically used plants.	**1,2**
2	Describe and classify the economically important plants according to their use.	**1,3,6**
3	Documentation of Ethno botanically used plants along with the type of use.	**1,4**
4	Understand the need for development of new drugs for safe and more rational use of herbal preparations.	**1,3**
5	Develop laboratory skill in testing of herbal drugs and new commercial products.	**1,3**

SEMESTER – III										
Course Title	**Plant molecular biology and biotechnology**									
Course code	**24MSBO215R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. To introduce to rapid contemporary changes witnessed in plant molecular biology. 2. To define large-scale, systems-level, and high-through put data sets to derive novel biological in sights that are difficult to gain using other methods. 3. To give students the knowledge about DNA-based technology for a wide range of novel in fectious disease diagnostic techniques.								
CO1	Describe DNA structure, replication, and sequencing principles.								
CO2	Describe RNA structures, synthesis, processing including small RNAs.								
CO3	Explain hormones, receptors, signalling, chemo taxis.								
CO4	Explain the application of genetic engineering.								
CO5	Describe the process of creation of genetically engineered plants.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Structure of DNA, forms and function, DNA topology, DNA -Protein Interactions, DNA replication, formation of leading and lagging strands, DNA topoisomerase, polymerases & DNA ligase, Principles of DNA sequencing.	10	Able to describe and explain about structure of DNA and its functions.	1,2
II	Structure of RNA, Synthesis and processing of genetic and non-genetic RNA, mRNA, tRNA, rRNA, RNA synthesis and Processing, RNA Splicing, Capping and Polyadenylation of mRNA, small RNAs.	8	Able to describe and explain about structure of RNA and its functions.	1,2
III	Hormones and their receptors, Cell surface receptors, signaling through G-protein coupled receptors, Signal transduction pathways, regulation of signaling pathways, Bacterial chemotaxis, genome analysis, genetic mapping, Molecular systematics and diagnosis, Autogenous regulation of ribosomal protein synthesis. protein sorting and intracellular trafficking, post translational modifications,	10	Able to describe and explain about the role of hormones in signal transduction.	1,2
IV	Geneticengineeringprinciples,cloningvectors,enzymesinvolvedinrDNAtechnology,transformations,intellectualpropertyrights,andlegalandbiosafetyissuesassociatedtoGMOs.TheuseofDNAmarkersingeneticdiversityresearch,genomeanalysis,geneticmapping,moleculardiagnostics,anddiagnosis.HumanGenome Project.	10	Knowledge of genetic engineering.	1,2
V	Genetically engineered plants, Chimeric	7	To understand Concepts of	1,2

	DNA, DNA probes and Genomic /c DNA libraries, chloroplast engineering, and transplastomic plants. Techniques for identification of diseased gene and insertion into host cell.		genetically engineered plants.	
Practical	1. DNA isolation, quantification and electrophoresis. 2. RNA isolation, quantification and electrophoresis. 3. PCR reaction and gelelectrophoresis. 4. Protein isolation and gelelec trophoresis. 5. Restriction digestion and mapping.	30	Able to explain and demonstrate, different techniques of biotechnology.	1,2, 3,4

Text Books

T1. Elements of Biotechnology-P.K Gupta, Rastogi Publication.
T2. Biotechnology and Genomics-P.KGupta, Rastogi Publications.
T3. Lab Manualon Biotechnology-P.M.Swamy, Rastogi Publications

Reference Books

R1. B.M.Turner, Chromatin & Generegulation, 1st Edition, Wiley-Blackwell, 2002.
R2. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
R3. Lodishetal., Molecular cell Biology, 4th Edition,W.H.Freeman & Company, 2000.
R4. The Cell: A Molecular Approach by Geoffrey M.Cooper, Robert E.Hausman.
R5. Molecular Cell Biology by LodishH., BerkA, Kaiser C., KReigerM., BretscherA., PloeghH., Angelika Amon A., Matthew P. Scott M.P.

Other Learning Resources:

https://link.springer.com/journal/11103
https://www.sciencedirect.com/journal/molecular-plant

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe DNA structure, replication, and sequencing principles.	**1,2,7**
2	Describe RNA structures, synthesis, processing including small RNAs.	**1,3,6**
3	Explain hormones, receptors, signalling, chemotaxis.	**1,2,4**
4	Explain the application of genetic engineering.	**1,3,7**
5	Describe the process of creation of genetically engineered plants.	**1,3,4**

SEMESTER – III									
Course Title	**Plant anatomy, Micro Techniques and Evolution**								
Course code	**24MSBO216R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Fall/ III semester of second year of the programme**								
Course Objectives	1. The course deals with the structural and functional development of cells and tissues. 2. To make learner understand about the concept of normal and anomalous secondary growth in dicots and monocots. 3. To impart concept of micro techniques and evolution.								
CO1	Describe meristems, vascular cambium, their types and factors affecting cambial activity.								
CO2	Explain vascular tissues its origin, structure, development, and ontogeny, compare reaction wood, distinctions between heartwood and sapwood, and identify and classify the plant specimen by assessing their anomalous secondary growth.								
CO3	Describe leaf ontogeny, vascular tissue development, and calculate plastochronic index, and describe transfer cells, floral anatomy, and explain its role in classification.								
CO4	Prepare specimens using microtome, maceration, squash, and clearing techniques, and assess.								
CO5	Explain the theories of evolution.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Meristems–characters, classification and theories–Apical cell theory, Tunica–Corpustheory and Korper-Kappe concept. Vascular Cambium–Types, divisions, arrangement and seasonal activity, Factors affecting cambial activity	10	Able to describe and explain about plant cell structure and functions.	1, 2
II	Origin, Structure, development and ontogeny of xylem and phloem. Reaction wood–structure and properties. Heart wood and sapwood-strength, ability, grains, texture and defects. Anomalous secondary growth in Dicots and Monocots.	8	Able to describe and explain about structure of conducting tissues in plants.	1, 2
III	Leafontogeny–initiation, apical, intercalary, marginal andadaxial growth, plate meristem and development of vascular tissues plastochronic index. Transfer cells–Structure, development and functions. Classical concept of flower; Floral anatomy and its role in classification. Plant galls, types.	10	Knowledge of leaf and floral anatomy of plants.	1, 2
IV	Maceration, squash and clearing techniques. Sample preparation for light microscopy. Classification of fixatives, formulas', Sample preparation for light microscopy: Fixation, dehydration and infiltration procedures. Microtomes: Rotary, sliding, cryostat.	10	Able to describe and explain about the Maceration, squas hand clearing technique.	1, 2
V	Organic evolution, Darwinism, Lamark theory, Neo Darwinism.	7	To understand Concepts of evolution in plants.	1, 2
Practical	1. Study of anomalous secondary growth of selective families of Angiosperms.	30	Able to explain and demonstrate, different	1, 2,

	2. Preparation of microtome block, Preparation of permanent slides by the process of microtome technique		techniques of anatomy and micro technique.	3, 4

Text Books

T1. Cutler, D.F.1978, Applied plant Anatomy, Orient Longman Publishers, New Delhi.

T2. Easu, 1987. The Anatomy of seed plants.Wiley Eastern Ltd., New Delhi.

Reference Books

R1. Fahn, A.1989 Plant Anatomy, Pergamon press, Oxford, New York.

Other Learning Resources:

https://www.cell.com/trends/plant-science/abstract/S1360-1385(01)02050-7

https://shop.elsevier.com/books/integrative-plant-anatomy/dickison/978-0-12-215170-5

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe meristems, vascular cambium, their types and factors affecting cambial activity.	**1, 2, 6**
2	Explain vascular tissues its origin, structure, development, and ontogeny, compare reaction wood, distinctions between heartwood and sapwood, and identify and classify the plant specimen by assessing their anomalous secondary growth.	**1, 2, 3, 6**
3	Describe leaf ontogeny, vascular tissue development, and calculate plastochronic index, and describe transfer cells, floral anatomy, and explain its role in classification.	**1, 2, 6**
4	Prepare specimens using microtome, maceration, squash, and clearing techniques, and assess.	**1, 3, 6**
5	Explain the theories of evolution.	**1, 2, 6**

SEMESTER - IV									
Course Title	**Research/data analysis/documentation-R4**								
Course code	**24MSBO221R**	**Total credits: 13**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 40P	**0**	**0**	**20**	**8**	**6**	**0**	**13**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course objectives	1. To determine whether the objectives of review of literature gap analysis have been met, if not what steps can be taken accordingly.								
CO1	Create and implement a plan to bridge the gap								
CO2	Find the gap and evaluate solutions.								
CO3	Identify the ideal future state/action plan								
CO4	To analyse the current state/work of research								
CO5	To implement the strategies to meet the research gap under supervision.								

SEMESTER – IV									
Course Title	**Angiosperm taxonomy-I**								
Course code	**24MSBO222R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course Objectives	1. To study the fundamental concept of flowering plants for proper classification and identification. 2. Field visit help students to study the flowering plants and identify up to the genus level. 3. By visiting field students can gather knowledge about the ethnobotanical use of plants by local people. 4. To learn about the herbarium process, students visit research organisations like BSI, NBRI, FRI and can gather knowledge. 5. Students can apply for research fellowships for Ph.D. and other higher degrees in plant taxonomy in universities.								
CO1	Explain the principles, classifications and identification of plants.								
CO2	Describe botanical keys, taxonomic literature methods, and computer-assisted identification.								
CO3	Explain botanical nomenclature principles, rules, priority, effective publication, and related terms.								
CO4	Prepare herbarium, discuss botanical gardens, libraries, and the Botanical Survey of India, their significance in knowing plant species.								
CO5	Explain OTUs, character coding, resemblance measures, cluster analysis, dendrogram/ cladogram construction, bioinformatics, and sequencing methods.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Basics of Taxonomy:** Aims, objective and principles. Pre and Post Darwinian Classifications, Phenetic, Phylogenetic, Cladistic and APG System, Alpha and Omega taxonomy, Taxonomic hierarchy, Concept of species, genus, family and infra-specific categories. **Concept of Characters**–Qualitative and quantitative characters, Good and bad characters, analytical and synthetic characters, conservative characters, co-relation of characters, Isolation and speciation of characters.	10	Knowledge of different classification systems and concept of characters.	1,2
II	**Basics of Taxonomy:** Botanical keys-sequential keys, multi-access keys, automated pattern recognition systems, web identification Punched Card Keys; Taxonomic literature-Preparation and presentation of data in floras, rich and poor flora, manuals, monographs, revisions, icons, journals and others. Checklist, an noted list, revisionary study, Computer in identification.	8	To learn the basics of taxonomy, use of botanical keys and taxonomic literature.	1,2

III	**Botanical Nomenclature**: Principles and major rules, typification, rule of priority, effective and valid publication, retention, choice and rejection of names, illegimate names, Authors'citation, synonym, basionym, nomina conservenda, St. Louis Code, Biocode, nomennudum, tautonym, later homonym, Names of hybrids, Names of cultivated plants.	10	To know about the nomenclature of plants.	1,2
IV	**Herbarium techniques:** Methods of Collection, Identification and Documentation. Role and importance of herbaria. Kinds of herbaria. Important herbaria in the world and India. Virtual Herbarium. **Botanical Gardenmuseums and Botanical library-** Function and role intaxonomic studies. **Botanical Survey of India**: Organization, activities and publications.	10	To understand the basics of herbarium techniques, function of botanical gardens and BSI.	1,2
V	**Taxometric-**Principles, OTUs, character coding, measure of resemblances, cluster analysis, commonly available software, construction of Dendrograms and cladograms, basic of bio informatics, biological databases, data search, sequencing methods.	7	Able to describe and explain about the principle and applications of taxometric.	1,2
Practical	1. Field excursion (5-7 days) to the neighbouring states of Assam/NE India, making collection of angiosperm plant species and describe the specimen using botanical terms and keying out the prominent characters for identification up to the rank of species for the preparation of a flora. (Students are required to submit at least 25 herbarium /museum specimens). 2. Basing on collection of locally available angiospermic plants, students may be assigned to study any one of the following branches in relation to angiosperm taxonomy-(a) External morphology, (b) Anatomy, (c) Cytology, (d) Palynology (e) Chemotaxonomy. 3. Practices on Nomenclatural problems by handling of floras, manuals, icons and index kewensis etc. 4. Handling of taxonomic softwares.	30	Describe, illustrate and explain and apply taxonomic tools to solve critical problems related to identification and nomenclature of plant species.	1,2, 3,4

Text Books

T1. A HandBook of Field and Herbarium Methods. Today and Tomorrow Publications, New Delhi. Jain, S.K. and Rao, R.R. Publications, New Delhi.
T2. Advanched Plant Taxonomy. Mondal, A.K.Central BookAgency, Kolkata.
T3. An Introduction to Angiosperms, N.C.Kumar, Himalaya Publishing House, 1995.
T4. Evolution and Classification of Flowering Plants. Cronquist, A.New York Botanic Gardens, Bronx, New York.
T5. Evolution and Phylogeny of flowering plants; Hutchinson, J. Academic Press, London & New York.
T6. Taxonomy of Angiosperms. Naik, V.N.Tata McGraw Hill, New Delhi.
T7. The families of flowering plants: Hutchinson, J.Oxford University Press.
T8. The geography of flowering plants. Good, R. Longman, London.
T9. The Plant Book. Moberly, D.J. Cambridge University Press, London.

Reference Books

R1. Genera of flowering plants. Hutchinson, J. Cambridge University Press, London.
R2. Greuter.W.etal. Scientific Books, Konigstein.
R3. International Code of Botanical Nomenclature. St.Louis Code. Koeltz.
R4. Introduction to the principles of plant taxonomy. Sivarajan, V.V.and Robinson Oxford IBH.
R5. Modern Plant Taxonomy, N.S, Subrahmanyam, Vikas Publishing house Pvt.Ltd, Noida, 2008.
R6. Origin and dispersal of Flowering Plants.Takhtajan, A.
R7. Plantsystematics, Singh, Gurcharan: Oxford IBH

Other Learning Resources:

https://www.sciencedirect.com/journal/plant-Diversity
https://www.sciencedirect.com/journal/perspectives-in-plant-ecology-evolution-and-systematics

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the principles, classifications and identification of plants.	**1, 2**
2	Describe botanical keys, taxonomic literature methods, and computer-assisted identification.	**1, 2, 6**
3	Explain botanical nomenclature principles, rules, priority, effective publication, and related terms.	**1, 2, 6**
4	Prepare herbarium; discuss botanical gardens, libraries, and the Botanical Survey of India, their significance in knowing plant species.	**1, 3**
5	Explain OTUs, character coding, resemblance measures, cluster analysis, dendrogram/ cladogram construction, bioinformatics, and sequencing methods.	**1, 2, 6**

SEMESTER – IV									
Course Title	**Angiosperm taxonomy-II**								
Course code	**24MSBO223R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course Objectives	1. To study the plant morphology student will be benefitted to identify plants (visual identification) properly. Proper identification and classification are important in the fields like genetics, ecology, physiology, Embryology etc. 2. To study all the applied disciplines of plant sciences such as Agriculture, Horticulture, Forestry, Pharmacognosy, Biotechnology, etc. 3. By studying phytogeography students can able to know about the differences of plants pecies in different geographical zones. 4. By studying forest types students can able to know about the different plant species distributed in different types of forests.								
CO1	Describe taxonomic evidences, molecular taxonomy, diagnostic tools, PCR analysis, and applications of molecular markers.								
CO2	Explain angiosperm origin, characteristics, and evolution, as well as ethno botanical uses concerning North-East tribes.								
CO3	Describe North East India's flora, endangered plant conservation, and sustainable forest management.								
CO4	Explain phytogeography, India's biodiversity, migration, and plant domestication.								
CO5	Explain phylogeny and evolution of Angiospermic taxa, covering key dicotyledons and monocotyledons.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Sources of taxonomic evidences:** Morphology, Anatomy, Palynology, Ecology, Embryology, Cytology, genetics, Chemotaxonomy, Phytochemistry, Serology Biosystematics, Numerical taxonomy, Molecular plant taxonomy, diagonostic tools, PCR analysis, application of molecular markers in plant taxonomy, scope and importance of molecular taxonomy.	10	Knowledge of different taxonomic evidences for proper identification and classification of angiosperms.	1,2
II	**Origin and evolution-** Origin of angiosperms with special reference to their ancestral stock, Characteristic features of Primitive and advanced angiosperms, Evolutionary trends in Angiosperms. Cradle of flowering plants. **Ethnobotany**-Use of plants by the tribal societies in North-Eastern India for subsistence, medicine and cultural purposes.	8	Knowledge of probable origin and evolution of angiosperms.	1,2
III	**Forest types**-Flora and forest types of North East India, RET plants of India with special reference to NE India. Conservation of endanger plants and their habitats. endemic, exotic, alien and introduced elements in North East flora. Bio diversity	10	To know about the forest types of North- east India and their conservation strategies.	1,2

	assessment and magnitude, use of GPS and GIS. Conservation and Utilization of forest resources.			
IV	**Phytogeography** -Concept, Static and Dynamic Phytogeography, Phytochoria and botanical provinces of India; Major theories, Ranges, Migration and Barriers, Vicariance biogeography, Endemism, IUCN categories, Hotspots, India as a mega diversity country. Plant introduction and plant domestication, Patterns of geographical distribution, Centre of Origin.	10	To understand the basics of phytogeography and IUCN.	1,2
V	**Phylogeny andevolution of angiospermic taxa-** **Dicotyledons:** Magnoliales, Ranunculales, Lamiales, Asterales, Malvales, Fabales, Scrophulariales, Caryophyllales, **Monocotyledons:** Arales, Orchidales, Poales, Cyperales, Zingiberales.	7	Able to describe and explain about the principle and applications of taxometric.	1,2

Text Books

T1. Evolution and Phylogeny of flowering plants; Hutchinson, J. Academic Press, London & New York.
T2. Genera of flowering plants. Hutchinson, J. Cambridge University Press, London Greuter.W. et al. Scientific Books, Konigstein.
T3. International Code of Botanical Nomenclature. St.Louis Code. Koe.
T4. Introduction to the principles of plant taxonomy. Sivarajan, V.V. and Robinson Oxford IBH.
T5. Modern Plant Taxonomy, N.S, Subrahmanyam, Vikas Publishing house Pvt. Ltd, Noida, 2008.
T6. Origin and dispersal of Flowering Plants.Takhtajan, A.
T7. Plant Systamatics: Theory and Practice. Gurcharan Singh, 2004. Oxford & Ibh Publishing Co.P.Ltd., New Delhi.
T8. PlantTaxonomy,N.B.SaxenaandSaxena,PragatiPrakashan,Meerat,2010.
T9. TaxonomyofAngiosperms,V.SinghandD.K.Jain,RastogiPublication,Meerat2005.
T10. Taxonomy of Angiosperms. Naik, V.N.Tata McGraw Hill, New Delhi.
T11. The Plant Book. Moberly, D.J. Cambridge University Press, London.

Reference Books

R1. Origin and dispersal of Flowering Plants. Takhtajan, A.
R2. Plant Systamatics: Theory and Practice. Gurcharan Singh, 2004. Oxford & Ibh Publishing Co. P.Ltd., New Delhi.
R3. Plant Taxonomy, N.B.Saxena and Saxena,PragatiPrakashan,Meerat,2010.
R4. TaxonomyofAngiosperms,V.SinghandD.K.Jain,RastogiPublication,Meerat2005.
R5. Taxonomy of Angiosperms. Naik, V.N.Tata Mc Graw Hill, New Delhi.
R6. The Plant Book. Mabberley, D.J. Cambridge University Press, London.

Other Learning Resources:

https://www.sciencedirect.com/topics/earth-and-planetary-sciences/phytogeography
https://link.springer.com/chapter/10.1007/978-90-481-8725-6_4

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe taxonomic evidences, molecular taxonomy, diagnostic tools, PCR analysis, and applications of molecular markers.	**1, 2**
2	Explain angiosperm origin, characteristics, and evolution, as well as ethno botanical uses concerning North-East tribes.	**1, 2, 6**
3	Describe North East India's flora, endangered plant conservation, and sustainable forest management.	**1, 2, 6**
4	Explain phytogeography, India's biodiversity, migration, and plant domestication.	**1, 3**
5	Explain phylogeny and evolution of Angiospermic taxa, covering key dicotyledons and monocotyledons.	**1, 2, 6**

SEMESTER – IV									
Course Title	**Microbiology-I**								
Course code	**24MSBO222R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course Objectives	1. The course deals with the microbial ecology, diversity of microorganisms in soil, water and air. 2. To make learner understand about the application of microorganisms in agriculture and industry. 3. The course deals with microorganisms involve in the food industry.								
CO1	Discuss microbial interactions, microbes in extreme environment.								
CO2	Describe the characteristics, isolate, identify, classify microbe present soil, air and water, and demonstrate the method of bacteriological analysis of water, antimicrobial activity of microbes.								
CO3	Describe microbial application in agriculture for crop production.								
CO4	Describe microbial application in industry including pharmaceuticals, food and beverage and bio fuel industries.								
CO5	Describe food microbiology, food safely, preservation, and quality of products.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Microbial Ecology-Interaction among microbial population, microbial interaction with plants and animals, microbial interaction with xenobiotics and inorganic pollutants, Microbes of extremeen vironments.	10	Knowledge of microbial interaction with other organisms.	1,2
II	Soil microbiology-Microbial diversity in soil, soil microbial communities and decomposition of organic matter, methods to detect and quantify soil microbes, soil met genomics, biosensors to monitor soil health and toxicity. Airmicrobiology- Phyllosphere and phylloplane, distribution of microbes in Air, allergic disorders by air microflora, sampling techniques, Water microbiology-Microbial components of water, Purification of drinking water in municipal water supply, bacteriological analysis of water.	8	To learn the basics of microbial diversity in soil, water and air.	1,2
III	Agricultural Microbiology- Agriculturally Important microbes, biological N_2 fixation, phosphate solubilization, PGPRs, rhizosphere, Mycorrhiza, Biofertilizers, Crop diseases caused by different pathogens, Bio-control of plant diseases.	10	To know about the agricultural microbiology.	1,2
IV	Industrial Microbiology-Industrial importance of micro organisms, Fermentation process, bioreactors, isolation, preservation and maintenance of industrial microbes, downstream processing, single cell protein, Industrial production of organic acids, antibiotics, ethanol, vitamins and amino acids.	10	To understand the basics of industrial microbiology.	1,2

V	Food microbiology- Fermented food (milk, meat, vegetables, beer, wine and vinegar), Food spoilage and preservation, Food borne diseases.	7	Able to describe and explain about the applications of microbes in food and dairy industry.	1,2
Practical	1. Isolation of specific microorganisms using specific media. Study of micro flora from the rhizosphere of agriculturally important crop. Study the spore and mycelia of different fungus and their morphological identification. Mycorrhiza– spore population and root colonization. 2. Assessment of antimicrobial activity of microbes against plant pathogens. Bacteriological analysis of water 3. Detection of organic acids produced by fungi by paper chromatography method. 4. Biochemical tests for identification of bacteria (catalase, IMViC, oxidase, etc.). 5. Field excursion (5-7 days) to the neibhouring states of Assam/ NE India to visit different research, educational institute, industry etc.	30	Describe, illustrate and explain and apply microbial tools and techniques for solving microbiological problems.	1,2,3,4

Text Books

T1. Textbook of Microbiology by Ananthanarayan and Paniker.

T2. Microbiology by Lansing MPrescott, Donald A Klein, John P Harley, Mc Graw Hill.

Reference Books

R1. Microbiology: Principles and Explorations by Jacquelyn Black7e, John Wiley & Sons, inc.

R2. General Microbiology by Roger Y Stanier, John L Ingraham, Mark L Wheelis, 5th edition Tata Mac Graw Hill.

Other Learning Resources:

https://www.sciencedirect.com/bookseries/progress-in-industrial-microbiology/vol/31/suppl/C

https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/industrial-microbiology

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the principles, classifications and identification of plants.	**1, 2, 3, 6**
2	Describe botanical keys, taxonomic literature methods, and computer-assisted identification.	**1, 3, 4, 6**
3	Explain botanical nomenclature principles, rules, priority, effective publication, and related terms.	**1, 2, 3, 6**
4	Prepare herbarium, discuss botanical gardens, libraries, and the Botanical Survey of India, their significance in knowing plant species.	**1, 2, 3, 6**
5	Explain OTUs, character coding, resemblance measures, cluster analysis, dendrogram/ cladogram construction, bioinformatics, and sequencing methods.	**1, 2, 3, 6**

SEMESTER – IV									
Course Title	**Microbiology-II**								
Course code	**24MSBO223R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course Objectives	1. The course deals with the microbial growth and microbial genetics. 2. To make learner understand about genetic recombination, microbial biotechnology and concept of genetic engineering. 3. To impart method of control of microorganisms.								
CO1	Explain the microbial growth pattern, continuous culture and batch culture.								
CO2	Explain microbial genetics, encompassing genetic materials, inheritance mechanisms, gene transfer processes, and fundamental aspects of DNA, RNA, and protein synthesis in microorganisms.								
CO3	Describe genetic recombination, molecular genetics, and gene expression regulation in bacteria.								
CO4	Explain microbial biotechnology, genetic engineering, and application of genetic engineering.								
CO5	Describe methods for controlling microorganisms, role of antibiotics, and challenges related to multidrug resistance in bacteria.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Microbial Growth-Definition of growth, Microbial growth conditions and growth curves, Mathematical expression of exponential growth phase, Measurement of growth and growth yields; Synchronous growth; Continuous culture, Effect of environmental factors on growth.	10	Knowledge of microbial growth and growth conditions.	1,2
II	MicrobialGenetics-Geneticmaterials,nuclearDNA,chloroplastDNA,mitochondrialDNA,plasmids,inheritanceoftraits,verticalandhorizontalgenetransfer,genesandchromosomes,DNAreplication,RNAand protein synthesis.	8	To learn the basics of microbial genetics and genetic materials.	1,2
III	Genetic recombination, conjugation, transduction and transformation in bacteria, host cell restriction, mobile genetic elements, fine structure of agene, Operon concept, promoter, enhancer, repressor, negative feedback, RNA processing (RNA capping, Poly (A) tail formation, RNA splicing).	10	To know about the forest types of North- east India and their conservation strategies.	1,2
IV	Microbial biotechnology for human welfare**,** cDNA and genomic DNA library, geneisolation, genecloning, expression of cloned genes, genetherapy, DNA fingerprinting, GMOs, application of RNAi technology (miRNA and siRNA) in agriculture and medical sciences. Genetic engineering – tools and techniques,	10	To understand the basics of microbial biotechnology and genetic engineering.	1,2

	manipulation of natural genetical processes in biotechnology, restriction enzymes and ligases, cloning and expression vectors (plasmid, Tiplasmid, cosmid, fosmid, BAC, YAC and PAC).			
V	Control of micro organisms: Physical, chemical and biological, Antibiotics, modeo faction of antibiotics, multi drug resistance in bacteria.	7	Able to describe and explain about the control of microorganisms and conrol action.	1,2

Text Books

T1. Textbook of Microbiology by Ananthanarayan and Paniker.

T2. Microbiology by Lansing MPrescott, Donald AKlein, John PHarley, Mc Graw Hill.

Reference Books

R1. Microbiology: Principles and Explorations by Jacquelyn Black7e, John Wiley & Sons, inc.

R2. General Microbiology by Roger Y Stanier, John LIngraham, Mark LWheelis, 5th edition Tata Mac Graw Hill.

Other Learning Resources:

https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/soil-microbiology

https://www.sciencedirect.com/topics/immunology-and-microbiology/microbiology

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the microbial growth pattern, continuous culture and batch culture.	**1, 3, 6**
2	Explain microbial genetics, encompassing genetic materials, inheritance mechanisms, gene transfer processes, and fundamental aspects of DNA, RNA, and protein synthesis in microorganisms.	**1, 2, 3**
3	Describe genetic recombination, molecular genetics, and gene expression regulation in bacteria.	**1, 2, 3**
4	Explain microbial biotechnology, genetic engineering, and application of genetic engineering.	**1, 2, 3, 6**
5	Describe methods for controlling microorganisms, role of antibiotics, and challenges related to multidrug resistance in bacteria.	**1, 2, 3, 6**

SEMESTER – IV									
Course Title	**Plant Ecology-I**								
Course code	**24MSBO222R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course Objectives	1. To study the detail about Plant Population and Plant community. 2. To study about Ecosystem stability, Ecosystem degradation and its consequences. 3. To study the different techniques of bio waste and e-waste management.								
CO1	Describe System Ecology, Evolutionary Ecology, Statistical Ecology and related branches.								
CO2	Explain characteristics of population and community, regulation of ecosystem processes, complex relationships with other organisms, patterns of development and diversity.								
CO3	Explain the ecological perturbations (natural and anthropogenic), bio resource sustainability, protect and conserve nature and analyse communities.								
CO4	Describe vegetation development, mechanism of ecological succession and changes in ecosystem properties.								
CO5	Describe bioremediation, biotransformation, biodegradation and ecological techniques for bio waste and e-waste management.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Development of ecology in India from ancient to recent times, evolutionary ecology, Interaction of ecological factors in the environment. Principle spertaining to limiting factors. Introduction and elements of system ecology; eco system modeling, conceptual model, working model, auxiliary variable and foresters diagram. Basic concepts to statistical ecology, fundamental knowledge on pattern analysis, cluster analysis and ordination.	10	Knowledge of ecological development in India.	1,2
II	Population concepts-characteristics, dynamics and control. Mechanisms of population regulation, habitat specific demography, population viability analysis. Species interactions -types of interactions, inter specific competition, herbivory, carnivory, symbiosis, allelopathy, weed-cropinter ference. Concept of meta population–demes and dispersal, interdemic extinctions, age structured populations. Ecological amplitude of a species and adaptation - ecads, eco types, eco species.	8	To learn the basics of population concepts in ecology.	1,2
III	Eco system stability-Concept (resistance and resilience); ecological perturbations (natural and anthropogenic) and their impact on plants and eco systems; ecology of plant invasion; Wetlands, its importance & benefits, causes of degradation and its consequences, Concepts of community and continuum; analysis of	10	To know about the stability in ecosystem.	1,2

	communities (analytical and synthetic characters); community coefficients; inter specific associations; ordination; concept of ecological niche, species diversity (α, β, γ).			
IV	Vegetation development, temporal changes (cyclicandnon-cyclic); mechanism of ecological succession (relay floristics and initial floristic composition; facilitation, to lerance and inhibition models); changes in eco system properties during succession.	10	To understand the ecological succession.	1,2
V	Bioremediation, biotransformation, biodegradation and phytoremediation, Insituand Ex-situpractices. Use of microbes (algae, bacteria and fungi) and plants to check biodegradation, biotrans for mation; waste water treatment using a quaticplants; root zone treatment. Ecological techniques for biowaste and e-waste management.	7	Able to describe and explain about the	1,2
Practical	1. Estimation of above ground and below ground biomass from unit area. 2. Effect of biotic disturbances on botanical composition. 3. To study the similarity between plant communities using index of similarities and dissimilarities. 4. To study primary productivity for herbaceous community by Harvest method; Leaf Area Index and anatomic aladaptive features of plants. 5. Field excursion to the neibouring states of Assam/ NE India for ecological study of different vegetation pattern. 6. Plant Geography: To study the distribution of vegetation type of India 7. To study the vegetation type of North east India 8. To plot Biosphere Reserves/ Ramsarsites/ National Parks/ Wildlife Sanctuaries located in different biogeographical zones of India. 9. To plot Biosphere Reserves /Ramsarsites /National Parks /Wild life Sanctuaries located in NE India 10. Study of dispersal mechanism of seeds in plants pecies.	30	Describe, illustrate and explain and apply ecological methods of studying ecosystem.	1,2, 3,4

Text Books

T1. Freeman, B. (ed.), 1995.-Environmental Ecology-The ecological effects of pollution, disturbance, and other stresses. Academic press.

T2. Michael, P.1990.-Ecological methods for field and laboratory in vestigations. Tata Mc Graw Hill, New.

Reference Books

R1. Odum, E.P. (1983), Basic Ecology, Sanders, Philadelphia.
R2. Smith, R.L. (1996*), Ecology and Field Biology*, Harper Collins, New York.
R3. Townsend, C.R., Begon, M. and Harper, J.L. 2003. *Essentials of Ecology*. Second Edition. Black well Publishing, Oxford.

Other Learning Resources:

https://www.sciencedirect.com/topics/earth-and-planetary-sciences/plant-ecology
https://link.springer.com/journal/11258

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe System Ecology, Evolutionary Ecology, Statistical Ecology and related branches.	1, 2, 3, 6
2	Explain characteristics of population and community, regulation of ecosystem processes, complex relationships with other organisms, patterns of development and diversity.	1, 2, 3, 6
3	Explain the ecological perturbations (natural and anthropogenic), bio resource sustainability, protect and conserve nature and analyse communities.	1, 3, 6, 7
4	Describe vegetation development, mechanism of ecological succession and changes in ecosystem properties.	1, 3, 6, 7
5	Describe bioremediation, biotransformation, biodegradation and ecological techniques for bio waste and e-waste management.	1, 3, 6, 7

SEMESTER – IV									
Course Title	**Plant Ecology-II**								
Course code	**24MSBO223R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course Objectives	1. To study the detail about Plant Population and Plant community. 2. To study about Ecosystem stability, Ecosystem degradation and its consequences. 3. To study the different techniques of bio waste and e-waste management.								
CO1	Describe ecological restoration, ecosystem reconstruction and restoration of degraded ecosystem.								
CO2	Explain environmental management, sustainable development, environmental monitoring and apply environmental impact assessment methods.								
CO3	Explain forest ecology, different forest types of India, forest composition, discuss the Environmental issues of North East India.								
CO4	Explain remote sensing and Geographical Information System (GIS) in ecological studies.								
CO5	Describe phytogeographical regions of India, Vegetation types of India, Biodiversity significance of NE region.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Concepts of ecological restoration, aims and strategies; ecosystem reconstruction, major tools used in restoration, restoration of biological diversity-Acceleration of ecological succession, reintroduction of biota; restoration of degraded ecosystems - Forest, grassland and lake including contaminateds oils, mines poils etc.	10	Knowledge of concepts of ecological restorations and strategies.	1,2
II	Scope of environmental management, basic concepts of sustainable development, advantages of environmental monitoring, deterioration of environmental quality with reference to anthropogenic impact; methods of assessment of environmental quality; Short term studies/ surveys; Rapid assessment; Continuous short- and long-term monitoring; general guidelines for the preparation of environmental impact statement.	8	Knowledge of environmental management and impact management.	1,2
III	Scope of environmental management: Forest ecology and forest types of India; changes in Forest Composition and Cover; issues and problems associated with shifting cultivation and industrialization; Environmental Impact of coalmining, quarrying of sand from hills and rivers; Extraction of petroleum and natural gas; issues relating to conservation of Ramsar sites of north-east India: Loktak lake, Deeparbeel.	10	To know about the scopes of environmental management.	1,2
IV	Principles and basic concepts of remote sensing; application of remote sensing in environmental studies: forest survey, habitat	10	To understand the basic concept and principle of remote sensing.	1,2

	analysis, water management, welt and survey, rain fall estimation, pollution studies, soil conservation, vegetation mapping. Geographical Information System (GIS) - basic principles, techniques and importance. Global Positioning System (GPS): basic principles, Applications in ecological studies.			
V	Phytogeography: Phytogeographical regions of India, Vegetation types of India (vegetation of Western Himalayas, Eastern Himalayas, Assam, Gangetic plain, Indusplain, Malabar, Deccanetc, Bio diversity significance of NE region.	7	Able to describe and explain about the phytogeography and vegetation pattern of India.	1,2

Text Books

T1. Misra, R.1968. -Ecology Work Book. Oxford & IBH, New Delhi.
T2. Mukherjee, B.1996.-Environmental biology. Tata Mc Graw Hill Publ., New Delhi.
T3. Bharucha,F.R.-A text book of plant geography. Oxford UniPress.
T4. Cain, S.A. 1944.-Foundation of Plant Geography. Harper, New York.
T5. Freeman, B.(ed.), 1995.-Environmental Ecology-The ecological effect of pollution, disturbance, and other stresses. Academic press.

Reference Books

R1. Cain, S.A. 1944.-Foundation of Plant Geography. Harper, New York.
R2. Freeman, B.(ed.),1995.-Environmental Ecology-The ecological effects of pollution, disturbance, and other stresses. Academic press.

Other Learning Resources:

https://www.nature.com/subjects/plant-ecology/ncomms
https://link.springer.com/journal/11258

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe ecological restoration, ecosystem reconstruction and restoration of degraded ecosystem.	1, 3, 6
2	Explain environmental management, sustainable development, environmental monitoring and apply environmental impact assessment methods.	1, 2, 3, 6
3	Explain forest ecology, different forest types of India, forest composition, discuss the Environmental issues of North East India.	1, 3, 6
4	Explain remote sensing and Geographical Information System (GIS) in ecological studies.	1, 2, 3, 6, 7
5	Describe phytogeographical regions of India, Vegetation types of India, Biodiversity significance of NE region.	1, 3

SEMESTER – IV										
Course Title	**Plant Physiology and Biochemistry-I**									
Course code	**24MSBO222R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course Objectives	1. To understand the mechanisms of membrane transport, water potential, mineral uptake, and their regulation in plant cells. 2. To gain knowledge of nitrogen fixation, nitrogen metabolism, and photosynthesis in plants. 3. To explore the physiological processes involved in flowering and the regulation of fruit development. 4. To understand the plant's physiological responses to a biotic stresses 5. To examine the role and mechanisms of plant growth regulators and growth retardants in controlling plant growth and development									
CO1	Students will gain an understanding of the mechanisms of membrane transport, water potential, and mineral uptake in plants, enabling them to analyze water regulation and ecological interactions in plant cells.									
CO2	Students will develop a deep understanding of nitrogen fixation, nitrogen metabolism, and photosynthesis in plants, and their ecological importance in nutrient cycling and plant growth.									
CO3	Students will learn the physiological processes of flowering, photoperiodism, floral induction, and fruit development, applying this knowledge to plant reproduction and ecosystem stability.									
CO4	Students will acquire knowledge of plant responses to a biotic stresses, oxidative stress, and plant toxins, enabling them to understand plant survival strategies under environmental stress.									
CO5	Students will understand the role and mechanisms of plant growth regulators and growth retardants, with practical applications in controlling plant growth and development in agriculture.									

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Membrane transport and water relations**: Membrane transport of proteins, water potential and plant cell, mineral uptake and transport, boron, phosphate, sulphate and iron transporter in plant, light and microbes induced signalling in guard cell, regulation of water supply	10	Knowledge of mechanisms of membrane transport, water potential and mineral uptake in plants.	1,2, 3
II	**Nitrogen and molecular aspects of metabolism**: Regulation of nitrogen fixation, products of nitrogen fixation and their transport, mechanism of nitrate uptake Physiological and molecular aspect of photosynthesis. NO metabolism in plants, nitrogen metabolism in relation to respiration.	8	Deep understanding of nitrogen fixation, nitrogen metabolism, and photosynthesis in plants	1,2, 3

III	**The flowering process**: Photoperiodism and its significance, endogenous clock and its regulation, floral induction, role of vernalization. Fruit development and ripening: Stages of fruit development and their regulation, biochemical and related events during fruit ripening in climacteric and non-climacteric fruits. Physiology and biochemistry of fruit abscission, production of transgenic fruits.	10	To know about the physiological processes of flowering of plants.	1,2, 3
IV	**Stress physiology and plant toxin**: Plant responses to a biotic stresses, mechanisms of a biotic stress tolerance, water deficit and drought tolerance, salinity stress, metal toxicity and freezing. Plant responses to metal ion stress, freezing and heat stress. Effect of elevated CO_2 concentration on plant metabolism. Oxidative stress, my cotoxins, protein toxins in plants. Nitrosative and oxidative stress - causes and effects.	10	To acquire knowledge of plant responses to a biotic stresses, oxidative stress, and plant toxins.	1,2, 3
V	**Plant growth regulators**: A brief idea about discovers, role and possible mechanism of action of Triacontanol, Brassins, Salicylic acid. A brief idea about role of plant growth retardants-CCC, Maleic hydrazide, Trizoles and TIBA.	7	Able to understand the role and mechanisms of plant growth regulators and growth retardants.	1,2, 3
Practical	1. Determination of lipid from oil seeds.	3	Students will be able to estimate the lipid content in oilseeds.	1,2, 3,4
	2. Estimation of photosynthetic pigments by spectrophotometric and chromatographic techniques.	3	Practical skills in measuring and analyzing chlorophyll and carotenoid content in plant tissues.	1,2, 3,4
	3. To estimate the percentage of soluble protein of fresh moong, bean seedling by Lowry's Method and biuret reagent	3	Students will learn to estimate protein content in plant seedlings	1,2, 3,4
	4. Estimation of oxalic acid from leaf tissue.	3	Ability to measure oxalic acid levels in plants.	1,2, 3,4
	5. Estimation of starch, ascorbic acid, polyphenols, cellulose.	3	Students will learn to extract and estimate starch, Cellulose from plants	1,2, 3,4
	6. Extraction of plant phenols and estimation of total phenols.	3	Students will learn to extract and estimate phenolic compounds from plants	1,2, 3,4
	7. Study of seed germination under stress condition	3	practical experience in studying the effects of environmental stress on seed germination,	1,2, 3,4
	8. Study of effect of fungal infection on peroxidase activity.	3	Understand the role of peroxidase enzymes in plant defence mechanisms against fungal infections.	1,2, 3,4
	9. Estimation of total free amino acids from plant	3	To quantify free amino acids	1,2,

	materials through spectrophotometer.		in plant tissues.	3,4
	10. To measure the activity of amylase in germinating barley and moong seeds and to study the effect of: (i) substrate concentration, (ii) pH.	3	Students will acquire practical knowledge of enzyme activity	1,2, 3,4

Text Books

T1. Buchanan B.B., Gruissem W and Jones R.L.(2007): Biochemistry and Molecular Biology of plants. 1st Edition IK International.
T2. Salisburry, F.B. and Ross C.W.(1992): Plant physiology (Fourth Edition). Wadsworth Publishing Company, California, U.S.A.
T3. Dennis D. T., Turpin, D. H. Lefebvre D. D. and Layzell D. B.(eds) (1997). Plant Metabolism (Second Edition) Longman, Essex, England.
T4. Willium G Hopkins, Norman P Hunar (2009) Introduction to Plant Physiology, Wiley.
T5. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition

Reference Books

R1. Buchanan B.B, Gruissem W. and Jones R. L (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland,USA.
R2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology.John Wiley & Sons, U.S.A. 4th Edition.
R3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

Other Learning Resources:

https://www.esalq.usp.br/lepse/imgs/conteudo/Plant-Physiology-by-Vince-Ordog.pdf
https://onlinelibrary.wiley.com/journal/1365313x

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will gain an understanding of the mechanisms of membrane transport, water potential, and mineral uptake in plants, enabling them to analyze water regulation and ecological interactions in plant cells...	1, 2, 3, 6
2	Students will develop a deep understanding of nitrogen fixation, nitrogen metabolism, and photosynthesis in plants, and their ecological importance in nutrient cycling and plant growth...	1, 2, 3, 6
3	Students will learn the physiological processes of flowering, photoperiodism, floral induction, and fruit development, applying this knowledge to plant reproduction and ecosystem stability.	1, 3, 6, 7
4	Students will acquire knowledge of plant responses to a biotic stresses, oxidative stress, and plant toxins, enabling them to understand plant survival strategies under environmental stress...	1, 3, 6, 7
5	Students will understand the role and mechanisms of plant growth regulators and growth retardants, with practical applications in controlling plant growth and development in agriculture.	1, 3, 6, 7

SEMESTER – IV									
Course Title	**Plant Physiology and Biochemistry-II**								
Course code	**24MSBO223R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Botany**								
Semester	**Winter/II semester of First year of the programme**								
Course Objectives	1. To understand the key biochemical pathways involved in plant respiration. **2.** To explore the mechanisms of photochemistry and photosynthesis. **3.** To understand carbohydrate and organic acid metabolism. **4.** To study enzyme kinetics and nitrogen metabolism. **5.** To explore plant signal transduction pathways to understand various plant signalling mechanisms.								
CO1	Students will gain an in-depth understanding of the biochemical processes involved in plant respiration.								
CO2	Students will acquire a comprehensive understanding of the mechanisms of photosynthesis								
CO3	Students will learn the regulation of carbohydrate metabolism and sucrose biosynthesis, cellulose synthesis and metabolic roles of organic acids.								
CO4	Students will develop an understanding of enzyme kinetics, including the calculation of Km values.								
CO5	Students will gain knowledge of plant signal transduction mechanisms, including receptor-G-protein signaling, phospholipid signaling,								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Respiration and lipid metabolism**: Overview of plant respiration, electron transport and ATP synthesis, glycolysis in plants and its regulation, regulation of pentose phosphate pathway and TCA cycle, inhibitor of respiration, glyoxylate cycle, synthesis of membrane lipids	10	Students will understand the molecular processes of plant respiration.	1,2,3
II	**Photochemistry and photosynthesis**:, Photo-oxidation of water, mechanism of electron and proton transport, Regulation of PCR cycle and C4 pathway, RUBISCO and PEP Case, C3-C4 intermediates, ecological significance and modification of CAM.	8	Students will learn the mechanisms of photosynthesis, including the photo-oxidation of water, electron and proton transport.	1,2,3
III	**Carbohydrate and organic acid metabolism**: Regulation of starch and sucrose biosynthesis, synthesis and degradation of cellulose, a brief idea of pectin biosynthesis and enzymes involved in pectin degradation, metabolism and roles of oxalic acid, ascorbic acid and malic acid	10	Students will understand the regulation of starch and sucrose biosynthesis..	1,2,3
IV	**Enzyme kinetics**: Km value, enzyme inhibition, factors responsible for enzyme interaction, abzyme and ribozyme. Organization, function and regulation of nif and nod genes. Transcriptional and post transcriptional regulation of nitrate assimilation in plant.. Molecular aspects of seed germination and dormancy	10	Students will gain knowledge of enzyme kinetics, including the determination of Km values.	1,2,3

V	**Signal transduction**: Receptors and G-proteins, phospholipids signalling, calcium- bcalmodulin cascade. Specific signalling mechanisms, two component sensing/signalling system in plants. Secondary metabolites: Shikimate pathway and its role in biosynthesis of secondary metabolites, biosynthesis of terpens, phenols and nitrogenous compounds.	7	Students will gain knowledge of plant signal transduction mechanisms, including receptor-G-protein.	1,2,3

Text Books

T1. Buchanan B.B., Gruissem W and Jones R.L.(2007): Biochemistry and Molecular Biology of plants. 1st Edition IK International.
T2. Salisburry, F.B. and Ross C.W.(1992): Plant physiology (Fourth Edition). Wadsworth Publishing Company, California, U.S.A.
T3. Dennis D. T., Turpin, D. H. Lefebvre D. D. and Layzell D. B.(eds) (1997). Plant Metabolism (Second Edition) Longman, Essex, England.
T4. Willium G Hopkins, Norman P Hunar (2009) Introduction to Plant Physiology, Wiley.
T5. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition

Reference Books

R1. Buchanan B.B, Gruissem W. and Jones R. L (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland,USA.
R2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology.John Wiley & Sons, U.S.A. 4th Edition.
R3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi

Other Learning Resources:

https://www.sciencedirect.com/journal/journal-of-plant-physiology
https://link.springer.com/journal/40502

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will gain an in-depth understanding of the biochemical processes involved in plant respiration.	1, 3, 6
2	Students will acquire a comprehensive understanding of the mechanisms of photosynthesis.	1, 2, 3, 6
3	Students will learn the regulation of carbohydrate metabolism and sucrose biosynthesis, cellulose synthesis and metabolic roles of organic acids.	1, 3, 6
4	Students will develop an understanding of enzyme kinetics, including the calculation of Km values.	1, 2, 3, 6, 7
5	Students will gain knowledge of plant signal transduction mechanisms, including receptor-G-protein signaling, phospholipid signaling,	1, 3

Assam down town University

Curriculum and Syllabus

Master of Science in Chemistry

OUTCOME BASED EDUCATION FRAMEWORK
CHOICE BASED CREDIT SYSTEM
Version: 1.0

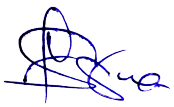
FACULTY OF SCIENCE

July, 2024

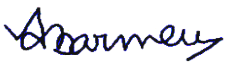
PREAMBLE

Assam down town University is a premier higher educational institution which offers Bachelor, Master, and Ph.D. degree programmes across various faculties. These programmes, collectively embodies the vision and mission of the university. In keeping with the vision of evolutionary changes taking place in the educational landscape of the country, the university has restructured the course curriculum as per the guidelines of National Education Policy 2020. This document contains outline of teaching and learning framework and complete detailing of the courses. This document is a guidebook for the students to choose desired courses for completing the programme and to be eligible for the degree. This volume also includes the prescribed literature, study materials, texts, and reference books under different courses as guidance for the students to follow.

Recommended by the Board of Studies (BOS) meeting of the Faculty of Science held on dated 16th & 17th July, 2024 and approved by the 51st Academic Council (AC) meeting held on dated 26/07/2024



Chairperson, Board of Studies



Member Secretary, Academic Council

Vision

To become a Globally Recognized University from North Eastern Region of India, dedicated to the Holistic Development of Students and Making Society Better

Missions

1. Creation of curricula that address the local, regional, national, and international needs of graduates, providing them with diverse and well-rounded education.
2. Build a diverse student body from various socio-economic backgrounds, provide exceptional value-based education, and foster holistic personal development, strong academic careers, and confidence.
3. Achieve high placement success by offering students skill-based, innovative education and strong industry connections.
4. Become the premier destination of young people, desirous of becoming future professional leaders through multidisciplinary learning and serving society better.
5. Create a highly inspiring intellectual environment for exceptional learners, empowering them to aspire to join internationally acclaimed institutions and contribute to global efforts in addressing critical issues, such as sustainable development, Climate mitigation and fostering a conflict-free global society.
6. To be renowned for creating new knowledge through high quality interdisciplinary research for betterment of society.
7. Become a key hub for the growth and excellence of AdtU's stakeholders including educators, researchers and innovators
8. Adapt to the evolving needs and changing realities of our students and community by incorporating national and global perspectives, while ensuring our actions are in harmony with our foundational values and objectives of serving the community.

Programme Details

Programme Overview

Master of Science (M.Sc.) in Chemistry is a two-year-long postgraduate degree programme in the field of science and it is divided into four semesters. M.Sc. in Chemistry provides an understanding of the variety of physical and biological phenomena with the knowledge of natural and chemical processes. The chemistry course at the postgraduate degree programme is specially designed for students willing to pursue a career in industry, academia, and research. The course provides in-depth knowledge in the fields of Inorganic Chemistry, Organic Chemistry, Medicinal Chemistry, Physical Chemistry, and Analytical Chemistry. Through research-driven approach the candidates will get practical knowledge to solve complex problems in various fields, such as pharmaceuticals, petrochemicals and other research-based industries. It will give a wide range of scope and career opportunities for students in science-related fields both in private as well as government companies.

I. Specific Features of the Curriculum

The Master of Chemistry curriculum features core courses in inorganic chemistry, organic chemistry, and physical chemistry, with electives in organic synthesis, natural products, organometallic chemistry and catalysis, Inorganic Reaction Mechanism and Kinetics. It emphasizes hands-on laboratory skills, and includes a substantial research thesis project along with seminars, workshops, or industrial internships. The program incorporates interdisciplinary approaches, regulatory and ethical training, and develops essential soft skills such as scientific communication and project management. Additionally, it offers global perspectives on issues related to chemistry and environment, preparing graduates for diverse careers in research, industry, and academia.

The curriculum provides skill enhancement and value-added courses along with the core papers.

II. Eligibility Criteria:

Graduation with Chemistry as honours subject along with any two of the following as subsidiary subjects: i) Physics, ii) Mathematics iii) Biotechnology iv) Zoology v) Botany with minimum of 45% marks in aggregate or equivalent grades (CGPA) (5% relaxation for reserved categories) from any recognized University/Institution

III. Program Educational Objectives (PEOs):

PEO-1: AdtU Chemistry Postgraduates will be well prepared for successful careers in industry and/or in government in one or more following areas: petrochemicals, pharmaceuticals, polymers, paints, research and forensic laboratories, etc.

PEO-2: AdtU Chemistry Postgraduates will be academically prepared to contribute effectively to the growth and development of applied chemical sciences and allied domains.

PEO-3: AdtU Postgraduates will be successful in higher education in related areas of energy, pharmaceuticals, material science, polymer technology, chemical engineering if pursued.

IV. Program Specific Outcomes (PSOs):

PSO1: Interdisciplinary Knowledge: Exhibit an in-depth understanding of the concept of chemical sciences and apply interdisciplinary knowledge and proficiency to address the challenges within the domains of chemistry and relevant fields.

PSO2: Innovation and Entrepreneurship: Apply multidisciplinary approach for research exploration and collaboration with professionals across diverse disciplines contributing to innovation and entrepreneurship

PSO3: Global certification: Exhibit global competency to excel in the profession.

V. Program Outcome:

PO1: Disciplinary knowledge: Apply fundamental knowledge of chemical sciences in practice.

PO2: **Problem Solving:** Identify, assess, plan, design and carry out scientific experiments accurately and analyze the results to resolve problems

PO3: Communication: Communicate effectively with peers, community and society at large to exchange clear instructions.

PO4: **Professional Ethics and Values**: Comply with ethical principles in the profession and act in accordance with human values.

PO5: Research-In-Practice: Identify, apply and analyze the complex scientific problems using advanced research methodology in chemistry and design a meaningful solution.

PO6: Modern Tool Usage: Apply appropriate resources, modern scientific tools and techniques to resolve scientific problems with a proper explanation.

PO7: Environment and Sustainability: Apply principles of chemistry for addressing social, economic, environmental problems, and towards achieving sustainable ecosystem.

PO8: Lifelong Learning: Engage in independent and lifelong learning staying abreast with the advancements in technology and practices related to chemistry.

VI. Total Credits to be Earned: 89

VII. Career Prospects:

Upon completing the program, graduates can pursue a wide range of careers across industries, academia, and government as well as private sectors. They are well prepared for industrial and research work in fields such as Pharmaceuticals & Biotechnology, Chemical Manufacturing, Food & Beverage Industry, Cosmetics & Personal Care, Petroleum & Energy. They can also opt for academic positions as teachers and research assistant. The graduates can pursue career in interdisciplinary fields like Forensic Science, Environmental Science, Regulatory Affairs and other Emerging Fields such as Nanotechnology & Materials Science, Data Science & Computational Chemistry, Intellectual Property & Patent Law. Moreover, graduates can go for a Ph.D. in Chemistry and for advanced research positions or specialized careers.

EVALUATION METHODS

The student performance shall be evaluated through In-semester (Sessional) and semester-end examinations. A weight age of 40% or as prescribed by the programme shall be added to the score of the end semester examination.

A. INTERNAL ASSESSMENT:

The teacher who offers the course shall be responsible for internal assessment by conducting in-semester (sessional) examination and evaluating the performance of the students pursuing that course. The components for internal assessment are illustrated in the table given below.

SN	Components/ Examinations	Marks Allotted
1.	In-Sem Exam – I (ISE-I) (Written Examination)*	30
2.	In-Sem Exam – II (ISE-II) (Written Examination)*	30
3.	Assignment	10
4.	Presentation (SP)	10
5.	Quiz	5
6.	Class Performance based score*	5

are compulsory

Note: *Total Internal assessment should be out of 40*

INSTRUCTION

1. If a student fails to appear in the any of the component without any valid reason he/she shall be marked zero in that component. However, the course teacher at his discretion may arrange for the missed test on an alternate date for the absentee students after determining ground with genuine/valid reasons for the absent.
2. The report of evaluation of an activity towards the in-semester (sessional) component of a course shall be duly notified by the concerned course teacher within a week of completion.
3. The program coordinators should upload the in-semester marks to the ERP and forward acknowledgement of all the courses of the program to the Controller of Examinations before the start of the End-semester examination.

B. SEMESTER END EXAMINATION:

Time table for end semester examination is published at least 25 days prior to the start of Examination.

I. Pre-Examination:

Eligibility Criteria for a student to appear in University Examinations:

The student shall only be allowed to appear in a University Examination, if:

i) He/ She is a registered student of the University;
ii) He/ She is of good conduct and character;
iii) He/ She has completed the prescribed Programme of study with minimum percentage of attendance as laid down in the Regulations of the Programme concerned.

Under special cases, a student may be allowed to appear for an examination without being registered in the University but the result of the said student will be kept on hold till the registration of the concerned student is completed.

II. Admit Card:

Admit card for the examination may be downloaded through ERP where the system will generate a Unique ID Cards through online.

The University shall have the right to cancel admission for examination of any candidate on valid grounds.

III. Pattern of Question Papers:

The question paper shall follow the principles of Bloom's Taxonomy.

Table

S. N.	Level	Questions /verbs for test
1	Remember	List, Define, tell, describe, recite, recall, identify, show who, when, where, etc.
2	Understand	Describe, explain, contrast, summarize, differentiate, discuss etc.
3	Apply	Predict, apply, solve, illustrate, determine, examine, modify
4	Analyze	Classify, outline, categorize, analyze, diagrams, illustrate, infer, etc.
5	Evaluate	Assess, summarize, choose, evaluate, recommend, justify, compare etc.
6	Create	Design, Formulate, Modify, Develop, integrate, etc.

Note: No course is to be evaluated on basis of **all 6 knowledge levels.**

The format of the question paper across all the program follow a unique pattern and the total marks is 60

Table 1: Question paper pattern for End semester examination

Sl no	Question pattern	Total marks
1	MCQs (10 Questions)	10
2	2 Marks questions (10 Questions)	20
3	4 Marks questions (5 Questions)	20
4	10 Marks questions (1 Question)	10

IV. Examination Duration:

Each paper of 60 marks shall ordinarily be of two hours duration.

V. Practical Examinations, Viva-Voice etc.:

i) Practical examination shall be conducted in the presence of one external expert and one or more internal examiners.

ii) Viva-Voice, Oral examinations of the Project report, Dissertation etc. shall be undertaken by a Board of Examiners constituted by the respective Dean of Program with the advice of Supervisor(s).

VI. Procedure of Expulsion:

If any candidate is found to be using any unfair-means during the examination, the invigilator may cease his/her answer sheet and report it directly to the Officer-in-Charge. The Office-in-Charge of the center may take appropriate decisions as per the rules and procedure of the examination. The Officer-in-Charge may allow the students to write the exam with new

answer sheet or may expel the student from appearing the paper depending on the nature of unfair-means. In case of Computer based test, the students may be directed to write an apology letter and sign in the prescribe expulsion form. The student may not be allowed to write that examination.

VII. Instruction to the Students:

(i) The students shall not bring to the Examination Hall, any electronic gadget used as a means of communication or record except electronic calculator, if required.

(ii) The students shall not receive any book or printed or hand written or photo copy (Xerox) or blank-paper from any other person while he/she is in the examination-room or in laboratory or in any other place to which he/she is allowed to have access during course of examination.

(iii) The students shall not communicate with any other candidate in the examination room or with any other person in and outside the examination-room.

(iv) The students shall not see, read or copy anything written by any other candidate, nor shall he/she knowingly or negligently permit any other candidate to see, read or copy anything written by him/her or conveyed by him/her.

(v) The students shall not write anything on the Question Paper or in other paper or materials during the examination, or pass any kind of paper to any other candidate in the examination-room, or to any person outside the room.

(vi) The students shall not disclose his/her identity to the examiner by writing his/her name or putting any sign / symbol in any part of his answer-script.

(vii) The students shall not use any abusive language or write any objectionable remark or make any appeal to examiner by writing in any part of his answer-script.

(viii) The students shall not detach any page from the answer-script or insert any authorized or unauthorized loose sheet into it. He /she shall also not insert any other answer-script / loose sheet by removing the pins of the origin answer-scripts and re-fixing it.

(ix) The students shall not resort to any disorderly conduct inside the examination-room or misbehave with the invigilator or any other examination official.

VIII. Provision for an Amanuensis (writer):

(i) A candidate may be provided with an Amanuensis (writer) to write down on dictation on his / her behalf on ground of his / her physical disability to write down by himself / herself due to accident or any other reason. The amanuensis may be provided till he / she recovers from the physical disability. The physical disability to write down by himself / herself must be supported by Medical Certificate from a competent Medical Officer.

(ii) The qualifications of the amanuensis so provided must not be equal or higher than that of the candidate. This is also to be supported by Certificate from the Faculty of Study where the Amanuensis is provided.

(iii) Such candidates are to be accommodated in a separate room under the supervision of an invigilator so that the fellow candidates are not disturbed in the process.

C. Credit Point:

It is the product of grade point and number of credits for a course, thus, CP = GP x CR

i. Credit:

A unit by which the course work is measured. It determines the number of hours of instructions required per week. 'Credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. Credits assigned for a single course always pay attention to how many hours it would take for an average learner to complete a single course successfully.

ii. Grade Point:

Grade Point is a numerical weight allotted to each Grade Letter on a 10-point scale.

iii. Letter Grade:

Letter Grade is an index of the performance of students in a said paper of a particular course. Grades are denoted by letters O, A+, A, B+, B, C, P, F and Abs. Student obtaining Grade F / Grade Abs shall be considered failed/ absent and, will be required to appear in the subsequent ESE. The UGC recommends a 10-point grading system with the following (Table: 1) Letter Grades:

(i) A Letter Grade shall signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point shall indicate the numerical weight of the Letter Grade on a 10-point scale.

(ii) There shall be 08 (eight) Letter Grades bearing specific Grade Points as listed in Table 1, where the Letter Grades 'O' to 'P' shall indicate successful completion of a course.

(iii) Apart from the 08 (eight) regular Letter Grades listed in Table 1, there shall be 03 (three) additional Letter Grades, which shall be awarded if a Course is withdrawn or spanned over the next Semester or remains incomplete as stated in Table 2.

Table 2: Letter Grades and Grade Points

Letter Grade	Grade Points	Description
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Abs	0	Absent
UFM	0	Unfair Means

iv. Grade Point Average:

a. SGPA (Semester Grade Point Average)

The SGPA of a student in a Semester shall be the weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered in that Semester, irrespective of whether he/she could or could not complete the

Courses. More specifically, the calculation of SGPA shall take into account the Courses graded with Letter Grades 'O' to 'F' as given in Table 1.

$$\text{SGPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad (1.1)$$

The SGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.1) up to two decimal places, where n is the total number of Credit Courses registered by the student in that Semester, Gi is the Grade Point secured in the i^{th} registered Course and Ci is the Credit (weight) of that Course.

b. CGPA (Cumulative Grade Point Average)

(i) The CGPA of a student in a Semester of a Programme shall be the accumulated weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered and successfully completed so far starting from the enrollment in the Programme. In other words,taking into account all the Courses graded with 'O' to 'P' as given in Table 1.1, generally the CGPA of a student shall be calculated starting from the first Semester of his/her enrolled Programme, while the CGPA of a lateral-entry student shall be calculated starting from the Semester of his/her enrollment.

(ii) The CGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.2) up to two decimal places, where N is the total number of Credit Courses registered and successfully completed so far by the student, Gi is the Grade Point secured in the ith completed Course and Ci is the Credit (weight)of that Course.

$$\text{CGPA} = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i} \qquad (1.2)$$

(iii) The CGPA shall be convertible into equivalent percentage of marks using Equation Conversion of CGPA to percentage marks: = CGPA*10

D. Post-Examination

i. Transcript or Grade Card or Certificate:

A marking certificate shall be issued to all the registered students after every Semester. The Semester mark sheet will display the course details (code, title, number of credits, grade secured) along with total credit earned in that Semester.

ii. Grievance Readdress Mechanism:

Students with any dissatisfaction or grievance regarding the marks awarded in any of the Papers / Courses may appeal to the Controller of Examinations for remedial action such as Re-evaluation within 10 days of the declaration of result.

(i) A student has options to appeal for re-evaluation of his /her answer script to the Controller of Examination.

(ii) Application for re-evaluation / re-scrutiny of answer scripts shall be made in the definite proforma available with the Examination Office through the head of the respective departments within 10 days of declaration of the results of the respective examinations.

(iii) The Controller of Examination may appoint an examiner for re-evaluation and will consider and recognize the evaluation done by a University appointed examiner.

(iv) There shall be no provision for re-evaluation of the Practical Papers, Project Work, and Dissertation etc. However, the students fail in practical examination or viva voce and wish to appear again may apply to be evaluated can do so with the next schedule.

(v) After screening the application for re-evaluation, the CoE may send the answer scripts of the student to the examiners appointed by the CoE with the approval of Vice Chancellor.

(vi) The marks/grades achieved by the students after the re-evaluation shall be final and binding.

(vii) Fresh Marks – sheets / Grade Card shall be issued only if the candidate secures pass marks / passing grade in the re-evaluated paper.

(viii) Revaluation of answer scripts shall be deemed to be an additional facility provided to the students with a view to improving upon their results at the preceding examination result for any reason whatsoever shall not confer any right upon them for admission to next higher class which matters always be regulated in accordance with the relevant rules or regulations framed by the University.

(ix) If as a result of revaluation of the candidate attracts the provision of condonation of deficiency, the same may be applied to his/her only for fresh attempt.

INSTRUCTION TO TEACHERS AND STUDENTS

(Teaching and Learning Methods)

In all the courses the teacher has to select topics for teacher-method which should not be less than 20 percent. The approach will be direct class room teaching through series of lectures delivering concepts using ITC facilities, white or black board. Notes may also be circulated to the students however; the students are to be involved in preparation of the notes. The teacher will be responsible in selecting the best note for circulation. The teacher- centric methodology has recently fallen out of favour because this strategy for teaching is seen to favor passive students.

1. Student- centric / Constructivist Approach:

The topics of the courses may be selected at the start of the class and assigned one topic to each of the student for studying by themselves, prepare presentations, notes etc., and present at respective class time after consultation and discussion with the course teachers. The teacher facilitate the learning of the students by guiding and providing input and explaining concepts. 60 percent of the course contents may be selected for this purpose. To avoid behavior problems, teachers must lay a lot of groundwork in student- centric classrooms. Typically, it involves instilling a sense of responsibility in students. In addition, students must learn internal motivation.

a. Project-Based Learning: The teacher may select 5 percent of topics for the purpose and may conduct visit to the laboratory for experiments or field and survey. The selection of the topic may be done considering the available facility for the purpose. However, in the final semester of each of the programme the student has to undergo a project-Based learning at least 4 months duration. This approach will help the student to think critically, evaluate, analyze, make decisions, collaborate, and more.

b. Inquiry-Based Learning: The teacher/ students are supposed to list at least five questions in each contact hour and student solve these question or search for answer which becomes the home work for the students “question-driven” learning approach. The teacher may look for the correctness of the solution or the best possible answer and discuss in the successive class. This will help in the preparation for various competitive examination and develop a habit for search for solutions.

c. Flipped Classroom: About 10 percent of the course content has to be completed by this method. In this approach the students are asked to watchvideo or lecture prepared by the teacher or any video available (relevant to the course). A set of questions may be given to the students for searching answers by the students. The idea is that students should have more time in-classroom focusing on achieving these higher levels of thinking and learning. The Flipped classroom is also an acronym. The letters FLIP represent the four pillars included in this type of learning: Flexible environment, Learning culture shift, Intentional content, and Professional educator. As you can see, the second pillar refers to a culture shift from the traditional approach where students are more passive to an approach where students are active participants. As a result, this approach is also a student- centric teaching method.

d. Cooperative Learning: The remaining five percent has to be completed by cooperative learning approach. In this approach the students are allotted with problems. During the library hours the student along with the teacher visits library search probable solution for the assigned problem. The same has to be done in group so that the students discuss among

themselves for the appropriate answers. Essentially, cooperative learning believes that social interactions can improve learning. In addition, the approach recreates real-world work situations in which collaboration and cooperation are required.

The percentage categorization for the completion of a theory course

Teacher- centric or Direct Classroom Teaching: Delivery by series of lectures	20%
Student- centric Approach, Student present and deliver lectures in presence of teacher and supervised by teacher	60%
Student visit fields or perform experiments or teacher perform demonstration	05%
Flipped Classroom approach	10%
Cooperative learning approach	05%

Inquiry based approach has to be followed in all of the classes

Teacher has to distribute the topics to be considered for teaching by the above-mentioned approaches and prepare lesson plan for execution and maintain a file

Breakdown of Credits

Sl. No.	Category	Total number of Credits
1.	Discipline Specific Core (Major)	19
2.	Discipline Specific Core (Minor)	8
3.	Skill Enhancement Course (SEC)	4
4.	Discipline Specific Elective (DSE)	18
5.	Ability Enhancement Course (AEC)	6
6.	Value Added Course (VAC)	4
7.	Co and extra-Curricular	2
8.	Multidisciplinary Course (MDC)	2
9.	Field Training	2
10.	Research /Industry Internship	20
11.	Summer Internship	4

Breakdown by categories of courses

Sl no	Category	Credits	%
1	Science	83	93.26%
2	Humanities and Social Sciences	6	6.74%
Total		89	100%

SEMESTER WISE COURSE DISTRIBUTION

	S. N.	Course Code	Course Title	Course	Engagement							Maximum Marks for			
				Category	L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester I	1	24MSCH1101R	Inorganic Chemistry-I	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	2	24MSCH1102R	Organic Chemistry-I	**DSC Minor**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSCH1103R	Physical Chemistry-I	**DSC Minor**	3	0	2	0	0	0	4	40	60	100	200
	4	24UMFS1101R	Fundamental of Statistics	**MDC**	1	0	2	0	0	0	2	40	60	100	200
	5	24UMPD1101R	Effective Communication (PDP)	**AEC**	0	0	4	0	0	0	2	50	0	50	100
	6	24UMEC1101	Extra-curricular	**Co and extra-Curricular**	0	0	0	0	0	0	1	0	0	100	100
	Total										**17**				**1000**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester II	1	24MSCH1201R	Inorganic Chemistry-II	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	2	24MSCH1202R	Organic Chemistry-II	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSCH1203R	Physical Chemistry-II	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	4	24UMPD1201R	Advanced Communication	**AEC**	0	0	4	0	0	0	2	0	0	100	100
	5	24MSCH1204R	Postgraduate Practice Teaching	**SEC**	1	0	0	0	0	0	1	0	0	100	100
	6	24MSCH1205R	Research Methodology and Statistical Analysis	**SEC**	2	0	2	0	0	0	3	40	60	100	200
	7	24FSDA1201R	Data analysis using MS Excel	**VAC**	0	0	4	0	0	0	2	0	0	100	100
	8	24MSCH1206R	Field Visit	**Field Training**	0	0	0	0	0	8	1	0	0	100	100
	9	24UMCC1201	Co-curricular	**Co and extra Curricular**	0	0	0	0	0	0	1	0	0	100	100
	Total										**22**				**1300**

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester III	1	24MSCH2101R	Symmetry and Group Theory	**DSC Major**	3	0	0	0	0	0	3	40	60	0	100
	2	24UMPD2101R	(PDP)	**AEC**	0	0	4	0	0	0	2	0	0	100	100
	3	24MSCH2102R	Internship	**Internship**	0	0	0	0	0	32	4	0	0	100	100
	4	24MSCH2103R	Field Visit	**Field Training**	0	0	0	0	0	8	1	0	0	100	100
	5	24MSCH2104R	Research Project- I	**Research/ Industry Internship**	0	0	8	0	0	0	4	0	0	100	100
	6	24MSCH2105R	Indian knowledge system	**VAC**	0	0	0	0	0	0	2	0	0	100	100
	Discipline specific Elective (Any three subjects to be selected)														
	7	24MSCH2106R	Biochemistry	**DSE**	3	0	2	0	0	0	4	40	60	100	200
	8	24MSCH2107R	Spectroscopy	**DSE**	4	0	0	0	0	0	4	40	60	0	100
	9	24MSCH2108R	Environmental and Green Chemistry	**DSE**	3	0	2	0	0	0	4	40	60	100	200
	10	24MSCH2109R	Chemistry of Catalysis	**DSE**	4	0	0	0	0	0	4	40	60	0	100
	11	24MSCH2110R	Food Chemistry	**DSE**	3	0	2	0	0	0	4	40	60	100	200
	Total										**28**				**1000-1200**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester IV	1	24MSCH2201R	Research Project-II	**Research/ Industry Internship**	0	0	32	0	0	0	16	0	0	100	100
	Discipline specific Elective (Any two subjects to be selected)														
	2	24MSCH2202R	Advanced Organic Synthesis	**DSE**	3	0	0	0	0	0	3	40	60	0	100
	3	24MSCH2203R	Natural Products Chemistry	**DSE**	3	0	0	0	0	0	3	40	60	0	100
	4	24MSCH2204R	Organometallic Chemistry and Catalysis	**DSE**	3	0	0	0	0	0	3	40	60	0	100
	5	24MSCH2205R	Inorganic Reaction Mechanism and Kinetics	**DSE**	3	0	0	0	0	0	3	40	60	0	100
	Total										**22**				**300**
	Grand Total										**89**				

(Note: In third semester five and in fourth semester four elective courses are offered. Students may choose three courses in the third semester and two courses in the fourth semester. Although the total credit due to this selection will remain unchanged, the total marks may vary due to the combination of these courses.)

***IA: Internal Assessment, SEE: Semester End Examination, PE: Practical Examination**

SEMESTER- I									
Course Title	**Inorganic Chemistry-I**								
Course Code	**24MSCH1101R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	Nil	**Co-requisite**	**Nil**						
Anti-requisite	Nil								
Programme	**Master of Science in Chemistry**								
Semester	**Fall/I Semester of First Year of the Program**								
Course Objectives	1. To study the chemical bonding of different homo and hetero nuclear molecules. 2. To study the bonding of different borane and polyhedral borane compounds. 3. To understand the packing structures of different ionic solid compounds. 4. To study the concept of different acid base theories. 5. To study the basics of different redox reactions, corrosion and its prevention.								
CO1	Define chemical bonds and different bonding theories associated with various types of molecules.								
CO2	Identify the structure and bonding of borane and other polyhedral boranes.								
CO3	Describe the basics of different packing spheres associated with ionic solids.								
CO4	Analyze and apply the concepts of acid base theories.								
CO5	Identify the different oxidation and reduction reactions along with knowledge on corrosion and its prevention.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Chemical bonding** Types of bonding, Valence bond theory, VSEPR model and LCAO-MO theory, LCAO-MO methods in homo and heteronuclear diatomic molecules (O_2, N_2, CO,NO).MO description of tri and tetraatomic molecules (CO_2, NO_2, NO_2^+, CO_3^{2-}, O_3 and NO_3^-),hybridization and its applications, Walsh Diagram.	10	Knowledge on the concept of different chemical bonds and different atomic theories along with examples of both homo and hetero nuclear molecules.	1, 2
II	**Inorganic Chains, rings, cages and clusters** Catenation, Heterocatenation, Zeolites, Intercalation, Structure and bonding in borazine, phosphazenes, polyhedral boranes, carboranes, metalloboranes and metallocarboranes, Styx notation, Wade's rules, Synthesis and electron count in polyhedral boranes, Inorganic clathrates.	10	Understand the fundamental knowledgeof different ring, cage like structures along with different polyhedral structures of boranes, metalloboranes.	1,2
III	**Solid state Chemistry**: Packing of spheres – hexagonal and cubic close packing, tetrahedral and octahedral holes in close-packed structures- metals and alloys, solid solutions. The ionic model for the description of bonding in	10	Knowledge on different ionic solids along with their different	1,2

	ionic solids. Characteristic structures of ionic solids- the NaCl and CsCl types, the sphalerite and wurtzite types of ZnS, NiAs structure type, perovskite and spinel structure types of mixed-metal oxides. Importance ionic radii and radius ratios in determining structure type among ionic solids. Lattice energy considerations, Thermal stability and solubility of inorganic solids. Bonding in solids –free-electron and band theory ofsolids, metallic bonding.		packing arrangements.	
IV	**Acid, Base and Redox Chemistry**: Acid-Base concepts, Measure of Acid-Base Strengths, Acid-Base in water. Non- aqueous solvent, aprotic solvent and superacids. Hard and Soft Acids and Bases, Application of HSAB principle.	7	Understand the different acid base concepts along with the different applications of HSAB principle.	1, 2, 3
V	**Oxidation and Reduction**: Half cell reaction, reduction potential, application of reduction potential data, electrochemical series; brief idea of corrosion and its prevention; Nernst equation. Latimer and Frost diagram, redox reactions of metal complexes in excited states, excited electron transfer, role of spin orbit coupling, lifetimes of excited states in these complexes.	8	Understand and analyse the concept of oxidation, reduction, electrochemical series.	1,2, 3, 4
Practical	Preparation and characterization of the following complexes: 1.Potassium chromioxalate,$K_3[Cr(C_2O_4)_3]$ 2. Reinecke's salt. 3.Chloropentaminecobalt(III)chloride$[Co(NH_3)_5Cl]Cl_2$ 4. Nitropentaminecobalt(III)chloride$[Co(NO_2)(NH_3)_5]Cl_2$ 5.TetraamineCu(II)sulphate $[Cu(NH_3)_4]SO_4.H_2O$ 6. HexammineNi(II)chloride $[Ni(NH_3)_6]Cl_2$	30	Students will gain knowledge and also be able to demonstrate their experimenting skills in synthesizing and characterizing different inorganic compounds.	1,2,3, 4

TEXTBOOKS:

T1: J. E. Huheey, E. A. Keiter and R. L. Keiter; Inorganic Chemistry: Principles of Structure and Reactivity, 4th Ed. Pearson Education, 2006.

REFERENCE BOOKS:

R1: P.W. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong; Shriver & Atkins, Inorganic Chemistry, 5th Ed. Oxford University Press, 2010.
R2: G. L. Miessler, D Tarr; Inorganic Chemistry. 3rd Ed., Pearson Education, 2004.
R3: J. D. Lee, Concise Inorganic Chemistry, 5th Ed. Blackwell Science.
R4: J .Mendham, R .C .Denney, J.D Barnes, M. Thomas. Vogel's Textbook of Quantitative Chemical Analysis. 6th edition.

OTHER LEARNING RESOURCES*:*
https://nptel.ac.in

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Define chemical bonds and different bonding theories associated with various types of molecules.	**1, 2, 5, 6**
2	Identify the structure and bonding of borane and other polyhedral boranes.	**1, 5, 6**
3	Describe the basics of different packing spheres associated with ionic solids.	**1, 5, 6**
4	Analyze and apply the concepts of acid base theories.	**1, 5, 6**
5	Identify the different oxidation and reduction reactions along with knowledge on corrosion and its prevention.	**1, 5, 6**

SEMESTER- I									
Course Title	**Inorganic Chemistry-I**								
Course Code	**24MSCH1102R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	Nil	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Fall/I Semester of First Year of the Program**								
Course Objectives	1. To make students recall the stereochemistry and the different modes of representation of organic compounds along with the concepts of stereogenic center. 2. To revise the reaction mechanisms encountered in organic chemistry. 3. To make the students recall about the structure & reactivity of reaction intermediates of organic chemistry.								
CO1	Explore the different modes of representation of organic compounds, their interconversion, and explain the concept of isomerism and chirality in organic compounds.								
CO2	Explain the concepts of stereogenic center, topicity and prostereoisomerism								
CO3	Describe the reaction mechanisms encountered in organic chemistry.								
CO4	Analyse and describe the structure & reactivity of reactive organic intermediates like carbocations, carbanions, ylides.								
CO5	Analyse and describe the structure & reactivity of reactive organic intermediates like carbenes, nitrenes, free radicals.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Stereochemistry I:** Isomerism and Chirality in Organic compounds, conformational analysis of simple cyclic and acyclic molecules, cyclohexane and decalins, interconversion of Newman, Fischer and Sawhorse formula, R/S, E/Z nomenclature, concept of absolute and relative configurations, optical purity and optical activity in absence of chiral atoms.	**6**	Knowledge of different modes of representation of organic compounds and their interconversion; concept of isomerism and chirality in organic compounds	1,2
II	**Stereochemistry II:** Concepts of stereogenic center – chirotopic and achirotopic center, homotopic and heterotopic ligands and faces (prostereoisomerism and prochiralityetc), optical purity and enantiomeric excess.	**4**	To learn the concept of stereogenic center, topicity and prostereoisomerism.	1,2
III	**Reaction Mechanisms:** Substitution reactions, Aliphatic nucleophilic substitution, SN1, SN2, mixed SN1 and SN2, SET, SNi. Electrophilic substitution, Arenium ion, SE1, SE2 and SEi mechanism, aromatic nucleophilic substitution.S_NAr, SN1, Benzyne, SRN1mechanism, Reactivity, effect of substrate, leaving group and attacking species. Addition reactions, mechanism and Stereochemical aspects of addition reactions in C-C multiple bonds, regioselective, orientation and reactivity. Elimination reactions, E1, E2 and E1cB, orientation and reactivity.	**13**	To understand the reaction mechanisms encountered in organic chemistry.	1,2

IV	**Reaction Intermediates: Structure & Reactivity I:** Carbocations: structure and stability of carbocations, classical and non-classical carbocations, neighbouring group participation and rearrangements including Wagner-Meerwein, pinacol-pinacolone, semi-pinacol rearrangement, C-C bond formation involving carbocations, oxymercuration, halo-lactonisation, Tishchenko reaction, Ritter reaction, Prins reaction. Carbanions: enolates and enamines, Kinetic and thermodynamic enolates, lithium and boron enolates in aldol and Michael reactions, alkylation and acylation of enolates, name reactions under carbanion chemistry- Claisen, Dieckmann, Knoevenegal, Stobbe, Darzen, Acyloin condensations, Shapiro reaction, Julia olefination, Brook rearrangement,Sakurai reaction,Henry reaction,Kulinkovichreaction,Nefreaction,Baylis-Hillman reaction. Ylids: Chemistry of phosphorous and sulfur ylids- Wittig and related reactions, Peterson olefination.	**12**	To know about the reaction intermediates, their classifications, structure and reactivity.	1,2
V	**Reaction Intermediates: Structure & Reactivity II:** Carbenes and Nitrenes: Structure of carbenes, generation of carbenes, addition and insertion reactions, rearrangement reactions of carbenes such as Wolff rearrangement and Arndt-Eistert synthesis, generation and reactions of ylids by carbenoid decomposition (existence of O and N based ylids), Structure of nitrene, generation and reactions of nitrene and related electron deficient nitrogen intermediates, Curtius, Hoffmann, Schmidt, Lossen, Beckmann rearrangement, Tebbeolefination reactions. Radicals: Generation of radical intermediates and its (a) addition to alkenes, alkynes (inter &intramolecular) for C-C bond formation and Baldwin's rules (b) fragmentation and rearrangements. Name reactions involving radical intermediates (Barton deoxygenation and decarboxylation, McMurry coupling).	**10**	To know about the reaction intermediates, their classifications, structure and reactivity.	1,2

TEXTBOOKS:

T1: Nasipuri, D. Stereochemistry of Organic Compounds: Principles and Applications. Revised 2nd edition. New Age International Publishers; 2007.

T2: Bruice, P. Y. Organic Chemistry. 8th edition. Pearson; 2020.

T3: March, J. Advanced Organic Chemistry: Reactions, Mechanisms, and Structure. 4th edition. Wiley; 2016.

REFERENCE BOOKS:

R1: Clayden, J., Greeves, N. and Warren, S. Organic Chemistry. 2nd edition. Oxford University Press; 2012.

R2: Vogel, A.I. Textbook of Practical Organic Chemistry. 5th edition Prentice Hall.

OTHER LEARNING RESOURCES:

https://nptel.ac.in

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explore the different modes of representation of organic compounds, their interconversion, and explain the concept of isomerism and chirality in organic compounds.	**1, 5, 6**
2	Explain the concepts of stereogenic center, topicity and prostereoisomerism	**1, 5, 6**
3	Describe the reaction mechanisms encountered in organic chemistry.	**1, 5, 6**
4	Analyse and describe the structure & reactivity of reactive organic intermediates like carbocations, carbanions, ylides.	**1, 5, 6**
5	Analyse and describe the structure & reactivity of reactive organic intermediates like carbenes, nitrenes, free radicals.	**1, 5, 6**

SEMESTER – I										
Course Title	**Physical Chemistry-I**									
Course code	**24MSCH1103R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To determine the sequence of elementary reactions, or the reaction mechanism, that comprise complex reactions 2. To give the knowledge on equilibrium thermodynamics and phase diagrams. 3. To study the basics of quantum mechanics, particle in a box, its degeneracy and Jahn Teller distortion.									
CO1	Explore the integrated rate laws to find the value of one variable, given values of the other variables.									
CO2	Apply First and Second Law of Thermodynamics and entropy concepts in analysing the thermal efficiencies of heat engines.									
CO3	Discuss the postulates of quantum mechanics and operator algebra.									
CO4	State the origin of quantization: Particle in a box and Hydrogen atom.									
CO5	Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.									

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Chemical Kinetics-I:** Steady state approximation and its applications, Mechanism of photochemical (hydrogen-bromine and hydrogen-chlorine), chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde), consecutive and oscillatory reactions (Belousov-Zhabotinski reaction) Collision theory of reaction rates, Straight chain reactions, the hydrogen-oxygen reaction, explosion limits. Theory of absolute reaction rates, activated complex theory, thermodynamic interpretation, comparison of results with Erying and Arrhenius equations.	**10**	Knowledge on thekinetics of different types of reactions and their mechanisms. Understand the theory behind the different reaction rates.	1,2
II	**Equilibrium Thermodynamics:** Brief review of thermodynamic functions and laws of thermodynamics. Temperature dependence of thermodynamic functions. Gibbs-Helmholtz equation, partial molar properties: partial molar Gibbs free energy, partial molar volume, partial molar heat content and their significances. General methods of determination of partial molar properties – Gibbs-Duhem and Gibbs-Duhem Margules equation, excess thermodynamic functions. Third law of thermodynamics, calculation of entropy, Residual entropy. Non-ideal system: thermodynamics of real gases and gas mixtures, fugacity and its determination, non-ideal solutions, activity and activity coefficient-different scales of activity coefficient, electronic activity coefficients. Thermodynamic criteria of phase equilibrium, Gibbs phase rule and its application to one, two & three component systems - triangular plots-water-acetic acid-chloroform system.	**15**	Knowledge of various equilibrium thermodynamic functions and related laws.	1,2

III	**Basics of Quantum Chemistry**: Planck's Quantum theory, wave particle duality, Uncertainty Principle, Postulates of Quantum mechanics, operators- linear, Hermition and angular momentum operators, eigen values and eigen functions	**8**	Knowledge about various postulates of quantum mechanics like Planck's Quantum theory, wave particle duality, uncertainty Principle and discuss about the eigen functions.	1,2
IV	Schrodinger Equation, Free particle, particle in a box, degeneracy and Jahn- Teller distortion, harmonic oscillator, rigid rotator, the H-atom, angular momentum, Spin-spin orbit coupling.	**6**	Knowledge on the origin of quantization: Particle in a box degeneracy and Jahn- Teller distortion, harmonic oscillator, rigid rotator and Hydrogen atom.	1,2
V	**Sampling and Data Analysis:** Definition of terms, Precision, deviation, mean deviation, standard deviation, accuracy, absolute absolute and relative errors, linear regression, covariance and correlation coefficient.	**6**	Knowledge onevaluation of analytical data.	1,2
Practical	1. Chemical Kinetics (any five to be performed mandatorily) a) Study the hydrolysis of methyl acetate catalysed by HCl and equinormal solution of urea hydrochloride, and hence determines the degree of hydrolysis of the salt. b) Determination of relative strength of two acids by studying the hydrolysis of methyl ester. c) Study the saponification of ethyl acetate by sodium hydroxide and determine the order of reaction and energy of activation. d) Study the kinetics of the reaction between iodine and acetone in acidic medium by half-life period method and determine the order with respect to iodine and acetone. e) Study the inversion of cane sugar in presence of two acids and determine the relative strengths of the two acids. f) Study the kinetics of the reaction between hydrogen peroxide and hydrogen iodide. 2. Conductometry (any five to be performed mandatorily) a) Determine the equivalent conductivity of acetic acid at infinite dilution by Kohlrausch's method and determine the degree of hydrolysis of the acid. b) Determine the relative strength of chloroacetic acid and acetic acid by conductance measurements. c) Determine the solubility and solubility product of $PbSO_4$ at room temperature by conductance measurements. d) Determine the composition of a mixture of acetic acid and hydrochloric acid by	**30**	Gain knowledge, understand about chemical kinetics and conductometry, apply their concepts for various determinations and analyse their studies.	1,2,3,4

	conductometric titration. e) To estimate the concentration of H_2SO_4, CH_3COOH and $CuSO_4$ by conductometric titration with NaOH solution. f) To estimate the concentration of HCl, CH_3COOH and $CuSO_4$ by conductometric titration with NaOH solution.			

TEXT BOOKS:

T1. Puri, B.R., Sharma, L.R. and Pathania, M.S. Principles of Physical Chemistry. Vishal Publishing Company; 2008.

T2. P. W. Atkins, Molecular Quantum Mechanics, Oxford University Press, 1983.

REFERENCE BOOKS:

R1. Levine, I. R. Physical chemistry. 6th edition, Mcgraw Hill Education; 2011.

R2.Vogel, A. I., & Jeffery, G. H. Vogel's textbook of quantitative chemical analysis. 1989.

R3. I. N. Levine, Quantum Chemistry, Allyn and Bacon, 1983.

R4. D. A. McQuarrie, Quantum Chemistry, University Science Books, 1983.

OTHER LEARNING RESOURCES:

https://nptel.ac.in

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explore the integrated rate laws to find the value of one variable, given values of the other variables.	**1, 5, 6**
2	Apply First and Second Law of Thermodynamics and entropy concepts in analysing the thermal efficiencies of heat engines.	**1, 5, 6**
3	Discuss the postulates of quantum mechanics and operator algebra.	**1, 5, 6**
4	State the origin of quantization: Particle in a box and Hydrogen atom.	**1, 5, 6**
5	Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.	**1, 5, 6**

SEMESTER – I									
Course Title	**Fundamental of Statistics**								
Course code	**24UMFS1101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 15T+30P	**1**	**0**	**2**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Chemistry**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course objectives	1. Help to understand the role of statistics in data analysis, decision-making, and scientific research 2. Introduce students to descriptive statistics, including measures of central tendency (mean, median, mode) and measures of dispersion (range, variance, standard deviation). 3. Teach students how to summarize and present data effectively using tables, charts, and graphs								
CO1	Improve understanding of Descriptive Statistics and Demography.								
CO2	Develop knowledge to understand the Probability theory, Distribution, and sampling methods.								
CO3	Develop knowledge to understand the methods for hypothesis testing and Biological data analysis.								
CO4	Develop knowledge to understand the principles of various statistical analyses of data.								
CO5	Develop knowledge on R language for data analysis								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Statistical Methods**: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio.	3	Foundational Understanding of Statistical Concepts	1,2
II	**Presentation**: tabular and graphical, including histogram and ogives. Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, skewness and kurtosis.	3	Proficiency in Data Presentation and Analysis	1,2
III	**Bivariate data**: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, fitting of polynomials and exponential curves.	3	Knowledge on Analyzing Bivariate Data and Relationships	1,2
IV	**Random experiment**: trial, sample point and sample space, event, Operations of Events, concepts of mutually exclusive and exhaustive events. Definition of probability: classical and relative frequency approach. Discrete probability space, Properties of probability, Independence of events, Conditional probability, total and compound probability rules, Normal probability Distribution, Bionomial probability Distribution, Poisson Probability Distribution, Bayes' theorem and its applications.	3	Understanding of Probability and Distributions	1,2
V	**Testing of hypothesis**, parametric test: t-test, z-test, chi-square test. Non-Parametric test: One sample Kolmogorov test, wilcoxon Signed test, Mann-Whitney Test, Kruskal walis test.	3	Application of Hypothesi Testing and Statistical Tests	1,2
Practical	1.Introduction to R - A programming language and environment for data analysis and graphics. Syntax of R expressions: Vectors and assignment, vector arithmetic, generating regular sequence, logical vector, character vectors, Index vectors; selecting and modifying subsets of dataset	30	A brief knowledge on using R for data analysis and visualization	1,2, 3,4

	2.Data objects: Basic data objects, matrices, partition of matrices, arrays, lists, creating and using these objects; Functions- Elementary functions and summary functions, applying functions to subsets of data. Data frames: The benefits of data frames, creating data frames, combining data frames, Adding new classes of variables to data frames; Data frame attributes. 3.Importing data files: import. data function, read. table function; Exporting data: export. data function, cat, write, and write. table functions, function, formatting output - options, and format functions; Exporting graphs -export. graph function. Graphics in R: creating graphs using plot function, box plot, histogram, line plot, steam and leaf plot, pie chart, bar chart, multiple plot layout, plot titles, formatting plot axes; Visualizing the multivariate data: Scatter plot, Q-Q plot, P-plot. 4.Performing data analysis tasks: Reading data with scan function, exploring data using graphical tools, computing descriptive statistics, one sample tests, two sample tests, Goodness of fit tests. 5.Parametric test and Non-Parametric test			

Textbooks:

T1.Methods in Biostatistics by K S Negi, ISBN:9789374735053,4th Edition, Year:2023, AITBS Publishers, INDIA

Reference books

R1."Introduction to the Practice of Statistics" by David S. Moore, George P. McCabe, and Bruce A. Craig

R2. "Statistics" by David Freedman, Robert Pisani, and Roger Purves

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve understanding of Descriptive Statistics and Demography.	**1, 4,8**
2	Develop knowledge to understand the Probability theory, Distribution, and sampling methods.	**1, 4, 8**
3	Develop knowledge to understand the methods for hypothesis testing and Biological data analysis.	**1, 4, 8**
4	Develop knowledge to understand the principles of various statistical analyses of data.	**1, 4, 8**
5	Develop knowledge on R language for data analysis	**1, 4, 8**

SEMESTER – I									
Course Title	**EFFECTIVE COMMUNICATION**								
Course code	**24UMPD1101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Chemistry**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course objectives	1. To introduce the types of sentences and their significance. 2. To strengthen the students' vocabulary to enhance their speaking and writing skills. 3. To familiarize the students with the importance of dress codes in various organizations. 4. Tointroducethe3P's (Planning, prioritizing & performing) of Time Management. 5. To give insight into English pronunciation and into central concepts in phonetics.								
CO1	Analyse and identify the different types of sentences.								
CO2	Able to integrate the skills of reading and speaking in professional communication.								
CO3	Illustrate code Etiquette sessions will boost their confidence and morals.								
CO4	Describe about the effective and efficient utilization of time.								
CO5	Explain the concept of Phonetics and its importance will improve the learners 'pronunciation								
MODULES	**Module 1- Grammar** Interchange of Interrogative and Assertive Sentences, Exclamatory and Assertive Sentences, Types of Tenses, Common Errors, Synonyms, Antonyms, Homonyms **Module 2- Reading Skills** Techniques of Effective Reading, Gathering ideas and information from a text The SQ3R Technique Interpret the text **Module 3-Listening Skills** What is listening?, The Process of Listening, Factors that adversely affect Listening, Difference between Listening and Hearing, Purpose and Importance of Effective Listening, How to Improve Listening Process, **Module 4- Conflict Management** Definition**,** Type of Conflict Management**,** Effects of Conflict Management**,** Methods to deal with Conflicts (Negative) **Module 5- Time-Management Skills** Introduction To Time Management, Purpose And Importance of Time Management, Basic Tips to Maintain Time. **Activity: Problem solving activity**: A situation will be given to the students and they will have to tell us how to handle the situation or solve the problem.								

TEXTBOOKS:

T1. Wren, P.C and Martin, H. 1995. High School English Grammar and Composition, S Chand Publishing.
T2. English Grammar in Use, Raymond Murphy 4th edition, CUP.
T3. Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.

REFERENCE BOOKS:

R1. English Vocabulary in Use (Advanced), Michael McCarthy and Felicity, CUP.
R2. Effective Communication and Soft Skills, Nitin Bhatnagar, Pearsons.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Analyse and identify the different types of sentences.	**3, 8**
2	Able to integrate the skills of reading and speaking in professional communication.	**3, 8**
3	Illustrate code Etiquette sessions will boost their confidence and morals.	**3, 8**
4	Describe about the effective and efficient utilization of time.	**3, 8**
5	Explain the concept of Phonetics and its importance will improve the learners 'pronunciation	**3, 8**

SEMESTER – II										
Course Title	**Inorganic Chemistry-II**									
Course code	**24MSCH1201R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course Objectives	1. To make students understand the bonding as well as magnetic properties associated with the transition metal complexes. 2. To make students understand the different reaction mechanisms associated with octahedral and square planar complexes. 3. To give them knowledge on different radioactive processes and the applications associated with radioactive isotopes.									
CO1	Summarize the concept of different bonding systems associated with d^n systems of transition metal complexes.									
CO2	Explore the different term symbols associated with the different d^n systems and their use in construction of the Orgel diagrams									
CO3	Describe the magnetic properties of transition metal systems.									
CO4	Distinguish the properties shown by lanthanide and actinide elements.									
CO5	Describe the various radioactive processes along with the applications of radio isotopes.									

Unit-No.	Content	CH	Learning Outcome	KL
I	**Bonding in transition metal complexes -I:** Shapes of d orbitals, LFT and its limitations, CFT, d-orbital splitting in octahedral, square planar, square pyramidal, trigonal bipyramidal, and tetrahedral complexes;, CFSE .Effects of crystal field splitting, for d^1 to d^{10} systems, pairing energy, Spectrochemical series, low-spin and high-spin complexes, Jahn-Teller distortion, Orgel diagrams, magnetic properties.	**7**	Knowledge of d orbitals, bonding and energies associated with different d^n systems of transition metal complexes.	1, 2
II	**Bonding in transition metal complexes - II:** Term symbols and Tanabe Sugano diagram. Molecular orbital (MO) theory (π acceptors, π donors). Nomenclature of co-ordination compounds.	**10**	Understand the different term symbols associated with d^n systems.	1,2
III	**Magnetic Properties:** Magnetic properties of free ions, types of magnetic behaviour: dia-, para-, ferro- and antiferro-magnetism, temperature independent paramagnetism, magnetic susceptibility, magnetic moment, orbital contribution, quenching of contribution, effect of spin orbit coupling, spin crossover. Temperature dependence of magnetic susceptibility, exchange coupling effects. Magnetic properties of second and third transition series and lanthanides.	**10**	Understand the different magnetic behaviour associated with the molecules and their effect on temperature dependency.	1,2
IV	**Lanthanides and actinide elements:** Electronic configuration, lanthanide contraction, separation of lanthanides, spectral properties of lanthanides and actinides, lanthanide shift reagents, stability of complexes, Magnetic properties of second and third transition series and lanthanides.	**10**	Knowledge on different properties shown by lanthanide and actinide complexes.	1,2
V	**Nuclear and Radio Chemistry**:	**8**	Knowledge on radioactive	1,2

	Radioactive decay processes, Fermi theory, half-lives, auger effect. Nuclear reactions – notations, comparison with chemical reaction: Types of nuclear reactions. Applications of radioisotopes as tracers (activation and isotope dilution analysis).Age determination, radiolysis of water, units for measuring radiation absorbed by matter, Radiation induced chemistry–sources of radiation, chemical effects produced by the absorption of ionizing radiation and high energy ions and electrons from accelerators - radiation induced synthesis of materials		decay processes along with the applications of different radioisotopes.	
Practical	1. Estimation of Mg^{2+} and Ca^{2+} by complexometric method in different ores and from given solution with one/two components. 2. Estimation of Zn^{2+} and Cu^{2+} by complexometric method in different ores and from given solution with one/two components. 3. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator. 4. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$ 5. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically. 6. Determination of the composition of the Fe^{3+}-salicylic acid complex in solution by Job's method. 7. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$. 8. Estimation of oxalic acid by titrating it with $KMnO_4$.	**30**	Estimate and analyse the different metals by applying the concepts of different titrimetric analyltical techniques.	1,2,3,4

TEXTBOOKS

T1. J. E. Huheey, E. A. Keiter and R. L. Keiter; Inorganic Chemistry: Principles of Structure and Reactivity, 4th Ed. Pearson Education, 2006.

T2. G. L. Miessler, D Tarr; Inorganic Chemistry. 3rd Ed., Pearson Education, 2004.

REFERENCE BOOKS

R1. P.W. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong; Shriver & Atkins, Inorganic Chemistry, 5th ed. Oxford University Press, 2010.

R2. J.D.Lee ,Concise Inorganic Chemistry5th Ed, Blackwell Science

R3. J .Mendham, R .C .Denney, J.D Barnes, M. Thomas. Vogel's Textbook of Quantitative Chemical Analysis.6th edition.T1. Punt et al. Kuby Immunology 18th Edition. W H Freeman &Co (Sd); 2018.

OTHER LEARNING RESOURCES:

https://nptel.ac.in

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Summarize the concept of different bonding systems associated with d^n systems of transition metal complexes.	**1, 2, 3**
2	Explore the different term symbols associated with the different d^n systems and their use in construction of the Orgel diagrams	**1, 2, 6, 8**
3	Describe the magnetic properties of transition metal systems.	**1, 2, 5, 6**
4	Distinguish the properties shown by lanthanide and actinide elements.	**1, 2, 3**
5	Describe the various radioactive processes along with the applications of radio isotopes.	**1, 7, 3**

SEMESTER – II									
Course Title	**Organic Chemistry-II**								
Course code	**24MSCH1202R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Chemistry**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course objectives	1. To teach in depth about metal and non-metal based oxidations and reductions and the reagents employed for these reactions in organic chemistry. 2. To teach photochemistry of carbonyl compounds, olefins, conjugated polyenes, vision, enones and singlet oxygen photochemistry. 3. To explain some common and important organic name reactions along with the reagents used. 4. To teach in detail about pericyclic reactions and its different types.								
CO1	Identify the different oxidation reactions of organic compounds and the chemoselectivity of the reagents employed.								
CO2	Describe the different reduction reactions of organic compounds and explain the chemoselectivity of the reagents employed								
CO3	Explain the photochemistry of carbonyl compounds, olefins, conjugated polyenes, vision, enones and singlet oxygen photochemistry								
CO4	Explain some common and important organic name reactions along with the reagents used.								
CO5	Describe pericyclic reactions and distinguish between their different types.								

Unit-No.	Content	CH	Learning Outcome	KL
I	**Oxidation Reactions:** Metal based and non-metal based oxidations (Cr, Mn, Al, Ag, Os, Ru, Se, DMSO, hypervalent iodine and TEMPO based reagents), Reagents (Fremy's salt, silver carbonate, peroxides/per-acids), Sharpless asymmetric epoxidation, Jacobsen epoxidation, Shi epoxidation, Sharpless asymmetric dihydroxylation, Baeyer-Villiger oxidation, Wacker oxidation, hydroboration-oxidation, Prevost reaction and Woodward hydroxylation, cis- and trans- hydroxylation, cleavage of glycol with $KMnO_4$, OsO_4, HIO_4, $Pb(OAc)_4$, Mercuric acetate, oxidation of allylic C-H bond using SeO_2.	**8**	Knowledge about different oxidation reactions of organic compounds and the chemoselectivity of the reagents employed.	1,2
II	**Reduction Reactions:** Pd/Pt/Rh/Ni catalyzed hydrogenation, Wilkinson catalyst, Noyori asymmetric hydrogenation, Metal based reductions using Li/Na/Ca in liquid ammonia, Sodium, Magnesium, Zinc, Titanium and Samarium (Birch, Pinacol formation, McMurry, Acyloin formation, dehalogenation and deoxygenations), Hydride transfer reagents from Group III and Group IV in reductions ($NaBH_4$triacetoxyborohydride, L-selectride, K-selectride, Luche reduction, $LiAlH_4$, DIBAL-H, and Red-Al, Trialkylsilanes and Trialkylstannane, Meerwein-Pondorff-Verley reduction); Stereo/enantioselective reductions (Chiral Boranes, Corey-Bakshi-Shibata).	**8**	Knowledge about different reduction reactions of organic compounds and explain the chemoselectivity of the reagents employed.	1,2
III	**Organic Photochemistry:** Introduction to organic photochemical-photophysical processes, chemiluminescence, photosensitization, Photochemistry of carbonyl	**10**	Learn about photochemistry of carbonyl compounds, olefins, conjugated polyenes, vision, enones and singlet	1,2

	compounds (α-cleavage, β-cleavage, intramolecular H-abstraction, addition to π-systems- Paterno-Buchi reaction); Photochemistry of olefins (photostereomutation of cis-trans isomers, optical pumping, cycloaddition, photochemistry of conjugated polyenes, photochemistry of vision), Photochemistry of enones(Photo-rearrangement reactions, di-π-methane rearrangement, Photo-rearrangement of cyclohexadienones, Barton rearrangement); Singlet oxygen photochemistry.		oxygen photochemistry.	
IV	**Organic Name Reactions:** Wohl- Ziegler reaction, Hunsdiecker, Barton, Birch reaction, Hofmann Lofler Freytag, Favorski, Stork enamine, Michael Addition, Robinson Annulation, Mannich, Shapiro, Chichibabin, Witig Reaction, Gilman Reagent, DCC, LDA, 1, 3- dithane, trimethylsilyl iodide, Baker's yeast, Phase transfer catalyst.	**5**	Explain some common and important organic name reactions along with the reagents used.	1,2
V	**Pericyclic Reactions:** MO symmetry, FMO of conjugated polyenes. Woodward-Hoffmann principle of conservation of orbital symmetry, allowed and forbidden reactions, stereochemistry of pericyclic reactions, orbital symmetry correlation method, PMO method. Cycloaddition reactions: 2+2, 4+2, 6+2 cycloadditions, 3+2 and 4+3 dipolar cycloadditions; stereoselectivity of the reactions, regioselectivity of 4+2 cycloaddition reaction. Sigmatropic rearrangement: (m+n) sigmatropic rearrangement of hydrogen and chiral alkyl groups; Divinylcyclopropane rearrangement, fluxional molecules, stereoselectivity in Cope and Claisen rearrangement. Sommelet-Hauser rearrangement. Electrocyclic reactions and cycloreversions: Conrotatory and disrotatory process, Stereoselectivity of the reactions. Linear and nonlinear cheletropic rearrangement, theories of cheletropic reactions, stereoselectivity of the reactions. Ene reactions: of 1,7-dienes, carbonyl enophiles, simple problems. Claisen rearrangement and its variants, aza-Cope rearrangement (Overman rearrangement), ene reaction (metallo-ene; Coniaene).	**14**	Distinguish between the different types of pericyclic reactions and thus describe in detail about pericyclic reactions.	1,2
Practical	1. Synthesis of Organic compounds: (any five to be performed mandatorily) • Benzopinacolone from benzophenone. • Benzilic acid from benzoin. • Caprolactone from cyclohexanone. • Acetylation reaction • Coupling Reactioon • Diels Alder reaction 2. Isolation of natural products: (any five	**30**	Apply knowledge of synthesis of organic compounds and isolation of natural products	1,2,3,4

	to be performed mandatorily) • Isolation of caffeine from tea leaves • Isolation of piperine from black pepper. • Isolation of β- carotene from carrots. • Isolation of lycopene from tomatoes • Isolation of limonene from lemon peel. • Isolation of euginol from cloves			

TEXTBOOKS

T1: March, J. Advanced Organic Chemistry: Reactions, Mechanisms, and Structure. 4th edition. Wiley; 2016.
T2: Clayden, J., Greeves, N. and Warren, S. Organic Chemistry. 2nd edition. Oxford University Press; 2012.
T3: Norman, R.O.C. and Coxon, J.M. Principles of Organic Synthesis. 3rd edition. Chapman & Hall; 2003.
T4: Fleming, I. Oxford Chemistry Primers: Pericyclic Reactions. 2nd edition. Oxford University Press; 2015.
T5: Vogel, A.I. Textbook of Practical Organic Chemistry. 5th edition Prentice Hall.

REFERENCE BOOKS

R1: Bruice, P. Y. Organic Chemistry. 8th edition. Pearson; 2020.
R2: Horspool, W. M. Aspects of Organic Photochemistry. Academic Press.

Other learning resources

https://nptel.ac.in

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify the different oxidation reactions of organic compounds and the chemoselectivity of the reagents employed.	**1, 2, 5, 7, 8**
2	Describe the different reduction reactions of organic compounds and explain the chemoselectivity of the reagents employed	**1, 2, 5, 7, 8**
3	Explain the photochemistry of carbonyl compounds, olefins, conjugated polyenes, vision, enones and singlet oxygen photochemistry	**1, 7**
4	Explain some common and important organic name reactions along with the reagents used.	**1, 2, 5, 7**
5	Describe pericyclic reactions and distinguish between their different types.	**1**

SEMESTER – II									
Course Title	**Physical Chemistry-II**								
Course code	**24MSCH1203R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Spring/ II semester of First year of the programme**								
Course Objectives	1. To study the chemical reactions at the surfaces and interfaces between two materials. 2. To understand the theories of enzyme kinetics, mechanisms of enzyme catalysed reactions and their regulation in the cell. 3. To give the knowledge of different distribution laws and their statistical thermodynamic studies. 4. To apply the ideal gas law in stoichiometry problems in which chemical reactions involve gases. 5. To apply quantum mechanics of molecules and chemical bonding using Born-Oppenheimer approximation.								
CO1	Discuss surface chemistry phenomena and fundamentals of the chemistry occurring at surfaces and interfaces								
CO2	Explain the kinetics of enzymatic and fast reactions								
CO3	Explain different distribution laws and their statistical thermodynamic studies.								
CO4	Determine free energy and macroscopic quantities from partition function and apply them to simple systems (paramagnet, ideal gas, etc.).								
CO5	Discuss the Slater determinants, term symbols and spectroscopic states.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Surface tension, capillary action, Pressure across an interface: Laplace equation, Kelvin equation; Adsorption in liquid systems: Gibbs adsorption isotherm. Adsorption on solids: Langmuir isotherm, BET isotherm. electrical properties of colloidal systems, coagulation of colloidal sols, electrokinetic properties, electro-osmosis, size determination of colloidal particles. Surfactants, classification of surfactants, hydrophobic interaction, aggregation /micellization of surfactants, solubilization, critical micelle concentration (cmc), reverse micelles, factors affecting the cmc, microemulsion.	**10**	Knowledge on capillary action, adsorption phenomenon and discuss about the various isotherms. Interaction related to different types of surfactants.	1,2
II	Effect of ionic strength, Kinetic salt effect. Enzyme catalysis and Michaelis-Menton Mechanism, enzyme inhibition. Treatment of unimolecular reactions: Lindemann mechanism, RRKM theory, electron transfer reactions. Fast reactions,	**8**	Knowledge on the kinetic study of different enzymatic reactions.	1,2

	study of fast reactions by flow method, relaxation method, flash photolysis, nuclear magnetic resonance method, kinetic isotopic effect.			
III	Concept of distribution, Thermodynamic probability and most probale distribution. Canonical and other ensembles. Statistical mechanics for systems of independent particles. Maxwell Boltzman, Bose Einstein and Fermi Dirac statistics. Idea of microstates and macro states. Themodynamic probality for the three types of statistics. Derivation of distribution laws for the three types of statistics.	**7**	Knowledge on different distribution laws and their statistical thermodynamic studies.	1,2
IV	Molecular partition function and its factorization. Evaluation of transitional, rotational and vibrational partition functions for monatomic, diatomic and polyatomic gases. Calculation of thermodynamic properties of ideal gases in terms of partition function. Statistical Entropy: Statistical definition of entropy, ortho and para hydrogen, symmetry number. Calculation of equilibrium constants of gaseous solutions in terms of partition function, of gas mixtures.	**15**	Knowledge on the determination of free energy and macroscopic quantities from partition function.	1,2
V	**Chemical Bonding:** Born Oppenheimer approximation, Variation theorem, linear variation principle and perturbation theory, applications of variation method and perturbation theory, antisymmetry, Slater determinant, term symbols and spectroscopic states.	**5**	Knowledge on approximation method, Slater determinants, term symbols and spectroscopic states.	1,2
Practical	1. Study the variation of viscosity of nitrobenzene with temperature, and determine the temperature coefficient of viscosity of nitrobenzene. 2. Determine the limiting cross-section area of n-propyl alcohol by surface tension measurements. 3. Determine the critical micelle concentration of sodium dodecyl sulphate in aqueous medium by	**30**		1,2,3, 4

	surface tension measurements. 4. Determine the distribution coefficient of iodine between CCl_4 and water at a given temperature. 5. Determine the equilibrium constant of the reaction $KI + I_2 \overset{k}{\Leftrightarrow} KI_3$ by distribution method. 6. Determine the distribution coefficient of succinic acid between ether and water. 7. Determine the formula of the complex formed between the cupric ion and ammonia by distribution method. 8. Determine the strength of the components of the mixtures: (i) HCl and acetic acid, (ii) H_2SO_4 and $CuSO_4$. 9. Determine the amount of components of the following mixtures: (i) HCl and acetic acid, (ii) HCl and oxalic acid, (iii) KCl and KBr and KI. 10. Determine potentiometrically the strengths of solutions of HCl and acetic acid individually and a mixture of the two using standard NaOH solution. 11. Titration of ferrous ammonium sulphate against potassium dichromate and determine the standard electrode potential of the ferrous/ferric system.			

TEXTBOOKS:

T1. Physical Chemistry (Vol.1 & 2), K.L. Kapoor, Macmillan, 2001.

T2. Atkins Physical Chemistry, Peter Atkins and Julio D Paula, Oxford University Press, 2006.

T3. B.K. Sen, Quantum Chemistry - Including Spectroscopy. Kalyani publishers (2001).

REFERENCE BOOKS:

R1. Chemical Kinetics, Keith J. Leidler, Pearson, 2003.

R2. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma, Madan S. Pathania, Vishal Publishing Company, 2008.

R3. Advanced Physical Chemistry, Gurdeep Raj, Krishna Prakashan Media (p) ltd, 2011.

R4. Pathria, R.K., Statistical Mechanics, Butterworth-Heinemann, (1996).

R5. Yadav, J.B. Advanced Practical Physical Chemistry. KRISHNA Prakashan Media (P) Ltd; 2012.

R6. Das, R.C. & Behera, B. Experimental Physical Chemistry. Tata McGraw-Hill Publishing Company Limited.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss surface chemistry phenomena and fundamentals of the chemistry occurring at surfaces and interfaces	**1, 2, 7**
2	Explain the kinetics of enzymatic and fast reactions	**1, 2, 3, 5, 7**
3	Explain different distribution laws and their statistical thermodynamic studies.	**1, 2, 6, 7**
4	Determine free energy and macroscopic quantities from partition function and apply them to simple systems (paramagnet, ideal gas, etc.).	**1, 6, 7**
5	Discuss the Slater determinants, term symbols and spectroscopic states.	**1**

Course Title	Research Methodology and Statistical Analysis								
Course Code	24MSCH1205R	Totalcredits:3 Total Hours: 30T & 15P	L	T	P	S	R	O/F	C
			2	0	2	0	0	0	3
Pre-Requisite	NIL	CO-REQUISITE	NIL						
Anti-Requisite	NIL								
Programmes	All PG Programme								
Semester	First Year, Winter Semester								

Course Objectives

1. The course aims to enhances the students' a broad understanding of research methodology, including theory of science and qualitative and quantitative methods in research.
2. The course seeks to enhance the students' skills for developing critical thinking through research literature review in different domain. Consequently it aims to develop skills for preparation of a research proposal for a master' thesis project/Mini research.
3. To develop Students competency in planning, conducting, evaluating and presenting a research project.

Course Outcomes

1. Students will have basic knowledge of Research methods.
2. Students will gain the knowledge of Research Methodology.
3. Students will be able to gain the Skill questionnaire development. Students will be able to acquire the knowledge of basic Report/dissertation Procedure.
4. Students will be able to plan, organize, and structure research reports, theses, and dissertations using appropriate formatting, citation methods, and statistical presentation techniques, including tabular and graphical representations.
5. Students will acquire knowledge of various aspects of IPR, including patents, trademarks, copyrights, industrial designs, traditional knowledge, and geographical indications.

Course Description

This course offers "An overview of research methodology including basic concepts employed in quantitative and qualitative research methods. Includes computer applications for research.

References

1. Boyle JS. Styles of ethnography. In: JM Morse, editor. Critical issues in qualitative research methods. Thousand Oaks, CA: Sage, 1994:159–85.
2. Coughlan M., Cronin P. and Ryan F. (2007).Step-by-step guide to critiquing research. Part 1: quantitative research. British journal of Nursing 16 (11).
3. Creswell, JW. (1998).Qualitative Inquiry and Research Design Choosing Among Five Traditions. Thousand Oaks, CA: Sage Publications.
4. Crotty, M. (1998). The Foundations of social research: Meaning and perspective in the research process. London: Sage.
5. Denzin, NK. (1978). Sociological Methods. New York: McGraw-Hill.
6. Hanson WE, JW Creswell, VL Plano Clark, KS Petska and JD Creswell. Mixed Methods Research Designs in Counseling Psychology. Journal of Counseling Psychology, 2005, Vol. 52, No. 2, 224–235. http://www.preciousheart.net/chaplaincy/Auditor_Manual/13casesd.pdf
7. Johnson & Christensen. (2004). Educational Research: Quantitative, qualitative and mixes approaches, 2nd Ed. Boston: Allyn & Bacon.
8. Kothari C., R. (2004). Research Methodology: Methods and Techniques. New Delhi. New Age International (P) Limited, Publishers.
9. Krueger, A. R. (1994). Focus Groups: A Practical guide for Applied Research, Thousand Oaks, CA: Sage Publications

10. L., L. Espinosa and M. Yamashita (2015). Evaluation Toolkit. Evaluation Guide. Analyze Data. Retrieved from: http://toolkit.pellinstitute.org/evaluation-guide/analyze/analyze-qualitative-data/
11. Neuman, W. L. (2000). Social research methods. Qualitative and Quantitative approaches (4th Ed.). Boston: Allyn and Bacon.
12. Patton, MQ. (1999)."Enhancing the quality and credibility of qualitative analysis."HSR: Health Services Research. 34 (5) Part II. pp. 1189-1208.
13. Patton, MQ. (2001).Qualitative Evaluation and Research Methods (2^{nd} Edition).Thousand oaks, CA: Sage Publications.
14. Strauss, A. & Corbin, J. (1994)."Grounded Theory Methodology."In NK Denzin & YS Lincoln (Eds.) Handbook of Qualitative Research (pp. 217-285). Thousand Oaks, Sage Publications.

Unit–1

Research Methodology- An Introduction- meaning and objectives of research, motivation in research, types and significance of research, criteria of good research. Defining the Research Problems- definition of research problem, necessity of defining research problem

Unit-2

Research Design- meaning and need of research design, features of a good design, different research designs, Sampling Design- steps in sampling design, Sample Size determination, criteria for selecting a sampling design, different types of sampling design, Experimental Design, Principles of Design of Experiment, One – way ANOVA, Two- Way ANOVA, CRD, RBD, LSD, 2^2, 2^3 Factorial Design

Unit-3

Types of data, sources of data collection, tools of data collection, Nominal, ordinal, interval and ratio – Attitude scale construction and measurement, rating scales, semantic differential (SD), Use of scale in statistical analysis, Schedules for interviews preparation and standardization, development of survey instruments and item analysis for the questionnaire

Unit-4

Planning and organizing research report, Format of research report, Different steps of writing report, layout of the research report, How to organize thesis/Dissertation, mechanics of writing research report, standard methods of quoting- presenting the result, written and oral reports, Uses of abstract, format of research report, presentation of statistics - tabular and graphic references and uses of references, Bibliography and presentation of bibliography

Unit-5

Intellectual property right (IPR), Introduction and the need for IPR, IPR in India and worldwide, Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications, Patentable and non-patentable, patenting life, Filing of a patent application, The different layers of the international patent system, Case studies on Basmati rice, Turmeric, and Neem patents

Laboratory using R Software:

1. Analysis of One way ANOVA;
2. Analysis of Two way ANOVA;
3. Analysis of CRD
4. Analysis of RBD
5. Analysis of 22 and 23 Factorial Experiment
6. Simulation-I using R (Bernoulli, Binomial, Poisson and Geometric distribution).

7. Simulation-II using R (Exponential and Normal distribution).
8. Simple random Sampling
9. Stratified Random Sampling

			Theory	Practical
Component	Internal (Daily lab Exercises +Pre final test)	Marks	20	20
		% (weightage)	25	25
	External (Sem End Exam)	Marks	30	30
		% (weightage)	25	25

RELATIONSHIP BETWEEN THE COURSE (COs) AND PROGRAMME OUTCOMES (POs)

Mapping between Cos and POs		
Sl No	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Students will have basic knowledge of Research methods.	
2	Students will gain the knowledge of Research Methodology.	
3	Students will be able to gain the Skill questionnaire development.	
4	Students will be able to acquire the knowledge of basic Report/dissertation Procedure.	

		Concepts of	Concept of Sampling	Methods of Data	Concept of	Determination of	Concept of Scaling	Skill of Reliability	Skill of	Concept of Intellectual	Concept of Patents	Use of Plagiarism	Life Long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
24MSCH1205R	Research Methodology and Statistical Analysis												

1=Addressed to small extent
2= Addressed Significantly
3=Major part of the course

SEMESTER-II									
Course Title	**Data Analysis Using Microsoft Excel**								
Course code	**24FSDA1201R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30P	**0**	**0**	**2**	**0**	**0**	**0**	**2**
Pre- requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science**								
Semester	**Spring/II semester of First year of the Programme**								
Course Objectives	1. The course aims to enhances the students' a broad understanding of Microsoft Excel, including theory of Statistics. 2. The course seeks to enhance the students' skills for developing practical thinking through excel in different domain. Consequently, it aims to develop skills for preparation of a developing practical skill in the field of statistics.								
CO1	Students will have basic knowledge of Microsoft Excel.								
CO2	Students will gain the knowledge of Advance level of Excel.								
CO3	Students will be able to gain the Skill to calculate mean, median, mode or other.								
CO4	Students will be able to acquire the knowledge of correlation and regression using Microsoft Excel.								
CO5	Knowledge on fitting of a distribution using Microsoft excel.								

Unit no	**Content**	**Contact Hours**	**Learning Outcome**	**BL**
I	Introduction to Microsoft Excel for Data Analysis (Organization and Cleaning)	5	Understanding ribbons, menus, and toolbars, Workbooks, worksheets, and cells, Data Entry and Formatting, Import data from other file, organization, pivottable (basic level)	1,2
II	Data Analysis Tools and Techniques	6	Pivot Tables and Pivot Charts, Descriptive Statistics: Measures of central tendency: Mean, Median, Mode, Measures of variability: Standard deviation, Variance, Range	1,2
III	Advanced Excel Functions and Data Visualization	6	Logical functions: IF,AND,OR, NOT, etc., Chart types: Bar, Line, Pie, Scatter, etc.	1,2
IV	Regression Analysis and Model Building	6	Fitting a linear regression model using Excel, interpreting regression output: Slope, intercept, R^2, Predictive analysis using the regression equation	2,3
V	Probability and Inferential Statistics	7	Using Excel's NORM.DIST, BINOM. DIST, and P OISSON.DIST functions	2,3

Textbooks

T1: Mastering Advanced Excel, Ritu Arora, BPB publishers.

T2: Microsoft Excel Formulas and Functions**,** Paul Mc. Fedries, Pearson Education

Reference books

R1: Data Analysis with Excel, Manisha Nigam, BPB Publications; First Edition (5 September 2019).

R2: Basic Statistics by B.L. Agarwal, New age international limited.

SEMESTER – III									
Course Title	**Symmetry and Group Theory**								
Course code	**24MSCH2101R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Fall/III Semester of Second Year of the Programme**								
Course objectives	1. To understand the basic concept of matrices. 2. To gain knowledge on the different symmetry elements and operations. 3. To understand how point groups are being represented in character tables. 4. To understand and apply the knowledge of different symmetry operations in molecular systems.								
CO1	Determine the matrix and elements of group theory.								
CO2	Identify the symmetry elements, point groups and different symmetry operations.								
CO3	Identify the different character tables associated with various point groups.								
CO4	Identify the selection rules for different vibrational frequencies using symmetry.								
CO5	Analyze the bonding of complexes using group theory.								

Unit-No.	Content	CH	Learning Outcome	KL
I	**Matrices and Groups:** Concept of group theory, definitions and elements of group theory.	**8**	Gain the basic concept on groups, formation of matrices.	1,2
II	**Molecular symmetry and symmetry groups** Symmetry elements and symmetry operations, Classes of symmetry operation, Symmetry point groups, Assignment of point groups to simple molecules, Shapes and Symmetry of s, p and d orbitals.	**12**	Understand the symmetry elements and symmetry operations associated with molecules.	1,2
III	**Representation of groups** Matrix representation of symmetry operations, The Great Orthogonality Theorem, Reducible and Irreducible representation of groups, Features and Construction of Character tables (C2v, C3v and C2h).	**16**	Gain knowledge of the great orthogonality theorem in understanding the different character tables.	2,3
IV	**Applications of Group Theory and Symmetry** Molecular Vibrations- determining symmetry types of normal modes of vibrations with selected examples, Selection rules for Fundamental Vibrational Transition (IR and Raman).	**12**	Application of the character tables in understanding the different vibrational transitions.	2,3
V	**Symmetry bonding of molecular orbitals** Symmetry properties of atomic orbitals, molecular orbitals for σ and $\prod$ bonding in AB_4 molecules, MO treatment of the bonding in ferrocene. Ligand field states, construction of the correlation diagram for the d^2 configuration in an octahedral environment.	**12**	Understand the bonding of atomic, molecular orbitals.	2,3,4

TEXTBOOKS

T1: F. A. Cotton, Chemical Applications of Group Theory, 3rdEdition, Willey India Pvt. Ltd. 2008.

REFERENCE BOOKS

R1: R. L. Carter, Molecular Symmetry and Group Theory, John Wiley & Sons, 1998

OTHER LEARNING RESOURCES

https://nptel.ac.in

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Determine the matrix and elements of group theory.	**1, 5,6**
2	Identify the symmetry elements, point groups and different symmetry operations.	**1, 5,6**
3	Identify the different character tables associated with various point groups.	**1, 5,6**
4	Identify the selection rules for different vibrational frequencies using symmetry.	**1, 5,6**
5	Analyze the bonding of complexes using group theory.	**1, 5,6**

SEMESTER-III									
Course Title	**Biochemistry**								
Course code	**24MSCH2106R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Fall/ III semester of Second year of the programme**								
Course Objectives	1. To make students recall about the different types of biomolecules involved in the human system. 2. To make the students learn in detail about the chemistry of bioorganic molecules. 3. To explain the meaning of essential and non essential biological elements, the toxicity of different metals in biological processes. 4. To help the students in identification of the different metals present in metalloproteins, enzymes.								
CO1	Describe in detail about carbohydrates and lipids.								
CO2	Explain amino acids, proteins and nucleic acids along with classification of amino acids.								
CO3	Describe vitamins, hormones and enzymes and explain their differences.								
CO4	Explain the meaning of essential and non-essential biological elements and the toxicity of different metals in biological processes.								
CO5	Identify the different metals present in metalloproteins and enzymes								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Carbohydrates:** Classification of carbohydrates, deoxy sugars, amino sugars, branched chain sugars, sugar methyl ethers and acid derivatives of sugars, biological importance of carbohydrates. Lipids: Classification, stereochemical notations of lipids, properties of lipid aggregates, micelles, bilayers, lyposomes and biological importance of lipids.	**10**	Learn about carbohydrates and lipids in detail.	1,2
II	**Amino acids and Proteins**: Introduction, Classification, Physical and Chemical properties of Amino acids, methods of synthesis of peptides and polypeptides, naming of polypeptides chain, amino acid sequence determination, structure of protein, biosynthesis of proteins. Medicinal and diagnostic applications of proteins. Nucleic acids: Purine and pyrimidine bases and their biosynthesis, nucleosides and nucleotides, structure of DNA and RNA, Stabilizing forces, replication of DNA and mutagenesis. Codon, anticodon, tRNA, structure and genetic code, transcription and translation. Biological importance of DNA and RNA	**10**	To harness ideas on amino acids, proteins, nucleic acids in detail.	1,2
III	**Vitamins, hormones and enzymes**: Classification, occurrence and chemistry of vitamins, synthesis and biological importance (deficiency syndromes). Introduction and classification of Hormones, mechanism of action of hormones (TSH, ACTH, Insulin, glucagon, steroid hormones). Introduction, definition, names and classification of enzymes, properties of	**10**	To get the knowledge on vitamins, hormones and enzymes	1,2

	enzymes, mechanism of action of enzymes, cofactors, coenzymes.			
IV	**Fundamentals of inorganic biochemistry**: Essential and non-essential elements in bio-systems, different aspects of organo-transition metal complexes in bioinorganic chemistry. Poisioning effect due to non-metals, toxic effects of oxides of carbon, nitrogen and sulphur. Acid rain, poisioning effect due to Nitrite, CFC's and O_3^- layer depletion, Na/K pump, crown ethers, Toxicity of Hg, Cd, Pb.	**7**	To understand the basic concept of organotransition metal complexes within the living body.	1,2, 3,4
V	**Hemeproteins, Fe-S proteins and Enzymes** Haemoglobin and myoglobin, hemerythrin, ferritin and transferrins, 43eroxidase, catalase, cytochrome P-450. Fe-S proteins: rubredoxin and ferredoxins. Cytochrome C oxidase and superoxide dismutase, ceruloplasmin, vitamin-B12, carbonic anhydrase, carboxypeptidase and metallothionins, Biological nitrogen fixation, photosystem I and II in cleavage of water.	**8**	To gain knowledge about the functioning and application of different metalloproteins,enzymes present in the living systems.	1,2,3
Practical	1. Quantitative analysis: (i) Estimation of glucose by chemical methods. (ii) Estimation of amino acids by chemical methods. (iii) Estimation of nitro group in organic compounds. (iv) Estimation of carbohydrates, amino acids, proteins and caffeine by uv-visible spectra. (v) Estimation of ascorbic acid by chemical or UV method. 2. Study of Enzymatic reaction: (i) Reduction of ethyl acetoacetate with Baker's yeast (ii) PPL catalysed deacetylation of 2,4-diacetoxyacetophenone.	**30**	Estimation of amino acids, nitro group, biomolecules like carbohydrates, proteins, vitamins and caffeine by chemical and spectroscopic methods, study of enzymatic reactions.	1,2, 3,4

TEXTBOOKS:

T1: Nelson, D. L. and Cox, M. M. Lehninger Principles of Biochemistry.4th edition. Macmillan Publishers.

T2: Huheey, J. E.,Keiter, E. A. and Keiter, R. L. Inorganic Chemistry: Principles of Structure and Reactivity. 4th edition. Pearson Education, 2006.

REFERENCEBOOKS:

R1: Conn, E. E., Stumpf, P.K., Bruening, G., Doi, R. H. Outlines of Biochemistry. 5th edition. Wiley; 2007.

OTHERLEARNINGRESOURCES:

https://nptel.ac.in

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe in detail about carbohydrates and lipids.	**1, 5,6**
2	Explain amino acids, proteins and nucleic acids along with classification of amino acids.	**1, 5,6**
3	Describe vitamins, hormones and enzymes and explain their differences.	**1, 5,6**
4	Explain the meaning of essential and non-essential biological elements and the toxicity of different metals in biological processes.	**1, 5,6**
5	Identify the different metals present in metalloproteins and enzymes	**1, 5,6**

SEMESTER-III									
Course Title	**Spectroscopy**								
Course code	**24MSCH2107R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Fall/ III semester of Second year of the programme**								
Course Objectives	1. To gain knowledge on the basic concept of electromagnetic spectrum and understand the selection rules for rotational and vibrational spectroscopy. 2. To understand the working and mechanism of NMR, ESR spectroscopy. 3. To gain knowledge on Mass, Mossbauer spectroscopy and try to solve problems for inorganic molecules.								
CO1	Explain the basic principle and selection rules for rotational, vibrational spectroscopy.								
CO2	Explain the molecules based on electronic spectra and Raman effect.								
CO3	Explain the mechanism and working technique of NMR and ESR spectroscopy.								
CO4	Identify the mass fragments of different molecular systems using mass spectroscopy.								
CO5	Explain the Mossbauer spectroscopy and distinguish the effect of iron, tin compounds using the technique								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction to Spectroscopy** Electromagnetic spectrum, Interaction of electromagnetic spectrum with matter, Line width and broadening, Doppler effect. Selection rules. **Rotational Spectroscopy:** Microwave region, Selection rule for microwave spectroscopy, Rotational levels of heteronuclear molecules, Isotopic substitution, **Vibrational Spectroscopy:** Fundamental Vibrational frequencies, Selection rules for harmonic and anharmonic oscillators, Fundamental overtone and combination bands P, Q, R branches, hot bands.	**12**	Understand the meaning of electromagnetic spectrum and selection rules for rotational and vibrational spectroscopy.	1,2
II	**Electronic spectroscopy:** UV-visible spectroscopy: Electronic transitions, Franck-Condon principle, Selection rules, parity, symmetry and spin selection rules. Fluorescence and phosphorescence spectroscopy: Jablonski Diagram, quantum yield, fluorescence quenching, Instrumentation and applications. **Raman effect:** Quantum theory of Raman effect, Selection rules, mutual exclusion principle	**12**	Understand the selection rules for electronic transition and understand the different molecules based on mutual exclusion principle showing Raman effect.	1,2
III	**NMR Spectroscopy:** Chemical shift, factors contributing to chemical shift, spin-spin coupling and its implication to structure determination; simplification of complex spectra; Use of ^{31}P and ^{19}F NMR in coordination chemistry: metal-ligand interaction; isomer determination. **ESR Spectroscopy:**	**12**	Understand the basic principle of NMR, ESR spectroscopy and understand the concept of hyperfine, zero concept splitting of different molecules.	1,2

	Principle, resonance condition, Origin of g-value, spin orbit coupling, Kramer degeneracy, zero-field splitting, hyperfine &super hyper interaction, line width and application of ESR in organic radicals and transition metal coordination complexes.			
IV	**Mass Spectroscopy:** Ion fragmentation mechanism, Base peak and molecular ion peak, metastable peak, instrumentation and techniques, ionization methods, isotopic distribution, Application in determining the structure of organic and inorganic compounds	**12**	Understand and then identify the different ion fragments and apply the technique for various molecular systems.	1,2
V	**Mossbauer Spectroscopy:** Principle of Mossbauer spectroscopy, Instrumentation, Application of Mossbauer spectroscopy: The isomer shifts, magnetic interaction, quadruple splitting, line with. Application to iron to iron and tin compounds.	**12**	Knowledge on the principle, instrumentation and application of Mossbauer spectroscopy.	1,2, 3,4

TEXT BOOKS:

T1. C. N. Banwell, E.M. McCash, Fundamentals of Molecular Spectroscopy,3rd Ed. Tata McGraw Hills

T2. G. M. Barrow, McGraw Hill, Introduction to Molecular Spectroscopy.

REFERENCE BOOKS:

R1. D.L. Pavia, G. M. Lampman, G. S. Kriz, Introduction to Spectroscopy, 4th Ed., Cengage, 2001

R2. R. S. Drago, Physical Methods in Chemistry, 1992T1. Environmental Microbiology by Eugene L Madsen

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the basic principle and selection rules for rotational, vibrational spectroscopy.	**1, 5,6**
2	Explain the molecules based on electronic spectra and Raman effect.	**1, 5,6**
3	Explain the mechanism and working technique of NMR and ESR spectroscopy.	**1, 5,6**
4	Identify the mass fragments of different molecular systems using mass spectroscopy.	**1, 5,6**
5	Explain the Mossbauer spectroscopy and distinguish the effect of iron, tin compounds using the technique	**1, 5,6**

SEMESTER-III									
Course Title	**Environmental and Green Chemistry**								
Course code	**24MSCH2108R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Fall/ III semester of Second year of the programme**								
Course Objectives	1. To give the basic concepts about the environmental chemistry, its definition and explanation of various terms, segments and cycles. 2. To discuss the chemistry behind toxicity and hazards chemicals reactions on macro and microorganisms. 3. To assess the reason behind the atmospheric, water and soil pollution and their remediation. 4. To evaluate the sources of solid waste, their Classification, and prepare a Management Plan. 5. To give knowledge on the principles of green chemistry, synthesis of less hazardous and safer chemicals.								
CO1	Define Environmental Chemistry, and explain the various terms, segments and cycles.								
CO2	Explain the theory behind toxicity and hazardous chemical reactions on macro and microorganisms.								
CO3	Explain the factors affecting the atmospheric, water and soil pollutions and their remediation.								
CO4	Identify the sources of solid waste, their Classification, and prepare a Management Plan.								
CO5	Explain the principles of green chemistry, synthesis of less hazardous and safer chemicals								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Concept and scope of environmental Chemistry: Definition and explanation of various terms, segments of environment, principles and cycles in the environment.	**8**	Knowledge on the basic concepts of environmental Chemistry, definition and explanation of various environmental terms, its segments and cycles.	1, 2
II	Toxicity and hazards: Chemistry of various organic and inorganic toxic materials and their effects. Introduction to chemical hazards and safety, environmental effects on macro and microorganism, industrial wastes.	**7**	Knowledge about the chemistry behind toxicity and hazards chemicals reactions on macro and microorganisms.	**1, 2**
III	Atmospheric pollution: Acid rain, smog, industrial pollution, ozone-layer depletion, global warming and their minimisation. Water pollution: Eutrophication, ground water contamination with arsenic, fluoride, toxic heavy metals and remediation. Drinking water contamination. Soil pollution: Soil pollution due to industrial disposal and use of chemicals including pesticides and synthetic fertilizers, remediation of agricultural lands.	**10**	Knowledge about the Atmospheric, water and soil pollution and their remediation.	**1, 2**
IV	Solid Waste Management Plan, Waste minimization technologies, Hazardous Waste Management, Sources & Classification, physicochemical properties, Hazardous Waste Control & Treatment	**10**	Knowledge on the Solid Waste Management Plan, Sources, Classification, & Waste minimization technologies.	**1, 2**
V	Green Chemistry: Principles of green	**10**	Knowledge about the	**1, 2**

	chemistry, less hazardous chemical synthesis, designing safer chemicals, solvents and auxiliaries, design for energy efficient techniques, renewable feedstocks, catalysis, design for degradation, real time analysis for pollution prevention and design for green synthesis.		Principles of green chemistry, synthesis of less hazardous chemical, designing safer chemicals, solvents and auxiliaries.	
Practical	1. Nitration of Salicylic acid using ceric ammonium (green chemistry approach) 2. Benzil-benzilic acid rearrangement 3. Organic preparations (any two from each): Bezoylation of organic compounds: amines (aniline, toluidines, anisidine) and phenols (phenol, β-naphthol, salicylic acid) by green chemistry approach. 4. Aldol condensation using green method	**30**	Students learn the alternative greener methods for the organic reactions and synthesis.	1 2 3 4

TEXTBOOKS:

T1. Manahan, S. E. Environmental Chemistry, 9th edn., (CRC Press 2009).

T2. Anastas, P.T. & Williamson, T.C. Green Chemistry: Designing Chemistry for Environment, (ACS, 2000).

REFERENCE BOOKS:

R1. Solid Waste Management CPCB. New Delhi.

R2. Ecotechnology for pollution control & environmental management - By R.K. Trivedi & Arvind Kr.

R3. Basic Environmental Technology - J.A. Nathanson.

OTHER LEARNING RESOURCES:

https://nptel.ac.in

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Define Environmental Chemistry, and explain the various terms, segments and cycles.	**1,5,6,7**
2	Explain the theory behind toxicity and hazardous chemical reactions on macro and microorganisms.	**1,5,6,7**
3	Explain the factors affecting the atmospheric, water and soil pollutions and their remediation.	**1,5,6,7**
4	Identify the sources of solid waste, their Classification, and prepare a Management Plan.	**1,5,6,7**
5	Explain the principles of green chemistry, synthesis of less hazardous and safer chemicals	**1,5,6,7**

SEMESTER-III									
Course Title	**Food Chemistry**								
Course code	**24MSCH2110R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Fall/ III semester of Second year of the programme**								
Course Objectives	1. Students will be introduced to the importance of food/nutrition, function of foods and prevention of deficiencies. 2. Aspects related to various classes naturally occurring chemical species/additives, their isolation, characterization and synthesis will be discussed								
CO1	Explain the basic concepts of food & nutrients								
CO2	Describe Food groups								
CO3	Discuss Nutritional needs during life cycle								
CO4	Summarize Prevention and management of deficiencies								
CO5	Explain Dietary goals & guidelines								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Basic concepts of food & nutrients:** Understanding the relationship between food, nutrition & health. Functions of food—Physiological & Social Functions, dietary sources and clinical manifestations of deficiency/excess of the following nutrients: Proteins and Amino Acids, Carbohydrates, Lipids, Sterols & metabolites, Minerals, Vitamins : Fat soluble vitamins (A, D, E, K) Water Soluble Vitamins (Thiamine, Riboflavin, Niacin, Biotin, Pyridoxine, Cyanocobalamin), Other imp. Compounds of nutritional relevance (Cholin, Cysteine, Carotenoids)	**12**	Students will be able to explain the basic concepts of food & nutrients	1, 2
II	**Food groups** Selection, nutritional contribution and changes during Cooking/Ripening/storage of the following groups: Cereals, Pulses, Fruits and vegetables, Milk and milk products, Eggs, Meat, Poultry & fish, Fats & oils	**8**	Students learn about the description of food groups	**1, 2**
III	**Nutritional needs during life cycle:** Body composition, Influence of Nutrition, Physical Activity, Growth and Aging Maternal Nutrition, Nutritional Requirement during Infancy, Childhood Diet, Nutrition and Adolescence Nutrition in the Elderly	**8**	Students are able to discuss the nutritional needs during life cycle	**1, 2**
IV	**Prevention and management of deficiencies**	**9**	Students learn to summarize about the	**1, 2**

	Causes, Symptoms, Treatments, Prevention of the following: Protein-Energy Malnutrition(PEM) amongst Children, Vitamin A-Deficiency (VAD), Iron Deficiency Anemia (IDA), Fluorosis: Over nutrition: Obesity, Coronary Heart Disease, Diabetes (Type I & II), Diet, Nutrition & Cancer		prevention and management of deficiencies	
V	**Dietary goals & guidelines** National Perspectives, Nutritional Perspectives of Vegetarian Diets, Social Health Issues – Smoking, Alcoholism, Drug Addiction, AIDS and AIDS Control Programs, Food Preservation & Food Additives & Colourants	**8**	Students learn about the dietary goals & guidelines	**1, 2**
Practical	To find out the moisture content from a given food sample by lab oven method To determine the pH of a given sample using pH paper and universal indicator. To test the presence of saccharine in the given sample of beverage. To identify different pigments present in a given food sample by paper chromatography. To find out the amount of total carbohydrates in a given food sample. To find out the amount of crude fiber in a given food sample.	**30**	Students learn about processes involved in food chemistry	**1, 2, 3, 4**

Text Book:

1. S. R. Mudambi, M. V. Rajagopal, Fundamentals of Foods, Nutrition and Diet Therapy, 5th Ed, New Age International, 2012

Reference Books:

1. B.Srilakshmi, Nutrition Science, New Age International, 2012.
2. Handbook of Food and Nutrition, 5th Edition, BAPPCO, 1986

OTHER LEARNING RESOURCES:

https://nptel.ac.in

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the basic concepts of food & nutrients	**1, 5, 7, 8**
2	Describe Food groups	**1, 5, 7, 8**
3	Discuss Nutritional needs during life cycle	**1, 5, 7, 8**
4	Summarize Prevention and management of deficiencies	**1, 5, 7, 8**
5	Explain Dietary goals & guidelines	**1, 5, 7, 8**

SEMESTER-III									
Course Title	**COMMUNICATION MASTERY (Communicative English & Soft Skills)**								
Course code	**24UMPD2101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/f**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**22UMPD111R Effective communication**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Fall/III semester of Second year of the programme**								
Course Objectives	1. To familiarize students with the transformation of sentences and the appropriate use of prepositions. 2. To enhance the writing skills in different areas including CV and cover letter writing. 3. To convey meaning by reinforcing, substituting for, or contradicting verbal communication. 4. Productivity and performance boosting activities for professional goal achievement.								
CO1	Explain prepositions, tag questions, and idioms correctly.								
CO2	Discuss and analyze different sentence types and voices.								
CO3	Explain effective paragraphs, precis, and professional documents.								
CO4	Describe SWOT analysis, goal setting, and personal hygiene principles.								
CO5	Illustrate non-verbal communication and body language concepts.								
Unit	**Content**								
Module 1- Grammar	. Use of Prepositions . Tag questions . Idioms, Phrases and Clauses . Simple, complex, compound sentences								
Module 2- Grammar	. Active and Passive Voice . Direct and Indirect Speech								
Module 3- Writing Skills	. The Basics of Writing; avoid ambiguity and vagueness . Paragraph Writing . Precis Writing . Letter Writing . Resume, CV and Cover Letter								
Module 4- Self-Management Skills	. SWOT Analysis . Self-Regulation- Goal Setting . Personal Hygiene								
Module 5- Non- Verbal Communication-Sciences of Body Language	. What is Non-Verbal Communication & Body Language, . Elements of Communication, . Types of Body Language, . Importance and Impact of Body Language, . Types of Communication through Body Language, . Introduction to Haptic, Introduction to Kinesics Introduction to Proxemics, Body Language Do's and Don'ts, Doubt Clearing Session.								
Module 6- Group Discussion (Theory)	. Importance, . Planning, Elements, and Skills assessed; . Effectively disagreeing, . Initiating, Summarizing and Attaining the Objective								

TEXTBOOKS

T1. Barrett, Grant. 2016.Perfect English Grammar: The Indispensible Guide to Excellent Writing and Speaking, Zephyros Press.

T2. McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition).

REFERENCE BOOKS

R1. Communication Skills Training: A Practical Guide to Improving Your Social Intelligence, Presentation and Social Speaking, Ian Tuhovsky,2019

R2. A Textbook for AECC English Communication: Interface, Dr.Kironmoy Chetia and Pranami Bania Breez Mohan Hazarika, January 2019.

OTHER LEARNING RESOURCES:

1. https://youtu.be/x60GHpQ8gJk
2. https://youtu.be/Ke_oSN-BCaY
3. https://youtu.be/TDPDtrLxT-c
4. https://www.classcentral.com/report/toefl-preparation/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain prepositions, tag questions, and idioms correctly.	**3, 8**
2	Discuss and analyze different sentence types and voices.	**3, 8**
3	Explain effective paragraphs, precis, and professional documents.	**3, 8**
4	Describe SWOT analysis, goal setting, and personal hygiene principles.	**3, 8**
5	Illustrate non-verbal communication and body language concepts.	**3, 8**

SEMESTER – III									
Course Title	**RESEARCH PROJECT I (SURVEY/EXPERIMENTS-R1)**								
Course code	**24MSCH2104R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 8 (P)	**0**	**0**	**8**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Microbiology**								
Semester	**Fall/III Semester of Second Year of the Programme**								
Course objectives	1. To learn the principles of designing effective surveys, including question formulation and sampling techniques. 2. To gain hands-on experience in designing and conducting research experiments to test hypotheses								
CO1	Formulate research methodology								
CO2	Prepare research tool(s)								
CO3	Apply the knowledge of sampling methods in sample collection.								
CO4	Design experiment using scientific method								
CO5	Investigate the research Problem								

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Formulate research methodology	**1, 2, 4, 5, 6, 8**
2	Prepare research tool(s)	**1, 3, 4**
3	Apply the knowledge of sampling methods in sample collection.	**1, 2, 3, 4**
4	Design experiment using scientific method	**1, 2, 3, 4, 6**
5	Investigate the research Problem	**1, 2, 3, 4, 8**

SEMESTER – IV									
Course Title	**RESEARCH PROJECT II (RESEARCH DATA ANALYSIS AND DOCUMENTATION-R4)**								
Course code	**24MSCH2201R**	**Total credits: 16**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 32(P)	**0**	**0**	**32**	**0**	**0**	**0**	**16**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Chemistry**								
Semester	**Spring/IV Semester of Second Year of the Programme**								
Course Objectives	1. To enable students to apply experimental methods to solve a given scientific task. 2. To be able to analyse research data 3. To be able to compile and document research data.								
CO1	Learn to tabulate research data								
CO2	Analyze research outcomes								
CO3	Corelate with exiting literature								
CO4	Prepare an effective dissertation report								
CO5	Able to communicate research outcome								

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn to tabulate research data	**2, 3, 4, 5, 8**
2	Analyze research outcomes	**1, 2, 5**
3	Correlate with exiting literature	**2, 5, 8**
4	Prepare an effective dissertation report	**4, 5, 6**
5	Able to communicate research outcome	**3, 4, 8**

	Semester IV								
Course Title	**Advanced Organic Synthesis**								
Course code	**24MSCH2202R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/f**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti-requisite	**Nil**								
Programme	**Master of Science in Chemistry**								
Semester	**Spring/IV Semester**								
Course objectives	1. To educate the students about the concept and significance of dynamic stereochemistry in organic synthesis. 2. To familiarize the students about the principles of organic synthesis, asymmetric synthesis and the concept of retrosynthesis. 3. To explain in details about the synthesis, structure and reactivity of single and polyheteroatom containing heterocyclic compounds.								
CO1	Explain the concept of selectivity in organic reactions.								
CO2	Describe the strategies for the formation of carbon-carbon and carbon-heteroatom bonds.								
CO3	Explain the concept of asymmetric synthesis and its importance in the synthesis of complex molecules.								
CO4	Design synthetic strategies for multistep synthesis.								
CO5	Explain in detail the synthesis, structure and reactivity of single and polyheteroatom containing heterocyclic compounds.								

Unit-No.	Content	CH	Learning Outcome	KL	Ref
I	**Dynamic stereochemistry** Stereospecific and Stereoselective synthesis; classification of stereoselective synthesis, diastereoselective, enantioselective and double stereo-differentiating reactions, nucleophilic addition to aldehyde and acyclic ketones– Cram, Felkin and Felkin-Anh model, Prelog's rule, Stereoselective nucleophilic addition to cyclic ketones (Cram and Felkin-Anh models). Acyclic stereoselection: reactions at α-and β-positions of a chiral center.	**9**	Understand stereospecific and stereoselective synthesis, Cram, Felkin and Felkin-Anh model, Prelog's rule	1,2	**T1**
II	**Synthetic methods** Formation of carbon-carbon single bonds involving Csp^3, Csp^2 and Csp carbon centers (with emphasis on important name reactions); Carbon-carbon bond forming reactions through enolates (including boron enolates), enamines and silyl enol ethers. Michael addition reaction. Formation of C-C multiple bonds involving Csp^2 and Csp carbon centers (with emphasis on important name reactions). Formation of carbon-heteroatom bonds: New methods for the construction of C-N, C-O, C-S and C-X bonds (including aspects related to the activation of C-H bonds)	**9**	Describe, illustrate and explain the synthetic methods of formation of carbon-carbon single bonds, C-C multiple bonds, carbon-heteroatom bonds	1,2,3	**T2, R1, R2**
III	**Asymmetric Synthetic Methods**	**9**	Describe and explain	1,2, 3, 4	**T2,**

	Enantioselective synthesis (alkylation, allylation and crotylation reactions), use of chiral reagent; Chiral catalyst and chiral auxiliary; Use of chiral auxiliaries (Evans oxazolidones, Oppolzersultams, Myers amides, Schöllkopf Chiral Auxiliaries). Concepts of asymmetric synthesis: Kinetic resolution (including enzymatic resolution), desymmetrization reactions Asymmetric reactions: Epoxidation (Sharpless, Jacobsen, Shi), Dihydroxylation (Sharpless), Reduction (Noyori, Corey, Pfaltz)		asymmetric synthetic methods		**R1, R2**
IV	**Retrosynthetic Analysis** Basic principles and terminology of retrosynthesis, synthesis of aromatic compounds, one group and two group C-X disconnections, One group C-C and two group C-C disconnections, amine and alkene synthesis, important strategies of retrosynthesis, functional group transposition, important functional group interconversions.	**9**	Describe and explain retrosynthetic analysis	1,2, 3, 4	**T3, R3**
V	**Heterocyclic Compounds** Structure and reactivity of heterocycles containing one heteroatom (O, N, S) including furan, pyrrole, thiophene, pyridine (Hantzsch pyridine synthesis, Hofmann-Loffler-Freytag reaction), indole (Fischer Synthesis, Bischler Synthesis), quinoline and isoquinoline (Conrad-Limpach reaction, Bischler-Napieralski reaction, Combes reaction, Pictet-Gams synthesis, Skraup/Doebner-von Miller reaction) Heterocyclic rings (with two or more heteroatoms): Pyrazoles, isoxazoles, thiazoles, triazoles and pyrimidines (Claisen synthesis, Fischer synthesis)	**9**	Describe and explain the chemistry of heterocyclic compounds	1,2	**T4**

TEXTBOOKS:

T1: Eliel, E.L., Wilen, S. H. Stereochemistry of Organic Compounds. Wiley; 2010.
T2: Carruthers, W. and Coldham, I. Modern methods of Organic Synthesis. Cambridge University Press; 2005.
T3: Warren, S. Organic Synthesis: The Disconnection Approach, Wiley India Pvt. Ltd.; 2004.
T4: Li, J.J. Name Reactions in Heterocyclic Chemistry. Wiley; 2006

REFERENCE BOOKS:
R1. Cary, F. A. and Sundberg, R. I. Advanced Organic Chemistry, Part A and B. 5th edition. Springer; 2009.
R2.Smith, M. B. Organic Synthesis. 2nd edition. McGraw Hill Higher Education; 2005.
R3: Norman, R.O.C. and Coxon, J.M. Principles of Organic Synthesis. 3rd edition. Chapman & Hall; 2003.

***OTHER LEARNING RESOURCES*:**
https://nptel.ac.in

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the concept of selectivity in organic reactions.	**1,2, 5**
2	Describe the strategies for the formation of carbon-carbon and carbon-heteroatom bonds.	**1,2, 5**
3	Explain the concept of asymmetric synthesis and its importance in the synthesis of complex molecules.	**1,2, 5**
4	Design synthetic strategies for multistep synthesis.	**1,2,5**
5	Explain in detail the synthesis, structure and reactivity of single and polyheteroatom containing heterocyclic compounds.	**1,2,5**

SEMESTER-IV									
Course Title	**Natural Products Chemistry**								
Course code	**24MSCH2203R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Spring/IV Semester of Second year of the programme**								
Course Objectives	1.The course aims to provide an advanced understanding of all aspects of natural products chemistry. 2.To find new materials which make the study of natural products a very important subject. 3.To teach several classes of natural products, their isolation, extraction, synthesis, biosynthesis etc.								
CO1	Identify different types of natural products.								
CO2	Describe and explain the reactions of carbohydrates. Illustrate protection and deprotection in carbohydrate synthesis.								
CO3	Discuss about terpenoids, their biosynthesis and total synthesis.								
CO4	Explain and summarize about steroids and carotenoids								
CO5	Discuss about alkaloids, their physiological activity and total synthesis.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction** Natural products chemistry: a general treatment. Primary and secondary metabolites.	4	Understand the chemistry of natural products, identify different types of natural products	1,2
II	**Carbohydrates** Open chain and ring structure of monosaccharides, reactions of the anomericcentre, reactions of hydroxyl groups, cyclic acetals, Glycosyl activation, chemical disaccharide formation, enzymatic dissacharide formation, introductory chemical glycobiology, Illustration of protection and deprotection in carbohydrate synthesis.	10	Learn about carbohydrates	1,2
III	**Terpenoids** Introduction to terpenoids, isoprene and biogenetic isoprene rule, Biosynthesis of mono and sesquiterpenoids, discussion on caryophylene, longifolene, santonin, abietic acid, and taxol, total synthesis of terpenes (caryophylene)	10	Learn about terpenoids and their total synthesis	1,2
IV	**Steroids and Carotenoids** Introduction to steroids: cholesterol, bile acids, sex hormones, cardiac glycosides and corticosteroids. General introduction to carotenoids, discussion on alpha-, beta- and gamma-carotenes, vitamin-A.	11	Learn about steroids and carotenoids	1,2

V	**Alkaloids** Introduction to alkaloids, physiological activity of alkaloids, Discussion on morphine and reserpine and their total synthesis	10	Learn about alkaloids and their total synthesis	1,2

TEXTBOOKS:

T1: Bhat, S. V., Nagasampagi, B.A., Sivakumar, M. Chemistry of natural products. Springer Narosa; 2005.

T2: Kalsi, P. S.andJagtap,S. Pharmaceutical, medicinal and natural products chemistry. Alpha Science International Ltd.; 2013.

T3: Finar, I. L. Organic Chemistry.Vol-2, Pearson; 2009.

T4: Davis,B. G. and Fairbanks, A. J. Carbohydrate Chemistry. Oxford University Press; 2002.

T5: Sell, C. A Fragrant Introduction to Terpenoid Chemistry. RSC; 2003.

REFERENCE BOOKS:

R1: Krishnaswami,N. R. Chemistry of natural products-A Unified Approach. University Press; 1999.

R2: Talapatra, S. K. and Talapatra, B. Chemistry of Plant Natural Products. Springer; 2015.

OTHER LEARNING RESOURCES:
https://nptel.ac.in

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify different types of natural products.	**1, 2, 5**
2	Describe and explain the reactions of carbohydrates. Illustrate protection and deprotection in carbohydrate synthesis.	**1, 2, 5**
3	Discuss about terpenoids, their biosynthesis and total synthesis.	**1, 2, 5**
4	Explain and summarize about steroids and carotenoids	**1, 2, 5**
5	Discuss about alkaloids, their physiological activity and total synthesis.	**1, 2, 5**

SEMESTER-IV									
Course Title	**Organometallic Chemistry and Catalysis**								
Course code	**24MSCH2204R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Spring/IV Semester of Second year of the programme**								
Course Objectives	1. To study the concept of 18 electron- system in organometallics. 2. To study the structure and bonding of different alkyl complexes. 3. To understand the bonding of metal carbonyl complexes. 4. To study the concept and reactions associated with different organometallic compounds. 5. To study the basics of different metal clusters.								
CO1	Explain the18 electron system								
CO2	Describethe structure and bonding of various alkyl, arene complexes.								
CO3	Describe the bonding of metal carbonyl, nitrosyl complexes and apply the concept to identify the stretching strength of the various types of carbonyl compounds.								
CO4	Describe the different metal cluster complexes.								
CO5	Analyse and apply the concepts of different organometallic catalytic reactions								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**18 electron system** 18 electron system, molecular orbital theory, Isolobal analogy.	**6**	Understand the concept of 18 electron system, molecular orbital theory in organometallics.	1,2
II	**Metal alkyl, arenes, metallocene complexes** Structure, bonding and synthesis and reactions of metal complexes with alkyls, aryls, alkenes, alkynes, allyls, carbenes, carbide alkyl complexes, arenecomplexes,Пallyl complexes, metallocenes and bent metallocenes ,double and multidecker sandwich complexes.	**10**	Describeandexplain the structure and bonding of alkyl complexes.	1,2
III	**Metal carbonyl and nitrosyl complexes** Synthesis, structure, bonding and reactivity of mono and polynuclear metal carbonyls. Substituted metal carbonyls. Vibrational spectra of metal carbonyls, nitrosyls, tertiary phosphines, metallation reactions. Substitution, Oxidative addition, Reductive elimination, Insertion reactions	**10**	Understand the structure, bonding and reactivity of metal carbonyl complexes.	1,2
IV	**Metal clusters:** Synthesis and bonding in metal clusters. Low and high nuclearity metal carbonyl and metal halide clusters, Metal-metal quadruple bonding in $Re_2Cl_8^{2-}$,Isolobal analogy in organometallic and cluster compounds.	**9**	Understand the bonding in different metal clusters.	1,2
V	**Catalysis:** Introduction and definition, Catalysis - hydrogenation, hydroformylation, Monsanto process, Wacker process, alkenepolymerization, olefin metathesis, Fischer-Tropsch carbon chain growth, use of ZSM-5 for organic transformation, Suzuki coupling reaction.	**10**	Understand the different catalysis reactions associated with organometallic complexes	1,2

TEXTBOOKS:

T1. J. E. Huheey, E. A. Keiter and R. L. Keiter; Inorganic Chemistry: Principles of Structure and Reactivity, 4th Ed. Pearson Education, 2006.

REFERENCE BOOKS:

R1. P.W. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong; Shriver & Atkins, Inorganic Chemistry, 5th Ed. Oxford University Press, 2010.

R2. G. L. Miessler, D Tarr; Inorganic Chemistry. 3rd Ed., Pearson Education, 2004.

R3. A.K. Das , M. Das, Fundamental Concepts of Inorganic Chemistry, Vols. 1-7, CBS Publishers and Distributors, 2015

OTHER LEARNING RESOURCES:

https://nptel.ac.in

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the 18 electron system	**1, 2, 5**
2	Describethe structure and bonding of various alkyl, arene complexes.	**1, 2, 5**
3	Describe the bonding of metal carbonyl, nitrosyl complexes and apply the concept to identify the stretching strength of the various types of carbonyl compounds.	**1, 2, 5**
4	Describe the different metal cluster complexes.	**1, 2, 5**
5	Analyse and apply the concepts of different organometallic catalytic reactions	**1, 2, 5**

SEMESTER-IV									
Course Title	**Inorganic Reaction Mechanism and Kinetics**								
Course code	**24MSCH2205R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Chemistry**								
Semester	**Spring/IV Semester of Second year of the programme**								
Course Objectives	1. To gain knowledge on inert and labile complexes. 2. To make the students understand the basic concept and factors responsible for stability of complexes. 3. To understand the different inorganic reaction mechanisms, the kinetics, reaction and mechanism of different coordination complexes.								
CO1	Define inert and labile complexes and explain their kinetic as well as thermodynamic stability								
CO2	Summarize the basic concept as well as factors responsible for stability of complexes								
CO3	Analyze the different inorganic reaction mechanisms-ligand replacement, substitution reactions								
CO4	Assess on the kinetics, reaction mechanism of different coordination complexes								
CO5	Summarize the different redox mechanism of co-ordination complexes								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Thermodynamic and Kinetic stability:** Inert and labile complexes, Factors affecting on lability of a complex	7	Gain knowledge on the difference between labile and inert complexes.	1,2
II	**Stability and stability constant:** Stability constant, Factors affecting on stability of complexes, Correlation of stability constant with thermodynamic factors G,H and S. Determination of stability constant-Jobs and Bjerrum's methods.	10	Understand the different thermodynamic concepts related to stability constant.	1,2
III	**Reaction mechanisms and Isomerism:** Mechanism of ligand replacement reactions, Factors affecting the rate of substitution reaction, Substitution reactions in octahedral complexes. Solvolysis and hydrolysis reaction, acid and base hydrolysis, Racemization and Isomerism.	10	Understand the different inorganic reaction mechanisms.	1,2,3
IV	**Reaction, Kinetics and mechanism of Coordination Chemistry:** Substitution reaction in square planar reaction**,** [Rh(I),Pt(II),Pd(II)] complexes. Trans effect and its applications.	8	Understand the trans effect and apply it to determine the different inorganic compounds.	1,2
V	**Mechanism of Redox reactions:** Electron transfer reaction, Mechanism of redox reaction, Inner sphere and Outer sphere reaction. Nature of bridging ligand, Factors affecting the rates of direct electron transfer reaction.	10	Understand the different redox mechanisms.	1,2,3

TEXTBOOKS:

T1. G. L. Miessler, D Tarr; Inorganic Chemistry. 3rd Ed., Pearson Education, 2004

T2. P.W. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong; Shriver & Atkins, Inorganic Chemistry, 5th Ed. Oxford University Press, 2010.

REFERENCEBOOKS:

R1. J. E. Huheey, E. A. Keiter and R. L. Keiter; Inorganic Chemistry: Principles of Structure and Reactivity, 4th Ed. Pearson Education, 2006.

R2. A.K. Das , M. Das, Fundamental Concepts of Inorganic Chemistry, Vols. 1-7, CBS Publishers and Distributors, 2015

OTHER LEARNING RESOURCES:

https://nptel.ac.in

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Define inert and labile complexes and explain their kinetic as well as thermodynamic stability	**1, 2, 5**
2	Summarize the basic concept as well as factors responsible for stability of complexes	**1, 2, 5**
3	Analyze the different inorganic reaction mechanisms-ligand replacement, substitution reactions	**1, 2, 5**
4	Assess on the kinetics, reaction mechanism of different coordination complexes	**1, 2, 5**
5	Summarize the different redox mechanism of co-ordination complexes	**1, 2, 5**

Assam down town University

Curriculum and Syllabus

Master of Science in Mathematics

OUTCOME BASED EDUCATION FRAMEWORK
CHOICE BASED CREDIT SYSTEM
Version: 1.0

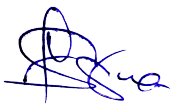
FACULTY OF SCIENCE

July, 2024

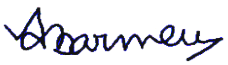
PREAMBLE

Assam down town University is a premier higher educational institution which offers Bachelor, Master, and Ph.D. degree programmes across various faculties. These programmes, collectively embodies the vision and mission of the university. In keeping with the vision of evolutionary changes taking place in the educational landscape of the country, the university has restructured the course curriculum as per the guidelines of National Education Policy 2020. This document contains outline of teaching and learning framework and complete detailing of the courses. This document is a guidebook for the students to choose desired courses for completing the programme and to be eligible for the degree. This volume also includes the prescribed literature, study materials, texts, and reference books under different courses as guidance for the students to follow.

Recommended by the Board of Studies (BOS) meeting of the Faculty of Science held on dated 16th & 17th July, 2024 and approved by the 51st Academic Council (AC) meeting held on dated 26/07/2024



Chairperson, Board of Studies



Member Secretary, Academic Council

Vision

To become a Globally Recognized University from North Eastern Region of India, dedicated to the Holistic Development of Students and Making Society Better

Missions

1. Creation of curricula that address the local, regional, national, and international needs of graduates, providing them with diverse and well-rounded education.
2. Build a diverse student body from various socio-economic backgrounds, provide exceptional value-based education, and foster holistic personal development, strong academic careers, and confidence.
3. Achieve high placement success by offering students skill-based, innovative education and strong industry connections.
4. Become the premier destination of young people, desirous of becoming future professional leaders through multidisciplinary learning and serving society better.
5. Create a highly inspiring intellectual environment for exceptional learners, empowering them to aspire to join internationally acclaimed institutions and contribute to global efforts in addressing critical issues, such as sustainable development, Climate mitigation and fostering a conflict-free global society.
6. To be renowned for creating new knowledge through high quality interdisciplinary research for betterment of society.
7. Become a key hub for the growth and excellence of AdtU's stakeholders including educators, researchers and innovators
8. Adapt to the evolving needs and changing realities of our students and community by incorporating national and global perspectives, while ensuring our actions are in harmony with our foundational values and objectives of serving the community.

Programme Details

Programme Overview

M.Sc. Mathematics offers a wide range of courses covering various pure and applied areas of mathematical science. The students develop a disciplined thought process, logical articulation and problem-solving attitude through different thrust areas of this branch of science. It is designed to strengthen students mathematical background by in-depth knowledge of mathematical concepts. An M.Sc. in Mathematics gives students who want to work in science, engineering or computing a solid core education. The programme also includes various aspects of knowledge like- universal ethics, overall development and employability scopes in research, industry and teaching sectors. The course duration is a period of 2years.

I. Specific Features of the Curriculum

- Interactive learning
- Constructivist approach to learn
- Project based learning

The curriculum provides ability enhancement, skill enhancement and value-added courses along with the core papers.

II. Eligibility Criteria:

B.Sc. with45% marks or equivalent CGPA in Mathematics.(5 % relaxation for SC/ST, EWS, and Specially abled candidates).

III. Program Educational Objectives (PEOs):

PEO-1: Graduates will be able to pursue respectable employment in the domain of teaching and research and banking sectors.

PEO-2: Graduates will contribute to the application, advancement, and transmission of knowledge in interdisciplinary fields of engineering and technology.

PEO-3: As an effective team member, graduates will demonstrate great professional skills, communication abilities, and ethical traits in a globally competitive environment.

IV. Program Specific Outcomes (PSOs):

PSO1: Capable of identifying problems, design strategy for solving them, and analyse effective solution(s) applying mathematical principles and associated tools.

PSO2: Capable of excelling mathematical modelling, designing and developing algorithms including application tools.

PSO3: Comprehend and apply mathematical knowledge and skill, apply them to resolve problems associated with socio-scientific structures for societal upliftment.

V. Program Outcome (PO):

PO1: Scientific Knowledge: Ability towards logical reasoning with articulation of mathematical aspects associated with various scientific phenomena.

PO2: **Analytical skill**: Ability to analyse and interpret problems relevant to technologies, Socio economics etc.

PO3: Problem solving skills: Ability to apply theoretical concept to solve various problems.

PO4: **Proficiency:** To encourage towards proficiency in mathematical software like- Math type, Mathematical, Latex etc.

PO5: Communication skill: Development of communication skill to communicate

scientific and technological thoughts with the peers and society.

PO6: Professional ethics: Enrichment of knowledge towards professional ethics.

PO7: Research: Temperament to take up research as a career to develop new knowledge in thrust areas.

PO8: Social Responsibility: Sense of responsibility to do utmost possible for development of Society by educating mass for numeracy skill, solving problems, removing superstitions and there by contribution to nation building as a whole.

VI. Total Credits to be Earned: 89

VII. Career Prospects:

- Capabilities for a career in wide range of potential job prospects, including from Mathematician, Statistician, Teacher/Professor, Software Developer/Engineer.
- Demonstrate concepts and research approaches for a future profession in mathematics and develop their scientific interest.
- Insurance and Banking sectors afford a plethora of job opportunities after M.Sc. Both the private and public sectors are actively in the fray. The Banking and Insurance sectors provide various Career options after M.Sc. Mathematics as M.Sc. Mathematics degree holders have multiple avenues to join big firms as Data analysts, Estimators or as Data Scientists.
- For those students who have a knack for solving complex numerals, there are bright Career options after M.Sc. Mathematics to assume the role of a Numerical Analyst.
- For those students who have a knack for solving complex numerals, there are bright Career options after M.Sc. Mathematics to assume the role of a Numerical Analyst.

EVALUATION METHODS

The student performance shall be evaluated through In-semester (Sessional) and semester-end examinations. A weight age of 40% or as prescribed by the programme shall be added to the score of the end semester examination.

A. INTERNAL ASSESSMENT:

The teacher who offers the course shall be responsible for internal assessment by conducting in-semester (sessional) examination and evaluating the performance of the students pursuing that course. The components for internal assessment are illustrated in the table given below.

SN	Components/ Examinations	Marks Allotted
1.	In-Sem Exam – I (ISE-I) (Written Examination)*	30
2.	In-Sem Exam – II (ISE-II) (Written Examination)*	30
3.	Assignment	10
4.	Presentation (SP)	10
5.	Quiz	5
6.	Class Performance based score*	5

are compulsory

Note: *Total Internal assessment should be out of 40*

INSTRUCTION

1. If a student fails to appear in the any of the component without any valid reason he/she shall be marked zero in that component. However, the course teacher at his discretion may arrange for the missed test on an alternate date for the absentee students after determining ground with genuine/valid reasons for the absent.
2. The report of evaluation of an activity towards the in-semester (sessional) component of a course shall be duly notified by the concerned course teacher within a week of completion.
3. The program coordinators should upload the in-semester marks to the ERP and forward acknowledgement of all the courses of the program to the Controller of Examinations before the start of the End-semester examination.

B. SEMESTER END EXAMINATION:

Time table for end semester examination is published at least 25 days prior to the start of Examination.

I. Pre-Examination:

Eligibility Criteria for a student to appear in University Examinations:

The student shall only be allowed to appear in a University Examination, if:

i) He/ She is a registered student of the University;
ii) He/ She is of good conduct and character;
iii) He/ She has completed the prescribed Programme of study with minimum percentage of attendance as laid down in the Regulations of the Programme concerned.

Under special cases, a student may be allowed to appear for an examination without being registered in the University but the result of the said student will be kept on hold till the registration of the concerned student is completed.

II. Admit Card:

Admit card for the examination may be downloaded through ERP where the system will generate a Unique ID Cards through online.

The University shall have the right to cancel admission for examination of any candidate on valid grounds.

III. Pattern of Question Papers:

The question paper shall follow the principles of Bloom's Taxonomy.

Table

S. N.	Level	Questions /verbs for test
1	Remember	List, Define, tell, describe, recite, recall, identify, show who, when, where, etc.
2	Understand	Describe, explain, contrast, summarize, differentiate, discuss etc.
3	Apply	Predict, apply, solve, illustrate, determine, examine, modify
4	Analyze	Classify, outline, categorize, analyze, diagrams, illustrate, infer, etc.
5	Evaluate	Assess, summarize, choose, evaluate, recommend, justify, compare etc.
6	Create	Design, Formulate, Modify, Develop, integrate, etc.

Note: No course is to be evaluated on basis of **all 6 knowledge levels.**

The format of the question paper across all the program follow a unique pattern and the total marks is 60

Table 1: Question paper pattern for End semester examination

Sl no	Question pattern	Total marks
1	MCQs (10 Questions)	10
2	2 Marks questions (10 Questions)	20
3	4 Marks questions (5 Questions)	20
4	10 Marks questions (1 Question)	10

IV. Examination Duration:

Each paper of 60 marks shall ordinarily be of two hours duration.

V. Practical Examinations, Viva-Voice etc.:

i) Practical examination shall be conducted in the presence of one external expert and one or more internal examiners.

ii) Viva-Voice, Oral examinations of the Project report, Dissertation etc. shall be undertaken by a Board of Examiners constituted by the respective Dean of Program with the advice of Supervisor(s).

VI. Procedure of Expulsion:

If any candidate is found to be using any unfair-means during the examination, the invigilator may cease his/her answer sheet and report it directly to the Officer-in-Charge. The Office-in-Charge of the center may take appropriate decisions as per the rules and procedure of the examination. The Officer-in-Charge may allow the students to write the exam with new

answer sheet or may expel the student from appearing the paper depending on the nature of unfair-means. In case of Computer based test, the students may be directed to write an apology letter and sign in the prescribe expulsion form. The student may not be allowed to write that examination.

VII. Instruction to the Students:

(i) The students shall not bring to the Examination Hall, any electronic gadget used as a means of communication or record except electronic calculator, if required.

(ii) The students shall not receive any book or printed or hand written or photo copy (Xerox) or blank-paper from any other person while he/she is in the examination-room or in laboratory or in any other place to which he/she is allowed to have access during course of examination.

(iii) The students shall not communicate with any other candidate in the examination room or with any other person in and outside the examination-room.

(iv) The students shall not see, read or copy anything written by any other candidate, nor shall he/she knowingly or negligently permit any other candidate to see, read or copy anything written by him/her or conveyed by him/her.

(v) The students shall not write anything on the Question Paper or in other paper or materials during the examination, or pass any kind of paper to any other candidate in the examination-room, or to any person outside the room.

(vi) The students shall not disclose his/her identity to the examiner by writing his/her name or putting any sign / symbol in any part of his answer-script.

(vii) The students shall not use any abusive language or write any objectionable remark or make any appeal to examiner by writing in any part of his answer-script.

(viii) The students shall not detach any page from the answer-script or insert any authorized or unauthorized loose sheet into it. He /she shall also not insert any other answer-script / loose sheet by removing the pins of the origin answer-scripts and re-fixing it.

(ix) The students shall not resort to any disorderly conduct inside the examination-room or misbehave with the invigilator or any other examination official.

VIII. Provision for an Amanuensis (writer):

(i) A candidate may be provided with an Amanuensis (writer) to write down on dictation on his / her behalf on ground of his / her physical disability to write down by himself / herself due to accident or any other reason. The amanuensis may be provided till he / she recovers from the physical disability. The physical disability to write down by himself / herself must be supported by Medical Certificate from a competent Medical Officer.

(ii) The qualifications of the amanuensis so provided must not be equal or higher than that of the candidate. This is also to be supported by Certificate from the Faculty of Study where the Amanuensis is provided.

(iii) Such candidates are to be accommodated in a separate room under the supervision of an invigilator so that the fellow candidates are not disturbed in the process.

C. Credit Point:

It is the product of grade point and number of credits for a course, thus, CP = GP x CR

i. Credit:

A unit by which the course work is measured. It determines the number of hours of instructions required per week. 'Credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. Credits assigned for a single course always pay attention to how many hours it would take for an average learner to complete a single course successfully.

ii. Grade Point:

Grade Point is a numerical weight allotted to each Grade Letter on a 10-point scale.

iii. Letter Grade:

Letter Grade is an index of the performance of students in a said paper of a particular course. Grades are denoted by letters O, A+, A, B+, B, C, P, F and Abs. Student obtaining Grade F / Grade Abs shall be considered failed/ absent and, will be required to appear in the subsequent ESE. The UGC recommends a 10-point grading system with the following (Table: 1) Letter Grades:

(i) A Letter Grade shall signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point shall indicate the numerical weight of the Letter Grade on a 10-point scale.

(ii) There shall be 08 (eight) Letter Grades bearing specific Grade Points as listed in Table 1, where the Letter Grades 'O' to 'P' shall indicate successful completion of a course.

(iii) Apart from the 08 (eight) regular Letter Grades listed in Table 1, there shall be 03 (three) additional Letter Grades, which shall be awarded if a Course is withdrawn or spanned over the next Semester or remains incomplete as stated in Table 2.

Table 2: Letter Grades and Grade Points

Letter Grade	Grade Points	Description
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Abs	0	Absent
UFM	0	Unfair Means

iv. Grade Point Average:

a. SGPA (Semester Grade Point Average)

The SGPA of a student in a Semester shall be the weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered in that Semester, irrespective of whether he/she could or could not complete the Courses. More specifically, the calculation of SGPA shall take into account the Courses

graded with Letter Grades 'O' to 'F' as given in Table 1.

$$\text{SGPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad (1.1)$$

The SGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.1) up to two decimal places, where n is the total number of Credit Courses registered by the student in that Semester, Gi is the Grade Point secured in the i^{th} registered Course and Ci is the Credit (weight) of that Course.

b. CGPA (Cumulative Grade Point Average)

(i) The CGPA of a student in a Semester of a Programme shall be the accumulated weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered and successfully completed so far starting from the enrollment in the Programme. In other words,taking into account all the Courses graded with 'O' to 'P' as given in Table 1.1, generally the CGPA of a student shall be calculated starting from the first Semester of his/her enrolled Programme, while the CGPA of a lateral-entry student shall be calculated starting from the Semester of his/her enrollment.

(ii) The CGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.2) up to two decimal places, where N is the total number of Credit Courses registered and successfully completed so far by the student, Gi is the Grade Point secured in the ith completed Course and Ci is the Credit (weight)of that Course.

$$\text{CGPA} = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i} \qquad (1.2)$$

(iii) The CGPA shall be convertible into equivalent percentage of marks using Equation Conversion of CGPA to percentage marks: = CGPA*10

D. Post-Examination

i. Transcript or Grade Card or Certificate:

A marking certificate shall be issued to all the registered students after every Semester. The Semester mark sheet will display the course details (code, title, number of credits, grade secured) along with total credit earned in that Semester.

ii. Grievance Readdress Mechanism:

Students with any dissatisfaction or grievance regarding the marks awarded in any of the Papers / Courses may appeal to the Controller of Examinations for remedial action such as Re-evaluation within 10 days of the declaration of result.

(i) A student has options to appeal for re-evaluation of his /her answer script to the Controller of Examination.

(ii) Application for re-evaluation / re-scrutiny of answer scripts shall be made in the definite proforma available with the Examination Office through the head of the respective departments within 10 days of declaration of the results of the respective examinations.

(iii) The Controller of Examination may appoint an examiner for re-evaluation and will consider and recognize the evaluation done by a University appointed examiner.

(iv) There shall be no provision for re-evaluation of the Practical Papers, Project Work, and Dissertation etc. However, the students fail in practical examination or viva voce and wish to appear again may apply to be evaluated can do so with the next schedule.

(v) After screening the application for re-evaluation, the CoE may send the answer scripts of the student to the examiners appointed by the CoE with the approval of Vice Chancellor.

(vi) The marks/grades achieved by the students after the re-evaluation shall be final and binding.

(vii) Fresh Marks – sheets / Grade Card shall be issued only if the candidate secures pass marks / passing grade in the re-evaluated paper.

(viii) Revaluation of answer scripts shall be deemed to be an additional facility provided to the students with a view to improving upon their results at the preceding examination result for any reason whatsoever shall not confer any right upon them for admission to next higher class which matters always be regulated in accordance with the relevant rules or regulations framed by the University.

(ix) If as a result of revaluation of the candidate attracts the provision of condonation of deficiency, the same may be applied to his/her only for fresh attempt.

INSTRUCTION TO TEACHERS AND STUDENTS

(Teaching and Learning Methods)

In all the courses the teacher has to select topics for teacher-method which should not be less than 20 percent. The approach will be direct class room teaching through series of lectures delivering concepts using ITC facilities, white or black board. Notes may also be circulated to the students however; the students are to be involved in preparation of the notes. The teacher will be responsible in selecting the best note for circulation. The teacher- centric methodology has recently fallen out of favour because this strategy for teaching is seen to favor passive students.

1. Student- centric / Constructivist Approach:

The topics of the courses may be selected at the start of the class and assigned one topic to each of the student for studying by themselves, prepare presentations, notes etc., and present at respective class time after consultation and discussion with the course teachers. The teacher facilitate the learning of the students by guiding and providing input and explaining concepts. 60 percent of the course contents may be selected for this purpose. To avoid behavior problems, teachers must lay a lot of groundwork in student- centric classrooms. Typically, it involves instilling a sense of responsibility in students. In addition, students must learn internal motivation.

a. Project-Based Learning: The teacher may select 5 percent of topics for the purpose and may conduct visit to the laboratory for experiments or field and survey. The selection of the topic may be done considering the available facility for the purpose. However, in the final semester of each of the programme the student has to undergo a project-Based learning at least 4 months duration. This approach will help the student to think critically, evaluate, analyze, make decisions, collaborate, and more.

b. Inquiry-Based Learning: The teacher/ students are supposed to list at least five questions in each contact hour and student solve these question or search for answer which becomes the home work for the students "question-driven" learning approach. The teacher may look for the correctness of the solution or the best possible answer and discuss in the successive class. This will help in the preparation for various competitive examination and develop a habit for search for solutions.

c. Flipped Classroom: About 10 percent of the course content has to be completed by this method. In this approach the students are asked to watchvideo or lecture prepared by the teacher or any video available (relevant to the course). A set of questions may be given to the students for searching answers by the students. The idea is that students should have more time in-classroom focusing on achieving these higher levels of thinking and learning. The Flipped classroom is also an acronym. The letters FLIP represent the four pillars included in this type of learning: Flexible environment, Learning culture shift, Intentional content, and Professional educator. As you can see, the second pillar refers to a culture shift from the traditional approach where students are more passive to an approach where students are active participants. As a result, this approach is also a student- centric teaching method.

d. Cooperative Learning: The remaining five percent has to be completed by cooperative learning approach. In this approach the students are allotted with problems. During the library hours the student along with the teacher visits library search probable solution for the assigned problem. The same has to be done in group so that the students discuss among

themselves for the appropriate answers. Essentially, cooperative learning believes that social interactions can improve learning. In addition, the approach recreates real-world work situations in which collaboration and cooperation are required.

The percentage categorization for the completion of a theory course

Teacher- centric or Direct Classroom Teaching: Delivery by series of lectures	20%
Student- centric Approach, Student present and deliver lectures in presence of teacher and supervised by teacher	60%
Student visit fields or perform experiments or teacher perform demonstration	05%
Flipped Classroom approach	10%
Cooperative learning approach	05%

Inquiry based approach has to be followed in all of the classes

Teacher has to distribute the topics to be considered for teaching by the above-mentioned approaches and prepare lesson plan for execution and maintain a file

Breakdown of Credits

Sl. No	Category		Total number of Credits
1	University Core(UC)	Skill Enhancement Course (SEC)	2
		Ability Enhancement Course(AEC)	4
		Field Training	-
		Discipline Specific Elective (DSE)	-
		Value Added Course (VAC)	6
		Co and extra-Curricular	2
2	University Elective (UE)	Multidisciplinary Course (MDC)	2
		Value Added Course (VAC)	-
3	Program Core(PC)	Discipline Specific Core(DSC)	27
		Field Training	2
		Research /Industry Internship	20
		Summer Internship	4
4	Program Elective (PE)	Discipline Specific Elective (DSE)	18
		Value Added Course (VAC)	-
5	Faculty Core(FC)	Skill Enhancement Course (SEC)	2
		Ability Enhancement Course(AEC)	-
Total			**89**

Breakdown by categories of courses

Sl no	Category	Credits	%
1	Science	83	93.26%
2	Humanities and Social Sciences	6	6.74%
Total		89	100%

SEMESTER WISE COURSE DISTRIBUTION

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester I	1.	24MSMT1101R	Differential Equation	**DSC Major**	3	1	0	0	0	0	4	40	60	0	100
	2	24MSMT1102R	Abstract Algebra	**DSC Minor**	3	1	0	0	0	0	4	40	60	0	100
	3	24MSMT1103R	Real Analysis	**DSC Minor**	3	1	0	0	0	0	4	40	60	0	100
	4	24UMNM1102R	Numerical Methods for Interdisciplinary Sciences	**MDC**	2	0	0	0	0	0	2	40	60	0	100
	5	24UMPD1101R	Effective Communication(PDP)	**AEC**	0	0	4	0	0	0	2	50	0	50	100
	6	24UMEC1101	Extra-curricular	**Co and extra-Curricular**	0	0	0	0	0	0	1	0	0	100	100
	Total										**17**				**600**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester II	1.	24MSMT1201R	Partial Differential Equation	**DSC Major**	3	1	0	0	0	0	4	40	60	0	100
	2	24MSMT1202R	Linear Algebra	**DSC Major**	3	1	0	0	0	0	4	40	60	0	100
	3	24MSMT1203R	Complex Analysis	**DSC Major**	3	1	0	0	0	0	4	40	60	0	100
	4	24UMPD1201R	Advanced Communication	**SEC**	0	0	4	0	0	0	2	0	0	100	100
	5	24MSMT1204R	Postgraduate Practice Teaching	**SEC**	2	0	0	0	0	0	1	0	0	100	100
	6	24MSMT1205R	Research methodology and Statistical Analysis	**SEC**	2	0	2	0	0	0	3	40	60	100	200
	7	24FSDA1201R	Data analysis using MS Excel	**VAC**	0	0	4	0	0	0	2	0	0	100	100
	8	24MSMT1206R	Field Visit	**Field Training**	0	0	0	0	0	8	1	0	0	100	100
	9	24UMCC1201	Co-curricular	**Co and extra Curricular**	0	0	0	0	0	0	1	0	0	100	100
	Total										**22**				**1000**

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester III	1.	24MSMT2101R	Computer Programming C+	**DSC Major**	2	0	2	0	0	0	3	40	60	100	200
	2	24UMPD2101R	(PDP)	**AEC**	0	0	4	0	0	0	2	0	0	100	100
	3	24MSMT2102R	Internship	**Internship**	0	0	0	0	0	32	4	0	0	100	100
	4	24MSMT2103R	Field Visit	**Field Training**	0	0	`	0	0	8	1	0	0	100	100
	5	24MSMT2104R	Research Project I	**Research/ Industry Internship**	2	1	0	4	0	0	4	0	100	0	100
	6	24MSMT2105R	Indian Knowledge System	**VAC**	0	0	0	0	0	0	2	0	0	100	100
	Discipline specific Elective (Any three subjects to be selected)														
	7	24MSMT2106R	Topology	**DSE**	4	0	0	0	0	0	4	40	60	0	100
	8	24MSMT2107R	Mechanics and Tensor	**DSE**	4	0	0	0	0	0	4	40	60	0	100
	9	24MSMT2108R	Functional analysis	**DSE**	4	0	0	0	0	0	4	40	60	0	100
	10	24MSMT2109R	Number Theory	**DSE**	4	0	0	0	0	0	4	40	60	0	100
	11	24MSMT2110R	Fluid dynamics	**DSE**	4	0	0	0	0	0	4	40	60	0	100
	Total										**28**				**1000**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester IV	1.	24MSMT2201R	Research Project II	**Research/ Industry Internship**	8	4	0	12	6	0	16	0	100	0	100
	Discipline specific Elective (Any two subjects to be selected)														
	2.	24MSMT2202R	Continuum Mechanics and Hydrodynamics	**DSE**	3	0	0	0	0	0	3	40	60	0	100
	3.	24MSMT2203R	Mathematical Methods	**DSE**	3	0	0	0	0	0	3	40	60	0	100
	4.	24MSMT2204R	Operation Research	**DSE**	3	0	0	0	0	0	3	40	60	0	100
	5.	24MSMT2205R	Fuzzy Sets & Systems	**DSE**	3	0	0	0	0	0	3	40	60	0	100
	Total										**22**				**300**
	Grand Total										**89**				**2900**

***IA: Internal Assessment, SEE: Semester End Examination, PE: Practical Examination**

SEMESTER – I									
Course Title	**Differential Equation**								
Course code	**24MSMT1101R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**3**	**1**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	ODE of first order and second order and their General Solutions	**Co-requisite**	**Nil**						
Programme	**Master of Science in Mathematics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To identify and know the methods of finding solution of Differential Equations in explicit form. 2. To explain and able to apply whether a Differential Equation has a unique solution or not. 3. To explain various series solution of 2nd order Differential Equations. 4. To explain initial and boundary value problem. 5. To study Eigen values and Eigen functions of Sturm Lioville systems, stability of systems of ODEs.								
CO1	Describe Differential Equation and its classification according to linearity and order.								
CO2	Prove the existence theorem for a system of 1st order Differential Equation.								
CO3	Identify the series solution of 2nd order Differential Equation with particular reference to Legendre, Bessel, Hermite and Gauss.								
CO4	Verify the existence and uniqueness of Differential Equations involving initialand boundary value problems.								
CO5	Identify the concept of stability of system of ODE as well as Eigen values and Eigen functions of Sturm Lioville systems.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Linear differential equation of 2nd order, General solution of homogenous and non-homogenous equations, variable coefficients, variation of parameters.	**15**	Able to understand Differential Equation and its classification according to linearity and order.	1 2 3
II	Existence theorems of 1st order equation, Statements of existence theorems for a system of 1st order equation and for nth order differential equations, Wronskian.	**10**	Able to understand the existence theorem for a system of 1st order Differential Equation.	1 2 3
III	Series solution for ODE, solution about an arbitrary point, types of singularity, solution at a singular point. Method of series solution of 2nd order differential equation with particular reference to Legendre, Bessel, Hermite and Gauss.	**10**	Able to solve series solution of 2nd order Differential Equation with particular reference to Legendre, Bessel, Hermite and Gauss.	1 2 3
IV	Existence and uniqueness of solutions of initial value problems for 1st order ODE, Singular solution of 1st order ODE.	**10**	Able to find the existence and uniqueness of Differential Equations involving initial and boundary value problems.	2 3
V	General theory of homogenous and non-homogenous linear 2nd order ODE's, Sturm-	**15**	Discuss Eigen values and	1 2

	Liouville boundary value problem. Self adjoint boundary problems associated with 2^{nd} order linear differential equation.		Eigen functions of Sturm–Liouville systems, and the solutions of initial and boundary value problems.	3

TEXTBOOKS:

T1. Ross, S. L. (1984), Differential Equations, Wiley India.

T2. Coddington, E. A. (2001), An Introduction to Ordinary Differential Equations, PHI.

REFERENCEBOOKS:

R1. Boyce, W. E., DiPrima, R. C. (2009), Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India

R2. Piaggio, E. T. H. (1985), Differential Equations, CBS Publishers and Distributors.

OTHERLEARNINGRESOURCES:

1. http://mathforum.org.
2. http://ocw.mit.edu/ocwweb/Mathematics.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe Differential Equation and its classification according to linearity and order.	**1, 3**
2	Prove the existence theorem for a system of 1^{st} order Differential Equation.	**1, 3, 4, 7**
3	Identify the series solution of 2^{nd} order Differential Equation with particular reference to Legendre, Bessel, Hermite and Gauss.	**1, 2, 3, 4, 8**
4	Verify the existence and uniqueness of Differential Equations involving initialand boundary value problems.	**1, 2, 3, 8**
5	Identify the concept of stability of system of ODE as well as Eigen values and Eigen functions of Sturm Lioville systems.	**1, 3, 4, 8**

SEMESTER – I									
Course Title	**Abstract Algebra**								
Course Code	**24MSMT1102R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**3**	**1**	**0**	**0**	**0**	**0**	**4**
Pre- requisite	Nil	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Mathematics**								
Semester	**Fall/I Semester of First Year of the Program**								
Course objectives:	1. To know some special groups, subgroups, normal subgroup and their properties. 2. To study the class equation of a group and its related results. 3. To study the series of groups. Jordan Holder theorem and its applications. 4. To know the ring structure, their properties and related results. 5. To study three important classes of Ring structures, viz., the Principal ideal Domain, Euclidean domain and the unique factorization domain.								
CO1	Define group, subgroups, normal subgroups including properties and related results.								
CO2	Define class equation of group, Sylow's theorems and their applications.								
CO3	Define series of groups and its related results.								
CO4	Describe ring structure along with properties and its related results.								
CO5	Describe the classes of Ring structures, viz., the Principal ideal Domain, Euclidean domain and the unique factorization domain.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Introduction to Groups, Dihedral group, permutation groups, Quaternion groups, Group Homomorphism, Direct product of groups, Fundamental theorem of finite abelian groups.	15	Describe the Group and their properties, various types of groups and the related results. Group homomorphism and direct product of groups.	1,2
II	Group actions, Class equation of finite groups, Sylow's theorem and application.	10	Describe the Group theoretic notions of class equation and the related results	1,2
III	Series of groups, Normal and sub-normal series, composition series, solvable groups, Jordan Holder theorem and applications.	10	Describe the series if groups. Jordan Holder theorem and its applications	1,2
IV	Introduction to Rings, Homomorphism of ring, Ideal and factor ring, Polynomial rings.	10	Describe the ring structure, their properties and related results.	1,2,3
V	Irreducibility of ring, ED, PID, UFD, Field extensions.	15	Discuss three important classes of Ring structures, viz., the Principal ideal Domain, Euclidean domain and the unique factorization domain.	1,2,3, 4

TEXTBOOKS:

T1. Herstein, I. N. (1975). Topics in Algebra Wiley. Eastern Limited.

T2. Dummit, D. S., Foote, R. M. (2004). Abstract Algebra. Hoboken: Wiley.+

T3. Gallian, J. A.(2013). Contemporary Abstract Algebra, New Age International.

REFERENCE BOOKS:

R1. Hungerford, T. W., Algebra. (1974). Springer-Verlag. New York.

R2. Bhattacharya, P. B., Jain, S. K., Nagpaul, S. R. (1994). Basic Abstract Algebra. Cambridge University Press.

OTHER LEARNING RESOURCES:

1. www.algebra.com

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Define group, subgroups, normal subgroups including properties and related results.	**1,3**
2	Define class equation of group, Sylow's theorems and their applications.	**1, 4**
3	Define series of groups and its related results.	**1,3,4**
4	Describe ring structure along with properties and its related results.	**1, 2, 7**
5	Describe the classes of Ring structures, viz., the Principal ideal Domain, Euclidean domain and the unique factorization domain.	**1, 8.**

SEMESTER – I									
Course Title	**Real Analysis**								
Course code	**24MSMT1103R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**3**	**1**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Convergence of sequence and series**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Mathematics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To understand Real Number System and its properties. Also describe R as a metric space and identify its special metric properties. 2. To analyze the properties of advanced differentiation and Integration of real valued functions in one or multiple variables. 3. To understand the difference between convergence and uniform convergence. 4. To know the nature of convergence in terms of series of function. 5. To know the concept of R-S integral and the difference between Riemann and R-S integral.								
CO1	Describe Real Number System, its properties including metric space.								
CO2	Analyze the properties of advanced differentiation and Integration of real valued functions in one or multiple variables.								
CO3	Explore the difference between convergence and uniform convergence including the methods of convergence, absolute convergence in terms of sequence of functions.								
CO4	Describe the nature of convergence in terms of series of function.								
CO5	Describe the concept of R-S integral and the difference between Riemann and R-S integral.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Preliminaries, Countable and uncountable sets, Real number system, Archimedean property, Convergence of sequence, Continuity and Uniform continuity, Metric spaces, Compactness, Connectedness, Bolzano- weierstrass theorem, Heine-Borel theorem.	**15**	Able to understand Real Number System and its properties. Also describe R as a metric space and identify its special metric properties.	1,2
II	Function of several variables, Continuity, Directional derivatives, total derivatives, Jacobian matrix, Mean value theorem for differentiable function, maxima and minima.	**10**	Able to analyze the properties of advanced differentiation and Integration of real valued functions in one or multiple variables.	1,2
III	Sequence of functions, Pointwise and uniform convergence, absolute convergence, test of convergence, functions of bounded variation.	**10**	Able to understand the difference between convergence and uniform convergence.	1,2
IV	Series of functions, test of convergence in terms of series of functions.	**10**	Able to know the nature of convergence in terms of series of function.	1,2
V	Riemann-Stieltjes integrals, The R-S integral as a limit of sum, Classes of R-S integral functions, Algebra of R-S integrable functions, Relation between Riemann and Riemann-Stieltjes integral.	**15**	Able to understand R-S integral and knowing the difference between Riemann and R-S integral.	1,2

TEXT BOOKS:

T1. Upadhyay. Biophysical chemistry: principle and technique. 12th edition. Himalaya Publishing House Pvt. Ltd; 2017.

REFERENCE BOOKS:

R1. Kakkar. Atomic and Molecular Spectroscopy. 1st edition. Cambridge English; 2017.

R2. Evans. Handbook of Chromatography. 2nd Edition, Willford Press; 2019.

R3. Holme and Peck. Analytical biochemistry. 3rd edition. Longman, 1983.

OTHER LEARNING RESOURCES:

https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/chromatography

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss Chromatography techniques including history, classification, principles, operation, analysis and application.	**1, 3, 4**
2	Define Centrifugation techniques, classification, principles, operation and its application.	**1, 3**
3	Explain and investigate Electrophoresis, its categorization, underlying principle, operational methods, pH meter functionality, dialysis, and blotting methodologies.	**1,3, 4**
4	Discuss radioisotope dating principles, including detection, measurement, isotopes, radiation, units and decay.	**1, 3, 4**
5	Develop the comprehensive understanding of principles, and practical application skills in various spectroscopic methods for scientific analysis.	**1, 3, 4**

SEMESTER – I									
Course Title	**Numerical Methods for Interdisciplinary Sciences**								
Course code	**24UMNM1102R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Mathematics**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course Objectives	1. To study basic statistical concepts, errors and finite difference. 2. To develop and use problem solving skills through the use of various numerical methods in solving system of linear equations. 3. To learn various numerical methods in solving scientific problems. 4. To discuss various issues in numerical techniques such as convergence and stability using various methods. 5. To learn how to fit polynomial and exponential function to a given set of data.								
CO1	Describe the basic concepts of statistics, finite difference, errors and operators.								
CO2	Master the solving skills of system of linear equations using numerical methods.								
CO3	Utilize integral methods to solve the problems related to science and engineering.								
CO4	Explore various issues in numerical techniques such as convergence and stability.								
CO5	Analyze graphical representation of functions using general least square method.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	**Floating point representation and errors:** Definition and sources of errors, stability and accuracy, brief review of finite difference, various operators and its properties.	**7**	Introduce with basic statistical concepts, errors and finite difference.	1,2
II	**Solution of system of linear equations:** Successive approximation by Gauss Jacobi, Gauss Seidel's Methods, Convergence of successive approximations.	**10**	Able to analyze various numerical methods in solving system of equations.	1,2
III	**Numerical Integration:** General Newton's quadrature formula, Weddle's rule, Newton-Cotes formula, Gaussian quadrature.	**10**	Able to analyze various numerical methods in solving scientific problem.	1,2
IV	**Solution of Ordinary Differential Equations:** Stability and Convergence of numerical methods, Picard method, Euler method, backward Euler method, modified Euler method, Runge-Kutta class of methods.	**8**	Discuss various issues in a numerical techniques such as convergence and stability using various methods.	1,2
V	**Curve fitting:** General Least square method, Normal equations, Fitting of a polynomial (second and third degree), Fitting of exponential curves, Chebyshev polynomials.	**10**	Able to fit polynomial and exponential function to a given set of data.	1,2

TEXT BOOKS:

T1. Kincaid, D., Cheney, W. (2002). Numerical Analysis: Mathematics of Scientific Computing. AMS.

T2. Atkinson, K., Han, W. (2003). Elementary Numerical Analysis, John Wiley & Sons

REFERENCE BOOKS:

R1. Conte, S.D. (1980). Elementary Numerical Analysis: Algorithmic approach. Tata McGraw Hills

R2. Madhumangal, P. (2009). Numerical Analysis for Scientist and Engineers. Narosa Pub. House.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the basic concepts of statistics, finite difference, errors and operators.	**1, 4**
2	Master the solving skills of system of linear equations using numerical methods.	**1, 4**
3	Utilize integral methods to solve the problems related to science and engineering.	**1, 4**
4	Explore various issues in numerical techniques such as convergence and stability.	**1, 4**
5	Analyze graphical representation of functions using general least square method.	**1, 4, 7.**

<table>
<tr><th colspan="10">SEMESTER – I</th></tr>
<tr><th>Course Title</th><th colspan="9">EFFECTIVE COMMUNICATION</th></tr>
<tr><th rowspan="2">Course code</th><th rowspan="2">24UMPD1101R</th><th rowspan="2">Total credits: 2
Total hours: 60P</th><th>L</th><th>T</th><th>P</th><th>S</th><th>R</th><th>O/F</th><th>C</th></tr>
<tr><td>0</td><td>0</td><td>4</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><th>Pre-requisite</th><td>Nil</td><td>Co-requisite</td><td colspan="7">Nil</td></tr>
<tr><th>Programmes</th><td colspan="9">Master of Science in Biotechnology</td></tr>
<tr><th>Semester</th><td colspan="9">Fall/I Semester of First Year of the Programme</td></tr>
<tr><th>Course objectives</th><td colspan="9">1. To introduce the types of sentences and their significance.
2. To strengthen the students' vocabulary to enhance their speaking and writing skills.
3. To familiarize the students with the importance of dress codes in various organizations.
4. Tointroducethe3P’s (Planning, prioritizing & performing) of Time Management.
5. To give insight into English pronunciation and into central concepts in phonetics.</td></tr>
<tr><th>CO1</th><td colspan="9">Analyse and identify the different types of sentences.</td></tr>
<tr><th>CO2</th><td colspan="9">Able to integrate the skills of reading and speaking in professional communication.</td></tr>
<tr><th>CO3</th><td colspan="9">Illustrate code Etiquette sessions will boost their confidence and morals.</td></tr>
<tr><th>CO4</th><td colspan="9">Describe about the effective and efficient utilization of time.</td></tr>
<tr><th>CO5</th><td colspan="9">Explain the concept of Phonetics and its importance will improve the learners ‘pronunciation</td></tr>
<tr><th>MODULES</th><td colspan="9">Module 1- Grammar
Interchange of Interrogative and Assertive Sentences, Exclamatory and Assertive Sentences, Types of Tenses, Common Errors, Synonyms, Antonyms, Homonyms
Module 2- Reading Skills
Techniques of Effective Reading, gathering ideas and information from a text The SQ3R Technique Interpret the text
Module 3-Listening Skills
What is listening? The Process of Listening, Factors that adversely affect Listening, Difference between Listening and Hearing, Purpose and Importance of Effective Listening, How to Improve Listening Process,
Module 4- Conflict Management
Definition, Type of Conflict Management, Effects of Conflict Management, Methods to deal with Conflicts (Negative)
Module 5- Time-Management Skills
Introduction To Time Management, Purpose and Importance of Time Management, Basic Tips to Maintain Time.
Activity: Problem solving activity: A situation will be given to the students and they will have to tell us how to handle the situation or solve the problem.</td></tr>
</table>

TEXTBOOKS:

T1. Wren, P.C and Martin, H. 1995. High School English Grammar and Composition, S Chand Publishing.

T2. English Grammar in Use, Raymond Murphy 4th edition, CUP.

T3. Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.

REFERENCE BOOKS:

R1. English Vocabulary in Use (Advanced), Michael McCarthy and Felicity, CUP.

R2. Effective Communication and Soft Skills, Nitin Bhatnagar, Pearsons.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Analyse and identify the different types of sentences.	**1, 5**
2	Able to integrate the skills of reading and speaking in professional communication.	**1, 5, 9**
3	Illustrate code Etiquette sessions will boost their confidence and morals.	**5, 6, 9**
4	Describe about the effective and efficient utilization of time.	**5, 9**
5	Explain the concept of Phonetics and its importance will improve the learners 'pronunciation	**1, 5, 9**

SEMESTER – II										
Course Title	**Partial Differential equation**									
Course code	**24MSMT1201R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
		Total hours: 60T	**3**	**1**	**0**	**0**	**0**	**0**	**4**	
Pre-requisite	**Nil**	**Co-requisite**	**Nil**							
Programmes	**Master of Science in Microbiology**									
Semester	**Spring/II Semester of First Year of the Programme**									
Course objectives	1. To induce with partial differential equation and able to solve first order linear and non-linear PDE. 2. To study higher order linear PDE with constant coefficients and it's solution. 3. To understand the classification of second order PDE, characteristic curve etc. 4. To find the solution of Laplace's equation, wave equation, diffusion equation by separation of variable. 5. To study wave equation, heat equation in terms of Green's function.									
CO1	Describe PDE and solution of first order linear and non-linear PDE.									
CO2	Describe the solving skill of linear PDE with constant coefficient.									
CO3	Explore the classification of second order PDE, characteristic curve etc.									
CO4	Solve Laplace's equation, wave equation and diffusion equation by separation of variable.									
CO5	Describe wave equation, heat equation in terms of Green's function.									

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Basics of partial differential equations, Linear and nonlinear partial differential equation of the first order. Cauchy's method of characteristics, Compatible systems of first order equations, Charpit's and Jacobi's method.	**15**	Able to solve first order linear and non-linear PDE.	1,2
II	Linear PDE with constant coefficients, reducible and irreducible equations. Different methods of solution.	**10**	Able to solve higher order linear PDE with constant coefficient.	1,2
III	Second order PDE with variable coefficients, classification of second order PDE, Characteristic curves of second order PDE, Reduction to canonical forms. Solutions of PDE of second order by the method of separation of variables.	**10**	Able to identify the types of second order PDE.	1,2
IV	Laplace equation, Boundary value problem, solution of Laplace equation by separation of variable, Wave equation, Elementary solutions of the one-dimensional Wave equation, Solution of the Wave equation by separation of variables Diffusion equation, Elementary solutions of the Diffusion equation, Solution of the Diffusion equation by separation of variables.	**15**	Able to understand Laplace's equation, wave equation, diffusion equation and solve by separation of variable.	1,2
V	Green's function, Green's function for Laplace's equation, wave equation and Diffusion equation.	**10**	Able to understand wave equation, heat equation in terms of Green's function.	1,2

TEXTBOOKS

T1. Sneddon, I. N. (2006), Elements of Partial Differential Equations, Dover Publications, Inc.

T2. Rao, K. S. (2010), Introduction to Partial Differential Equations, PHI Learning Pvt.Ltd..

REFERENCE BOOKS

R1. Raisinghania, M. D. (2010) , Advanced Differential Equations,18th Edition, S Chand,

R2. Bhamra, K. S. (2010), Partial Differential Equations, PHI Learning Pvt. Ltd.

OTHER LEARNING RESOURCES:

1. http://mathforum.org
2. http://ocw.mit.edu/ocwweb/Mathematics
3. http://www.opensource.org

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe PDE and solution of first order linear and non-linear PDE.	**1, 2**
2	Describe the solving skill of linear PDE with constant coefficient.	**1, 3, 4**
3	Explore the classification of second order PDE, characteristic curve etc.	**1, 2, 3, 4**
4	Solve Laplace's equation, wave equation and diffusion equation by separation of variable.	**1, 2, 4**
5	Describe wave equation, heat equation in terms of Green's function.	**1, 2, 3, 4**

SEMESTER – II									
Course Title	**Linear Algebra**								
Course code	**24MSMT1202R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**3**	**1**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Mathematics**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course objectives	1. Introduction to vector space, basis and dimension etc. 2. To study of linear transformation, representation of linear transformation by matrices, rank nullity theorem. 3. To know Eigen value, Eigen vectors, diagonalization, invariant subspace. 4. To understand diagonal form, Jordan and rational canonical form. 5. To study inner product space, orthogonality, orthonormal etc.								
CO1	Define vector space, linear dependence and independence of set, basis and dimension.								
CO2	Define linear transformation, representation of linear transformation by matrices, rank nullity theorem.								
CO3	Explore problem solving techniques like finding Eigen value, Eigen vectors, linear dependence, independence, rank and nullity etc.								
CO4	Describe diagonal form, Jordan and rational canonical form.								
CO5	Define inner product space along with linear functionals and different kinds of operators.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Vector spaces, sub spaces, linearly independent set, Basis and dimension, sums and direct sums.	**15**	Able to know vector space, linear dependence and independence of set, basis and dimension.	1,2
II	Linear transformation and Operator, rank and nullity theorem, matrix representation of linear transformation, Annihilating polynomial of a linear transformation.	**10**	Able to know the linear transformation, representation of linear transformation by matrices, rank nullity theorem.	1, 2
III	Eigen values and eigenvectors, invariant subspaces, polynomials apples to operators, Elementary Canonical forms: diagonalization and triangulation of linear operators.	**10**	Able to know Eigen value, Eigen vectors, diagonalization, invariant subspace	1, 2
IV	Decomposition of an operator, Jordan and rational canonical form.	**10**	Able to understand diagonal form, Jordan and rational canonical form.	1, 2
V	Inner products, norms, orthogonal bases, linear functional and adjoints, self-adjoint and normal operators, spectral theorem, normal operators on real inner product spaces, positive operators, Isometries.	**15**	Able to Study inner product space, orthogonality, orthonormal set, linear functionals and different kinds of operators.	1, 2

TEXTBOOKS:

T1. Strang, G. (2005). Linear Algebra and its Applications. Cengage Learning.

T2. Saikia, P. K. (2014). Linear Algebra. Pearson Education India.

REFERENCE BOOKS:

R1. Artin, M. (2015). Algebra. Pearson Ed. India.

R2.Axler. S. (1997). Linear Algebra Done Right. Springer.

OTHER LEARNING RESOURCES:

1. MIT OCW 18.06SC: Linear Algebra by Gilbert Strang.http://ocw.mit.edu./

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Define vector space, linear dependence and independence of set, basis and dimension.	**1, 6**
2	Define linear transformation, representation of linear transformation by matrices, rank nullity theorem.	**1, 2, 3, 4, 6**
3	Explore problem solving techniques like finding Eigen value, Eigen vectors, linear dependence, independence, rank and nullity etc.	**1, 2, 3, 4, 6, 8**
4	Describe diagonal form, Jordan and rational canonical form.	**1, 4, 8**
5	Define inner product space along with linear functionals and different kinds of operators.	**1, 2, 7, 8**

SEMESTER – II									
Course Title	**Complex Analysis**								
Course code	**23MSMT1201R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**3**	**1**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Mathematics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To understand the concepts of limit, continuity, derivability of a complex variable function together with the knowledge of analytic function, harmonic function, exponential and logarithmic function, trigonometric, hyperbolic and inverse trigonometric functions. 2. To learn the basic properties of complex integration and the various theorems related to it viz., Cauchy's theorem, Morera's theorem etc. 3. To have the knowledge of convergence of sequence, series and uniqueness of series representation. 4. To understand the residue theorem, residue at a finite point, residues at the point at infinity, Rouche's theorem etc. 5. To understand the concept of conformal mappings and problems related to it.								
CO1	Describe the concept of limit, continuity, derivability of a complex variable function.								
CO2	Explore the basic properties of complex integration and theorems related to it.								
CO3	Describe the concept of convergence of sequence, series and uniqueness of series representation.								
CO4	Describe the residue theorem, residue at a finite point, residues at the point at infinity etc.								
CO5	Describe the concept of conformal mappings and problems related to it.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Functions of Complex variables, Mappings by exponential functions, limits, continuity, derivative, Cauchy-Riemann equations, Analytic functions, Harmonic functions, Reflection principles, the exponential functions, logarithmic function, branches and derivatives of logarithm, complex exponents, trigonometric functions, hyperbolic functions, inverse trigonometric functions.	**15**	Students will be able to understand the concept of limit, continuity, derivability, analytic functions etc.	1, 2
II	Basic properties of Complex Integration, Cauchy's theorem, Morera's theorem, Cauchy Integral formula, Laurent's series, The Maximum modulus principle, Schwarz lemma, Liouville's theorem.	**10**	Students will learn the properties of complex integration, some theorems and related to it.	1, 2
III	Convergence of sequences, convergence of series, Taylor series, Laurent Series, Absolute and uniform convergence of power series, Uniqueness of series representation.	**10**	Students will have the knowledge of sequences, convergence of series, etc.	1, 2, 3

IV	Residue at a finite point, residue at the point at infinity, residue theorem, number of zeros and poles, argument principle, Rouche's theorem, evaluation of integrals, application of residues, Jordan's lemma, Indented paths.	**10**	Students will have the knowledge of residues and its related concepts.	1, 2, 3
V	Linear transformation, linear fractional transformation, mappings of upper half plane, the transformation w=sin z; mappings of z^2 and branches of $z^{1/2}$, square roots of polynomials, preservation of angles, scale factor, local inverses, harmonic conjugates, transformation of harmonic functions, applications.	**15**	Students will be able to understand the concept of conformal mappings.	1, 2

TEXTBOOKS:

T1. Brown, J. W., Churchill, R.V. (2009), Complex variables and applications, Boston: McGraw-Hill Higher Education.

T2. Agarwal, R. P., Perera, K. Ans Pinelas, S., An Introduction To Complex Analysis, Springer-Verla's, 2011.

T3. Narasimhan, R., Complex Analysis in one variable, Birkhauser, Boston, 1984.

REFERENCE BOOKS:

R1. Karunakaran, V. (2005), Complex Analysis, Alpha Science Int'l Ltd.

R2. Rubin, W. (2006), Real and Complex analysis, Tata McGraw-Hill Education.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the concept of limit, continuity, derivability of a complex variable function.	**1, 6**
2	Explore the basic properties of complex integration and theorems related to it.	**1, 3, 4, 7**
3	Describe the concept of convergence of sequence, series and uniqueness of series representation.	**1, 3, 4, 6, 8**
4	Describe the residue theorem, residue at a finite point, residues at the point at infinity etc.	**1, 2, 3, 4, 8**
5	Describe the concept of conformal mappings and problems related to it.	**1, 2, 3, 4, 8.**

SEMESTER – II									
Course Title	**Research Methodology and Statistical Analysis**								
Course code	**24MSMT2105R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T+15P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Mathematics**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course objectives	1. The course aims to enhance the students' a broad understanding of research methodology, including theory of science and qualitative and quantitative methods in research. 2. The course seeks to enhance the students' skills for developing critical thinking through research literature review in different domain. Consequently, it aims to develop skills for preparation of a research proposal for a master'the sis project/Mini research. 3. To develop Students competency in planning, conducting, evaluating and presenting a research project.								
CO1	Students will have basic knowledge of Research methods.								
CO2	Students will gain the knowledge of Research Methodology.								
CO3	Students will be able to gain the Skill questionnaire development.								
CO4	Students will be able to acquire the knowledge of basic Report/dissertation Procedure.								
CO5	Students will acquire knowledge of various aspects of IPR, including patents, trademarks, copyrights, industrial designs, traditional knowledge and geographical indications.								

Unit-No.	**Content**
I	Research Methodology- An Introduction- meaning and objectives of research, motivation in research, typesandsignificanceofresearch,criteriaofgoodresearch.DefiningtheResearchProblems-definitionofresearchproblem, necessity of defining research problem
II	Research Design- meaning and need of research design, features of a good design, different research designs, Sampling Design- steps in sampling design, Sample Size determination, criteria for selecting a sampling design, different types of sampling design, Experimental Design, Principles of Design of Experiment, One –way ANOVA, Two-Way ANOVA, CRD,RBD, LSD, 22,23Factorial Design
III	Types of data, sources of data collection, tools of data collection, Nominal, ordinal, interval and ratio –Attitude scale construction and measurement, rating scales, semantic differential (SD),Use of scale in statistical analysis, Schedules for interviews preparation and standardization, development of survey instruments and item analysis for the questionnaire.
IV	Planning and organizing research report, Format of research report, Different steps of writing report, Layout of there search report, how to organizethesis /Dissertation, mechanics of writing research report, standard methods of quoting- presenting the result, written and oral reports, Uses of abstract, format of research report, presentation of statistics - tabular and graphic references and uses of references, Bibliography and presentation of bibliography.
V	Intellectual property right (IPR), Introduction and the need for IPR, IPR in India and worldwide, Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications, Patentable and non-patentable, patenting life, Filing of a patent application, The different layers of the international patent system, Case studies on Basmatirice, Turmeric, and Neem patents

Laboratory	Laboratory using R Software: 1. Analysis of One way ANOVA; 2. Analysis of Two way ANOVA; 3. Analysis of CRD 4.Analysis of RBD 5. Analysis of 22 and 23 Factorial Experiment 6. Simulation-using R (Bernoulli, Binomial, Poisson and Geometric distribution.). 7. 7 Simulation-II using R (Exponential and Normal distribution). 8 Simple random Sampling/ Stratified Random Sampling

SEMESTER – III									
Course Title	**Computer programming C+**								
Course code	**24MSMT2101R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T+15P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Mathematics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To provide an overview of C, various operators, loops and statements. 2. To learn the basic ideas and properties of arrays, data types and searching and sorting. 3. To know various functions in C and analyze their arguments. 4. To analyze the idea of pointers, their expressions, array of pointers. 5. To learn operations on files in C and types, concepts, creation of a linked list.								
CO1	Explore C, its operators, loops and statements.								
CO2	Describe the idea and properties of arrays, data types searching and sorting.								
CO3	Define functions in C and analyze their arguments.								
CO4	Describe the concept of pointers, their expressions, array of pointers.								
CO5	Describe operations on files in C and types, concepts, creation of a linked list.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Revision of fundamentals of C: Data types in C, variables in C, input output statements, constant declaration, arithmetic operators in C, arithmetic expressions, assignment statements, arithmetic assignment operators, increment and decrement operators, type conversions, operator precedence. for loop, while loop, do…while loop, if statement, if…else statement, switch statement, conditional operators. The break statement, the continue statement, the go-to statement.	**7**	Introduce with basic concepts of C, various operators, loops and statements.	1,2
II	Arrays: Arrays, declaration of one-dimensional arrays, two dimensional arrays. Structures and Unions: User defined data types, structures, array of structures, unions, enumerated data type. Searching and Sorting: Bubble sort, selection sort, insertion sort, linear search and binary search.	**7**	Able to learn the basic ideas and properties of arrays, data types and searching and sorting.	1,2
III	Function in C: Simple functions, passing arguments to functions with return value, call by value, call by reference, overloaded functions, inline functions, default arguments.	**6**	Able to learn various functions in C and their arguments.	1,2
IV	Pointers: Introduction; accessing address of a variable; pointer declaration, initialization, accessing variable through pointer, chain of pointers; pointer expressions,	**5**	Able to know the idea of pointers, their expressions, array of pointers.	1,2

	increment and scale factor. Pointers and Arrays. Array of pointers. Pointers as function arguments			
V	Files in C: Defining and opening a file, closing a file. Input/Output operations on files. Dynamic Memory Allocation and Linked list: Dynamic memory allocation, Malloc, Calloc, Free, Realloc. Concepts of linked list, advantages of linked list, types of linked list. Creating a linked list.	**5**	Able to learn operations on files in C and types, concepts, creation of a linked list.	1,2
Practical	(i) C-Programming (ii) Mathematica (iii) Latex	**30**	Able to solve various mathematical problems using Mathematica	1, 2, 3

TEXTBOOKS

T1. Rajaraman, V. Fundamentals of Computers (Prentice Hall of India, New Delhi, 2002).

T2. Balaguruswamy, E. Programming in ANSI C (Tata McGraw-Hill, 2004).

REFERENCE BOOKS

R1. Kanetkar, Y. P. Let us C (BPB Publication, 2001).

R2. Venkateshmurthy, M. G. Programming Techniques through C (Pearson Education, 2002).

OTHER LEARNING RESOURCES:

1.https://www.w3schools.com

2.https://edu.gcfglobal.org

3.https://www.tutorialspoint.com

4.https://www.javatpoint.com

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explore C, its operators, loops and statements.	**1**
2	Describe the idea and properties of arrays, data types searching and sorting.	**1, 3**
3	Define functions in C and analyze their arguments.	**5**
4	Describe the concept of pointers, their expressions, array of pointers.	**2, 5**
5	Describe operations on files in C and types, concepts, creation of a linked list.	**2, 5**

SEMESTER – III									
Course Title	**RESEARCH PROJECT I (RESEARCH/ INDUSTRY INTERNSHIP)**								
Course code	**24MSMT2105R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours:	**2**	**1**	**0**	**4**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Mathematics**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course Objectives	1. To learn the principles of designing effective surveys, including question formulation and sampling techniques. 2. To gain hands-on experience in designing and conducting research experiments to test hypotheses								
CO1	Formulate research methodology								
CO2	Prepare research tool(s)								
CO3	Apply the knowledge of sampling methods in sample collection.								
CO4	Design experiment using scientific method								
CO5	Investigate the research Problem								

SEMESTER – III									
Course Title	**Topology**								
Course code	**24MSMT2106R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Mathematics**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course Objectives	8. To provide an overview of basic topological concepts. 9. To prove results of classical analysis in a more general setting. 10. To describe relationship of continuity with connectedness. 11. To describe relationship of continuity with connectedness. 12. To describe relationship of continuity with Separation axioms.								
CO1	Describe the basic topological concepts.								
CO2	Explore the results of classical analysis in a more general setting.								
CO3	Analyze relationship of continuity with connectedness.								
CO4	Describe relationship of continuity with compactness.								
CO5	Explain relationship of continuity with Separation axioms.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Basic concepts of topology, Metric topology, Product and Box topology, order topology, quotient spaces.	**15**	Introduction with basic topological concepts.	1,2
II	Countability axioms, first countable spaces, second countable spaces, separable spaces, Lindelöf spaces.	**10**	Prove results of classical analysis in a more general setting	1,2
III	Compactness, limit point compactness, local compactness, one-point compactification. Tychonoff's product theorem, Baire spaces, Baire category theorem.	**10**	Able to obtain relationship of continuity with compactness	1,2
IV	Connectedness, Local connectedness, Path connectedness, Components, Products of connected spaces.	**10**	Able to obtain relationship of continuity with connectedness,	1,2
V	Separation axioms, Hausdorff, regular and Normal spaces, Urysohn'scharaterization of normality, Urysohn'smetrzation theorem, Tietze's extension theorem , Completely regular spaces.	**15**	Able to obtain relationship of continuity with Separation axioms	1,2

TEXTBOOKS

T1. Munkres, J. (2015). Topology, Pearson.

T2. Simmons, G. F., Hammitt, J. K. (2017). Introduction to topology and modern analysis. New York: McGraw-Hill.

REFERENCE BOOKS

R1. Lipschutz ines. New York: McGraw-Hill.

R2. Kelley, J. L. (1975). General Topology. Springer.

OTHER LEARNING RESOURCES

1. http://mathforum.org
2. http://ocw.mit.edu/ocwweb/Mathematics

3. http://www.opensource.org

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the basic topological concepts.	**1, 4, 9**
2	Explore the results of classical analysis in a more general setting.	**1, 4, 5**
3	Analyze relationship of continuity with connectedness.	**1, 4, 5**
4	Describe relationship of continuity with compactness.	**1, 4**
5	Explain relationship of continuity with Separation axioms.	**1, 3, 4**

SEMESTER-III										
Course Title	**Mechanics and Tensor**									
Course code	**24MSMT2107R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Mathematics**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	1. To introduce with motion of three dimension in cylindrical and polar co-ordinate form. 2. To understand about motion of a rigid body and its related results. 3. To understand generalized co-ordinate, Lagrange's equation of motion in different dynamical system 4. To know tensors and its operations. 5. To know Covariant derivatives of tensors and its generalizations.									
CO1	Describe three-dimensional motion in cylindrical and polar co-ordinate form.									
CO2	Explain motion of a rigid body and its related results.									
CO3	Describe generalized co-ordinate, Lagrange's equation of motion in different dynamical system.									
CO4	Explore tensors and its operations.									
CO5	Define Covariant derivatives of tensors and its generalizations.									

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Motion in three dimensions, velocity and acceleration in cylindrical and spherical polar Coordinates, motion of cylindrical, spherical and conical surfaces	**10**	Introduce with three-dimensionalmotion in cylindrical and polar co-ordinate form	1,2
II	Motion of a rigid body under impulsive motions, Carnot's theorem, Kelvin's theorem and Bertrands theorem, motion of a rigid body about a fixed point, Euler Geometrical and Dynamical systems, motion under external forces.	**10**	Knowledge about motion of a rigid body and its related results.	1,2
III	Generalized coordinates, Lagrange's equation of motion for finite and impulsive forcesin holonomic systems, Case of conservative forces and theory of small oscillation	**10**	Knowledge of generalized co-ordinate, Lagrange's equation of motion in different dynamical system	1,2
IV	Transformation laws of covariant and contravariant tensors, Mixed tensor, Rank oftensors, symmetric and anti-symmetric tensors and related theorems, Algebraic operations on tensors, contraction, Inner and outer product of tensors, Quotient law, group property of tensors, Christoffel's brackets of 1st first and second kinds, their properties, Riemannian metric Definitions of metric tensors, Transformation laws of Christoffel brackets.	**7**	Able to know tensors and its operations	1,2

V	Covariant derivatives of tensors A_i, A^i, A_{ij}, $A^{ij}$and A^i_j, Generalizations, Covariantderivatives of . metric tensors and scalar invariant function, Application in problems. Angle between two vectors, Curl, grad, divergence of vectors.	**8**	Able to know Covariant derivatives of tensors and its generalizations	1,2

TEXTBOOKS:

T1. An introduction to Riemannian Geometry and Tensor Calculus, Cambridge University Press.

REFERENCEBOOKS:

R1. Riemannian Geometry, Princeton University Press (1949) LP Eisenhart

R2. Tensor Calculus and Riemannian Geometry – D C Agarwal, Krishna Prakasahan Media (P) Ltd.

R3. Dynamics, Part II, A. S. Ramsey, Cambridge University Press

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe three dimensional motion in cylindrical and polar co-ordinate form.	**1, 2, 4**
2	Explain motion of a rigid body and its related results.	**1, 2, 3, 4, 8**
3	Describe generalized co-ordinate, Lagrange's equation of motion in different dynamical system.	**1, 2, 3, 4, 7**
4	Explore tensors and its operations.	**1, 2, 3, 4, 7**
5	Define Covariant derivatives of tensors and its generalizations.	**1, 2, 3, 4, 8.**

SEMESTER-III									
Course Title	**Functional Analysis**								
Course code	**24MSMT2108R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Mathematics**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	1. To understand the classical Banach space, L^p spaces, Holder's inequality, Minkowski's inequality; convergence and completeness; Riesz-Fischer theorem, bounded linear functional on L^p spaces, Riesz representation theorem. 2. To learn General Banach spaces, continuous linear transformations between normed linear spaces; Hahn-Banach theorem and its consequences. 3. To understand embedding of a normed linear space, strong and weak topologies, open mapping theorem, uniform boundedness theorem etc. 4. To learn about Hilbert's spaces and its properties, Bessel's inequalities, Gram-Schmidt orthogonalization process. 5. To understand normal and unitary operators, projections, spectrum of an operator, spectral theorem for a normal operator on a finite dimensional Hilbert space.								
CO1	Describe the concept of classical Banach spaces and its related results, L^p spaces along with inequalities.								
CO2	Define General Banach spaces, Hahn-Banach theorem and its consequences.								
CO3	Describe embedding of a normed linear space, strong and weak topologies and open mapping theorem.								
CO4	Describe Hilbert's spaces and its properties, Bessel's inequalities, and Gram-Schmidt orhtogonalization process.								
CO5	Define normal and unitary operators, projections, spectrum of an operator etc.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Classical Banach spaces, L^p spaces; Holder's inequality, Minkowski's inequality; convergence and completeness; Riesz-Fischer theorem, bounded linear functional on L^p spaces, Riesz representation theorem.	**10**	Students will learn about classical Banch spaces, Holder's inequality, minkowski's inequality.	1,2
II	General Banach spaces-definition and examples; continuous linear transformations between normed linear spaces; Hahn-Banach theorem and its consequences.	**10**	Students will have understanding of General Banach spaces, continuous linear transformations between normed linear spaces.	1, 2
III	Embedding of a normed linear space in its second conjugate space; strong and weak topologies; open mapping theorem; closed graph theorem; uniform boundedness theorem; conjugate of an operator	**15**	Students will learn boast theembedding of a normed linear space, weak and strong topologies, open mapping theorem.	1, 2, 3
IV	Hilbert's spaces, examples and simple properties, orthogonal complements, orthonormal set, Bessel's inequalities, complete orthonormal sets, Gram-Schmidt orthogonalization process, self adjoint operators.	**10**	Students will learn about the basic s of Hilbert's spaces, examples and properties, complete orthonormalisation sets, Gram Schmidt orthogonalization process.	1, 2
V	Normal and unitary operators, projections,	**15**	Students will have	1,

	spectrum of an operator, spectral theorem for a normal operator on a finite dimensional Hilbert space.		understanding of normal and unitary operators, projections, spectrum of an operator, spectral theorem on a finite dimensional Hilbert space.	2, 3

TEXTBOOKS:

T1. Kreyszig, E. (1978), Introductory functional analysis with applications, New York: Wiley.
T2. Choudhury, B., Nanda, S. (1989), Functional analysis with applications, Wiley.
T3. Limaye, B. V. (2014), Functional Analysis, New Age International Pvt. Ltd.

REFERENCEBOOKS:

R1. Ponnusamy, S. (2002), Foundations of functional analysis, CRC Press.
R2. Jain, P. K., Ahuja, O.P., Ahmed, K. (1995), Functional Analysis, New Age International Pvt. Ltd.**R3**. Dynamics, Part II, A. S. Ramsey, Cambridge University Press.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the concept of classical Banach spaces and its related results, L^p spaces along with inequalities.	**1, 2, 4**
2	Define General Banach spaces, Hahn-Banach theorem and its consequences.	**1, 2, 3, 4, 8**
3	Describe embedding of a normed linear space, strong and weak topologies and open mapping theorem.	**1, 2, 3, 4, 7**
4	Describe Hilbert's spaces and its properties, Bessel's inequalities, and Gram-Schmidt orhtogonalization process.	**1, 2, 3, 4, 8**
5	Define normal and unitary operators, projections, spectrum of an operator etc.	**1, 2, 3, 4, 6**

SEMESTER-III									
Course Title	**Number Theory**								
Course code	**24MSMT2109R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Mathematics**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	1. To understand Euclidean algorithm, Fermat's theorem, Euler's Theorem, Wilson's theorem. 2. To learn congruence module, primitive roots, quadratic residues, Legendre symbol, Quadratic Reciprocity Law. 3. To understand greatest integer function, arithmetic functions, Mobius inversion formula, Fibonacci numbers and their properties. 4. To understand Diophantine equations, properties of Pythagorean triples, sums of two, four and five squares. 5. To learn simple continued fractions, finite and infinite continued fractions, Herwitz's theorem, Pell's equation.								
CO1	Describe Euclidean algorithm, Fermat's theorem, Euler's theorem, Wilson's theorem and solve problems related to these.								
CO2	Define congruence modulo, primitive roots, quadratic residues and describe their properties.								
CO3	Explore the greatest integer function, arithmetic function, multiplicative function and their properties.								
CO4	Describe Diophantine equations, properties of Pythagorean triples, sums of two, four and five squares.								
CO5	Describe simple continued fractions, finite and infinite continued fractions and solve problems related to it.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Divisibility; Euclidean algorithm; primes; congruences; Fermat's theorem; Euler's theorem and Wilson's Theorem; Fermat's quotients and their elementary consequences; solutions of congruences; Chinese remainder theorem; Euler's phi-function.	**10**	Students will learn about Euclidean algorithm, Fermat's theorem, Euler's theorem, Wilson's theorem.	1,2
II	Congruences modulo, powers of prime; power residues, primitive roots and their existence; quadratic residues; Legendre symbol, Gauss' Lemma about Legendre symbol; Quadratic reciprocity law; proofs of various formulations.	**15**	Students will learn about congruence modulo, powers of prime, quadratic residues, Legendre symbol etc.	1, 2
III	Greatest integer function; arithmetic functions, multiplicative arithmetic functions (elementary ones); Mobius inversion formula; convulation of arithmetic functions. Group properties of arithmetic functions; recurrence functions; Fibonacci numbers and their properties.	**10**	Students will have knowledge about the greatest integer function, arithmetic function and will be able to solve problems related to it.	1, 2, 3
IV	Diophantine equations-solutions of $ax+by=c$, $x^2+y^2=z^2$; properties of Pythagorean triples; sums of two, four and five squares; assorted examples of Diophantine equations.	**10**	Students will have understanding of Diophantine equations, Pythagorean triples, sums of two, four and five squares and problems associated with it.	1, 2
V	Simple continued fractions, finite and infinite continued fractions, uniqueness,	**15**	Students will have the understanding of simple	1, 2,

	representation of rational and irrational numbers as simple continued fraction, rational approximation to irrational numbers, Herwitz theorem, basic facts of periodiccontinued fractions and their illustrations, Pell's equation.		continued fractions, finite and infinite continued fractions, Herwitz theorem, Pell's equation.	3

TEXTBOOKS:

T1. Burton, D. M., Elementary Number Theory, Wm.C. Brown Publishers, Dulreque, Lowa, 1989.

T2. Kenneth, H. Rosen, Elementary Number Theory and its Applications, AT&T Bell Laboratories, Addition-Wesley Publishing Company, 3rd Edition.

REFERENCEBOOKS:

R1. Gareth, A. Jones and J Mary Jones, elementary Number Theory, Springer International Edition.

R2. Richard A Mollin, Advanced Number Theory with Applications, CRC Press, A Chapman & Hall Book.

R3. SabanAlaca and Kenneth S Williams, Introduction to Algebraic Number Theory, Cambridge University Press.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe Euclidean algorithm, Fermat's theorem, Euler's theorem, Wilson's theorem and solve problems related to these.	**1, 2, 4**
2	Define congruence modulo, primitive roots, quadratic residues and describe their properties.	**1, 2, 3, 4, 8**
3	Explore the greatest integer function, arithmetic function, multiplicative function and their properties.	**1, 2, 3, 4, 7**
4	Describe Diophantine equations, properties of Pythagorean triples, sums of two, four and five squares.	**1, 2, 3, 4, 8**
5	Describe simple continued fractions, finite and infinite continued fractions and solve problems related to it.	**1, 2, 3, 4, 7**

SEMESTER-III										
Course Title	**Fluid Dynamics**									
Course code	**24MSMT2110R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Mathematics**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	1. To introduce with waves and its basic concepts. 2. To describe stress-strain relationship of Newtonian fluids. 3. To describe two and three-Dimensional Inviscid Fluid Flows and its related results. 4. To derive some exact solutions of Navier-Stokes equations under different geometries. 5. To describe Laminar boundary layer.									
CO1	Define waves and its basic concepts.									
CO2	Describe stress-strain relationship of Newtonian fluids.									
CO3	Describe two and three Dimensional Inviscid Fluid Flows.									
CO4	Derive Navier-Stokes equations under different geometries.									
CO5	Describe Laminar boundary layer and Blasius equation.									

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Waves: Long wave and surface wave and surface , stationary wave, Energy of thewaves, Waves between different media, Group velocity, Dynamical significance of Group velocity, Surface tension and Capillary waves, Effects of Surface tension in water waves.	**10**	The students will learn about the properties, energy, and effects of surface tension in different types of waves.	1,2
II	Kinematics of Fluids in motion & Stress and Strain Analysis: Methods of describing fluid motion, material, local and convective derivatives, path lines, stream lines, vortex lines, strain and its types, small deformation theory, stress vector and stress tensor, various stresses, constitutive equations, Reynolds transport formula, conservation laws and mathematical forms in various fluid motions (steady and unsteady, compressible and incompressible) Bernoulli's equation.	**15**	The students will learn about the mathematical description of fluid motion, stress-strain analysis, and conservation laws.	1, 2
III	Two and Three-Dimensional Inviscid Fluid Flows: Complex potential, Sources, sinks, doublets, images with respect to plane and circle, MilneThomson circle theorem, Blasius theorem, motion past a circular cylinder, axi-symmetric flows, Stoke's stream function.	**10**	The students will learn about complex potential theory and its applications in modeling inviscid fluid flows.	1, 2, 3
IV	Navier-Stokes Equations and its Exact Solutions: Navier-Stokes equations, rate of change of circulation, diffusion of vorticity, vorticity equation and energy	**10**	The students will learn about the Navier-Stokes equations and their exact solutions in various fluid flow scenarios.	1, 2

	dissipation due to viscosity, exact solutions of Navier-Stokes equations: Couette flow, Poiseuille flow, Hagen-Poiesuille flow through a pipe, flow through annular region, Stokes firs problem.			
V	Boundary Layer Theory: Laminar boundary layer, two-dimensional boundary layer equations, Blasius equation, boundary layer parameters, separation of boundary layer, momentum and energy integral equation.	**15**	The students will learn about boundary layer formation, equations, and the conditions leading to separation.	1, 2, 3

TEXTBOOKS:

T1. Chatterjee, R. (2015). Mathematical Theory of Continuum Mechanics. Narosa Publishing House.

T2. Schlichting, H., Gersten, K. (2016). Boundary-layer theory. Springer.

T3. Chorlton, F. (2004). Textbook of fluid dynamics. CBS Publisher.

REFERENCEBOOKS:

R1. Spencer, A. J. M. (2004). Continuum Mechanics. Dover Publications.

R2. Raisinghania, M. D. (2003). Fluid Dynamics. S. Chand Publications.

R3. Lamb, S. R. (1945). Hydrodynamics. Dover Publications.

R4. Ramsay, A. S. (1913). Hydrodynamics (A Treatise on Hydromechanics). G. Bell and Sons, ltd.

R5. Kundu, P.K. Cohen, I. M., Dowling, D. R. (2011). Fluid Mechanics. Academic Press. 6. Thomson, L. M. M. (2011). Theoretical Hydrodynamics. Dover Publications.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Define waves and its basic concepts.	**1, 2, 4**
2	Describe stress-strain relationship of Newtonian fluids.	**1, 2, 3, 4, 7**
3	Describe two and three-Dimensional Inviscid Fluid Flows.	**1, 2, 3, 4, 8**
4	Derive Navier-Stokes equations under different geometries.	**1, 2, 3, 4, 7**
5	Describe Laminar boundary layer and Blasius equation.	**1, 2, 3, 4, 6**

SEMESTER-IV									
Course Title	**Continuum Mechanics and Hydrodynamics**								
Course code	**24MSMT2202R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Mathematics**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	To understand about the continuum concept, Cauchy's stress principle, stress tensor, deviation and spherical stress tensors etc. To learn about the Lagrangian and Eulerian descriptions of strain, deformation tensors, different forms of strain. To understand about motion and its material derivative, path lines and streamlines, material surface and line elements. To understand about the kinematics of fluids in motion and Easton's of motion in inviscid fluids. To learn about the motion in a plane and motion in space. Also, to understand about vortex motion and general theory of irrotational motion.								
CO1	Describe the continuum concept of stress, Cauchy's stress principle, stress tensor etc.								
CO2	Define strain and its different types together with the Lagrangian and Eulerian descriptions.								
CO3	Describe motion, rate of deformation and Vorticity with their physical interpretation.								
CO4	Define the kinematics of fluids in motion and equations of motion of inviscid fluids.								
CO5	Describe motion in a plane and motion in space, Vortex motion and general theory of irrotational motion.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Analysis of stress: The continuum concept, homogeneity, isotrophy, mass density, Cauchy's stress principle,stress tensor, equations of equilibrium, stress quadric of Cauchy, principal Stress, stress invariants, deviation and spherical stress tensors.	**15**	Students will have an in-depth knowledge stress, the continuum concept related to it, Cauchy's stress principle etc.	1,2
II	Analysis of strain: Lagrangian and Eularian descriptions, deformation tensors, finite strain tensor, small deformation theory, linear strain tensor and physical interpretation, stress ration and finite strain interpretation, strain quadric of Cauchy, principle strains, strain invariants, spherical and deviator strain components, equation of compatibility.	**10**	Students will understand about strain, Lagrangian and Eulerian descriptions, deformation tensors, finite strain etc.	1,2
III	Motion: Material derivatives, path lines and stream lines, rate of deformation and Vorticity with their physical interpretation, material derivatives of volume surface and line elements, volume, surface and line integrals, fundamental laws of continuum	**10**	Students will learn about the concept of motion, its material derivatives, path lines and stream lines, Vorticity with their physical interpretation.	1, 2

	mechanics.			
IV	Kinematics of fluids in motion and equations of motion of inviscid fluids: methods of describing fluid motion, material, local and convective derivatives, path lines, stream lines, vortex lines, equations of continuity, equations of motion and their integrals, boundary conditions, impulsive motions.	**15**	Students will have knowledge about the kinematics of fluids in motion and equations of motion of inviscid fluids, method of describing fluid motion etc.	1, 2
V	Motion in a plane and motion in space: Use of complex potential, source, sink, doublet, method of images, the circle theorem, the theorem of Blasius, motion past circular cylinder. Vortex motion and general theory of irrotational motion: Vorticity equation , properties of vortex filaments, motion due to rectilinear vortex and a system of vortices, Kelvin's circulation theorem and its use.	**10**	Students will have knowledge about the motion in a plane and a motion in space together with the concept of Vortex motion and general theory of irrotational motion.	1, 2

TEXTBOOKS:

T1. A Treatise on Hydromechanics, part II- W. H. Basant and A. S. Ramsay, CBS Publishers, Delhi.

T2. Text Book on Fluid Dynamics-Frank Chorlton, CBS Publishers, Delhi.

T3. Continuum Mechanics, G.E. Mass, Schaum's Outline series, McGraw Hill Co.

REFERENCEBOOKS:

R1. An introduction to Fluid Mechanics- G. K. Batchelor, Foundation Books, New Delhi.

R2. Hydrodynamics-M. D. Raisinghania, S. Chand and Co. Limited.

R3. Mathematical Theory of Continuum Mechanics-R.Chatterjee, Naroda Publishing House.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the continuum concept of stress, Cauchy's stress principle, stress tensor etc.	**1, 2, 4**
2	Define strain and its different types together with the Lagrangian and Eulerian descriptions.	**1, 2, 3, 4, 8**
3	Describe motion, rate of deformation and Vorticity with their physical interpretation.	**1, 2, 3, 4, 7**
4	Define the kinematics of fluids in motion and equations of motion of inviscid fluids.	**1, 2, 3, 4, 8**
5	Describe motion in a plane and motion in space, Vortex motion and general theory of irrotational motion.	**1, 2, 3, 4, 6.**

SEMESTER-IV										
Course Title	**Mathematical Methods**									
Course code	**24MSMT2203R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**	
Pre-requisite	**Nil**	**Co-requisite**	**Nil**							
Programme	**Master of Science in Mathematics**									
Semester	**Fall/ III semester of first year of the programme**									
Course Objectives	1. To provide an overview of integral equation and describe various mathematical methods to solve integral equations. 2. To describe Laplace transformation and its application. 3. To describe Fourier transformation and its application. 4. To provide solution methodologies of wide range of problems in physical sciences using calculus of variation.									
CO1	Define integral equation and describe mathematical methods to solve integral equations.									
CO2	Describe Laplace transformation and its application.									
CO3	Describe Fourier transformation and its application.									
CO4	Explore the solutions of wide range of problems in physical sciences using calculus of variation.									
CO5	Describe Volterra integral equations of the second kind, their resolvent kernel, and iterative solution techniques.									

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Integral Equations : Definition of Integral Equation, Reduction of ordinary differential equations into integral equations. Fredholm integral equations with separable kernels, Eigen values and Eigen functions.	**7**	Introduction of integral equations	1,2
II	Volterra Integral Equations: Volterra Integral Equations of second kind, Resolvent Kernal of Volterra equation and its results, Application of iterative scheme to Volterra equation of the second kind. Convolution type kernals.	**8**	Understand Volterra Integral Equations, Resolvent Kernal of Volterra equation and its results	1,2
III	Laplace Transform: Basic properties of Laplace Transform, Convolution theorem and properties of convolution, Inverse Laplace Transform, Application of Laplace Transform to solution of ordinary and partial differential equations of initial and boundary value problems.	**10**	Describe Laplace transformation and its application	1,2
IV	Fourier Transform: Fourier Integral Transform. Properties of Fourier Transform, Fouriersine and cosine transforms, Application of Fourier transform to ordinary and partial differential equations of initial and boundary value problems. Evaluation of definite integrals.	**10**	Describe Fourier transformation and it's application.	1,2
V	Calculus of variation with one	**10**	Able to solve wide range	

	independent variable: Basic ideas of calculus of variations, Euler's equation with fixed boundary of the functional Containing only the first order derivative of the only dependent variable with respect to one independent variable. Variational problems with functional having higher order derivatives of the only dependent variable, general case of Euler's equation, applications.		of problems in physical sciences using calculus of variation.	1,2

TEXTBOOKS:

T1. Gupta, A. S. (1996). Calculus of variations with applications. PHI.

T2. Parashar, B. P. (1994). Differential and Integral Equations. CBS Pub and Distributors.

T3. Raisinghania, M. D. (2007). Integral equations and boundary value problems. S.Chand.

REFERENCE BOOKS:

R1. Hildebrand, F. B. (2012). Methods of applied mathematics. Courier Corporation.

R2. Spiegel, M. R. (1986). Theory and Problems of Laplace Transform.

R3. Courant, R., Hilbert, D. (2008). Methods of Mathematical Physics: Partial Differential Equations. John Wiley & Sons.

OTHER LEARNING RESOURCES:

1. http://mathforum.org
2. http://ocw.mit.edu/ocwweb/Mathematics

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Define integral equation and describe mathematical methods to solve integral equations.	**1, 2, 4**
2	Describe Laplace transformation and its application.	**1, 2, 3, 4**
3	Describe Fourier transformation and its application.	**1, 2, 3, 4, 8**
4	Explore the solutions of wide range of problems in physical sciences using calculus of variation.	**1, 2, 3, 4, 7**
5	Describe Volterra integral equations of the second kind, their resolvent kernel, and iterative solution techniques.	**1, 2, 4, 8**

SEMESTER-IV									
Course Title	**Operation Research**								
Course code	**24MSMT2204R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Mathematics**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	1. To understand about the basics of linear programming and its formulation together with the graphical solution of linear programs in two variables, basic solution and basic feasible solution. 2. To learn about the solution of linear programming problem using simplex method, Big-M simplex method, duality in linear programming and dual simplex method. 3. To understand Transportation problem and its mathematical formulation, finding the initial basic feasible solution and Least Cost Method etc. 4. To understand Assignment problem, Hungarian method for solving an assignment problem, Unbalanced Assignment problem and Salesman problem. 5. To learn about Queueing Theory and its basic concepts, fundamental structure of Queueing system, together with introduction of Game theory, some basic definitions and Two-Person Zero-Sum game.								
CO1	Describe the basic concepts of linear programming and its formulation together with graphical solution.								
CO2	Solve linear programming problems using simplex method, Big-M simplex method and dual simplex method.								
CO3	Find the initial basic fessible solution by Least Cost Method.								
CO4	Define Assignment Problem and its mathematical formulation, Hungarian method for solving an assignment problem, unbalanced assignment problem and salesman problem.								
CO5	Describe the Queueing theory and its basic concepts together with Basic of Game theory, some definitions and Two-Person Zero-Sum game.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Linear programming: Formulation of Linear Programming models, Graphical solution of linear programmes in two variables, Linear programs in standard form, basic variables, basic solution, basic feasible solution.	**10**	Students will learn about the basic of linear programming and graphical solution of linear programs in two variables.	1, 2
II	Solution of linear programming problem using simplex method, Bid-M simplex method, the two-phase simplex method. Duality in linear programming problems, dual simplex method.	**10**	Students will understand simplex method for solving linear programming problems.	1, 2, 3
III	Transportation Problems: Mathematical formulation of the Transportation problem, Finding initial basic feasible solution, Least Cost Method, Unbalanced Transportation Problem, Degeneracy.	**10**	Students will learn about Transportation Problems and formulation of Transportation problem together with its solution.	2, 3
IV	Assignment problem: Standard assignment problems, Hungarian method for solving an assignment problem,	**15**	Students will understand about Assignment problem and method of solving	1, 2, 3

	Unbalanced Assignment Problem, Travelling Salesman Problem.		Assignment problem like Hungarian method.	
V	Queueing Theory: Basic concepts of Queueing theory, fundamental structure of Queueing system, Operating characteristics of a Queueing system. Introduction to Game theory, some basic definitions, Two-Person Zero-Sum game.	**15**	Students will have in-depth knowledge about Queueing theory, it basic concepts, fundamental structure, a brief introduction on Game theory, some basic definitions and concept of Two-Person Zero-Sum game.	1, 2

TEXTBOOKS:

T1. Tasha, H. A. (2007), Operations Research: an introduction, Pearson Education, 2007.

T2. Branson, R., Naadimuthu, G. (1997), Operations Research, Schaum's Outlines.

REFERENCE BOOKS:

R1. Sharma, J. K. (2007), Operation Research Theory and Applications, Macmillan India Ltd.

R2. Raju. N.V.S. (2002), Operations Research, HI-TECH.

R3. Swarup, K., Gupta, P. K., Mohan, M. (2014), Operation Research, Sharma, S. Chand& Sons.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the basic concepts of linear programming and its formulation together with graphical solution.	**1, 2, 4**
2	Solve linear programming problems using simplex method, Big-M simplex method and dual simplex method.	**1, 2, 3, 4**
3	Find the initial basic feasible solution by Least Cost Method.	**1, 2, 3, 4, 8**
4	Define Assignment Problem and its mathematical formulation, Hungarian method for solving an assignment problem, unbalanced assignment problem and salesman problem.	**1, 2, 3, 4, 7**
5	Describe the Queueing theory and its basic concepts together with Basic of Game theory, some definitions and Two-Person Zero-Sum game.	**1, 2, 4, 8**

SEMESTER-IV									
Course Title	**Fuzzy sets & Systems**								
Course code	**24MSMT2205R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T	**3**	**0**	**0**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Mathematics**								
Semester	**Fall/ III semester of first year of the programme**								
Course Objectives	1. To introduce with Fuzzy sets and explain uncertainty using fuzzy set theory. 2. To know Fuzzy number and method of construction of Membership Function. 3. To understand Fuzzy relations and its types. 4. To understand Fuzzy logic and fuzzy rule-based system. 5. To provide solution methodologies of different types real world problems under uncertainty using Fuzzy sets.								
CO1	Define Fuzzy sets and explain uncertainty using fuzzy set theory.								
CO2	Define Fuzzy number and method of construction of Membership Function.								
CO3	Describe Fuzzy relations and its types.								
CO4	Explain Fuzzy logic and fuzzy rule-based system.								
CO5	Describe the solution of real world problems under uncertainty using Fuzzy sets.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Basic of Fuzzy Sets: Uncertainty, Taxonomy of Uncertainty, Motivation, Concepts of crispness and fuzziness, Fuzzy set and its representation, α-cut, convex fuzzy set, basic operations on fuzzy sets, types of fuzzy sets, extension principle, t-norm, t-conorms and their properties.	**15**	Introduction with Fuzzy sets and explain uncertainty using fuzzy set theory.	1,2
II	Fuzzy Arithmetic and Method of Construction of Membership Function: Fuzzy Numbers, Types of Fuzzy numbers, Interval Arithmetic, Arithmetic operations on fuzzy numbers, membership function formulation.	**10**	Knowledge of Fuzzy number and method of construction of Membership Function.	1,2
III	Fuzzy Relations: Fuzzy relation, binary fuzzy relations, union and intersection of fuzzy relations, projection and cylindrical extensions, fuzzy equivalence relation, Fuzzy compatibility relations, Fuzzy ordering relations, compositions of fuzzy relations and their properties.	**10**	Able to understand Fuzzy relations and its types.	1,2
IV	Fuzzy logic and Fuzzy System: Defuzzification, classic and fuzzy logic, approximate reasoning, linguistic hedges, fuzzy inference, fuzzy rule-based system.	**10**	Able to understand Fuzzy logic and fuzzy rule-based system.	1,2
V	Uncertainty measure and Applications of Fuzzy sets: Uncertainty based information, non-specificity of fuzzy set, fuzziness of fuzzy sets, Applications of fuzzy sets in decision making and other real-world problems.	**15**	Able to solve different types of real-world problems under uncertainty using Fuzzy sets.	1,2

TEXTBOOKS:

T1.Stanbury P.F.,A. Whitaker,S.j. Hall,Principles of Fermentation Technology Publisher :Butterworth-Heinemann.

T2.ShulerM.L.andF.Kargi:BioprocessEngineering BasicVonceptsbyPublisherPrenticeHall

REFERENCE BOOKS:

R1. Prescott and Dunn's Industrial Microbiology, Publisher: GeraldReed: Books

R2. W.Crueger and A. Crueger: Biotechnology. A text book of Industrial Microbiology, Publisher: Sinauer Associates.

OTHER LEARNING RESOURCES:

1.https://microbenotes.com/

2. **www.youtube.com.**

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the principles of diverse bioreactors and their advantages	**1, 3**
2	Illustrate different microbial strain improvement strategies and the development of novel applications.	**1, 2, 3, 4, 8**
3	Illustrate various fermentation products and the underlying biotechnological principles involved.	**1, 2, 3, 4, 7**
4	Describe various downstream processes and their storage and packaging techniques.	**1, 2, 3, 4, 8**
5	Explore the potential of using microbes to produce metabolites in industrial settings.	**1, 2, 3, 4, 8, 8**

Assam down town University

Curriculum and Syllabus

Master of Science in Physics

OUTCOME BASED EDUCATION FRAMEWORK
CHOICE BASED CREDIT SYSTEM
Version: 1.0

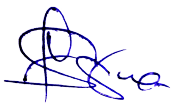
FACULTY OF SCIENCE

July, 2024

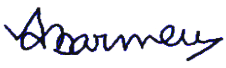
PREAMBLE

Assam down town University is a premier higher educational institution which offers Bachelor, Master, and Ph.D. degree programmes across various faculties. These programmes, collectively embodies the vision and mission of the university. In keeping with the vision of evolutionary changes taking place in the educational landscape of the country, the university has restructured the course curriculum as per the guidelines of National Education Policy 2020. This document contains outline of teaching and learning framework and complete detailing of the courses. This document is a guidebook for the students to choose desired courses for completing the programme and to be eligible for the degree. This volume also includes the prescribed literature, study materials, texts, and reference books under different courses as guidance for the students to follow.

Recommended by the Board of Studies (BOS) meeting of the Faculty of Science held on dated 16th & 17th July, 2024 and approved by the 51st Academic Council (AC) meeting held on dated 26/07/2024



Chairperson, Board of Studies



Member Secretary, Academic Council

Vision

To become a Globally Recognized University from North Eastern Region of India, Dedicated to the Holistic Development of Students and Making Society Better

Missions

1. Creation of curricula that address the local, regional, national, and international needs of graduates, providing them with diverse and well-rounded education.
2. Build a diverse student body from various socio-economic backgrounds, provide exceptional value-based education, and foster holistic personal development, strong academic careers, and confidence.
3. Achieve high placement success by offering students skill-based, innovative education and strong industry connections.
4. Become the premier destination of young people, desirous of becoming future professional leaders through multidisciplinary learning and serving society better.
5. Create a highly inspiring intellectual environment for exceptional learners, empowering them to aspire to join internationally acclaimed institutions and contribute to global efforts in addressing critical issues, such as sustainable development, Climate mitigation and fostering a conflict-free global society.
6. To be renowned for creating new knowledge through high quality interdisciplinary research for betterment of society.
7. Become a key hub for the growth and excellence of AdtU's stakeholders including educators, researchers and innovators
8. Adapt to the evolving needs and changing realities of our students and community by incorporating national and global perspectives, while ensuring our actions are in harmony with our foundational values and objectives of serving the community.

Programme Details

Programme Overview

MSc Physics offers a wide range of courses covering various basic and applied areas of life sciences. The student develops an aptitude and scientific temperament to apply the technical skills in various important areas of physics such as Condensed Matter Physics, Nuclear Physics, Atomic, Molecular spectroscopy & Laser, Astrophysics, General Theory of Relativity & Cosmology, Plasma Physics etc. The course also offers various techno specific skills, universal ethics and elective courses considering overall development and employability scopes in research, industry and teaching sectors. The course duration is for a period of 2 years.

I. Specific Features of the Curriculum

The Master of Physics curriculum features core courses typically provides advanced theoretical and practical knowledge in physics and prepares students for research or professional work in various scientific and technical fields. The curriculum often includes a mix of compulsory core courses, elective courses, and hands-on research or project work along with seminars, workshops, and industry or internships. The program incorporates interdisciplinary approaches, regulatory and ethical training, and develops essential soft skills such as scientific communication and project management. Additionally, it offers global perspectives on strong foundation in physics and the necessary skills for pursuing advanced research, teaching, or careers in industries like aerospace, data science, energy, healthcare, and materials science.

Eligibility Criteria:

The minimum required qualification for the proposed program is Bachelor degree with 50% aggregate marks or equivalent CGPS in Physics/Applied Physics (honours subject) and Mathematics as one of the pass subjects.

II. Program Educational Objectives (PEOs):

PEO-1: AdtU Physics Postgraduates will be well prepared for successful careers in academic, research, industry and government sector as academician, scientist, quality control & quality assurance officers, geophysists etc.

PEO-2: AdtU Physics Postgraduates will be academically prepared to contribute effectively to the growth and development of applied physics and allied domains

PEO-3: Graduates will be able to communicate effectively, work collaboratively, exhibit professionalism, engage in lifelong learning and a successful entrepreneur.

III. Program Specific Outcomes (PSOs):

PSO-1: Global certification: Exhibit global competency to excel in the profession.

PSO-2: Innovation and Entrepreneurship: Apply multidisciplinary approach for research exploration and collaboration with professionals across diverse disciplines contributing to innovation and entrepreneurship.

PSO-3: Experiential Learning: Exhibit an in-depth understanding of the concept of physical science and apply interdisciplinary knowledge to address the challenges within the domains of physics and relevant fields.

IV. Program Outcome (PO):

PO-1: Disciplinary Knowledge: Apply fundamental principles of basic and applied physics to elucidate various phenomena occurring in the universe.

PO-2: Analytical Skill: Identify and analyze problems, derive solution related to physical phenomenon of molecules, matters, life, society, intrastellar and extrastellar systems to formulate solutions.

PO-3: Problem solving and Interpretation: Identify complex physical problems and analyze them using the various theory and laws of Physics.

PO-4: Proficiency: Proficient in using software such as FORTRAN, MATLAB, SKYLAB, PYTHON for analysis and solving complex problems.

PO-5: Communication: Communicate efficiently with scientific temperament and thoughts with the all stakeholders including peers and beneficiaries.

PO-6: Professional ethics: Apply ethical principles and commit to professional ethics and responsibilities.

PO-7: Research: Exhibit temperament to take up research project on topics related to physics and independently framing relevant questions, designing experiments and interpret the results.

PO-8: Career aptitude: Ability to build a career in different scientific and technological fields by acquiring the adequate knowledge of Physics.

V. Total Credits to be Earned: 89

Career Prospects:

Capable of find better carrier opportunities in research labs, medical labs, academic institutions, IT field, technical field, automobile industry and various government-owned Scientific Research and Development Organizations

M.Sc. Physics graduates after successful completion of their master degree can do research in various field of physics and simultaneously apply for various fellowships offered by different institutes and agencies.

In India, students could get the opportunity to work with Oil and Natural Gas Corporation (ONGC), Oil India Ltd (OIL), Defense Research and Development Organization (DRDO), Bhabha Atomic Research Centre (BARC), Saha Institute of Nuclear Physics Kolkata, Bharat Heavy Electricals Ltd (BHEL), Indian Space Research Organization (ISRO) etc.

Exhibit in-depth practical expertise to students in many thrust areas of Physivs in order to fulfil worldwide industry and academic demands.

The ability to design aids in the development of solutions for complicated problems while taking into account public health and safety, as well as cultural, sociological, and environmental considerations.

EVALUATION METHODS

The student performance shall be evaluated through In-semester (Sessional) and semester-end examinations. A weight age of 40% or as prescribed by the programme shall be added to the score of the end semester examination.

A. INTERNAL ASSESSMENT:

The teacher who offers the course shall be responsible for internal assessment by conducting in-semester (sessional) examination and evaluating the performance of the students pursuing that course. The components for internal assessment are illustrated in the table given below.

SN	Components/ Examinations	Marks Allotted
1.	In-Sem Exam – I (ISE-I) (Written Examination)*	30
2.	In-Sem Exam – II (ISE-II) (Written Examination)*	30
3.	Assignment	10
4.	Presentation (SP)	10
5.	Quiz	5
6.	Class Performance based score*	5

are compulsory

Note: *Total Internal assessment should be out of 40*

INSTRUCTION

1. If a student fails to appear in the any of the component without any valid reason he/she shall be marked zero in that component. However, the course teacher at his discretion may arrange for the missed test on an alternate date for the absentee students after determining ground with genuine/valid reasons for the absent.
2. The report of evaluation of an activity towards the in-semester (sessional) component of a course shall be duly notified by the concerned course teacher within a week of completion.
3. The program coordinators should upload the in-semester marks to the ERP and forward acknowledgement of all the courses of the program to the Controller of Examinations before the start of the End-semester examination.

B. SEMESTER END EXAMINATION:

Time table for end semester examination is published at least 25 days prior to the start of Examination.

I. Pre-Examination:

Eligibility Criteria for a student to appear in University Examinations:

The student shall only be allowed to appear in a University Examination, if:

i) He/ She is a registered student of the University;
ii) He/ She is of good conduct and character;
iii) He/ She has completed the prescribed Programme of study with minimum percentage of attendance as laid down in the Regulations of the Programme concerned.

Under special cases, a student may be allowed to appear for an examination without being registered in the University but the result of the said student will be kept on hold till the registration of the concerned student is completed.

II. Admit Card:

Admit card for the examination may be downloaded through ERP where the system will generate a Unique ID Cards through online.

The University shall have the right to cancel admission for examination of any candidate on valid grounds.

III. Pattern of Question Papers:

The question paper shall follow the principles of Bloom's Taxonomy.

Table

S. N.	Level	Questions /verbs for test
1	Remember	List, Define, tell, describe, recite, recall, identify, show who, when, where, etc.
2	Understand	Describe, explain, contrast, summarize, differentiate, discuss etc.
3	Apply	Predict, apply, solve, illustrate, determine, examine, modify
4	Analyze	Classify, outline, categorize, analyze, diagrams, illustrate, infer, etc.
5	Evaluate	Assess, summarize, choose, evaluate, recommend, justify, compare etc.
6	Create	Design, Formulate, Modify, Develop, integrate, etc.

Note: No course is to be evaluated on basis of **all 6 knowledge levels.**

The format of the question paper across all the program follow a unique pattern and the total marks is 60

Table 1: Question paper pattern for End semester examination

Sl no	Question pattern	Total marks
1	MCQs (10 Questions)	10
2	2 Marks questions (10 Questions)	20
3	4 Marks questions (5 Questions)	20
4	10 Marks questions (1 Question)	10

IV. Examination Duration:

Each paper of 60 marks shall ordinarily be of two hours duration.

V. Practical Examinations, Viva-Voice etc.:

i) Practical examination shall be conducted in the presence of one external expert and one or more internal examiners.

ii) Viva-Voice, Oral examinations of the Project report, Dissertation etc. shall be undertaken by a Board of Examiners constituted by the respective Dean of Program with the advice of Supervisor(s).

VI. Procedure of Expulsion:

If any candidate is found to be using any unfair-means during the examination, the invigilator may cease his/her answer sheet and report it directly to the Officer-in-Charge. The Office-in-Charge of the center may take appropriate decisions as per the rules and procedure of the examination. The Officer-in-Charge may allow the students to write the exam with new answer sheet or may expel the student from appearing the paper depending on the nature of unfair-means. In case of Computer based test,

the students may be directed to write an apology letter and sign in the prescribe expulsion form. The student may not be allowed to write that examination.

VII. Instruction to the Students:

(i) The students shall not bring to the Examination Hall, any electronic gadget used as a means of communication or record except electronic calculator, if required.

(ii) The students shall not receive any book or printed or hand written or photo copy (Xerox) or blank-paper from any other person while he/she is in the examination-room or in laboratory or in any other place to which he/she is allowed to have access during course of examination.

(iii) The students shall not communicate with any other candidate in the examination room or with any other person in and outside the examination-room.

(iv) The students shall not see, read or copy anything written by any other candidate, nor shall he/she knowingly or negligently permit any other candidate to see, read or copy anything written by him/her or conveyed by him/her.

(v) The students shall not write anything on the Question Paper or in other paper or materials during the examination, or pass any kind of paper to any other candidate in the examination-room, or to any person outside the room.

(vi) The students shall not disclose his/her identity to the examiner by writing his/her name or putting any sign / symbol in any part of his answer-script.

(vii) The students shall not use any abusive language or write any objectionable remark or make any appeal to examiner by writing in any part of his answer-script.

(viii) The students shall not detach any page from the answer-script or insert any authorized or unauthorized loose sheet into it. He /she shall also not insert any other answer-script / loose sheet by removing the pins of the origin answer-scripts and re-fixing it.

(ix) The students shall not resort to any disorderly conduct inside the examination-room or misbehave with the invigilator or any other examination official.

VIII. Provision for an Amanuensis (writer):

(i) A candidate may be provided with an Amanuensis (writer) to write down on dictation on his / her behalf on ground of his / her physical disability to write down by himself / herself due to accident or any other reason. The amanuensis may be provided till he / she recovers from the physical disability. The physical disability to write down by himself / herself must be supported by Medical Certificate from a competent Medical Officer.

(ii) The qualifications of the amanuensis so provided must not be equal or higher than that of the candidate. This is also to be supported by Certificate from the Faculty of Study where the Amanuensis is provided.

(iii) Such candidates are to be accommodated in a separate room under the supervision of an invigilator so that the fellow candidates are not disturbed in the process.

C. Credit Point:

It is the product of grade point and number of credits for a course, thus, CP = GP x CR

i. Credit:

A unit by which the course work is measured. It determines the number of hours of instructions required per week. 'Credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. Credits assigned for a single course always pay attention to how many hours it would take for an average learner to complete a single course successfully.

ii. Grade Point:

Grade Point is a numerical weight allotted to each Grade Letter on a 10-point scale.

iii. Letter Grade:

Letter Grade is an index of the performance of students in a said paper of a particular course. Grades are denoted by letters O, A+, A, B+, B, C, P, F and Abs. Student obtaining Grade F / Grade Abs shall be considered failed/ absent and, will be required to appear in the subsequent ESE. The UGC recommends a 10-point grading system with the following (Table: 1) Letter Grades:

(i) A Letter Grade shall signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point shall indicate the numerical weight of the Letter Grade on a 10-point scale.

(ii) There shall be 08 (eight) Letter Grades bearing specific Grade Points as listed in Table 1, where the Letter Grades 'O' to 'P' shall indicate successful completion of a course.

(iii) Apart from the 08 (eight) regular Letter Grades listed in Table 1, there shall be 03 (three) additional Letter Grades, which shall be awarded if a Course is withdrawn or spanned over the next Semester or remains incomplete as stated in Table 2.

Table 2: Letter Grades and Grade Points

Letter Grade	Grade Points	Description
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Abs	0	Absent
UFM	0	Unfair Means

iv. Grade Point Average:

a. SGPA (Semester Grade Point Average)

The SGPA of a student in a Semester shall be the weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered in that Semester, irrespective of whether he/she could or could not complete the Courses. More specifically, the calculation of SGPA shall take into account the Courses graded with Letter Grades 'O' to 'F' as given in Table 1.

$$\text{SGPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad (1.1)$$

The SGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.1) up to two decimal places, where n is the total number of Credit Courses registered by the student in that Semester, Gi is the Grade Point secured in the i^{th} registered Course and Ci is the Credit (weight) of that Course.

b. CGPA (Cumulative Grade Point Average)

(i) The CGPA of a student in a Semester of a Programme shall be the accumulated weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and

Elective Courses) he/she registered and successfully completed so far starting from the enrollment in the Programme. In other words,taking into account all the Courses graded with 'O' to 'P' as given in Table 1.1, generally the CGPA of a student shall be calculated starting from the first Semester of his/her enrolled Programme, while the CGPA of a lateral-entry student shall be calculated starting from the Semester of his/her enrollment.

(ii) The CGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.2) up to two decimal places, where N is the total number of Credit Courses registered and successfully completed so far by the student, Gi is the Grade Point secured in the ith completed Course and Ci is the Credit (weight)of that Course.

$$\text{CGPA} = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i} \qquad (1.2)$$

(iii) The CGPA shall be convertible into equivalent percentage of marks using Equation Conversion of CGPA to percentage marks: = CGPA*10

D. Post-Examination

i. Transcript or Grade Card or Certificate:

A marking certificate shall be issued to all the registered students after every Semester. The Semester mark sheet will display the course details (code, title, number of credits, grade secured) along with total credit earned in that Semester.

ii. Grievance Readdress Mechanism:

Students with any dissatisfaction or grievance regarding the marks awarded in any of the Papers / Courses may appeal to the Controller of Examinations for remedial action such as Re-evaluation within 10 days of the declaration of result.

(i) A student has options to appeal for re-evaluation of his /her answer script to the Controller of Examination.

(ii) Application for re-evaluation / re-scrutiny of answer scripts shall be made in the definite proforma available with the Examination Office through the head of the respective departments within 10 days of declaration of the results of the respective examinations.

(iii) The Controller of Examination may appoint an examiner for re-evaluation and will consider and recognize the evaluation done by a University appointed examiner.

(iv) There shall be no provision for re-evaluation of the Practical Papers, Project Work, and Dissertation etc. However, the students fail in practical examination or viva voce and wish to appear again may apply to be evaluated can do so with the next schedule.

(v) After screening the application for re-evaluation, the CoE may send the answer scripts of the student to the examiners appointed by the CoE with the approval of Vice Chancellor.

(vi) The marks/grades achieved by the students after the re-evaluation shall be final and binding.

(vii) Fresh Marks – sheets / Grade Card shall be issued only if the candidate secures pass marks / passing grade in the re-evaluated paper.

(viii) Revaluation of answer scripts shall be deemed to be an additional facility provided to the students with a view to improving upon their results at the preceding examination result for any reason whatsoever shall not confer any right upon them for admission to next higher class which matters always be regulated in accordance with the relevant rules or regulations framed by the University.

(ix) If as a result of revaluation of the candidate attracts the provision of condonation of deficiency, the same may be applied to his/her only for fresh attempt.

INSTRUCTION TO TEACHERS AND STUDENTS

(Teaching and Learning Methods)

In all the courses the teacher has to select topics for teacher-method which should not be less than 20 percent. The approach will be direct class room teaching through series of lectures delivering concepts using ITC facilities, white or black board. Notes may also be circulated to the students however; the students are to be involved in preparation of the notes. The teacher will be responsible in selecting the best note for circulation. The teacher- centric methodology has recently fallen out of favour because this strategy for teaching is seen to favor passive students.

1. Student- centric / Constructivist Approach:

The topics of the courses may be selected at the start of the class and assigned one topic to each of the student for studying by themselves, prepare presentations, notes etc., and present at respective class time after consultation and discussion with the course teachers. The teacher facilitate the learning of the students by guiding and providing input and explaining concepts. 60 percent of the course contents may be selected for this purpose. To avoid behavior problems, teachers must lay a lot of groundwork in student- centric classrooms. Typically, it involves instilling a sense of responsibility in students. In addition, students must learn internal motivation.

a. Project-Based Learning: The teacher may select 5 percent of topics for the purpose and may conduct visit to the laboratory for experiments or field and survey. The selection of the topic may be done considering the available facility for the purpose. However, in the final semester of each of the programme the student has to undergo a project-Based learning at least 4 months duration. This approach will help the student to think critically, evaluate, analyze, make decisions, collaborate, and more.

b. Inquiry-Based Learning: The teacher/ students are supposed to list at least five questions in each contact hour and student solve these question or search for answer which becomes the home work for the students “question-driven” learning approach. The teacher may look for the correctness of the solution or the best possible answer and discuss in the successive class. This will help in the preparation for various competitive examination and develop a habit for search for solutions.

c. Flipped Classroom: About 10 percent of the course content has to be completed by this method. In this approach the students are asked to watchvideo or lecture prepared by the teacher or any video available (relevant to the course). A set of questions may be given to the students for searching answers by the students. The idea is that students should have more time in-classroom focusing on achieving these higher levels of thinking and learning. The Flipped classroom is also an acronym. The letters FLIP represent the four pillars included in this type of learning: Flexible environment, Learning culture shift, Intentional content, and Professional educator. As you can see, the second pillar refers to a culture shift from the traditional approach where students are more passive to an approach where students are active participants. As a result, this approach is also a student- centric teaching method.

d. Cooperative Learning: The remaining five percent has to be completed by cooperative learning approach. In this approach the students are allotted with problems. During the library hours the student along with the teacher visits library search probable solution for the assigned problem. The same has to be done in group so that the students discuss among themselves for the appropriate answers. Essentially, cooperative learning believes that social

interactions can improve learning. In addition, the approach recreates real-world work situations in which collaboration and cooperation are required.

The percentage categorization for the completion of a theory course

Teacher- centric or Direct Classroom Teaching: Delivery by series of lectures	20%
Student- centric Approach, Student present and deliver lectures in presence of teacher and supervised by teacher	60%
Student visit fields or perform experiments or teacher perform demonstration	05%
Flipped Classroom approach	10%
Cooperative learning approach	05%

Inquiry based approach has to be followed in all of the classes

Teacher has to distribute the topics to be considered for teaching by the above-mentioned approaches and prepare lesson plan for execution and maintain a file

Breakdown of Credits

Sl. No.	Category	Total number of Credits
1.	Discipline Specific Core (Major)	19
2.	Discipline Specific Core (Minor)	8
3.	Skill Enhancement Course (SEC)	4
4.	Discipline Specific Elective (DSE)	18
5.	Ability Enhancement Course (AEC)	6
6.	Value Added Course (VAC)	4
7.	Co and extra-Curricular	2
8.	Multidisciplinary Course (MDC)	2
9.	Field Training	2
10.	Research /Industry Internship	20
11.	Summer Internship	4

Breakdown by categories of courses

Sl no	Category	Credits	%
1	Science	83	93.26%
2	Humanities and Social Sciences	6	6.74%
Total		89	100%

SEMESTER WISE COURSE DISTRIBUTION

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester I	1.	24MSPH1101R	Quantum Mechanics	DSC Major	4	0	0	0	0	0	4	40	60	0	100
	2	24MSPH1102R	Classical Mechanics	DSC Minor	3	0	2	0	0	0	4	40	60	100	200
	3	24MSPH1103R	Electrodynamics	DSC Minor	3	0	2	0	0	0	4	40	60	100	200
	4	24UMFS1101R	Fundamental of Statistics	MDC	2	0	0	0	0	0	2	40	60	0	100
	5	24UMPD1101R	Effective Communication (PDP)	AEC	0	0	4	0	0	0	2	50	0	50	100
	6	24UMEC1101	Extra-curricular	Co and Extra-curricular	0	0	0		0	0	1	0	0	100	100
	Total										17				800

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester II	1.	24MSPH1201R	Mathematical Physics	DSC Major	4	0	0	0	0	0	4	40	60	0	100
	2	24MSPH1202R	Thermodynamics & Statistical Physics	DSC Major	4	0	0	0	0	0	4	40	60	0	100
	3	24MSPH1203R	Electronics	DSC Major	3	0	2	0	0	0	4	40	60	100	200
	4	24UMPD1201R	Advanced Communication	AEC	0	0	4	0	0	0	2	0	0	100	100
	5	24MSPH1204R	Post Graduate Practice Teaching	SEC	1	0	0	0	0	0	1	0	0	100	100
	6	24MSPH1205R	Research Methodology and Statistical Analysis	SEC	2	0	2	0	0	0	3	40	60	100	200
	7	24FSDA1201R	Data analysis using MS Excel	VAC	0	0	4	0	0	0	2	0	0	100	100
	8	24MSPH1206R	Field Visit	Field Training	0	0	0	0	0	8	1	0	0	100	100
	9	24UMCC1201	Co-curricular	Co and extra Curricular	0	0	0	0	0	0	1	0	0	100	100
	Total										22				1100

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester III	1.	24MSPH2101R	Atomic and Molecular Physics	DSC Major	2	0	2	0	0	0	3	40	60	100	200
	2	24UMPD2101R	(PDP)	AEC	0	0	4	0	0	0	2	0	0	100	100
	3	24MSPH2102R	Internship	Internship	0	0	0	0	0	32	4	0	0	100	100
	4	24MSPH2103R	Field Visit	Field Training	0	0	0	0	0	8	1	0	0	100	100
	5	24MSPH2104R	Research Project I	Research/ Industry Internship	0	0	8	0	0	0	4	0	0	100	100
	6	24MSPH2105R	Indian Knowledge System	VAC	0	0	0	0	0	0	2	0	0	100	100
	Discipline specific Elective (Any three subjects to be selected)														
		24MSPH2106R	Nuclear Physics I	DSE	3	0	2	0	0	0	4	40	60	100	200
		24MSPH2107R	Condensed Matter Physics	DSE	3	0	2	0	0	0	4	40	60	100	200
		24MSPH2108R	Astrophysics	DSE	4	0	0	0	0	0	4	40	60	0	100
		24MSPH2109R	Plasma Physics I	DSE	4	0	0	0	0	0	4	40	60	100	100
		24MSPH2110R	Non Linear Optics	DSE	4	0	0	0	0	0	4	40	60	100	100
	Total										28				

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester IV	1.	24MSPH2201R	Research Project II	Research/Industry Internship	0	0	32	0	0	0	16	0	0	100	100
	Discipline specific Elective (Any two subjects to be selected)														
	3	24MSPH2202R	Nuclear Physics II	DSE	2	0	2	0	0	0	3	40	60	100	200
	4	24MSPH2203R	Advanced Condensed Matter Physics	DSE	2	0	2	0	0	0	3	40	60	100	200
	5	24MSPH2204R	General Theory of Relativity & Cosmology	DSE	3	0	0	0	0	0	3	40	60	0	100
	6	24MSPH2205R	Plasma Physics II	DSE	3	0	0	0	0	0	3	40	60	0	100
	7	24MSPH2206R	Advanced Molecular Spectroscopy & laser	DSE	2	0	2	0	0	0	3	40	60	100	200
			Total								22				
	Total										89				

***IA: Internal Assessment, SEE: Semester End Examination, PE: Practical Examination**

SEMESSTER I									
Course Title	**Quantum Mechanics**								
Course Code	**24MSPH1104R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti-requisite	**Nil**								
Programmes	**Master of Science in Physics**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course Objectives	1. Introduction to Basic theory of quantum mechanics. 2. To develop and use critical thinking and problem solving skills through the use of quantum mechanics. 3. To enhance skills in applying quantum mechanics in advanced theory of physics.								
Course Outcomes	1. Identify the concept of quantum mechanics and its statistical interpretation 2. Describe the properties of state vectors and Heisenberg's uncertainty principle 3. Define Symmetry and invariance principle and angular momentum 4. Verify the Indistinguishable and identical particles in quantum mechanics 5. Describe the Approximation methods in quantum mechanics, different theories and applications.								
Course Description	This course covers the theoretical basis of quantum physics. It includes the topics as de Broglie waves, and the wave-particle duality of matter and light. Introduction to wave mechanics: Schrödinger's equation, wave functions, wave packets, probability amplitudes, stationary states, the Heisenberg uncertainty principle, and zero-point energies. Solutions to Schrödinger's equation in one dimension: transmission and reflection at a barrier, barrier penetration, potential wells, the simple harmonic oscillator. Symmetry and invariance principle and conservation. Space and time translations, rotational invariance under infinitesimal and finite rotations, angular momentum operators are also included.								

Other learning resources

Unit-No.	Content	CH	Learning Outcome	KL	Ref
I	Basic Principles of quantum mechanics Physical interpretation of wave function, Schrödinger wave equation and its application in 1-, 2-, and 3-dimensional potential well, step potential barrier, motion in a central potential (Hydrogen atom), angular momentum representation using spherical coordinates and spherical harmonics, matrix formulation of quantum mechanics, concept of probability.	**7**	Knowledge on the topics as de Broglie waves, and the wave-particle duality of matter	1,2	**T1**
II	properties of state vectors – Ket and Bra algebra, operators, Heisenberg's uncertainty principle – proof (wave and matrix mechanics) and applications, linear harmonic oscillator problem in operator method using Bra and Ket vectors, Heisenberg's equation of motion and its physical equivalence with Schrödinger equation	**10**	Knowledge on the Heisenberg uncertainty principle, and zero-point energies.	1,2	**T1, R1**
III	Symmetry and invariance principle and conservation		To learn about symmetry and		**T1**

	Space and time translations, rotational invariance under infinitesimal and finite rotations. Angular momentum operators, ladder operators, addition of angular momenta – Clebsch-Gordan coefficients	**10**	invariance principle	1,2	
IV	Pauli spin matrices and SU(2) group, identical particles, symmetric and antisymmetric wave functions, combination of wave functions for a system of particles, spin statistics connection, exchange symmetry and exchange degeneracy.	**8**	Knowledge on Pauli spin matrices.	1,2	**T1, R2**
V	Approximation methods in quantum mechanics Time independent perturbation theory, Stark and Zeeman effects, variational method and its applications, WKB approximation, time dependent perturbation theory, transition to continuum states, Fermi's Golden rule, adiabatic and sudden approximation.	**10**	Concept on approximation methods in QM	1,2	**T1**

TEXTBOOKS:

T1: Modern Quantum Mechanics : J.J. Sakurai (Addison Wesley, Reading), 2004.

REFERENCE BOOKS:

R1: A Ghatak, S Loaknathan, Quantum Mechanics, Laxmi Publications,2017.

R2: Quantum Physics : S. Gasiorowicz (Wiley, New York), 3rd ed. 2003.

R3: A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan (Tata McGrawn Hill, New Delhi) 2nd edition, 2004.

OTHER LEARNING RESOURCES:

1. https://ocw.mit.edu/courses/8-04-quantum-physics-i-spring-2016/pages/video-lectures/part-1/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify the concept of quantum mechanics and its statistical interpretation	**1, 3**
2	Describe the properties of state vectors and Heisenberg's uncertainty principle	**1, 3, 4, 7**
3	Define Symmetry and invariance principle and angular momentum	**1, 2, 3, 4, 8**
4	Verify the Indistinguishable and identical particles in quantum mechanics	**1, 2, 3, 8**
5	Describe the Approximation methods in quantum mechanics, different theories and applications	**1, 3, 4, 8**

SEMESSTER I										
Course Title	**Classical Mechanics**									
Course Code	**24MSPH1103R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti-requisite	**Nil**								
Programmes	**Master of Science in Physics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To make students understand the fundamental concepts of the Special Theory of Relativity. 2. To understand the relativistic effects on motion, energy, and momentum. 3. To provide the advanced understanding of classical mechanics such as Reference frame, Lagrange's and Hamilton's equations, central force motion, and rigid body dynamics.									
Course Outcomes	1. Identify the concept of reference frames and their role in describing physical phenomena. 2. Describe the postulates of the Special Theory of Relativity 3. Define the concepts of central force motion. 4. Describe the idea of rigid body dynamics 5. Define Poisson brackets and their properties									
Course Description	Classical Mechanics involves the study of Lagrangian and Hamiltonian dynamics, central force motion, rigid body dynamics and theory of small oscillation.									
Other learning resources https://www.sciencedirect.com/topics/physics/classical-mechanics										

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**	**Ref**
I	Reference frame, Galilean Transformation, postulates of special theory of relativity, Lorentz transformation, acceleration transformation, momentum and energy transformation, time-dilation, lengthcontraction & twinparadox.	**7**	Knowledge of frames of reference their role in describing physical phenomena	1,2	**T1**
II	Lagrangian and Hamiltonian formalisms and equations of motion-their applications to physical problems. Cyclic coordinates, relativistic form of Lagrangian and Hamiltonian.	**10**	To learn the basic of Lagrangian and Hamiltonian theory to know about relativistic mechanics	1,2	**T1, R1**
III	Central-force motion - Two-body collisions, scattering in laboratory and centre-of-mass frames. Variational principle, Symmetry, invariance and conservation laws	**10**	To understand the basics of Central force motion .	1,2	**T1**
IV	Rigid body dynamics, moment of inertia tensor, non-inertial frames and pseudo forces. Principal axes and principal moments of inertia. Euler's equation of motion. Symmetric top motion and Foucault's pendulum.	**8**	To know about the rigid body dynamics	1,2	**T1, R2**
V	Poisson brackets and their properties,		Knowledge of		**T1**

	Theory of canonical transformations and generating function. Hamilton's equation in terms of Poisson bracket, Jacobi identity. Theory of small oscillations, coupled oscillations, diatomic and triatomic molecules.	**10**	Hamilton's equations of motion to interpret the physical meaning of classical mechanics.	1,2	
Practical	1. To determine the Moment of Inertia of a Flywheel. 2. To determine the value of g using Bar Pendulum. 3. To determine the value of g using Katers Pendulum.	**30**	Describe, illustrate and explain and apply staining techniques and carry out microscopic examination.	1,2, 3,	**R1**

Text Books

T1: Classical Mechanics, H. Goldstein (Pearson Education, 2014).

Reference Books

R1: Classical Mechanics, N. C. Rana and P. S. Jaog (McGraw-Hill, 1991).
R2: Mechanics, L. D. Landau and E. M. Lifshitz (3rd Ed., Pergamon, 1976).
R3: Introduction Classical Mechanics, R. G. Takawale & P. S. Puranik

OTHER LEARNING RESOURCES:

1. https://www.sciencedirect.com/topics/physics/classical-mechanics

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify the concept of reference frames and their role in describing physical phenomena.	**1, 3**
2	Describe the postulates of the Special Theory of Relativity	**1, 3, 4, 7**
3	Define the concepts of central force motion.	**1, 2, 3, 4, 8**
4	Define Poisson brackets and their properties	**1, 2, 3, 8**
5	Describe the idea of rigid body dynamics	**1, 3, 4, 8**

SEMESSTER I									
Course Title	**Electrodynamics**								
Course Code	**24MSPH1101R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti-requisite	**Nil**								
Programmes	**Master of Science in Physics**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. Student will be able to learn about field lines, flux and electromagnetism. 2. Student will be able to differentiate between Lorentz gauge and coulomb gauge transformations. 3. Student will be able to solve boundary value problems by applying various boundary conditions.								
Course Outcomes	1. Describe the knowledge of electrostatic and magnetostatic and their application 2. Describe the Maxwell's equations and electromagnetic boundary conditions. 3. Identify the wave equation and their propagation. 4. Define the idea of electromagnetic radiation. 5. Verify the knowledge of retarded potential and its applications.								
Course Description	This subject teaches the theory and principle of electrodynamics and their applications in solving problems with different boundary values.								
Other learning: https://www.britannica.com/science/electrodynamics									

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**	**Ref**
I	Review of Electrostatics and magneto-statics: Electrostatic and magnetostatic fields in matter, Method of images, boundary value problems, Laplace equation in rectangular, cylindrical and spherical coordinates.	15	Able to describe, illustrate and explain the electrostatics, magnetostatics and their application.	1,2	**T1**
II	Gauge transformation, Coulomb and Lorentz gauges, Maxwell's equations, conservation of energy and momentum in electrodynamics, Poynting Theorem.	10	Able to describe, illustrate and explain the Gauge transformation and its applications.	1,2	**T1, R1**
III	Wave equation, reflection, refraction and propagation of electromagnetic waves in dispersive media, wave equation in a conducting medium.	10	Able to describe, illustrate and explain the wave equation and their propagation	1,2	**T1**
IV	Wave-guides and cavity resonance, EM wave propagation of various types of EM modes indifferent types of wave guides.	10	Able to describe, illustrate and explain the wave propagation	1,2	**T1, R2**
V	Retarded potential, radiation from oscillatory dipole, radiation fields, radiation from a point charge in motion, Lienard – Wiechart potential, fields of a point charge in motion, power radiated by a	15	Able to describe, illustrate and explain the charge and their properties.	1,2	**T1**

	point charge, Larmor formula.				
Practical	1. Investigation of a series resonant LCR circuit a. To draw the resonance curve and b. To determine Q factor. 2. Hall effect: To calculate the Hall coefficient and the carrier concentration of the sample material. 3. Determination of E.M.F. of a cell by using a potentiometer and cell of known E.M.F.	15	Able to use various instruments for analysis	1,2, 3,4	**R1**

Text Books

T1: Introduction to Electrodynamics, David J. Griffiths, Cambridge University Press.

Reference Books

R1. Satya Prakash. Electromagnetic Theory and Eletrodynamics. 1st edition, Kedar Nath Ram Nath Publisher.
R2. Edward Mills Purcell. Electricity and Magnetism, 3rd, 2013
R3. Melvin Schwartz, Principles of Electrodynamics, **Dover Publications**

OTHER LEARNING RESOURCES:

1. https://www.britannica.com/science/electrodynamics

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the knowledge of electrostatic and magnetostatic and their application	**1, 3**
2	Describe the Maxwell's equations and electromagnetic boundary conditions.	**1, 3, 4, 7**
3	Identify the wave equation and their propagation.	**1, 2, 3, 4, 8**
4	Define the idea of electromagnetic radiation.	**1, 2, 3, 8**
5	Verify the knowledge of retarded potential and its applications.	**1, 3, 4, 8**

SEMESSTER I										
Course Title	**Fundamental of Statistics**									
Course code	**23UMFS111R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti- requisite	**Nil**								
Programmes	**Master of Science in Biotechnology**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course objectives	1. Help to understand the role of statistics in data analysis, decision-making, and scientific research 2. Introduce students to descriptive statistics, including measures of central tendency (mean, median, mode) and measures of dispersion (range, variance, standard deviation). 3. Teach students how to summarize and present data effectively using tables, charts, and graphs									
CO1	• Improve understanding of Descriptive Statistics and Demography.									
CO2	Develop knowledge to understand the Probability theory, Distribution, and sampling methods.									
CO3	Develop knowledge to understand the methods for hypothesis testing and Biological data analysis.									
CO4	Develop knowledge to understand the principles of various statistical analyses of data.									
CO5	Develop knowledge on R language for data analysis									
Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**						
I	**Statistical Methods**: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio.	5	Foundational Understanding of Statistical Concepts	1,2						
II	**Presentation**: tabular and graphical, including histogram and ogives. Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, skewness and kurtosis.	5	Proficiency in Data Presentation and Analysis	1,2						
III	**Bivariate data**: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, fitting of polynomials and exponential curves.	5	Knowledge on Analyzing Bivariate Data and Relationships	1,2						
IV	**Random experiment**: trial, sample point and sample space, event, Operations of Events, concepts of mutually exclusive and exhaustive events. Definition of probability: classical and relative frequency approach. Discrete probability space, Properties of probability, Independence of events, Conditional	8	Understanding of Probability and Distributions	1,2						

	probability, total and compound probability rules, Normal probability Distribution, Bionomial probability Distribution, Poisson Probability Distribution, Bayes' theorem and its applications.			
V	**Testing of hypothesis**, parametric test: t-test, z-test, chi-square test. Non-Parametric test: One sample Kolmogorov test, wilcoxon Signed test, Mann-Whitney Test, Kruskal walis test.	7	Application of Hypothesis Testing and Statistical Tests	1,2
Practical	1.Introduction to R - A programming language and environment for data analysis and graphics. Syntax of R expressions: Vectors and assignment, vector arithmetic, generating regular sequence, logical vector, character vectors, Index vectors; selecting and modifying subsets of dataset 2.Data objects: Basic data objects, matrices, partition of matrices, arrays, lists, creating and using these objects; Functions- Elementary functions and summary functions, applying functions to subsets of data. Data frames: The benefits of data frames, creating data frames, combining data frames, Adding new classes of variables to data frames; Data frame attributes. 3.Importing data files: import. data function, read. table function; Exporting data: export. data function, cat, write, and write. table functions, function, formatting output - options, and format functions; Exporting graphs -export. graph function. Graphics in R: creating graphs using plot function, box plot, histogram, line plot, steam and leaf plot, pie chart, bar chart, multiple plot layout, plot titles, formatting plot axes; Visualizing the multivariate data: Scatter plot, Q-Q plot, P-plot. 4.Performing data analysis tasks: Reading data with scan function, exploring data using graphical tools, computing descriptive statistics, one sample tests, two sample tests, Goodness of fit tests. 5.Parametric test and Non-Parametric test	30	A brief knowledge on using R for data analysis and visualization	1,2, 3,4

Textbooks:

T1**.** Methods in Biostatistics by K S Negi, ISBN:9789374735053,4th Edition, Year:2023, AITBS Publishers, INDIA

Reference books

R1."Introduction to the Practice of Statistics" by David S. Moore, George P. McCabe, and Bruce A. Craig

R2. "Statistics" by David Freedman, Robert Pisani, and Roger Purves

OTHER LEARNING RESOURCES:

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve understanding of Descriptive Statistics and Demography.	**1, 4**
2	Develop knowledge to understand the Probability theory, Distribution, and sampling methods.	**1, 4**
3	Develop knowledge to understand the methods for hypothesis testing and Biological data analysis.	**1, 4**
4	Develop knowledge to understand the principles of various statistical analyses of data.	**1, 4**
5	Develop knowledge on R language for data analysis	**1, 4, 9**

SEMESTER – I									
Course Title	**EFFECTIVE COMMUNICATION**								
Course Code	**24UMPD1101R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course Objectives	1. To introduce the types of sentences and their significance. 2. To strengthen the students' vocabulary to enhance their speaking and writing skills. 3. To familiarize the students with the importance of dress codes in various organizations. 4. Tointroducethe3P's (Planning, prioritizing & performing) of Time Management. 5. To give insight into English pronunciation and into central concepts in phonetics.								
CO1	Analyse and identify the different types of sentences.								
CO2	Able to integrate the skills of reading and speaking in professional communication.								
CO3	Illustrate code Etiquette sessions will boost their confidence and morals.								
CO4	Describe about the effective and efficient utilization of time.								
CO5	Explain the concept of Phonetics and its importance will improve the learners 'pronunciation								
MODULES	**Module 1- Grammar** Interchange of Interrogative and Assertive Sentences, Exclamatory and Assertive Sentences, Types of Tenses, Common Errors, Synonyms, Antonyms, Homonyms **Module 2- Reading Skills** Techniques of Effective Reading, Gathering ideas and information from a text The SQ3R Technique Interpret the text **Module 3-Listening Skills** What is listening?, The Process of Listening, Factors that adversely affect Listening, Difference between Listening and Hearing, Purpose and Importance of Effective Listening, How to Improve Listening Process, **Module 4- Conflict Management** Definition**,** Type of Conflict Management**,** Effects of Conflict Management**,** Methods to deal with Conflicts (Negative) **Module 5- Time-Management Skills** Introduction To Time Management, Purpose And Importance of Time Management, Basic Tips to Maintain Time. **Activity: Problem solving activity**: A situation will be given to the students and they will have to tell us how to handle the situation or solve the problem.								

TEXTBOOKS:

T1. Wren, P.C and Martin, H. 1995. High School English Grammar and Composition, S Chand Publishing.
T2. English Grammar in Use, Raymond Murphy 4th edition, CUP.
T3. Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.

REFERENCE BOOKS:

R1. English Vocabulary in Use (Advanced), Michael McCarthy and Felicity, CUP.
R2. Effective Communication and Soft Skills, Nitin Bhatnagar, Pearsons.

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Analyse and identify the different types of sentences.	**1, 5**
2	Able to integrate the skills of reading and speaking in professional communication.	**1, 5, 9**
3	Illustrate code Etiquette sessions will boost their confidence and morals.	**5, 6, 9**
4	Describe about the effective and efficient utilization of time.	**5, 9**
5	Explain the concept of Phonetics and its importance will improve the learners 'pronunciation	**1, 5, 9**

SEMESTER – II										
Course Title	**Mathematical Physics**									
Course code	**24MSPH1102R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti- requisite	**Nil**								
Programmes	**Master of Science in Physics**								
Semester	**Fall/I Semester of First Year of the Program**								
Course objectives	1. To understand and apply the mathematical skills to solve quantitative problems in the study of physics 2. To impart knowledge about various mathematical theory which will enable the students to understand the physics problem. 3. Students can use differential and integral equations as a tool to analyze experimental data.								
Course outcomes:	1. Describe the linear vector space and matrices. 2. Verify the fundamentals of matrices and tensors for solving more complex mathematical expressions 3. Identify the concepts of differential and integral equation to solve mathematical problems in physics 4. Describe the concepts of complex variables. 5. Define the concepts of group theory.								
Course Description:	This paper is intended for students to impart knowledge on introduction to the study of mathematical physics by knowing the concepts of vector space and matrices, tensors, differential and integral equation, complex variables and group theory.								

Other learning resources:

Unit-No.	Content	CH	Learning Outcome	KL	Ref
I	N–dimensional linear vector space, basis, scalar product, metric spaces. Infinite dimensional space – Hilbert space. Matrix representation of operators, Unitary and Hermitian matrices. Diagonalisation of matrices, eigen values and eigen vectors.	10	Knowledge on the concept of scalars and vectors their multiplication and matrix representation.	1,2	**T1**
II	Contravariant and covariant tensors. Outer product and contraction. Kronecker delta and Levi Civita tensor.	10	Understanding the tensors and their applications.	1,2	**T1, R1**
III	Hermite and Legendre polynomials. Gamma and beta functions. Dirac functions. Partial differential equations: One dimensional wave equation, one dimensional heat flow equation (finite and infinite rod). Laplace's equation and its solution. Green's function. Fredholm and Volterra types. Method of substitution.	10	Build knowledge of the different differential and integral equation and their solution.	1,2	**T1**

IV	Analyticity, Cauchy integral theorem, residue theorem and complex integrations.	8	Understand the complex variables and their theory.	1,2, 3	**T1, R2, R1, R3**
V	Introduction to groups, subgroups, coset, classes and factor groups. Direct and semi-direct products. Group representation: reducible and irreducible representation.	7	Learn the concepts of group theory and their representation.	1,2, 3, 4	**T1**

TEXTBOOKS

T1. Satya Prakash, Mathematical Physics.

REFERENCE BOOKS

R1. Mathematical Physics, V. Balakrishnan (1st Ed., Ane Books, 2018).
R2. B. D. Gupta, Mathematical Physics.
R3. Mathematical Methods for Physicists, G. Arfken (7th Ed., Elsevier, 2012).

OTHER LEARNING RESOURCES:

https://web.mit.edu/8.Math/www/lectures/index.html

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the linear vector space and matrices.	**1**
2	Verify the fundamentals of matrices and tensors for solving more complex mathematical expressions	**1, 2, 3, 4, 6**
3	Identify the concepts of differential and integral equation to solve mathematical problems in physics	**1, 2, 3, 4, 6**
4	Describe the concepts of complex variables.	**1, 4**
5	Define the concepts of group theory.	**1, 2, 7**

SEMESTER – II									
Course Title	**Thermodynamics and Statistical Mechanics**								
Course code	**24MSPH1202R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Physics**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course objectives	1. Understand thermodynamic laws, potentials, statistical ensembles, and phase transitions in classical and quantum systems. 2. Apply statistical mechanics to analyze gases, fluctuations, and critical phenomena in real world systems. 2. Explore quantum statistics, including Bose-Einstein condensation, Fermi gases, and black body radiation.								
CO1	Understand thermodynamic laws, potentials, statistical ensembles, and phase transitions in classical and quantum systems.								
CO2	Apply statistical mechanics to analyze gases, fluctuations, and critical phenomena in real world systems.								
CO3	Explore quantum statistics, including Bose-Einstein condensation, Fermi gases, and black body radiation.								

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Unit-1: Thermodynamic variables, Thermal equilibrium; Temperature; Zeroth law of thermodynamics; First law of thermodynamics; Second law of thermodynamics; Entropy; Fundamental relation of a thermodynamic system; Helmholtz free energy; Enthalpy; Gibbs free energy; Maxwell's relations; Chemical potential; Third law of thermodynamics. Quasistatic and reversible processes; irreversibility. Carnot engine.	**7**	Understand thermodynamic laws, potentials, processes, and efficiencies.	1,2
II	Thermodynamic description of phase transitions; Condition of phase coexistence; Claussias-Clapeyron equation; van der Waal's equation of state, Critical point. Random walk. Kinetic theory of gases. Phase space; Distribution function; Liouville's theorem; Generalised equipartition theorem.	**10**	Understand phase transitions, kinetic theory, and statistical mechanics.	1,2
III	Statistical ensemble; Boltzmann entropy; Ergodicity; Microcanonical ensemble; Ideal classical gas; Gibbs paradox; Canonical ensemble; Canonical partition function; Free energy; grand-canonical ensembles, partition function, postulates of classical statistical mechanics, derivation of thermodynamics from statistical mechanics principles, equation of state for ideal and real gases, Gibbs paradox.	**10**	Understand statistical ensembles, entropy, partition functions, and thermodynamics.	1,2
IV	Framework of quantum statistics, quantum mechanical ensembles, microcanonical, canonical, and grand canonical ensembles, postulates of quantum statistical mechanics. Maxwell–Boltzmann, Bose–Einstein and Fermi–Dirac statistics, partition and grand	**8**	Understand quantum statistics, ensembles, and properties of gases.	1,2

	partition functions, statistics of occupation numbers, distinction between classical and quantum statistics, fluctuations. Ideal Bose gas and its properties, Bose-Einstein condensation (BEC) and experimental evidences, thermodynamics of black body radiation. Ideal Fermi gas and its properties, degenerate and nondegenerate Fermi gas, electrons in metals, white dwarfs.			
V	Fluctuations, Brownian motion, Einstein–Smoluchowski theory, Langevin theory, approach to equilibrium: Fokker-Planck equation. Critical Phenomena, Phase transitions, Ising model, Yang and Lee Theory. Properties of Liquid Helium, Two fluid hydrodynamics, Landau criterion, Theory of Feynman.	**10**	Understand fluctuations, critical phenomena and phase transitions.	1,2

TEXTBOOKS

T1. T1: Statistical Mechanics: R.K. Pathria and P.D. Beale.

REFERENCE BOOKS

R1. Statistical Mechanics: K. Huang.

R2. Callen, H. B., Thermodynamics and Introduction to Thermostatistics, 2nd edition, (Wiley Student Edition).

R3. Statistical Physics: L. Landau and E.M. LifShitz.

OTHER LEARNING RESOURCES:

https://ocw.mit.edu/courses/8-333-statistical-mechanics-i-statistical-mechanics-of-particles-fall-2013/video_galleries/video-lectures/

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Understand thermodynamic laws, potentials, statistical ensembles, and phase transitions in classical and quantum systems.	**1, 2**
2	Apply statistical mechanics to analyze gases, fluctuations, and critical phenomena in real world systems.	**1, 3, 4**
3	Explore quantum statistics, including Bose-Einstein condensation, Fermi gases, and black body radiation.	**1, 2, 3, 4**

SEMESTER – II									
Course Title	**Electronics**								
Course code	**24MSPH1204R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+ 30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Physics**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course objectives	1. To get the concept of various semiconductor devices such as diodes and transistors, LED and solar cell 2. Students will learn the basic concepts of Op-Amp and their applications 3. A basic idea on digital circuits, both sequential and combinational circuits								
Course Outcomes	1. Describe various semiconductor devices such as diodes and transistors 2. Identify operational Amplifier and its applications. 3. Define the building blocks of digital systems and combinational circuits. 4. Identify the basic concept of memory elements and sequential circuits. 5. Describe basic concepts of combination of logic gates								
Course Description	Through the electronics course, students will the knowledge on semiconductor devices such as Diodes, Zener diode as voltage regulator, transistors, Solar Cell, Photodetectors, LED etc. they will learn about amplifier logic gates and their designs.								
Other learning resources: https://www.youtube.com/watch?v=w8Dq8blTmSA									

Unit-No.	Content	CH	Learning Outcome	KL	REF
I	Semiconductor devices: Diodes, Zener diode as voltage regulator, transistors, transistor biasing and dcloadline analysis, Introduction to Optoelectronic devices, Solar Cell, Photodetectors, LED etc. Concepts of FET Devices: JFET, MOSFET, MESFET etc.	**7**	Knowledge on semiconductor devices and its applications	1,2	**T1**
II	Typical operational amplifier, differential amplifier, differential mode & common mode operation, CMRR, Open loop and close loop Op-Amp, application of inverting &noninverting amplifier, voltage follower.	**6**	Knowledge on amplifiers and its types.	1,2	**T1, R1**
III	Logic gates, Design of Half and Full Adders, Half and Full Subtractors, Magnitude Comparator, Encoders, Decoders, Multiplexers, Demultiplexer.	**7**	Knowledge on different types logic gates and its applications	1,2	**T1**
IV	Memory element, Flip flops (SR, D, JK and T), counters, registers, Analog to Digital and Digital to analog converters, Introduction to Microprocessors.	**5**	A good knowledge on sequential circuit	1,2	**T1, R2**
V	Combinational Circuit Logic gates, Design of Half and Full Adders, Half and Full Subtractors, Magnitude Comparator, Encoders, Decoders, Multiplexers, Demultiplexer.	**5**	A brief knowledge on logic gates and its design.	1,2	**T1**

Textbooks

T1. Electronic Devices and Circuit Theory, R L Boylestad.

Reference books

R1: Modern Digital and Analog Communication Systems, B P Lathi.
R2: Electronic Communication System, George Kennedy.
R3. OPAMPS and Linear Integrated Circuits, Ramakant A Gayakwad.
R4: Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.

Other learning resources

1. https://www.youtube.com/watch?v=w8Dq8blTmSA

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe various semiconductor devices such as diodes and transistors	**1**
2	Identify operational Amplifier and its applications.	**1, 2, 3, 4, 6**
3	Define the building blocks of digital systems and combinational circuits	**1, 2, 3, 4, 6**
4	Identify the basic concept of memory elements and sequential circuits.	**1, 4**
5	Describe basic concepts of combination of logic gates	**1, 2, 7**

<table>
<tr><th colspan="10">SEMESTER – II</th></tr>
<tr><td>Course Title</td><td colspan="9">Research Methodology and Statistical Analysis</td></tr>
<tr><td rowspan="2">Course code</td><td rowspan="2">24MSPH1205R</td><td rowspan="2">Total credits: 2
Total hours:15T+60S</td><td>L</td><td>T</td><td>P</td><td>S</td><td>R</td><td>O/f</td><td>C</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>4</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td>Nil</td><td>Co-requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Anti- requisite</td><td>Nil</td><td colspan="8"></td></tr>
<tr><td>Programmes</td><td colspan="9">Master of Science in Physics</td></tr>
<tr><td>Semester</td><td colspan="9">Spring/II semester of First year of the programme</td></tr>
<tr><td>Course Objectives</td><td colspan="9">1. The course aims to enhances the students' a broad understanding of research methodology,
includingtheoryofscienceandqualitativeandquantitativemethodsinresearch.
2. The course seeks to enhance the students' skills for developing critical thinking through research literature review in different domain. Consequently, it aims to develop skills for preparation of a research proposal for a master' thesis project/Mini research.
3. To develop Students competency in planning, conducting, evaluating and presenting a research project.</td></tr>
<tr><td>Course Outcomes</td><td colspan="9">1. Students will have basic knowledge of Research methods.
2. Students will gain the knowledge of Research Methodology.
3. Students will be able to gain the Skill questionnaire development. Students will be able to acquire the knowledge of basic Report/dissertation Procedure.</td></tr>
<tr><td>Course Description</td><td colspan="9">This course offers an overview of research methodology including basic concepts employed in
quantitative and qualitative research methods. Includes computer applications for research.</td></tr>
<tr><td>References</td><td colspan="9">1. Boyle JS. Styles of ethnography. In: JM Morse, editor. Critical issues in qualitative research methods.
3. Thousand Oaks, CA: Sage, 1994:159–85.
4. 2 Coughlan M., Cronin P. and Ryan F. (2007). Step-by-step guide to critiquing research. Part 1:
5. quantitative research. British journal of Nursing 16 (11).
6. 3 Creswell, JW. (1998). Qualitative Inquiry and Research Design Choosing Among Five Traditions.
7. Thousand Oaks, CA: Sage Publications.
8. 4 Crotty, M. (1998). The Foundations of social research: Meaning and perspective in the research
9. process. London: Sage.
10. 5 Denzin, NK. (1978). Sociological Methods. New York: McGraw-Hill.
11. 6 Hanson WE, JW Creswell, VL Plano Clark, KS Petska and JD Creswell. Mixed Methods Research
12. Designs in Counseling Psychology. Journal of Counseling Psychology, 2005, Vol. 52, No. 2, 224–
13. 235 http://www.preciousheart.net/chaplaincy/Auditor_Manual/13casesd.pdf
14. 7 Johnson & Christensen. (2004). Educational Research: Quantitative, qualitative and mixes</td></tr>
<tr><td>Unit</td><td colspan="9">Content</td></tr>
<tr><td>I</td><td colspan="9">Research Methodology- An Introduction- meaning and objectives of research, motivation in research, types and significance of research, criteria of good research. Defining the Research Problems- definition of research
problem, necessity of defining research problem</td></tr>
<tr><td>II</td><td colspan="9">Research Design- meaning and need of research design, features of a good design,</td></tr>
</table>

	different research designs, Sampling Design- steps in sampling design, Sample Size determination, criteria for selecting a sampling design, different types of sampling design, Experimental Design, Principles of Design of Experiment, One – way ANOVA, Two- Way ANOVA, CRD, RBD, LSD, 22, 23 Factorial Design
III	Types of data, sources of data collection, tools of data collection, Nominal, ordinal, interval and ratio – Attitude scale construction and measurement, rating scales, semantic differential (SD), Use of scale in statistical analysis, Schedules for interviews preparation and standardization, development of survey instruments and item analysis for the questionnaire
IV	Planning and organizing research report, Format of research report, Different steps of writing report, lay out of the research report , How to organize thesis/Dissertation, mechanics of writing research report, standard methods of quoting- presenting the result, written and oral reports, Uses of abstract, format of research report, presentation of statistics - tabular and graphic references and uses of references, Bibliography and presentation of bibliography
V	Intellectual property right (IPR), Introduction and the need for IPR, IPR in India and worldwide, Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications, Patentable and non-patentable, patenting life, Filing of a patent application, The different layers of the international patent system, Case studies on Basmati rice, Turmeric, and Neem patents
Laboratory	Laboratory using R Software: 1 Analysis of One way ANOVA; 2 Analysis of Two way ANOVA; 3 Analysis of CRD 4 Analysis of RBD 5 Analysis of 22 and 23 Factorial Experiment 6 Simulation-I using R (Bernoulli, Binomial, Poisson and Geometric distribution.). 7 Simulation-II using R (Exponential and Normal distribution). 8 Simple random Sampling Stratified Random Sampling

Textbooks

T1.

Reference books

1. Boyle JS. Styles of ethnography. In: JM Morse, editor. Critical issues in qualitative research methods.
2. Thousand Oaks, CA: Sage, 1994:159–85.
3. Coughlan M., Cronin P. and Ryan F. (2007). Step-by-step guide to critiquing research. Part 1:
4. quantitative research. British journal of Nursing 16 (11).
5. Creswell, JW. (1998). Qualitative Inquiry and Research Design Choosing Among Five Traditions.
6. Thousand Oaks, CA: Sage Publications.
7. Crotty, M. (1998). The Foundations of social research: Meaning and perspective in the research process. London: Sage.
8. Denzin, NK. (1978). Sociological Methods. New York: McGraw-Hill.
9. Hanson WE, JW Creswell, VL Plano Clark, KS Petska and JD Creswell. Mixed Methods Research
10. Designs in Counseling Psychology. Journal of Counseling Psychology, 2005, Vol. 52, No. 2, 224
11. Johnson & Christensen. (2004). Educational Research: Quantitative, qualitative and mixes

Other learning resources

1. http://www.preciousheart.net/chaplaincy/Auditor_Manual/13casesd.pdf

SEMESTER – III									
Course Title	**Atomic and Molecular Physics**								
Course code	**24MSPH2101R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Physics**								
Semester	**Spring/III Semester of First Year of the Programme**								
Course Objectives	1. Introduction to emission and absorption spectra of the atoms 2. Knowledge of different energy levels in atoms and various coupling schemes. 3. To know the Born-Oppenheimer Approximation and its application on molecular spectroscopy								
Course Outcomes	1.Identify different energy levels of atoms, frequencies of spectral lines of alkali spectra 2.Describe the concepts of Zeeman effect, Paschen Back effect and Stark effect in atomic spectrum. 3.Define the concept on molecular spectra. 4.Acquire adequate idea on Raman Spectroscopy. 5.Define the properties of laser, various types of lasers and their working principles.								
Course Description	The broad objective of the course is to provide a knowledge about the spectra of atoms and molecules and lasers.								
Other learning resources: https://www.youtube.com/playlist?list=PLslAZxgdwx64zd2RPrcrFxjt-1eSRLVui									

Unit-No.	Content	CH	Learning Outcome	KL	REF
I	Atomic emission and absorption spectra, fine structure of hydrogen atom, spectra of helium and alkali atoms, Lande interval rule, L-S and J-J coupling schemes.	10	To learn about the spectra of Hydrogen and alkali atoms, L-S and J-J coupling schemes	1,2	T1, R1
II	Zeeman effect, Paschen Back effect, Stark effect, Calculation of Zeeman pattern and intensity distribution in complex spectra. Hyperfine structure and determination of nuclear spin. Breadth of spectrum lines: Natural broadening, Doppler broadening, Collision broadening and Stark broadening.	**12**	To apply knowledge of Zeeman effect for Calculation of Zeeman pattern. To learn about Paschen Back effect, Stark effect, Hyperfine structure and Breadth of spectrum lines	**1,2**	**T1, R1, R4**
III	Rotation, vibration and rotation-vibration spectra of diatomic molecules, selection rules. Electronic spectra: Born-Oppenheimer approximation, formation of bands, progressions and sequences of vibrational bands, Intensity distribution, Franck Condon principle	**10**	To learn about Rotation, vibration and rotation-vibration spectra of diatomic molecules.	**1,2**	**T2, R2**
IV	Raman spectra: Classical theory of Raman effect, Vibrational Raman spectrum, selection rules, Stokes and antiStokes lines, Rotational Raman spectrum, selection rule.	**5**	To get knowledge of Raman effect and Rotational Raman spectrum	**1,2, 3,4**	**T2, R2**
V	Properties of laser light, spontaneous and stimulated emission – Einstein's coefficients, light amplification, population inversion and threshold condition for laser oscillations; optical resonator modes of a rectangular cavity, the quality factor (Q-factor). ammonia maser, Types of lasers: He-Ne laser, semiconductor lasers	**10**	To learn the applications of laser.	**1,2, 3,4**	**T3, R3**

Textbooks

T1. Introduction to Atomic Spectra - H E White.
T2. Fundamentals of Molecular Spectroscopy - C N Banwell and E M McCash.
T3. Lasers: Theory and Applications - K Thyagarajan and A K Ghatak.

Reference books

R1. Physics of atoms and molecules - B H Bransden and C J Joachain
R2. Spectra of Diatomic Molecules (Vol. 1) - G Herzberg.
R3. Laser Fundamentals: W.T silfvast.
R4. Atoms, molecules and quanta: A. E. Ruark, HC. Urey.

Other learning resources

https://www.youtube.com/playlist?list=PLslAZxgdwx64zd2RPrcrFxjt-1eSRLVui

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify different energy levels of atoms, frequencies of spectral lines of alkali spectra	**1, 2, 4, 8**
2	Describe the concepts of Zeeman effect, Paschen Back effect and Stark effect in atomic spectrum.	**1, 2, 3, 4, 8**
3	Define the concept on molecular spectra.	**1, 2, 4, 8**
4	Acquire adequate idea on Raman Spectroscopy.	**1, 2, 4, 8**
5	Define the properties of laser, various types of lasers and their working principles.	**1, 2, 4, 8**

SEMESTER – III									
Course Title	**RESEARCH PROJECT I (SURVEY/EXPERIMENTS-R1)**								
Course code	**24MSMB2104R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 8 (P)	**0**	**0**	**8**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Microbiology**								
Semester	**Fall/III Semester of Second Year of the Programme**								
Course objectives	1. To learn the principles of designing effective surveys, including question formulation and sampling techniques. 2. To gain hands-on experience in designing and conducting research experiments to test hypotheses								
CO1	Formulate research methodology								
CO2	Prepare research tool(s)								
CO3	Apply the knowledge of sampling methods in sample collection.								
CO4	Design experiment using scientific method								
CO5	Investigate the research Problem								

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Formulate research methodology	**1, 2, 4, 6, 7**
2	Prepare research tool(s)	**1, 3, 4**
3	Apply the knowledge of sampling methods in sample collection.	**1, 2, 3, 4**
4	Design experiment using scientific method	**1, 2, 3, 4, 6**
5	Investigate the research Problem	**1, 2, 3, 4, 7**

SEMESTER – III									
Course Title	**Nuclear Physics I**								
Course code	**24MSPH1203R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60 T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti-requisite	**Nil**								
Programmes	**Master of Science in Physics**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course Objectives	1. To impart knowledge about basic nuclear physics properties and related reaction dynamics. 2. To introduce the concept of bound state problem. 3. To familiarize with the fundamental forces and the dynamics of elementary particles under these force. 4. To give basic ideas on Beta decay and its importance in nuclear physics. 5. To introduce properties of nuclei and details of popular nuclear models								
Course Outcomes	1. Describe basic properties of nuclei, nuclear interactions, nuclear structure and reactions. 2. Apply laws of conservation and momentum in determination of particle properties and properties of processes in the subatomic world. 3. Describe bound state problems and properties of deuteron ground state with square well potential. 4. Explain beta decay and properties of neutrino. 5. Identify the strengths and limitations of various nuclear models.								
Course Description	The course will discuss nuclear physics. Properties of nuclei and details of popular nuclear models, properties of nuclear decays and nuclear reactions will be discussed in brief, but in a self-consistent manner. Study of different nuclear models are also included in the course.								
Other learning resources: https://www.sciencedirect.com/topics/physics/nuclear-physics									

Unit-No.	Content	CH	Learning Outcome	KL	Ref
I	Size of the nucleus and its determination from electron, scattering.	**7**	Introductory knowledge and refreshing the existing understanding	1,2	**T1**
II	Bound state problems: properties of deuteron ground state with square well potential, magnetic dipole moment and electric quadruple moment of deuteron.	**10**	Concept of bound states to solve problems	1,2	**T1, R1**
III	Nucleon stability; mass parabolas- prediction of stability against β decay; stability limits against spontaneous fission. Shell model	**10**	Knowledge on nuclear stability and shell model	1,2	**T1**
IV	Beta-decay: Fermi's theory of beta decay, Curie's plot, parity violation in beta-decay.	**8**	Concept of beta decay and elementary particle neutrino	1,2	**T1, R2**
V	Nuclear Models: Liquid drop model: Binding energy, semi empirical mass formula, nuclear stability, shell model	**10**	Knowledge on different nuclear models	1,2	**T1**

Textbooks

T1. Nuclear Structure Vol. 1 & 2., A Bohr & Ben R. Mottelson, World Scientific.

Reference books

R1. Introductory Nuclear Physics, Samuel S. M. Wong, Wiley-Vch.
R2: Fundamentals in Nuclear Physics, Jean-Louis Basdevant, James Rich, Michel Spiro, Springer
R3 S. N. Ghoshal. Nuclear Physics, S.Chand Publications

Other learning resources

https://www.sciencedirect.com/topics/physics/nuclear-physics.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe basic properties of nuclei, nuclear interactions, nuclear structure and reactions.	**1, 3**
2	Apply laws of conservation and momentum in determination of particle properties and properties of processes in the subatomic world.	**1, 3, 4, 7**
3	Describe bound state problems and properties of deuteron ground state with square well potential.	**1, 2, 3, 4, 8**
4	Explain beta decay and properties of neutrino.	**1, 2, 3, 8**
5	Identify the strengths and limitations of various nuclear models.	**1, 3, 4, 8**

SEMESTER – IV										
Course Title	**Condensed Matter Physics**									
Course code	**24MSPH1202R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti-requisite	**Nil**								
Programmes	**Master of Science in Physics**								
Semester	**Spring/IV Semester of Second Year of the Programme**								
Course objectives	1. To make students understand the crystal structures and their studies 2. To make students learn physics behind the formation of solids of different types To understand the natures of electrical and thermal conductivities of metals from free electron theory of metals								
Course outcomes	1. Define the crystalline state of solids and X-ray diffraction 2. Identify the crystal bonding and lattice dynamics 3. Describe the electric and magnetic properties of solids 4. Describe the lattice vibration in solids. 5. Define the properties of semiconductors.								
Course Description	This course aims at acquiring the knowledge of matter in the condensed phase, their structural, electrical, and magnetic properties. The students will be able to compute parameters related to extent and nature of crystallinity, conductivity, defects etc. and the way these affect some basic properties.								
Text Books	**T1**. Solid State Physics, A J Dekker.								
Reference Books	**R1**. Introduction to Solid State Physics, C Kittel **R2**. Lattice Dynamics, A K Ghatak and L S Kothari **R3**. Solid State Physics, N W Ashcroft and N D Mermin.								
Other learning resources: https://www.britannica.com/science/condensed-matter-physics									

Unit No.	Content	CH	Learning Outcome	KL	Ref
I	Amorphous and Crystalline Materials. Lattice Translation Vectors. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Diffraction of X-rays by Crystals. Bragg's Law.	**7**	Knowledge of crystal structure and laws	1,2	**T1**
II	Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T3 law	**10**	Knowledge on elementary lattice dynamics	1,2	**T1, R1**
III	Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Curie's law, Weiss's law	**10**	Knowledge on Magnetic Properties of Matter	1,2	**T1**
IV	Bloch function, Kronig-Penney model, Brillouin zones, effective mass of charge carriers. Tight binding and Wigner - Seitz method.	**8**	Knowledge on theoretical and mathematical model of crystal structure.	1,2	**T1, R2**
V	Intrinsic and extrinsic semiconductor, number density of carriers in intrinsic and extrinsic semiconductors, expression for Fermi levels, photoconductivity, Hall effect in metals and semiconductors.	**10**	Theoretical and practical knowledge of semiconductors.	1,2	**T1**

Textbooks

T1. Solid State Physics, A J Dekker.

Reference books

R1. Introduction to Solid State Physics, C Kittel

R2. Lattice Dynamics, A K Ghatak and L S Kothari

R3. Solid State Physics, N W Ashcroft and N D Mermin.

Other learning resources

https://www.britannica.com/science/condensed-matter-physics

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Define the crystalline state of solids and X-ray diffraction	**1, 3**
2	Identify the crystal bonding and lattice dynamics	**1, 3, 4, 7**
3	Describe the electric and magnetic properties of solids	**1, 2, 3, 4, 8**
4	Describe the lattice vibration in solids.	**1, 2, 3, 8**
5	Define the properties of semiconductors.	**1, 3, 4, 8**

SEMESTER – III										
Course Title	**Astrophysics**									
Course Code	**24MSPH2103R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours:	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre- Requisite		**CO-REQUISITE**	**NA**						
Anti- Requisite	**NA**								
Programmes	**Master of Science in Physics**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	1. 1. To impart adequate knowledge on the Astronomy & Astrophysics. 2. 2. To study about the stellar structure, stellar evolution, the solar system, formation of galaxies and stars.								
Course Outcomes	1. Identify and get adequate idea on astronomical observation, Magnitude scales, and various types of astronomical telescopes. 2. Describe Interstellar matter, Formation of galaxies and star clusters, Hertzsprung-Russel diagram. 3. Define the concept on stellar structure, stellar evolution, Black holes and gamma ray bursts. 4. Identify the energy production in stars e.g. p-p chain, carbon-nitrogen-oxygen cycle and Triple alpha process. 5. Define Hubble's classification of galaxies, surface brightness, galactic center and Active galactic nuclei.								
Course Description	Astrophysics courses study about the Celestial coordinate systems, Interstellar matter, stellar evolution, the solar system, formation of galaxies and stars.								
Text Books	T1: Astrophysics - Baidyanath Basu.								
Reference Books	R1: Physics of Stars - A C Phillips. R2: Introduction to stellar structure – S. Chandrasekhar R3: Astrophysics: Stars and Galaxies - K. D. Abhyankar, Universities Press R4: Introduction to stellar astrophysics - Francis LeBlanc, Wiley								
Other Learning Resources: https://www.youtube.com/channel/UC-UUo6Y7fP0N41Qw7KcKtcQ									

Unit no	Content	CH	Learning outcome	KL	REF
I	The celestial sphere, Celestial coordinate systems, Concept of time — solar time and sidereal time. Magnitude scales, colour index, apparent, absolute and instrumental magnitudes. Different types of astronomical telescopes and their mounts.	**10**	To learn the Celestial coordinate systems, apparent, absolute magnitudes and various types of astronomical telescopes	**1,2**	**T1, R1, R2**
II	Interstellar matter, Formation of galaxies and star clusters. Free-fall collapse and formation of stars. Hertzsprung-Russel (H-R) diagram and stellar classification. Stellar spectra. Main sequence, pre- and post-main sequence stars. Red giants.	**10**	To get the basic ideas on Interstellar matter, Formation of galaxies and star clusters.	**1,2**	**T1, R2**
III	Stellar structure and evolution: Hydrostatic equilibrium. Stellar structure equations. Polytropic stars and related integral theorems. Stellar atmosphere and Saha equation. Gravitational collapse, degeneracy pressure in stars – structure of white dwarf and neutron star. Supernova, Black holes and gamma ray bursts.	**12**	To get the basic knowledge of stellar structure and evolution, white dwarf and neutron star. Supernova, Black holes and gamma ray bursts.	**1,2**	**T1, R1, R2**
IV	Energy production in stars: nuclear reactions, reaction rates, p-p chain and carbon-nitrogen-oxygen (CNO) cycle, Triple alpha process. Solar System: Sun and its properties, planets and satellites, asteroids, comets and Oort's cloud.	**8**	To learn about the various nuclear reactions for energy production in stars, sun and solar system, asteroids, comets and Oort's cloud.	**1,2,**	**T1, R3, R4**

V	Galaxies: Hubble's classification of galaxies, properties of spirals, ellipticals and lenticular galaxies, surface brightness, distribution of light and mass, the galactic centre, 21 cm line, Active galactic nuclei.	**5**	To give the basic idea of Hubble's classification of galaxies, the galactic centre, 21 cm line, Active galactic nuclei.	**1,2, 3,4**	**T1, R3, R4**

Textbooks

T1. Astrophysics - Baidyanath Basu.

Reference books

R1: Physics of Stars - A C Phillips.
R2: Introduction to stellar structure – S. Chandrasekhar
R3: Astrophysics: Stars and Galaxies - K. D. Abhyankar, Universities Press
R4: Introduction to stellar astrophysics - Francis LeBlanc, Wiley

Other learning resources

https://www.youtube.com/channel/UC-UUo6Y7fP0N41Qw7KcKtcQ

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify and get adequate idea on astronomical observation, Magnitude scales, and various types of astronomical telescopes.	**1, 3,**
2	Describe Interstellar matter, Formation of galaxies and star clusters, Hertzsprung-Russel diagram.	**1, 3, 4, 7**
3	Define the concept on stellar structure, stellar evolution, Black holes and gamma ray bursts.	**1, 2, 3, 4, 8**
4	Identify the energy production in stars e.g. p-p chain, carbon-nitrogen-oxygen cycle and Triple alpha process.	**1, 2, 3, 8**
5	Define Hubble's classification of galaxies, surface brightness, galactic center and Active galactic nuclei	**1, 3, 4, 8**

SEMESTER – III										
Course Title	**Plasma Physics I**									
Course Code	**24MSPH2203R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 60T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre- Requisite		**CO-REQUISITE**	**NA**						
Anti- Requisite	**NA**								
Programmes	**Master of Science in Physics**								
Semester	**Spring/III Semester**								
Course Objectives	1. The course will give the comprehensive knowledge on plasma 2. The course enables the students to have a mature understanding of the applied electrodynamics 3. To learn about the nature and properties of plasma.								
Course Outcomes	1. Identify the basic concepts of plasma 2. Describe the plasma motion and its variation with electric and magnetic field. 3. Define the plasma fluid nature 4. Describe the need of kinetic theory in plasma. 5.Identify the nature of plasma waves in the universe								
Course Description	A course designed to incorporate introduction to plasma physics. The course provides a comprehensive description on the physics of plasmas along with the on plasma parameters and plasma waves.								
Text Books	**T1**: Introduction to Plasma Physics and Controlled Fusion: F F Chen								
Reference Books	**R1**: Fundamentals of Plasma Physics: J J Bittencourt **R2**: Plasma Physics :R J Goldstone and P H Rutherford								
Other Learning Resources: https://www.youtube.com/playlist?list=PLbMVogVj5nJS4KY5UFWBLSu7kMzPbL35T									

Unit no	Content	CH	Learning outcome	KL	REF
1	Review of basic concepts of plasma physics: Concept of Plasma Temperature and Debye Shielding, Guiding centre motion and drifts, Plasma Criteria, Plasma approximation	1	To understand the basics of plasma physics	1,2	**T1, R1**
2	Introduction to single particle motion, Uniform and Non-uniform E and B field, Time-Varying E and B field, Guiding center drifts, Adiabatic Invariants	2	To learn about plasma motion	1,2	**T1, R1**
3	Development of Ideal MHD theory. Plasma as a Fluid. Linear theory of Plasma Waves with MHD description - Electron and Ion Waves. Concept of Plasma Resistivity. Single Fluid MHD equations and MHD Waves. Two-stream Instability	3	To learn about plasma dynamics	1,2	**T1, R2**
4	Need for kinetic theory and MHD as approximation of kinetic theory. Application of Kinetic Theory to Electron Plasma Waves and Landau Damping.	3	To learn about kinetic theory of plasma	1,2	**T1, R2**
5	Wave Representation, Group Velocity, Plasma Oscillations, Different kinds of Plasma waves: Electron plasma waves, Ion Waves, Hydromagnetic waves, Magneto sonic waves	5	To learn about wave nature of plasma	1,2,3	**T1, R2**

Textbooks

T1. Introduction to Plasma Physics and Controlled Fusion: F F Chen.

Reference books

R1: Fundamentals of Plasma Physics: J J Bittencourt

R2: Plasma Physics :R J Goldstone and P H Rutherford

Other learning resources

https://www.youtube.com/playlist?list=PLbMVogVj5nJS4KY5UFWBLSu7kMzPbL35T

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify the basic concepts of plasma	**1, 3**
2	Describe the plasma motion and its variation with electric and magnetic field.	**1, 3, 4, 7**
3	Define the plasma fluid nature	**1, 2, 3, 4, 8**
4	Describe the need of kinetic theory in plasma	**1, 2, 3, 8**
5	Identify the nature of plasma waves in the universe	**1, 3, 4, 8**

SEMESTER – III									
Course Title	**Non- Linear Optics**								
Course Code	**24MSPH2104R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours:	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre- Requisite		**CO-REQUISITE**	**NA**						
Anti- Requisite	**NA**								
Programmes	**Master of Science in Physics**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	1. The students will be able to understand the Spectroscopic aspects of nonlinear optics. 2. The students will be able to learn about Non-linear processes and multi- photon processes.								
Course Outcomes	1. Describe the propagation of electromagnetic wave in nonlinear optical media. 2. Define the concept about non-linear processes. 3. Identify Phase-matching techniques in nonlinear optics 4. Identify the multi-photon processes. 5. Identify Rayleigh and Raman scattering in nonlinear optics								
Course Description	This course deals with the Spectroscopic aspects of nonlinear optics and Raman scattering.								
Text Books	T1: Nonlinear Optics: R.W Boyd. Academic Press.								
Reference Books	R1: Laser and Nonlinear Optics: B. B Land, New Age International. R2: Essentials of Laser & Nonlinear Optics: G. D. Baruah, Pragati Prakashan								
Other Learning Resources:	https://www.youtube.com/watch?v=jbzx-4L4W1s								

Unit no	Content	CH	Learning outcome	KL	REF
I	Non-Linear Optics introduction, propagation of electromagnetic wave in nonlinear optical media, nonlinear optical susceptibility.	**10**	To learn the propagation of electromagnetic wave in nonlinear optical media.	**1,2**	**T1, R1**
II	Harmonic generation, second harmonic generation, sum and difference frequency generation, third-harmonic generation, phase-matching technique, parametric generation, self-focusing	**8**	To get the knowledge about harmonic generation, second harmonic generation	**1,2**	**T1, R2**
III	Phase-matching technique, parametric generation, self-focusing.	**8**	To get the basic idea on third-harmonic generation, parametric generation and self-focusing.	**z**	**T1, R1**
IV	Multi-quantum photoelectric effect, two- and three-photon processes, experiments, parametric and phase conjugation optics.	**10**	To understand about multi-quantum photoelectric effect, two- and three-photon processes and phase conjugation optics.	**1,2,**	**T1, R2**
V	Rayleigh and Raman scattering, inelastic scattering processes, Stokes anti-Stokes coupling, stimulated Raman scattering.	**9**	To learn about stimulated Raman scattering	**1,2, 3,4**	**T1, R1, R2**

Textbooks

T1. Nonlinear Optics: R.W Boyd. Academic Press.

Reference books

R1: Laser and Nonlinear Optics: B. B Land, New Age International.

R2: Essentials of Laser & Nonlinear Optics: G. D. Baruah, Pragati Prakashan

Other learning resources

1. https://www.youtube.com/watch?v=jbzx-4L4W1s

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the propagation of electromagnetic wave in nonlinear optical media.	**1, 3**
2	Define the concept about non-linear processes.	**1, 3, 4, 7**
3	Identify Phase-matching techniques in nonlinear optics	**1, 2, 3, 4, 8**
4	Identify the multi-photon processes.	**1, 2, 3, 8**
5	Identify Rayleigh and Raman scattering in nonlinear optics	**1, 3, 4, 8**

SEMESTER – IV									
Course Title	**RESEARCH PROJECT II (RESEARCH DATA ANALYSIS AND DOCUMENTATION-R4)**								
Course code	**23MSMB221R**	**Total credits: 16**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 32(P)	**0**	**0**	**32**	**0**	**0**	**0**	**16**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Physics**								
Semester	**Spring/IV Semester of Second Year of the Programme**								
Course Objectives	1. To enable students to apply experimental methods to solve a given scientific task. 2. To be able to analyse research data 3. To be able to compile and document research data.								
CO1	Learn to tabulate research data								
CO2	Analyze research outcomes								
CO3	Corelate with exiting literature								
CO4	Prepare an effective dissertation report								
CO5	Able to communicate research outcome								

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn to tabulate research data	**1, 2, 3, 4, 6, 7**
2	Analyze research outcomes	**1, 2, 3, 4, 6, 7**
3	Corelate with exiting literature	**3, 4, 6, 7**
4	Prepare an effective dissertation report	**1, 2, 3, 5, 6, 7**
5	Able to communicate research outcome	**5, 6**

SEMESTER – IV									
Course Title	**Nuclear Physics II**								
Course code	**24MSPH1203R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60 T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti-requisite	**Nil**								
Programmes	**Master of Science in Physics**								
Semester	**Spring/IV Semester of Second Year of the Programme**								
Course Objectives	1. To impart knowledge about basic nuclear physics properties and related reaction dynamics. 2. To introduce the concept of bound state problem. 3. To familiarize with the fundamental forces and the dynamics of elementary particles under these force. 4. To give basic ideas on Beta decay and its importance in nuclear physics. 5. To introduce properties of nuclei and details of popular nuclear models								
Course outcomes	1. Describe basic properties of nuclei, nuclear interactions, nuclear structure and reactions. 2. Apply laws of conservation and momentum in determination of particle properties and properties of processes in the subatomic world. 3. Describe bound state problems and properties of deuteron ground state with square well potential. 4. Explain beta decay and properties of neutrino. 5. Identify the strengths and limitations of various nuclear models.								
Course Description	The course will discuss nuclear physics. Properties of nuclei and details of popular nuclear models, properties of nuclear decays and nuclear reactions will be discussed in brief, but in a self-consistent manner. Study of different nuclear models are also included in the course.								
Text books	T1. Nuclear Structure Vol. 1 & 2., A Bohr & Ben R. Mottelson, World Scientific.								
Reference books	**R1**. Introductory Nuclear Physics, Samuel S. M. Wong, Wiley-Vch **R2:** Fundamentals in Nuclear Physics, Jean-Louis Basdevant, James Rich, Michel Spiro, Springer **R3** S. N. Ghoshal. Nuclear Physics, S.Chand Publications.								
Other learning resources: https://www.sciencedirect.com/topics/physics/nuclear-physics									

Unit-No.	Content	CH	Learning Outcome	KL	Ref
I	Size of the nucleus and its determination from electron, scattering; form factor; angular momentum; spin and moments.	**7**	Introductory knowledge and refreshing the existing understanding	1,2	**T1**
II	Bound state problems: properties of deuteron ground state with square well potential, magnetic dipole moment and electric quadruple moment of deuteron.	**10**	Concept of bound states to solve problems	1,2	**T1, R1**
III	Nucleon stability; mass parabolas- prediction of stability against β decay; stability limits against spontaneous fission. Shell model: evidence of shell structure; magic numbers; effective single particle potentials-square well and harmonic oscillator; extreme single particle models-its success and failures in predicting ground state spin;parity.	**10**	Knowledge on nuclear stability and shell model	1,2	**T1**
IV	Beta-decay: Fermi's theory of beta decay, Curie's plot, parity violation in beta-decay and Wu's experiment, concept of neutrino mass and oscillations (solar and atmospheric neutrino puzzles), concept of double beta decay and Majorana neutrino, radioactive dating	**8**	Concept of beta decay and elementary particle neutrino	1,2	**T1, R2**
V	Nuclear Models: Liquid drop model: Binding energy, semi empirical mass formula, nuclear stability, shell model	**10**	Knowledge on different nuclear models	1,2	**T1**

Textbooks

T1. Nuclear Structure Vol. 1 & 2., A Bohr & Ben R. Mottelson, World Scientific.

Reference books

R1. Introductory Nuclear Physics, Samuel S. M. Wong, Wiley-Vch.
R2: Fundamentals in Nuclear Physics, Jean-Louis Basdevant, James Rich, Michel Spiro, Springer
R3 S. N. Ghoshal. Nuclear Physics, S.Chand Publications

Other learning resources

https://www.sciencedirect.com/topics/physics/nuclear-physics.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe basic properties of nuclei, nuclear interactions, nuclear structure and reactions.	**1, 3**
2	Apply laws of conservation and momentum in determination of particle properties and properties of processes in the subatomic world.	**1, 3, 4, 7**
3	Describe bound state problems and properties of deuteron ground state with square well potential.	**1, 2, 3, 4, 8**
4	Explain beta decay and properties of neutrino.	**1, 2, 3, 8**
5	Identify the strengths and limitations of various nuclear models	**1, 3, 4, 8**

SEMESTER – III									
Course Title	**Advanced Condense Matter Physics**								
Course code	**24MSPH1202R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti-requisite	**Nil**								
Programmes	**Master of Science in Physics**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course objectives	1. To make students understand the electrical properties of solid. 2. To make students learn physics behind superconductivity. 3. To understand the physics of thin film and critical phenomena.								
Course outcomes	1. Learn about advanced electrical properties of solids. 2. Learn about advanced semiconductor physics. 3. Learn about superconductivity. 4. Learn about physics of thin films. 5. Learn about critical phenomena.								
Course Description	This course aims at acquiring the knowledge of matter in the condensed phase, their structural, electrical, and magnetic properties. The students will be able to compute parameters related to extent and nature of crystallinity, conductivity, defects etc. and the way these affect some basic properties.								
Text books	**T1**. Solid State Physics, A J Dekker.								
Reference books	**R1**. Introduction to Solid State Physics, C Kittel **R2**. Lattice Dynamics, A K Ghatak and L S Kothari **R3**. Solid State Physics, N W Ashcroft and N D Mermin.								
Other learning resources: https://www.britannica.com/science/condensed-matter-physics									

Unit No.	Content	CH	Learning Outcome	KL	Ref
I	Band theory of solids, nearly free electron model, tight binding approximation, Dielectric constant, polarizability, Kronig-Kramer relations.	**7**	Learn about advanced electrical properties of solids.	1,2	**T1**
II	Thermodynamics of superconductivity, Rutger's formula, Isotope effect, London equations, Cooper pairs, electron-phonon interaction, BCS theory, flux quantization, A.C. & D.C. Josephson effects, High temperature super conductors, SQUIDS, super conducting magnets, Application and limitations of HTSC.	**10**	Learn about superconductivity.	1,2	**T1, R1**
III	Density of states and statistics of impurity semi conductors, scattering mechanism and mobility of charge carriers, transport carriers, continuity equation, surface recombination steady state and transient photo-conductivity, theory of simplified model of abrupt p-n junction, p-n junction rectifier and transistor, break down in p-n junction, P-N junction based devices: Tunnel diodes metal semiconductor junctions, semi conductor homo and hetero junctions, I-V characteristics of junctions, photo- generation at p-n junction, photo voltaic effect, Gunn effect	**10**	Learn about advanced semiconductor physics.	1,2	**T1**
IV	Thin and thick films and, their differences, deposition techniques of thin film-vacuum evaporation, sputtering, chemical vapour deposition, molecular beam epitaxy. Nucleation and growth process, epitaxial growth techniques for measuring this film thickness, size effect-change of electrical resistivity of thin films of metal, F-S theory,	**8**	Learn about physics of thin films.	1,2	**T1, R2**

	application of thin films.				
V	Phase transitions in different systems, first order and second order phase transitions, thermodynamics and statistical mechanics of phase transition, examples of critical phenomena: liquid-gas, paramagnetic-ferromagnetic, normal to superconductor, and superfluid transitions, phase diagrams, critical point exponents and exponent inequalities.	**10**	Learn about critical phenomena	1,2	**T1**

Textbooks

T1. Solid State Physics, A J Dekker.

Reference books

R1. Introduction to Solid State Physics, C Kittel

R2. Lattice Dynamics, A K Ghatak and L S Kothari

R3. Solid State Physics, N W Ashcroft and N D Mermin.

Other learning resources

https://www.britannica.com/science/condensed-matter-physics

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn about advanced electrical properties of solids.	**1, 3**
2	Learn about advanced semiconductor physics.	**1, 3, 4, 7**
3	Learn about superconductivity.	**1, 2, 3, 4, 8**
4	Learn about physics of thin films	**1, 2, 3, 8**
5	Learn about critical phenomena.	**1, 3, 4, 8**

SEMESTER – IV										
Course Title	**General Theory of Relativity & Cosmology**									
Course code	**24MSPH2202R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60T	**4**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti-requisite	**Nil**								
Programmes	**Master of Science in Physics**								
Semester	**Spring/IV Semester**								
Course objectives	1.To learn about basics of General Theory of Relativity and Cosmology. 2. To understand about metric tensor, motion in the gravitational field, bending of light, gravitational waves and Big Bang cosmological models. 3.Enable to apply theoretical knowledge of relativity in the practical field of relativity.									
Course outcomes	1. Describe the concept general theory of relativity, principle of equivalence, principle of general congruence. 2. Describe adequate idea on tensors, motion in the gravitational field 3. Verify different types of tensors like covariant, contravariant tensors and metric tensor. 4. Describe the idea on rotating black holes and gravitational waves 5. Describe the Cosmological principle, Big Bang Nucleosynthesis, dark matter and dark energy.									
Course Description	The course aims to provide adequate understanding to the elements of the General Theory of Relativity and Cosmology.									
Other learning resources: https://www.britannica.com/science/general-relativity										

Unit No.	**Content**	**CH**	**Learning Outcome**	**KL**	**Ref**
1	General relativity – special theory of relativity, equality of gravitational and inertial masses, Principle of equivalence, Principle of General Congruence.				
2	Gravity as metric phenomenon, geodesic, curvature, energy – momentum tensor, Einstein's law of gravitation (field equations), Newtonian approximation, Symmetries in general relativity – Killing vector, test particle orbits for massive and massless particles.	6	To understand the basics General theory of relativity.	1,2	**T1, R1**
3	Tensor Analysis: Covariant and contravariant tensors, quotient rule, metric tensor. Christoffel symbol, covariant derivative of contravariant and covariant tensors, Einstein tensor.	10	To learn about metric tensor, Einstein's law of gravitation (field equations), Newtonian approximation, Gravity as metric phenomenon.	1,2	**T1, R1, R2**
4	Schwarzschild solution, Schwarzschild black holes and Kerr solution (rotating black holes) and their astrophysical importance. Experimental tests – Precession of perihelion of Mercury, binary pulsars, gravitational redshift and bending of light, gravitational waves	8	To learn about Schwarzschild black holes, binary pulsars, gravitational redshift and bending of light, gravitational waves.	1,2	**T2, R2**
5	Cosmological principle, redshift and Hubble's law from Robertson – Walker metric, Friedmann models, Singularity. Cosmological parameters,	16	To learn about Cosmological principle, redshift		**T2, R2**

	magnitude -redshift relations. Age of the universe. Early universe , inflation. Thermal history of the universe: Big Bang Nucleosynthesis, matter radiation decoupling, Cosmic Microwave Background (CMB). Idea of dark matter and dark energy.		and Hubble's law. Friedmann models, Singularity. Cosmological parameters, Cosmic Microwave	1,2	

Textbooks

T1: Introduction to relativity - J V Narlikar.

T2: Gravitation and Cosmology - S Weinberg.

Reference books

R1: Relativity, Gravitation, and Cosmology - T P Cheng

R2: General relativity, astrophysics, and cosmology - Ray Choudhry, Banerji and Banerjee.

Other learning resources

https://www.britannica.com/science/general-relativity

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the concept general theory of relativity, principle of equivalence, principle of general congruence.	**1, 3**
2	Describe adequate idea on tensors, motion in the gravitational field	**1, 3, 4, 7**
3	Verify different types of tensors like covariant, contravariant tensors and metric tensor.	**1, 2, 3, 4, 8**
4	Describe the idea on rotating black holes and gravitational waves	**1, 2, 3, 8**
5	Describe the Cosmological principle, Big Bang Nucleosynthesis, dark matter and dark energy.	**1, 3, 4, 8**

SEMESTER – IV									
Course Title	**Plasma Physics II**								
Course code	**24MSPH2203R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/f**	**C**
		Total hours: 60 T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti- requisite	**Nil**								
Programmes	**Master of Science in Physics**								
Semester	**Spring/IVSemester**								
Course objectives	1. The course will give the comprehensive knowledge on plasma 2. The course enables the students to have a mature understanding of the applied electrodynamics 3. To learn about the nature and properties of plasma.								
Course outcomes	1. Identify the basic concepts of plasma 2. To learn Transport Phenomena in Plasma. 3. To learn about Kinetic Theory of Plasma 4. To learn about Nonlinear Effects 5. To learn about Plasma Applications								
Course description	A course designed to incorporate introduction to plasma physics. The course provides a comprehensive description on the physics of plasmas along with the on plasma parameters and plasma waves.								
Text books **Reference books**	**T1**: Introduction to Plasma Physics and Controlled Fusion: F F Chen **R1**: Fundamentals of Plasma Physics: J J Bittencourt **R2**: Plasma Physics :R J Goldstone and P H Rutherford								
Other learning resources	https://www.youtube.com/playlist?list=PLbMVogVj5nJS4KY5UFWBLSu7kMzPbL35T								

Unit no	Content	CH	Learning Outcome	KL	Ref
1	Review of basic concepts of plasma physics: Concept of Plasma Temperature and Debye Shielding, Guiding centre motion and drifts, Plasma Criteria, Plasma approximation	1	To understand the basics of plasma physics	1,2	**T1, R1**
2	Diffusion and resistivity in weakly Ionized plasma, Steady State Solutions, Diffusion across a magnetic field, Bohm Diffusion and Neoclassical Diffusion, Hydromagnetic equilibrium, Classification of Plasma Instabilities, Methods of Stability Analysis, Two-Stream Instability, Gravitational Instability.	2	To learn Transport Phenomena in Plasma	1,2	**T1, R1**
3	Introduction to kinetic theory, distribution function and macroscopic variables, Boltzmann Equation, Fluid Equations, application of Vlasov equation, Landau damping, Physical derivation of Landau damping, Kinetic effects in a magnetic field.	3	To learn about Kinetic Theory of Plasma	1,2	**T1, R2**
4	Introduction, Plasma Sheath, Langmuir Probe, Plasma Echoes, The Ponderomotive Force, Ion-acoustic Solitary Waves and the Korteweg-de Vries (KdV) Equation, Sagdeev Potential, Nonlinear Schrodinger Equation, Modulational Instability and Envelope Soliton	3	To learn about Nonlinear Effects	1,2	**T1, R2**
5	Introduction to practical aspects of Plasma Physics, Plasma production, Plasma Diagnostic Techniques, Heating of the Plasma, Tokamak theory, Confinement of the Plasma.	5	To learn about Plasma Applications	1,2,3	**T1, R2**

Textbooks

T1. Introduction to Plasma Physics and Controlled Fusion: F F Chen.

Reference books

R1: Fundamentals of Plasma Physics: J J Bittencourt

R2: Plasma Physics :R J Goldstone and P H Rutherford

Other learning resources

https://www.youtube.com/playlist?list=PLbMVogVj5nJS4KY5UFWBLSu7kMzPbL35T

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify the basic concepts of plasma	**1, 3**
2	To learn Transport Phenomena in Plasma.	**1, 3, 4, 7**
3	To learn about Kinetic Theory of Plasma	**1, 2, 3, 4, 8**
4	To learn about Nonlinear Effects	**1, 2, 3, 8**
5	To learn about Plasma Applications	**1, 3, 4, 8**

SEMESTER – IV									
Course Title	**Advanced Molecular Spectroscopy and laser**								
Course code	**24MSPH2101R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 60 T	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Anti-requisite	**Nil**								
Programmes	**Master of Science in Physics**								
Semester	**Spring/III Semester of First Year of the Programme**								
Course Objectives	1. Introduction to emission and absorption spectra of the atoms 2. Knowledge of different energy levels in atoms and various coupling schemes. 3. To know the Born-Oppenheimer Approximation and its application on molecular spectroscopy								
Course Outcomes	1.Identify different energy levels of atoms, frequencies of spectral lines of alkali spectra 2.Describe the concepts of Zeeman effect, Paschen Back effect and Stark effect in atomic spectrum. 3.Define the concept on molecular spectra. 4.Acquire adequate idea on Raman Spectroscopy. 5.Define the properties of laser, various types of lasers and their working principles.								
Course Description	The broad objective of the course is to provide a knowledge about the spectra of atoms and molecules and lasers.								
Other learning resources: http://www.preciousheart.net/chaplaincy/Auditor_Manual/13casesd.pdf									

Unit-No.	**Content**	**CH**	**Learning Outcome**	**KL**	**Ref**
I	Atomic emission and absorption spectra, fine structure of hydrogen atom, spectra of helium and alkali atoms, Lande interval rule, L-S and J-J coupling schemes.	**10**	To learn about the spectra of Hydrogen and alkali atoms, L-S and J-J coupling schemes	1,2	T1, R1
II	Zeeman effect, Paschen Back effect, Stark effect, Calculation of Zeeman pattern and intensity distribution in complex spectra. Hyperfine structure and determination of nuclear spin. Breadth of spectrum lines: Natural broadening, Doppler broadening, Collision broadening and Stark broadening.	**12**	To apply knowledge of Zeeman effect for Calculation of Zeeman pattern. To learn about Paschen Back effect, Stark effect, Hyperfine structure and Breadth of spectrum lines	**1,2**	**T1, R1, R4**
III	Rotation, vibration and rotation-vibration spectra of diatomic molecules, selection rules. Electronic spectra: Born-Oppenheimer approximation, formation of bands, progressions and sequences of vibrational bands, Intensity distribution, Franck Condon principle	**10**	To learn about Rotation, vibration and rotation-vibration spectra of diatomic molecules.	**1,2**	**T2, R2**
IV	Raman spectra: Classical theory of Raman effect, Vibrational Raman spectrum, selection rules, Stokes and anti Stokes lines, Rotational Raman spectrum, selection rule.	**5**	To get knowledge of Raman effect and Rotational Raman spectrum	**1,2, 3,4**	**T2, R2**
V	Properties of laser light, spontaneous and stimulated emission – Einstein's coefficients, light amplification, population inversion and threshold condition for laser oscillations; optical resonator modes of a rectangular cavity, the quality factor (Q-factor). ammonia maser, Types of lasers: He-Ne laser, semiconductor lasers	**10**	To learn the applications of laser.	**1,2, 3,4**	**T3, R3**

Textbooks

T1. Introduction to Atomic Spectra - H E White.
T2. Fundamentals of Molecular Spectroscopy - C N Banwell and E M McCash.
T3. Lasers: Theory and Applications - K Thyagarajan and A K Ghatak.

Reference books

R1. Physics of atoms and molecules - B H Bransden and C J Joachain
R2. Spectra of Diatomic Molecules (Vol. 1) - G Herzberg.
R3. Laser Fundamentals: W.T silfvast.
R4. Atoms, molecules and quanta: A. E. Ruark, HC. Urey.

Other learning resources

http://www.preciousheart.net/chaplaincy/Auditor_Manual/13casesd.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify different energy levels of atoms, frequencies of spectral lines of alkali spectra	**1, 3**
2	Describe the concepts of Zeeman effect, Paschen Back effect and Stark effect in atomic spectrum.	**1, 3, 4, 7**
3	Define the concept on molecular spectra.	**1, 2, 3, 4, 8**
4	Acquire adequate idea on Raman Spectroscopy.	**1, 2, 3, 8**
5	Define the properties of laser, various types of lasers and their working principles.	**1, 3, 4, 8**

Assam down town University

Curriculum and Syllabus

Master of Science
in
Zoology

OUTCOME BASED EDUCATION FRAMEWORK
CHOICE BASED CREDIT SYSTEM
Version: 2.2

FACULTY OF SCIENCE

July, 2024

PREAMBLE

Assam down town University is a premier higher educational institution which offers Bachelor, Master, and Ph.D. degree programmes across various faculties. These programmes, collectively embodies the vision and mission of the university. In keeping with the vision of evolutionary changes taking place in the educational landscape of the country, the university has restructured the course curriculum as per the guidelines of National Education Policy 2020. This document contains outline of teaching and learning framework and complete detailing of the courses. This document is a guidebook for the students to choose desired courses for completing the programme and to be eligible for the degree. This volume also includes the prescribed literature, study materials, texts, and reference books under different courses as guidance for the students to follow.

Recommended by the Board of Studies (BOS) meeting of the Faculty of Science held on dated 16th & 17th July, 2024 and approved by the 51st Academic Council (AC) meeting held on dated 26/07/2024

Chairperson, Board of Studies

Member Secretary, Academic Council

Vision

To become a Globally Recognized University from North Eastern Region of India,dedicated to the Holistic Development of Students and Making Society Better

Missions

1. Creation of curricula that address the local, regional, national, and international needs of graduates, providing them with diverse and well- rounded education.
2. Build a diverse student body from various socio-economic backgrounds, provide exceptional value-based education, and foster holistic personal development, strong academic careers, and confidence.
3. Achieve high placement success by offering students skill-based, innovative education and strong industry connections.
4. Become the premier destination of young people, desirous of becoming future professional leaders through multidisciplinary learning and serving societybetter.
5. Create a highly inspiring intellectual environment for exceptional learners, empowering them to aspire to join internationally acclaimed institutions and contribute to global efforts in addressing critical issues, such as sustainable development, Climate mitigation and fostering a conflict-free global society.
6. To be renowned for creating new knowledge through high quality interdisciplinary research for betterment of society.
7. Become a key hub for the growth and excellence of AdtU's stakeholders including educators, researchers and innovators
8. Adapt to the evolving needs and changing realities of our students and community by incorporating national and global perspectives, while ensuring our actions are in harmony with our foundational values and objectives of serving the community.

Programme Details

Programme Overview

The Zoology program equips graduates for careers in industry, agriculture, and research. They develop professional, communication, and ethical skills, blending innovation and entrepreneurship for personal and national growth, while remaining responsive to societal needs and committed to lifelong learning. Graduates will identify and analyze biotechnological problems, apply multidisciplinary concepts, and achieve global competency. They gain scientific knowledge, laboratory and analytical skills, and problem-solving abilities in various fields. Proficiency in scientific tools, enhanced communication skills, adherence to professional ethics, and a research-oriented mindset are emphasized. Social and environmental responsibility, promoting sustainability, and contributing to societal development are key outcomes.

The course duration is for a period of 2 years.

I. Specific Features of the Curriculum

- Experiential learning
- Constructivist approach to learn
- Practical and project-based learning

II. Eligibility Criteria:

BSc in any area of life sciences with minimum of 45% marks or equivalent CGPA.

III. Program Educational Objectives (PEOs):

PEO1: AdtU zoology postgraduates will be well prepared for successful careers in both government & private sectors in one or more of the following areas: ecological, conservation biology, pest, habitat, vector borne disease management and health sciences.

PEO2: The postgraduates will be academically prepared to become zoologists in due course and will contribute effectively to the growth and development of in broad field of ecology & life sciences.

PEO3: The postgraduates will engage in professional activities to enhance their stature and simultaneously contribute to the profession and society at large and be successful in higher education in zoology in apiculture, ornamental fish farming and health sciences, if pursed.

IV. Program Specific Outcomes (PSOs):

PSO1: Proficiency in Scientific Knowledge: Apply the skills necessary to address challenges within the domains of zoology and open a multitude of employment opportunities in the relevant field.

PSO2: Critical Thinking: Able to promote a multidisciplinary approach for research exploration and collaboration with professionals across diverse disciplines.

PSO3: Techno-Professional Competency: Develop capability to cultivate ethical values in professionalism, emphasising integrity, responsibility, continuous learning, and skill refinement in alignment with the latest advancements in zoological science.

V. Program Outcome:

PO1: Disciplinary Knowledge: Apply comprehensive knowledge of basic sciences, biostatistics, life sciences and specialization in zoological sciences for solving complex health, agricultural, taxonomical and ecological issues.

PO2: Problem Solving: Identify, review literature, formulate, analyse and evaluate complex zoological problems using critical thinking.

PO3: Reasoning and Research: Recognise the cause and effect, design hypotheses and experiments using modern tools and techniques, analyse and interpret the data to draw reasonable conclusions.

PO4: Communication: Communicate efficiently among stakeholders and society at large, and be able to write documents/scientific reports and deliver effective presentations.

PO5: Values and Ethics: Comply with human values and ethics and its strict application in the profession.

PO6: Environmental Sustainability: Understand the impact of the formulated solutions in socio-environmental context and redesign considering sustainable global development.

PO7: Teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO8: Lifelong Learning: Ability to engage in independent lifelong learning in the broadest context of scientific advancement.

VI. Total Credits to be Earned: 88

VII. Career Prospects:

A post Graduate in Zoology can make one attractive to a wide variety of organisations including charities, government agencies, universities, and research centres. They can join pharmaceutical companies, fisheries and sericulture Departments, Zoological Survey of India, Entomologist, Forest Department, Wildlife Institutes and NGO's, Wildlife related Broadcasting Channels, Health Department.

EVALUATION METHODS

The student performance shall be evaluated through In-semester (Sessional) and semester-end examinations. A weightage of 40% or as prescribed by the programme shall be added to the score of the end-semester examination.

A. INTERNAL ASSESSMENT:

The teacher who offers the course shall be responsible for internal assessment by conducting in-semester (sessional) examination and evaluating the performance of the students pursuing that course. The components for internal assessment are illustrated in the table given below.

SN	Components/ Examinations	Marks Allotted
1.	In-Sem Exam – I (ISE-I) (Written Examination)*	30
2.	In-Sem Exam – II (ISE-II) (Written Examination)*	30
3.	Assignment	10
4.	Presentation (SP)	10
5.	Quiz	5
6.	Class Performance based score*	5

are compulsory

Note: *Total Internal assessment should be out of 40*

INSTRUCTION

1. If a student fails to appear in the any of the component without any valid reason he/she shall be marked zero in that component. However, the course teacher at his discretion may arrange for the missed test on an alternate date for the absentee students after determining ground with genuine/valid reasons for the absent.
2. The report of evaluation of an activity towards the in-semester (sessional) component of a course shall be duly notified by the concerned course teacher within a week of completion.
3. The program coordinators should upload the in-semester marks to the ERP and forward acknowledgement of all the courses of the program to the Controller of Examinations before the start of the End-semester examination.

B. SEMESTER END EXAMINATION:

Time table for end semester examination is published at least 25 days prior to the start of Examination.

I. Pre-Examination:

Eligibility Criteria for a student to appear in University Examinations:

The student shall only be allowed to appear in a University Examination, if:

i) He/ She is a registered student of the University;

ii) He/ She is of good conduct and character;

iii) He/ She has completed the prescribed Programme of study with minimum percentage of attendance as laid down in the Regulations of the Programme concerned.

Under special cases, a student may be allowed to appear for an examination without being registered in the University but the result of the said student will be kept on hold till the registration of the concerned student is completed.

II. Admit Card:

Admit card for the examination may be downloaded through ERP where the system will generate a Unique ID Cards through online.

The University shall have the right to cancel admission for examination of any candidate on valid grounds.

III. Pattern of Question Papers:

The question paper shall follow the principles of Bloom's Taxonomy.

Table

S. N.	Level	Questions /verbs for test
1	Remember	List, Define, tell, describe, recite, recall, identify, show who, when, where, etc.
2	Understand	Describe, explain, contrast, summarize, differentiate, discuss etc.
3	Apply	Predict, apply, solve, illustrate, determine, examine, modify
4	Analyze	Classify, outline, categorize, analyze, diagrams, illustrate, infer, etc.
5	Evaluate	Assess, summarize, choose, evaluate, recommend, justify, compare etc.
6	Create	Design, Formulate, Modify, Develop, integrate, etc.

Note: No course is to be evaluated on basis of **all 6 knowledge levels.**

The format of the question paper across all the program follow a unique pattern and the total marks is 60

Table 1: Question paper pattern for End semester examination

Sl no	Question pattern	Total marks
1	MCQs (10 Questions)	10
2	2 Marks questions (10 Questions)	20
3	4 Marks questions (5 Questions)	20
4	10 Marks questions (1 Question)	10

IV. Examination Duration:

Each paper of 60 marks shall ordinarily be of two hours duration.

V. Practical Examinations, Viva-Voce etc.:

i) Practical examination shall be conducted in the presence of one external expert and one or more internal examiners.

ii) Viva-Voce, Oral examinations of the Project report, Dissertation etc. shall be undertaken by a Board of Examiners constituted by the respective Dean of Program with the advice of Supervisor(s).

VI. Procedure of Expulsion:

If any candidate is found to be using any unfair-means during the examination, the invigilator may cease his/her answer sheet and report it directly to the Officer-in-Charge. The Office-in-Charge of the center may take appropriate decisions as per the rules and procedure of the examination. The Officer-in-Charge may allow the students to write the exam with new answer sheet or may expel the student from appearing the paper depending on the nature of unfair-means. In case of Computer based test, the students may be directed to write an apology letter and sign in the prescribe expulsion form. The student may not be allowed to write that examination.

VII. Instruction to the Students:

(i) The students shall not bring to the Examination Hall, any electronic gadget used as a means of communication or record except electronic calculator, if required.

(ii) The students shall not receive any book or printed or hand written or photo copy (Xerox) or blank-paper from any other person while he/she is in the examination-room or in laboratory or in any other place to which he/she is allowed to have access during course of examination.

(iii) The students shall not communicate with any other candidate in the examination room or with any other person in and outside the examination-room.

(iv) The students shall not see, read or copy anything written by any other candidate, nor shall he/she knowingly or negligently permit any other candidate to see, read or copy anything written by him/her or conveyed by him/her.

(v) The students shall not write anything on the Question Paper or in other paper or materials during the examination, or pass any kind of paper to any other candidate in the examination-room, or to any person outside the room.

(vi) The students shall not disclose his/her identity to the examiner by writing his/her name or putting any sign / symbol in any part of his answer-script.

(vii) The students shall not use any abusive language or write any objectionable remark or make any appeal to examiner by writing in any part of his answer-script.

(viii) The students shall not detach any page from the answer-script or insert any authorized or unauthorized loose sheet into it. He /she shall also not insert any other answer-script / loose sheet by removing the pins of the origin answer-scripts and re-fixing it.

(ix) The students shall not resort to any disorderly conduct inside the examination-room or misbehave with the invigilator or any other examination official.

VIII. Provision for an Amanuensis (writer):

(i) A candidate may be provided with an Amanuensis (writer) to write down on dictation on his / her behalf on ground of his / her physical disability to write down by himself / herself due to accident or any other reason. The amanuensis may be provided till he / she recovers from the physical disability. The physical disability to write down by himself / herself must be supported by Medical Certificate from a competent Medical Officer.

(ii) The qualifications of the amanuensis so provided must not be equal or higher than that of the candidate. This is also to be supported by Certificate from the Faculty of Study where the Amanuensis is provided.

(iii) Such candidates are to be accommodated in a separate room under the supervision of an invigilator so that the fellow candidates are not disturbed in the process.

C. Credit Point:

It is the product of grade point and number of credits for a course, thus, CP = GP x CR

i. Credit:

A unit by which the course work is measured. It determines the number of hours of instructions required per week. 'Credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. Credits assigned for a single course always pay attention to how many hours it would take for an average learner to complete a single course successfully.

ii. Grade Point:

Grade Point is a numerical weight allotted to each Grade Letter on a 10-point scale.

iii. Letter Grade:

Letter Grade is an index of the performance of students in a said paper of a particular course. Grades are denoted by letters O, A+, A, B+, B, C, P, F and Abs. Student obtaining Grade F / Grade Abs shall be considered failed/ absent and, will be required to appear in the subsequent ESE. The UGC recommends a 10-point grading system with the following (Table: 1) Letter Grades:

(i) A Letter Grade shall signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point shall indicate the numerical weight of the Letter Grade on a 10-point scale.

(ii) There shall be 08 (eight) Letter Grades bearing specific Grade Points as listed in Table 1, where the Letter Grades 'O' to 'P' shall indicate successful completion of a course.

(iii) Apart from the 08 (eight) regular Letter Grades listed in Table 1, there shall be 03 (three) additional Letter Grades, which shall be awarded if a Course is withdrawn or spanned over the next Semester or remains incomplete as stated in Table 2.

Table 2: Letter Grades and Grade Points

Letter Grade	Grade Points	Description
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Abs	0	Absent
UFM	0	Unfair Means

iv. Grade Point Average:

a. SGPA (Semester Grade Point Average)

The SGPA of a student in a Semester shall be the weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered in that Semester, irrespective of whether he/she could or could not complete the Courses. More specifically, the calculation of SGPA shall take into account the Courses graded with Letter Grades 'O' to 'F' as given in Table 1.

$$\text{SGPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad (1.1)$$

The SGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.1) up to two decimal places, where n is the total number of Credit Courses registered by the student in that Semester, Gi is the Grade Point secured in the i^{th} registered Course and Ci is the Credit (weight) of that Course.

b. CGPA (Cumulative Grade Point Average)

(i) The CGPA of a student in a Semester of a Programme shall be the accumulated weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered and successfully completed so far starting from the enrollment in the Programme. In other words, taking into account all the Courses graded with 'O' to 'P' as given in Table 1.1, generally the CGPA of a student shall be calculated starting from the first Semester of his/her enrolled Programme, while the CGPA of a lateral-entry student shall be calculated starting from the Semester of his/her enrollment.

(ii) The CGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.2) up to two decimal places, where N is the total number of Credit Courses registered and successfully completed so far by the student, Gi is the Grade Point secured in the ith completed Course and Ci is the Credit (weight)of that Course.

$$\text{CGPA} = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i} \qquad (1.2)$$

(iii) The CGPA shall be convertible into equivalent percentage of marks using Equation Conversion of CGPA to percentage marks: = CGPA*10

D. Post-Examination

i. Transcript or Grade Card or Certificate:

A marking certificate shall be issued to all the registered students after every Semester. The Semester mark sheet will display the course details (code, title, number of credits, grade secured) along with total credit earned in that Semester.

ii. Grievance Readdress Mechanism:

Students with any dissatisfaction or grievance regarding the marks awarded in any of the Papers / Courses may appeal to the Controller of Examinations for remedial action such as Re-evaluation within 10 days of the declaration of result.

(i) A student has options to appeal for re-evaluation of his /her answer script to the Controller of Examination.

(ii) Application for re-evaluation / re-scrutiny of answer scripts shall be made in the definite proforma available with the Examination Office through the head of the respective departments within 10 days of declaration of the results of the respective examinations.

(iii) The Controller of Examination may appoint an examiner for re-evaluation and will consider and recognize the evaluation done by a University appointed examiner.

(iv) There shall be no provision for re-evaluation of the Practical Papers, Project Work, and Dissertation etc. However, the students fail in practical examination or viva voce and wish to appear again may apply to be evaluated can do so with the next schedule.

(v) After screening the application for re-evaluation, the CoE may send the answer scripts of the student to the examiners appointed by the CoE with the approval of Vice Chancellor.

(vi) The marks/grades achieved by the students after the re-evaluation shall be final and binding.

(vii) Fresh Marks – sheets / Grade Card shall be issued only if the candidate secures pass marks / passing grade in the re-evaluated paper.

(viii) Revaluation of answer scripts shall be deemed to be an additional facility provided to the students with a view to improving upon their results at the preceding examination result for any reason whatsoever shall not confer any right upon them for admission to next higher class which matters always be regulated in accordance with the relevant rules or regulations framed by the University.

(ix) If as a result of revaluation of the candidate attracts the provision of condonation of deficiency, the same may be applied to his/her only for fresh attempt.

INSTRUCTION TO TEACHERS AND STUDENTS

(Teaching and Learning Methods)

In all the courses the teacher has to select topics for teacher-method which should not be less than 20 percent. The approach will be direct classroom teaching through a series of lectures delivering concepts using ITC facilities, white or blackboard. Notes may also be circulated to the students; however, the students are to be involved in the preparation of the notes. The teacher will be responsible for selecting the best note for circulation. The teacher-centric methodology has recently fallen out of favour because this strategy for teaching is seen to favour passive students.

1. Student- centric / Constructivist Approach:

The topics of the courses may be selected at the start of the class and assigned one topic to each of the students for studying by themselves, prepare presentations, notes, etc., and present at respective class time after consultation and discussion with the course teachers. The teacher facilitates the learning of the students by guiding and providing input and explaining concepts. 60 percent of the course contents may be selected for this purpose. To avoid behaviour problems, teachers must lay a lot of groundwork in student-centric classrooms. Typically, it involves instilling a sense of responsibility in students. In addition, students must learn internal motivation.

a. Project-Based Learning: The teacher may select 5 percent of topics for the purpose and may conduct visits to the laboratory for experiments or field surveys. The selection of the topic may be done considering the available facility for the purpose. However, in the final semester of each of the programme the student has to undergo project-based learning at least 4 months duration. This approach will help the student to think critically, evaluate, analyze, make decisions, collaborate, and more.

b. Inquiry-Based Learning: The teacher/ students are supposed to list at least five questions in each contact hour and student solve these question or search for answer which becomes the home work for the students “question-driven” learning approach. The teacher may look for the correctness of the solution or the best possible answer and discuss in the successive class. This will help in the preparation for various competitive examination and develop a habit for search for solutions.

c. Flipped Classroom: About 10 percent of the course content has to be completed by this method. In this approach the students are asked to watch video or lecture prepared by the teacher or any video available (relevant to the course). A set of questions may be given to the students for searching answers by the students. The idea is that students should have more time in-classroom focusing on achieving these higher levels of thinking and learning. The Flipped classroom is also an acronym. The letters FLIP represent the four pillars included in this type of learning: Flexible environment, Learning culture shift, Intentional content, and Professional educator. As you can see, the second pillar refers to a culture shift from the traditional approach where students are more passive to an approach where students are active participants. As a result, this approach is also a student- centric teaching method.

d. Cooperative Learning: The remaining five percent has to be completed by cooperative learning approach. In this approach, the students are allotted problems. During library hours the students along with the teacher visit the library and search for probable solutions for the assigned problem. The same has to be done in groups so that the students discuss among themselves for the appropriate answers. Essentially, cooperative learning believes that social interactions can improve learning. In addition, the approach recreates real-world work situations in which collaboration and cooperation are required.

The percentage categorization for the completion of a theory course

Teacher-centric or Direct Classroom Teaching: Delivery by series of lectures	20%
Student-centric Approach, Students present and deliver lectures in the presence of teacher and supervised by teacher	60%
Students visit fields or perform experiments or teachers perform demonstration	05%
Flipped Classroom approach	10%
Cooperative learning approach	05%

Inquiry-based approach has to be followed in all of the classes

The teacher has to distribute the topics to be considered for teaching by the above-mentioned approaches and prepare a lesson plan for execution and maintain a file.

SEMESTER WISE COURSE DISTRIBUTION

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester I	1.	24MSZO1101R	Genetics	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	2	24MSZO1102R	Taxonomy and Basic Entomology	**DSC Minor**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSZO1103R	Biochemistry and Bioinstrumentation	**DSC Minor**	3	0	2	0	0	0	4	40	60	100	200
	4	24UMFS1101R	Fundamental of Statistics	**MDC**	1	0	2	0	0	0	2	40	60	100	200
	5	24UMPD1101R	Effective English	**AEC**	0	0	4	0	0	0	2	0	0	100	100
	6	24UMCC1101	Co-Curricular Activities	**Co and Extra-Curricular**	0	0	0	0	0	0	1	0	0	100	100
	Total										**17**				**1000**
	S. No.	**Course Code**	**Course Title**	**Course Category**	**Engagement**							**Maximum Marks for**			
					L	**T**	**P**	**S**	**R**	**O**	**C**	**IA***	**SEE***	**PE***	**Total**
Semester II	1.	24MSZO1201R	Endocrinology and Immunology	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	2	24MSZO1202R	Cell Biology	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSZO1203R	Molecular Biology, Genomics and Genetic Engineering	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	4	24UMPD1201R	Aptititute / Logical Course	**AEC**	2	0	0	0	0	0	2	40	60	0	100
	5	24MSZO1204R	Postgraduate Practice Teaching	**SEC**	1	0	0	0	0	0	1	0	0	100	100
		24MSZO1205R	Research Methodology and Statistical Analysis	**Research**	2	0	2	0	0	0	3	40	60	100	200
	8	24MSDA1201R	Data Analysis using Microsoft Excel	**VAC**	0	0	4	0	0	0	2	0	0	100	100
	9	24MSZO1206R	Field Visit	**Field Training**	0	0	0	0	0	0	1	0	0	100	100
	10	24UMEC1201	Extra-Curricular Activities	**Co and Extra-Curricular**	0	0	0	0	0	0	1	0	0	100	100
	Total										**22**				**1300**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester III	1.	24MSZO2101R	Animal Physiology	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	2	24MSZO2102R	Developmental Biology	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSZO2103R	Evolution and Ecology	**DSC Major**	2	0	2	0	0	0	3	40	60	100	200
	4	24MSZO2104R	Aquaculture	**DSC Major**	2	0	2	0	0	0	3	40	60	100	200
	5	24MSZO2105R	**Internship**	**Internship**	0	0	0	0	0	0	4	0	0	100	100
	6	24MSZO2106R	Project Dissertation	**Research**	0	0	8	0	0	0	4	0	0	100	100
	7	24UMPD2101R	English (PDP)	**AEC**	0	0	4	0	0	0	2	0	0	100	100
	8	24MSZO2108R	Field Visit	**Field Training**	0	0	0	0	0	0	1	40	60	0	100
	9		Indian Knowledge System	**VAC**	0	0	0	0	0	0	2	0	0	100	100
	Total										**27**				**1300**

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester IV	**1**	24MSZO2201R	Entomology I (Insect biology, Ecology and Pest management)	**DSC Major**	2	0	0	0	0	0	2	40	60	0	100
	2	24MSZO2202R	Entomology II (Insect Physiology and Toxicology)	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSZO2201R	Fish Biology and Fisheries I (Fish Physiology and Fish culture)	**DSC Major**	2	0	0	0	0	0	2	40	60	0	100
	4	24MSZO2202R	Fish Biology and Fisheries II (Fish reproductive biology, Endocrinology and fish genetics)	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	5	24MSZO2201R	Molecular Cell Biology I	**DSC Major**	2	0	0	0	0	0	2	40	60	0	100
	6	24MSZO2202R	Molecular Cell Biology II	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	7	24MSZO2201R	Animal Ecology and Wildlife Biology-I	**DSC Major**	2	0	0	0	0	0	2	40	60	0	100
	8	24MSZO2202R	Animal Ecology and Wildlife Biology-II	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	9	24MSZO2203R	Research/data analysis/documentation- R4	**Research**	0	0	24	8	12	0	16	0	0	100	100
	Total										**22**				**400**
	Grand Total										**88**				**4000**

***IA: Internal Assessment, SEE: Semester End Examination, PE: Practical Examination**

SEMESTER – I									
Course Title	**TAXONOMY AND BASIC ENTOMOLOGY**								
Course code	**24MSZO111R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To impart the knowledge of taxonomy and schools of biological classification. 2. To provide the knowledge of application of zoology in insect pest management. 3. To provide skill on insect- based industries for the benefit of mankind.								
CO1	Discuss the history and concept of taxonomy and its classification.								
CO2	Identify various approaches of taxonomy and its importance								
CO3	Describe the collection, identification and preservation process of animal								
CO4	Identify insect pests and vectors responsible for diseases.								
CO5	Determine the commercial value of insects and plan for rearing insects.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Definition and basic Concepts of taxonomy: History of classification and its importance Aims and objective of taxonomy Scope of taxonomy	**7**	Students will acquire knowledge regarding the history and concept of taxonomy	1,2
II	Different approaches in Taxonomy and its importance: Morphological, Embryological, Molecular, Ecological and Behavioural approach	**10**	Students will be able to apply knowledge on application of different approaches to be adopted in taxonomy for different group of organisms	1,2
III	Nature and Characteristics of Taxonomic procedures: Taxonomic procedures: collection, preservation and process of identification of biological species Taxonomic keys: Different kinds of taxonomic keys, their merits and demerits International Code of Zoological Nomenclature (ICZN), its operative principles; History of rules of Zoological nomenclature Interpretation and application of important rules Formation of scientific names of different taxa. Regulations governing this code and code of ethics	**10**	Students will gain knowledge on Different collection and preservation procedures and use of keys for species identification. Students will acquire knowledge on Principles and rules of nomenclature commission.	1,2
IV	Introduction to Applied Entomology: Economic importance of insects (honey bee, silkworm, lac insect). Insect pests, vectors of diseases: Mosquito, fly The role of insects in ecosystem as environmental indicator.	**8**	The course aims to provide students with an introduction of the application and economic importance of entomology	1,2

V	Commercial importance of insects and their culture: Honey bee and silk worm (life cycle, by product and commercial method of farming) Role of insects in pest management - Brief about chemical and biological control of insect pest Insects in the service of forensic science (role of insect in solving crime)	**10**	Students will know about the economic value of insect rearing and different methods of rearing the insects and also regarding different methods of controlling insect pests	1,2
Practical	• Identification and classification of important organisms from different phylum of animal kingdom. • Collection, identification and preservation of insects. • Permanent slide preparation of mouthparts of mosquito, cockroach, butterfly and honeybee. • Study of various types of social insects (honeybee/ants) and their nests. • Mounting of legs, antennae and wings (at least of two types). • Dissection of sting apparatus in honey bee.	**30**		1,2,3,4

TEXT BOOKS:

T1: Insect pest management by Dent D R, (latest edition). Westville Publishing House: Delhi

T2: An ecological and social approach to biological control, Eilenberg J, (latest edition). Springer.

T3: Theory and Practice of Animal Taxonomy and Biodiversity by Kapoor V C 8Ed. Oxford and IBH publishing.

T4: The insects: structure and functions by R. F. Chapman (5th Edition). Cambridge University Press.

T5: Handbook of entomology by T. V Prasad, (4th Edition). New Vishal Publications.

REFERENCE BOOKS:

R1: Principles of Animal Taxonomy by G. G. Simpson, (latest edition). Scientific publisher Animal Taxonomy by H. E. Goto (latest Edition). Arnold

R2: International Code of Zoological Nomenclature official publication

R3: A Text Book of Fundamental and Applied Entomology by M.S. Ali, S.V.S. Raju and M. Raghuraman Tanweer Alam, (latest edition). Kalyani publisher

R4: Introduction to general and applied entomology (Scientific Pub.: India) by Awasthi V B (latest Edition). Scientific publishers journal Dept.

OTHER LEARNING RESOURCES:

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss the history and concept of taxonomy and its classification.	**1, 5, 6**
2	Identify various approaches of taxonomy and its importance	**1, 3**
3	Describe the collection, identification and preservation process of animal	**1, 6, 8**
4	Identify insect pests and vectors responsible for diseases.	**1, 6, 8**
5	Determine the commercial value of insects and plan for rearing insects.	**1, 8**

SEMESTER – I									
Course Title	**BIOCHEMISTRY AND BIOINSTRUMENTATION**								
Course code	**24MSZO112R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1) To understand the fundamentals of structure, composition and function of biomolecules. To develop knowledge and identify the chemical logic of bioenergetics and metabolic pathways. 2) To impart knowledge of principles and applications of analytical instruments in life sciences. 3) To analyse biological samples for purification and characterisation of Proteins and Nucleic Acids								
CO1	Describe the concepts of carbohydrates, lipids, nucleic acids, vitamins and minerals.								
CO2	Explain concept of Bioenergetics including thermodynamics and enzymology.								
CO3	Discuss the principles and operation of instruments for detecting biomolecules.								
CO4	Explain the principles and application of separation and characterisation of biomolecules from biological samples.								
CO5	Identify chromatography techniques to separate molecules.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Concept of biomolecules (composition, structure and functions): • Carbohydrates • Lipids • Nucleic acids • vitamins and minerals. • Special focus on conformation of proteins (level of protein organization and Ramachandran plot), domains, motif and folds.	**7**	Students will learn about biomolecules, their unique structural characteristics and functions.	1,2
II	**Bioenergetics:** • Concept of thermodynamics (entropy, enthalpy and free energy) • Reaction kinetics: Substrate phosphorylation and oxidative phosphorylation, coupled reaction, group transfer and biological energy transducer). Enzymology/Enzymes: Definition and structural organization of enzyme, classification, mechanism of enzyme action and factors affecting enzyme activity. Salient features of active site. • Enzyme regulation and role of inhibitors.	**10**	They will gain knowledge in Basics of metabolism (Bioenergetics and thermo dynamics) Also, they will get to know about enzymes and their kinetics	1,2

III	**Metabolism of biomolecules:** • Carbohydrate metabolism- Glycolysis and its regulation, Gluconeogenesis, Glycogenolysis TCA cycle, Pentose phosphate pathway • Lipid metabolism: oxidation of fatty acid and biosynthesis of fatty synthesis. Heme synthesis and degradation. • Amino acid metabolism- Transamination, deamination and urea cycle. • Nucleotide metabolism - Biosynthesis of purines and pyrimidines by de novo and salvage pathways, inhibitors of nucleotide synthesis, degradation of purines and pyrimidines.	**10**	They will be gaining knowledge about carbohydrate metabolism. Also, they will get to know lipid, protein and nucleic acid metabolism.	1,2
IV	**Gel Electrophoresis**: • Introduction, principle, types, application. PCR: Introduction, types and application. • Blotting technique: Southern blot, Western Blot and Northern blot, **Microscopy**: • Introduction, types (light field microscope, dark field microscope, phase contrast microscope, fluorescence microscope, AFM and Electron microscope), and application. **Centrifugation:** • Introduction, principle, types of centrifuge and rotors, application of density gradient and analytical centrifugation **Radioactive tracer technology:** Principle, measurement and applications in biology	**8**	Students will understand the Techniques to measure, study And observe Biomolecules like Proteins, DNA,RNA etc. Students will learn Microscopic technique applied to understand cellular ultrastructure and function of genes and proteins. Students will apply the knowledge of radioactive tracer molecule to track down biochemical metabolism and gene expression	1,2
V	**Chromatography:** Introduction, Principle, Classification, Column Chromatography; Adsorption column chromatography; operational technique, elution procedure, application, Partition chromatography. Thin layer chromatography: Introduction, Principle, technique, application and	**10**	Students will learn the principle and applications of Chromatography in protein purification, MW determination Students will understand the principle and application of Spectroscopic technique to Gauge conformation and Concentration of biomolecules Students will be able to	1,2

	HPTLC. Rf value. Gas Chromatography Ion exchange chromatography: Ion exchange resins, mechanisms, procedure, applications. High Performance liquid chromatography: Introduction, instrumentation, application, advantages. Gel Chromatography: Introduction, Technique, instrumentation, application **Spectroscopic techniques:** Infra-red Spectrophotometry: Introduction, Instrumentation, application. NMR: Introduction, Principle, Instrumentation, Spin- Spin coupling, application. Mass Spectrometry: Introduction, Principle, Instrumentation, application, UV- Visible spectroscopy, atomic absorption spectroscopy.		separate biomolecules from complex mixtures.	
Practical	• Estimation of protein by Lowry's/ Bradford method. • Estimation of Glucose by Anthrone method. • Estimation of RNA/ DNA. • Achromic point of salivary amylase • Qualitative analysis of protein, carbohydrate and amino acid	**30**		1,2,3,4

TEXT BOOKS:

T1. "Lehninger Principles of Biochemistry" by David L Nelson and Michael M Cox
T2. "Biochemistry" by U Satyanaryana and U Chakrapani
T3. Principles of Biochemical Techniques, 5th edition, Wilson and Walker. Cambridge University Press.
T4. Modern Biochemistry Laboratory Techniques. 3rd edition. Rodney Boyer. Tata McGraw Hill.

REFERENCE BOOKS:

R1: "Haper's Illustrated Biochemistry" by Robert Murray, Daryl K Granner et al.
R2: "Biochemistry" by Lubert Stryer, Jeremy M Berg, et al.
R3: "Biochemistry" by David E Metzler.
R4: Lehninger's Principles of Biochemistry. 4th edition. Nelson and Cox. Prentice Hall.
R5: Biochemistry, 4th edition. Voet and Voet. Tata McGraw Hill.

OTHER LEARNING RESOURCES:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=MNhNzp1RQlU+6LM40KjY1Q.
2. Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]
3. ERP LMS-PRAN

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the concepts of carbohydrates, lipids, nucleic acids, vitamins and minerals.	**1**
2	Explain concept of Bioenergetics including thermodynamics and enzymology.	**1**
3	Discuss the principles and operation of instruments for detecting biomolecules.	**1, 8**
4	Explain the principles and application of separation and characterisation of biomolecules from biological samples.	**1, 8**
5	Identify chromatography techniques to separate molecules.	**1, 8**

SEMESTER – I									
Course Title	**GENETICS**								
Course code	**24MSZO113R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To introduce learner to the science of heredity, from its basic principles to the most recent advances in the field. 2. To impart knowledge on genetic alterations in human genome, classical and molecular genetics. 3. To impart knowledge on classical and molecular genetics.								
CO1	Describe chromatin, chromosomes, heterochromatin and euchromatin.								
CO2	Explain mechanisms of sex determination, dosage compensation in human, Drosophila, and *C. Elegans*, discuss on structural and numerical aberrations of chromosomes.								
CO3	Apply karyotyping and pedigree method for identification of inheritance patterns in genetic disorders, use logarithm of the odds scores for linkage testing in specific disease contexts.								
CO4	Evaluate polygenic inheritance, heritability through Quantitative Trait Locus mapping, linkage maps, and tetrad analysis, explain Human Genome Project and Mapping.								
CO5	Discuss lac and tryptophan operon concept of gene regulation, in prokaryotes, gene regulation in eukaryotes, explain restrictive enzymes and their role in recombinant DNA techniques.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Chromosome: Eukaryotic structure of chromatin and chromosome, heterochromatin, euchromatin Extension of Mendel's principles: Codominance, incomplete dominance, gene interactions, penetrance and expressivity, epistasis, pleiotropy, genomic imprinting, linkage and crossing over, sex linkage, sex limited and sex influenced characters.	**7**	Learners would be able to Understand basic concepts of chromatin and gene interaction	1,2
II	Mechanisms of sex determination and Dosage Compensation: Human, Drosophila and C. elegans Structural and numerical aberrations of chromosomes: Deletion, duplication, inversion, translocation and ploidy	**10**	The learners will become aware of the sex determination in human and Drosophila. It will also be able to distinguish between structural and numerical aberrations of chromosomes and learn the cause of human syndrome	1,2

III	Human Genetics: Karyotypes, pedigree analysis, LOD score for linkage testing, Chronic myeloid leukaemia, Burkett's lymphoma and retinoblastoma.	**10**	Learners will be able to understand inherited genetics and diseases associated to gene alteration	1,2
IV	Quantitative inheritance: Polygenic inheritance, heritability, QTL mapping. Gene mapping methods: Linkage maps, tetrad analysis, Basic idea of Human Genome Project and Mapping.	**8**	Learners would be able to Understand basic concepts of quantitative inheritance, methods of gene mapping and information of human genes	1,2
V	Regulation of Gene Expression: Regulation of gene activity in lac and Btrp operons of E. coli.; General introduction to gene regulation in Beukaryotes at transcriptional and posttranscriptional levels Genetic Engineering: Restrictive enzymes - Recombinant DNA techniques. Applications of Recombinant DNA technology.	**10**	Students will learn how genes were regulated in prokaryotes and eukaryotes. It will also assist them in understanding genetic engineering and biotechnology	1,2
Practical	• Study of divisional stages in Mitosis using onion root tip. • Study of divisional stages in Meiosis using permanent slides of grasshopper's testes. • Preparation and mapping of polyethene chromosomes from salivary gland of Chironomus/Drosophila larvae. • Preparation of human karyotypes: normal male and female: analysis of common human chromosomal aberrations from the pictures provided. • To solve some genetic problems based on pedigree analysis. • To solve some genetic problems based on gene interaction.	**30**		1,2, 3,4

TEXT BOOKS:

T1. Principles of Genetics by Snustad and Simmons (7th Edition) John Wiley and Sons, USA.

T2. Modern Genetic Analysis: Integrating Genes and Genomes by Griffiths, J.F., Gilbert, M., Lewontin, C. and Miller (2nd Edition) W. H. Freeman and Company, New York, USA.

T3. Genetics by J. Russell (3rd Edition) Benjamin-Cummings Publishing Company, San Francisco, California, USA.

T4. Molecular Biology of the Gene by Watson. J.D. Hopkins, N.H.., Roberts, J.W., Steitz, J.A. and Weiner, A.M.1987. W.A. (4th Edition) Benjamin/Cummings Co., New York.

T5. Recombinant DNA: Genes and Genomics – a short course by Watson et al., (3rd Edition) W. H. Freeman and Company, New York, USA.

REFERENCE BOOKS:

R1: Principles of Gene Manipulation and Genomics, Primrose by S. B. and Twyman, R.M., (7th Edition), Blackwell Publishing, West Sussex, UK.

R2: Concepts of genetics by William S Klung (Latest Edition), Benjamin-Cummings Publishing Company

R3: Genetics by BD Singh (Latest Edition), Kalyani Publishers

R4: Genetics: Analysis of gene and genetics by Harti and Ruvolu (8th Edition), Laxmi Publications.

R5: Principles of genetics by Tamarin (Latest Edition), McGraw Hill Education.

OTHER LEARNING RESOURCES:

2. NOC: Human Molecular Genetics: https://nptel.ac.in/courses/102/104/102104052/

3. Human gene: https://swayam.gov.in/nd2_cec20_bt17/preview

4. Tissue engineering: https://swayam.gov.in/nd1_noc19_bt33/preview

5. Genetic Engineering: Theory and Application: https://swayam.gov.in/nd1noc19_bt15/preview.

O5. Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe chromatin, chromosomes, heterochromatin and euchromatin.	**1, 3**
2	Explain mechanisms of sex determination, dosage compensation in human, Drosophila, and *C. Elegans*, discuss on structural and numerical aberrations of chromosomes.	**1, 3**
3	Apply karyotyping and pedigree method for identification of inheritance patterns in genetic disorders, use logarithm of the odds scores for linkage testing in specific disease contexts.	**1, 3, 8**
4	Evaluate polygenic inheritance, heritability through Quantitative Trait Locus mapping, linkage maps, and tetrad analysis, explain Human Genome Project and Mapping.	**1, 3, 8**
5	Discuss lac and tryptophan operon concept of gene regulation, in prokaryotes, gene regulation in eukaryotes, explain restrictive enzymes and their role in recombinant DNA techniques.	**1, 3**

SEMESTER – I									
Course Title	**CELL BIOLOGY**								
Course code	**24MSZO114R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1) To make students understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles 2) To define how the cellular components are used to generate and utilize energy in cells. 3) Familiarize the cellular components underlying mitotic cell division.								
CO1	Explain membrane structure and its functioning.								
CO2	Describe structural organization of cell and their roles.								
CO3	Illustrate different cell cycle processes.								
CO4	Discuss mechanism of cell-to-cell communications.								
CO5	Illustrate functions of cells and resulting diseases because their improper functioning.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Membrane Structure and Function: (Structure of a model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes)	**7**	Knowledge of structure of cell membrane and function	1,2
II	Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure and function of cytoskeleton and its role in motility)	**10**	To learn the basic structural organisation of intracellular organelles	1,2
III	Cell Division and Cell Cycle (Mitosis and Meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle)	**10**	To understand the basics of how a cell divides and its importance in cell cycle	1,2
IV	Cell signaling: (Ligands and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling pathways in plants, bacterial chemotaxis and quorum sensing) neurotransmission and its regulation	**8**	To know about the communications and signalling mechanisms in cells	1,2
V	Cellular communication: (Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins)	**10**	Knowledge on Basic regulatory mechanisms of cell communications	1,2

Practical	• Microscopic observation and comparison between prokaryotic and eukaryotic cell. • Isolation of mitochondria and staining. • Counting of RBC and WBC in human blood. • Extraction of membrane lipids and observation of lipid bilayer formation. • Squash preparation. sub-cellular fractionation - separation of macromolecules.	**30**		1,2, 3,4

TEXT BOOKS:

T1. The Cell: A Molecular Approach (7th Edition): Geoffrey M Cooper, Robert E Hausman, Sinauer Publication

T2. Essential Cell Biology (5th Edition) , Alberts, Hopkin, Johnson, Morgan, Raff, Roberts, Walter: W. W. Nortopn & Company

T3. Cell biology by CB Power (Latest Edition), Himalaya Publishing House.

T4. Cell biology (cytology, biomolecules and molecular biology), V. K. Agarwal and Dr. P.S. Verma

T5. Lewin B. et al. (2007). Cells. Jones and Bartlett Publishers

REFERENCE BOOKS:

R1: Molecular Biology of the Cell (6th Edition)

R2: Advanced practical zoology, Dr. P.S. Verma and P. C. Srivastava

R3: Sharma, V. K. (1991). Techniques in Microscopy and Cell Biology. Tata-McGraw Hill.

R4: Pollard T.D. and Earnshaw W.C. (2007). Cell Biology. Elsevier.

R5: Lodish H, Berk A, Lawrence S, et al., Molecular Cell Biology, Freeman WH & Co. New York.

OTHER LEARNING RESOURCES:

https://www.cellbio.com/education.html

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

https://www.genome.gov/genetics-glossary/Cell-Membrane

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOME

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain membrane structure and its functioning.	**1, 3**
2	Describe structural organization of cell and their roles.	**1, 3**
3	Illustrate different cell cycle processes.	**1, 3**
4	Discuss mechanism of cell to cell communications.	**1, 3**
5	Illustrate functions of cells and resulting diseases because their improper functioning.	**1, 3**

SEMESTER – I									
Course Title	**MINI RESEARCH (REVIEW OF LITERATURE- R1)**								
Course code	**24MSZO115R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**0**	**4**	**8**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To make Students familiar with and learn to identify the most relevant textbooks, reviews, papers and journals for their research topics. 2. To impart knowledge on how to critically read and assess research papers and reviews. 3. To make students familiar with the formulation of research work in proper scientific manner.								
CO1	Use of database and libraries for original research, books and other article.								
CO2	Summarize different types of reviews in the form of analytical and descriptive review.								
CO3	Identify relevant topic for continuing research and methods of collection including filtering of information.								
CO4	Analyse the demonstrations and findings made by previous authors and comprehend them.								
CO5	Write a review explaining the prospects of study chosen.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction, comprehension on research search engines, selection of topics	**15**	Describe, illustrate and explain cell organization and functions, microscopy and structural differences.	1,2
II	Tools for reference citation, different methods for writing citation and references.	**10**	Describe, illustrate and explain membrane structure, function; cell organization and the proteins involved in transportation.	1,2
III	Introduction to structure of review and specific features of review	**15**	Describe, illustrate and explain chromosomal structure and types.	1,2
IV	Plagiarism, ethical issues in writing the review	**10**	Describe, illustrate and explain the mechanism of cell-to-cell communication	1,2
V	Mapping and selection of journal of specific knowledge of discipline and submission for publications	**10**	Describe, illustrate and explain the cell cycle and division in general and in some specific cell types	1,2

TEXT BOOKS:

T1. **Conducting Research Literature Reviews** by Arlene Fink ISBN: 1412971896 Call Number: Q180.55.M4 F56 2010

T2. **Writing Literature Reviews-4th Ed** by Jose L. Galvan ISBN: 1884585868 Call Number: H62 .G35 2009

T3. **Approaches to Social Research** by Royce A. Singleton; Bruce C. Straits ISBN: 9780195147940 Publication Date: 2004-08-12

REFERENCE BOOKS:

R1: Literature Reviews from the Writing Center, The University of North Carolina at Chapel Hill

R2: Social Work Literature Review Guidelines from OWL Purdue Online Writing Lab

R3: Article available through PubMed Central® (PMC), "a free archive of biomedical and life sciences journal literature at the U.S. National Institutes of Health's National Library of Medicine (NIH/NLM)."

R4: Khan, K.S., Kunz, R., Kleijnen, J., & Antes, G. (2003). Five steps to conducting a systematic review. *Journal of the Royal Society of Medicine*, 96 (3), 118-121.

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOME

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Use of database and libraries for original research, books and other article.	**1, 2, 3**
2	Summarize different types of reviews in the form of analytical and descriptive review.	**1, 3**
3	Identify relevant topic for continuing research and methods of collection including filtering of information.	**1, 2, 3**
4	Analyse the demonstrations and findings made by previous authors and comprehend them.	**1, 5**
5	Write a review explaining the prospects of study chosen.	**1, 5, 8**

SEMESTER – I										
Course Title	**FUNDAMENTAL OF STATISTICS**									
Course code	**24UMFS111R**	**Total credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. Help to understand the role of statistics in data analysis, decision-making, and scientific research 2. Introduce students to descriptive statistics, including measures of central tendency (mean, median, mode) and measures of dispersion (range, variance, standard deviation). 3. Teach students how to summarize and present data effectively using tables, charts, and graphs								
CO1	Describe statistical population and sample, compile, classify and characterize data including scale of measurement.								
CO2	Compile and present univariate data in tabular and graphical form and explain the descriptive statistics.								
CO3	Compile and present bivariate data and explain it by various bivariate analysis, including the predictions/ forecasting.								
CO4	Compute probability including events and distributions (normal, binomial, Poisson).								
CO5	Explain the methods of hypothesis testing, parametric and non-parametric and use them to evaluate specific cases.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio.	**5**	Describe, illustrate and explain cell organization and functions, microscopy and structural differences.	1,2
II	Presentation: tabular and graphical, including histogram and ogives. Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, skewness and kurtosis	**5**	Describe, illustrate and explain membrane structure, function; cell organization and the proteins involved in transportation.	1,2
III	Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, fitting of polynomials and exponential curves.	**5**	Describe, illustrate and explain chromosomal structure and types.	1,2,3

IV	Random experiment: trial, sample point and sample space, event, Operations of Events, concepts of mutually exclusive and exhaustive events. Definition of probability: classical and relative frequency approach. Discrete probability space, Properties of probability, Independence of events, Conditional probability, total and compound probability rules, Normal probability Distribution, Bionomial probability Distribution, Poisson Probability Distribution, Bayes' theorem and its applications.	**8**	Describe, illustrate and explain the mechanism of cell to cell communication	1,2,3
V	Testing of hypothesis, parametric test: t-test, z-test, chi-square test. Non-Parametric test: One sample Kolmogorov test, wilcoxon Signed test, Mann-Whitney Test, Kruskal walis test	**7**	Describe, illustrate and explain the cell cycle and division in general and in some specific cell types	1,2,3
Practical	1. Introduction to R - A programming language and environment for data analysis and graphics. Syntax of R expressions: Vectors and assignment, vector arithmetic, generating regular sequence, logical vector, character vectors, Index vectors; selecting and modifying subsets of data set 2. Data objects: Basic data objects, matrices, partition of matrices, arrays, lists, creating and using these objects; Functions- Elementary functions and summary functions, applying functions to subsets of data. Data frames: The benefits of data frames, creating data frames, combining data frames, Adding new classes of variables to data frames; Data frame attributes. 3. Importing data files: import. Data function, read. table function; Exporting data: export. Data function, cat, write, and write. table functions, function, formatting output - options, and format functions; Exporting graphs -export. Graph function. Graphics in R: creating graphs using plot function,	**30**	Describe, illustrate and explain and apply staining techniques and carry out microscopic examination.	1,2,3,4

	box plot, histogram, line plot, steam and leaf plot, pie chart, bar chart, multiple plot layout, plot titles, formatting plot axes; Visualizing the multivariate data: Scatter plot, Q-Q plot, P-P plot. 4. Performing data analysis tasks: Reading data with scan function, exploring data using graphical tools, computing descriptive statistics, one sample tests, two sample tests, Goodness of fit tests. 5. Parametric test and Non-Parametric test			

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOME

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe statistical population and sample, compile, classify and characterize data including scale of measurement.	**1, 2**
2	Compile and present univariate data in tabular and graphical form and explain the descriptive statistics.	**1, 2, 3**
3	Compile and present bivariate data and explain it by various bivariate analysis, including the predictions/ forecasting.	**1, 2**
4	Compute probability including events and distributions (normal, binomial, Poisson).	**1, 2**
5	Explain the methods of hypothesis testing, parametric and non-parametric and use them to evaluate specific cases.	**1, 2, 3, 8**

SEMESTER – I									
Course Title	**EFFECTIVE ENGLISH (COMMUNICATIVE ENGLISH & SOFT SKILLS)**								
Course code	**24UMPD111R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To introduce the types of sentences and their significance. 2. To strengthen the students' vocabulary to enhance their speaking and writing skills. 3. To familiarize the students with the importance of dress codes in various organizations.								
CO1	This course will enable students to analysis and identify the different types of sentences.								
CO2	Learners will be able to integrate the skills of reading and speaking in professional communication.								
CO3	Dress code Etiquette sessions will boost their confidence and morals.								
CO4	Students will learn about the effective and efficient utilization of time.								
CO5	Introduction to Phonetics and its importance will improve the learners' pronunciation								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Grammar** i. Interchange of Interrogative and Assertive Sentences, Exclamatory and Assertive Sentences ii. Types of Tenses iii. Common Errors iv. Synonyms v. Antonyms vi. Homonyms	**7**	Identify and understand the structure of interrogative and assertive sentences. Transform and enhance grammatical accuracy and sentence formation skills.	1,2
II	**- Reading Skills** i. Techniques of Effective Reading ii. Gathering ideas and information from a text The SQ3R Technique Interpret the text	**10**	Develop strategies for faster reading with better comprehension and improve the ability to recall and organize textual information systematically.	1,2
III	**Listening Skills** i. What is listening? ii. The Process of Listening iii. Factors that adversely affect Listening iv. Difference between Listening and Hearing, v. Purpose and Importance of Effective Listening vi. How to Improve Listening Process	**10**	Understand the fundamental aspects and importance of listening. It also helps to enhance interpersonal and professional communication by practicing listening skills.	1,2

IV	**Conflict Management** i. Definition ii. Type of Conflict Management iii. Effects of Conflict Management iv. Methods to deal with Conflicts (Negative)	**8**	Learn strategies to manage and resolve conflicts effectively to encourage a positive environment by turning conflicts into opportunities for growth.	1,2
V	Time-Management Skills i. Introduction to Time Management, ii. Purpose and Importance of Time Management, iii. Basic Tips to Maintain Time.	**10**	Enhance productivity and stress management through effective time allocation and planning. It helps to understand the importance of time management in achieving personal and professional goals.	1,2
Practical	Activity: Problem solving activity: A situation will be given to the students and they will have to tell us how to handle the situation or solve the problem.	**30**		1,2, 3,4

Text Books:

T1: Wren,P.C and Martin,H. 1995. *High School English Grammar and Composition*, S Chand Publishing.

T2: *English Grammar in Use*, Raymond Murphy 4th edition,CUP.

T3: Barrett, Grant. 2016. *Perfect English Grammar: The Indispensible Guide to Excellent Writing and Speaking*, Zephyros Press.

Reference Books:

R1: English Vocabulary in Use (Advanced), Michael McCarthy and Felicity, CUP.

R2: Effective Communication and Soft Skills, Nitin Bhatnagar, Pearsons.

Other Learning Resources:

https://www.classcentral.com/report/toefl-preparation/

https://brightlinkprep.com/10-best-toefl-prep-books/

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOME

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	This course will enable students to analysis and identify the different types of sentences.	**1**
2	Learners will be able to integrate the skills of reading and speaking in professional communication.	**1, 2**
3	Dress code Etiquette sessions will boost their confidence and morals.	**1, 8**
4	Students will learn about the effective and efficient utilization of time.	**1, 8**
5	Introduction to Phonetics and its importance will improve the learners' pronunciation	**1, 8**

SEMESTER – II									
Course Title	**ENDOCRINOLOGY AND IMMUNOLOGY**								
Course code	**24MSZO121R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To understand the nature, functions and importance of endocrine glands like hypothalamus and its connections to the CNS and endocrine glands, hypophysis, thyroid, parathyroid, adrenal, pancreas and their hormones. 2. To familiarizes students with invertebrate endocrine systems for application in various fields like pest control. 3. To teach students about immunology and deals with the different aspects of the immune system including types of cells involved, acquired, innate immunities, immunogens and immunoglobulins.								
CO1	Identify various endocrine glands and their functions including biosynthesis and classification of hormones.								
CO2	Describe endocrine, hypothalamus and their functions including invertebrate hormones.								
CO3	Explain the types of immunity including functions of immune cells.								
CO4	Describe immunogens, properties, structure and functions including factors affecting antigenicity.								
CO5	Identify various immunoglobulins, their processing, presenting, activation and differentiation.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Endocrine glands, their hormones and classification; Biosynthesis, storage and mechanism of action of protein and steroid hormones.	**7**	To gain basic knowledge and understanding of endocrine glands and hormones	1,2
II	**Endocrine hypothalamus** • Pituitary, Thyroid, • Parathyroid, • Pancreas, • Adrenal Glands: Structure, secretions and functions of each gland. • Invertebrate hormones and their functions.	**10**	To understand the nature of y different glands and how their secretions regulate and control the metabolism, growth and other functions of the body.	1,2
III	**Types of immunity**: • Innate and acquired immunity; passive and active immunity; • Humoral and cell- mediated immunity. • Organs of immune system: Primary and Secondary lymphoid organs. • Brief account on immune cells: types and production.	**10**	Understand the complex system of immunity which helps in fighting pathogens and toxins etc to keep the body healthy	1,2

IV	**Immunogens (Antigens)** • General properties, Structure and function, Factors affecting antigenicity • Epitopes and Haptens • Adjuvants	**8**	To understand and analyse the knowledge gained on nature of immunogens. How vaccines are produced by knowing the antigenicity factors	1,2
V	**Immunoglobulins (antibodies)** • General Properties- Structure and functions • Different classes of immunoglobulins (IgA, IgD, IgE, IgG and IgM) • Antigen-antibody interactions: Primary and secondary immune responses • Major Histocompatibility Complex (MHC), antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors.	**10**	To understand the importance of antibodies in immune response, the functions of major immune cells and how the activation of these cells is done. Studying about how scientist created vaccine against Covid 19 virus	1,2
Practical	• Histology of various endocrine glands of vertebrates. • Study of various endocrine glands using models and charts and computer software. • Study of thyroxine and iodine solution in amphibian metamorphosis. • Estimation of urea and uric acid. • Blood glucose – Oral Glucose Tolerance Test. • Study of different types of cells in the blood of human beings. • Hemagglutination assay for ABO blood groups. • Total Leucocyte count. • Differential Leucocyte Count. • 3D structural organization of various antibodies using bioinformatics and online resources.	**30**		1,2,3,4

TEXT BOOKS:

T1. Endocrinology by Hadley Mac E and John Levine(sixth edition) Pears
T2. Yadav, Textbook of Endocrinology,2009,Sonali Publications, New Delhi
T3. Williams Textbook of Endocrinology,14th edition 2019, Elsevier publications Company, Philadelphia
T4. George Griffin, Endocrinology,2015, Star pearls publishing, USA
T5. DeGroot's Endocrinology,8th edition 2 volume set, Elsevier
T6. Elements of Immunology: F .H. Khan Pearson Education

REFERENCE BOOKS:

1. Vertebrate Endocrinology by O Davis, O Norris (6th Edition). Elsevier Science Publishing Co Inc.
2. Williams Text book of Endocrinology (14th Edition). Elsevier.
3. An introduction to Comparative. Endocrinology by Barrington, E.E.W (Latest Edition). Clarendon Press
4. Kuby Immunology (8th Edition) W.F.Freeman, U.S.A.
5. Fundamentals of Immunology by W. Paul (7th Edition). Wolters Kluwer | Lippincott Williams and Wilkins.

OTHER LEARNING RESOURCES:

1. Endocrinology: https://www.classcentral.com/course/swayam-endocrinology-19855
2. Immunology : https://www.classcentral.com/course/swayam-immunology-14117
3. Immunology : https://swayam.gov.in/nd2_cec20_bt05/preview
4. Fundamentals of Immunology:
5. https://www.classcentral.com/course/immunologyfundamentalsimmunitybcells-12724
6. Monoclonal Antibodies :
7. https://www.coursera.org/lecture/immunologyfundamentalsimmunitybcells/monoclonalantibo dies-KxBvo

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOME

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify various endocrine glands and their functions including biosynthesis and classification of hormones.	**1**
2	Describe endocrine, hypothalamus and their functions including invertebrate hormones.	**1, 2**
3	Explain the types of immunity including functions of immune cells.	1, 2
4	Describe immunogens, properties, structure and functions including factors affecting antigenicity.	1
5	Identify various immunoglobulins, their processing, presenting, activation and differentiation.	1, 2

SEMESTER – II									
Course Title	**MOLECULAR BIOLOGY, GENOMICS AND GENETIC ENGINEERING**								
Course code	**24MSZO122R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To teach in depth about genome and its arrangement in eukaryotes and microbes. 2. To teach the central dogma of life (replication, transcription, translation and post transcriptional modifications) with the best possible teaching tools (explanation/power point presentation/seminar/assignment) and with utmost attention. 3. Important topics like mutation, DNA damage and repair are explained.								
CO1	Discuss genomics, genome, proteome and transcriptome.								
CO2	Explain the central dogma including genome expression.								
CO3	Illustrate genome sequencing, chromosome painting and genome mapping.								
CO4	Explain DNA mutation and repair mechanisms.								
CO5	Describe genetic engineering.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction to genomics, definitions of genome, proteome and the transcriptome	**7**	Introductory knowledge and refreshing the existing understanding	1,2
II	The central dogma: transcription, translation, replication, post-transcriptional modification role of DNA binding proteins in genome expression, nucleosome modifications and genome expression, histone modification, acetylation	**10**	Sequencing techniques in detail followed by linkage mapping	1,2
III	Mapping of genomes, basics of genome sequencing, shotgun sequencing, Euchromatin and heterochromatin, chromosome painting.	**10**	Explain why a map is an important aid to genome sequencing	1,2
IV	Accessing the genome: chromosome painting, nucleosome modifications and genome expression, histone, chromosome painting, nucleosome modifications and genome expression, histone modification, acetylation, Mutations and DNA repair	**8**	Genome organisation is discussed in detail with various post translational events along with regulatory mechanisms	1,2
V	Introduction to genetic engineering, Different DNA manipulating enzymes, methods for isolating DNA, vectors for bacteria, plant and animals, expression vectors, DNA libraries, application of genetic engineering	**10**	Knowledge on DNA manipulation using recombinant DNA technology	1,2

Practical	• Isolation of genomic DNA. • Isolation of plasmid DNA. • Polymerase chain reaction. • Endonuclease digestion of DNA and analysis of DNA fragments by agarose electrophoresis.	**30**		1,2,3,4

TEXT BOOKS:

T1. The Molecular Biology of the Gene by J. D. Watson et al. (1987) Benjamin Cummings.

T2. Cell and Molecular Biology, Lohar (Prakash S), 1st Edition, Mjp Publishers

T3. Cell and Molecular Biology: Concepts and Experiments. Carp Gerald, 1996. John Wiley & Sons Publishers.

T4. Lodish H, Berk A, Lawrence S, et al., Molecular Cell Biology, Freeman WH & Co. New York.

T5. De Robertis EDP and De Robertis EMF, Cell and Molecular Biology Saunders College, Philadelphia Dowben RM, Cell Biology, Harper and Row Publ. London.

REFERENCE BOOKS:

R1: The Molecular Biology of the Cell by Alberts et al. (1991).

R2: Gene V by B. Lewin (1994) Oxford University Press, Oxford.

R3: Molecular cell biology by Lodish et al. (1995) Scientific American press.

R4: Alberts B, Johnson A, Lewis J, et al. Molecular Biology of the Cell, Taylor & Francis Group, New York, USA.

R5: Gerald Karpgen, 1999. *Cell and Molecular Biology*, Concepts & Epts. Sec. edn. John Wiley & Sons, Inc., New York.

OTHER LEARNING RESOURCES:

1. https://in.coursera.org/courses?query=molecular%20biology
2. Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOME

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss genomics, genome, proteome and transcriptome.	**1**
2	Explain the central dogma including genome expression.	**1, 2**
3	Illustrate genome sequencing, chromosome painting and genome mapping.	**1, 2**
4	Explain DNA mutation and repair mechanisms.	**1, 2**
5	Describe genetic engineering.	**1**

SEMESTER – II									
Course Title	**EVOLUTION AND ECOLOGY**								
Course code	**24MSZO123R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To sensitize the candidates with various aspects on evolutionary biology, various theories related to evolution, patterns of behaviour and biological communications. 2. To provide basic and advanced information on population and community ecology and the immensely fascinating world of biodiversity and wildlife. 3. To give advanced information on conservation biology.								
CO1	Explain the theories of evolution.								
CO2	Describe population genetics and phenomenon, mechanism, laws associated with it.								
CO3	Explain population and community ecology.								
CO4	Discuss the working mechanisms of an ecosystem.								
CO5	Describe biodiversity, conservation and management including case studies of Indian origin								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Darwinism** • Concepts of variation, • Adaptation, struggle, fitness and natural selection **Mendelism** • Spontaneity of mutations • The evolutionary synthesis. • Concepts of neutral evolution, molecular divergence and molecular clocks	**7**	Students will understand the theories of evolution	1,2
II	**Population genetics** • Populations • Gene pool, Gene frequency • Hardy-Weinberg Law • Concepts and rate of change in gene frequency through natural selection • Migration and random genetic drift • Adaptive radiation • Isolating mechanisms Speciation, Allopatricity and Sympatricity • Convergent evolution • Sexual selection • Co-evolution • Altruism and evolution- Group selection • Kin selection • Reciprocal altruism • Biological clocks • Development of behavior • Social communication • Social dominance • Use of space and territoriality	**10**	Students will acquire knowledge on population genetics and various behaviour shown by organisms	1,2
III	**Population ecology** • Characteristics and size of a population	**10**	Students will gain knowledge on	1,2

	• Growth curves and regulation of Population • r and K selection **Community ecology** • Nature of communities • Structure and attributes of communities • Edge effect and ecotones. • Ecological succession (causes and examples) • Stability and Climax community Predation • Model of prey predator dynamics • Predators and their role in nature		population and community ecology and ecological developmental processes	
IV	**Ecosystem Ecology** • Ecosystem structure and ecosystem function • Energy flow • Mineral cycling (C, N, P) • Primary production and decomposition • Structure and function of some Indian ecosystems, terrestrial (forest) and aquatic (fresh water, marine)	**8**	Students will gain knowledge about the structures and function of ecosystem	1,2
V	**Conservation Biology** • Major drivers of biodiversity change • Principles of conservation • Major approaches to management • Indian case studies on conservation/ management strategy (Project Tiger, Biosphere reserves)	**10**	Students will gain knowledge on various conservation strategies and process adopted of conservation of biodiversity	1,2
Practical	• Web based tools for sequence searches and homology screening. • Prediction and validation of protein structure using homology modelling. • Introduction to bioinformatics: FASTA, BLAST databases. • Analysis of water samples for various physico-chemical parameters-pH, free CO2, dissolved oxygen, hardness. • Estimation of primary productivity using dark and light bottles. • Quantitative estimation of planktons. • Assessment of invertebrate and vertebrate diversity in your locality (e.g. campus). • Visit to National parks, Wildlife sanctuaries and biosphere reserves of India.	**30**		1,2,3,4

TEXT BOOKS:

T1. Behaviour, development and Evolution by Patrick Batesson (Latest Edition). Open book publishers.

T2. Biodiversity by Wilson, E.O (Latest Edition). Academic Press, Washington.

T3. The Biology of Biodiversity by Kato (Latest Edition). M. Springer.

T4. Wildlife in India by V.B. Saharia Natraj Publishers (Latest Edition) Dehradun.

T5. The Wildlife of India by E.P. Gee (Latest Edition). Harper Collins India.
T6. Environmental Biology- K.C. Agrawal (Latest Edition). Agro Botanical Publishers
T7. Ecology and Environment- P.D (Latest Edition). Sharma Rastogi Publications.
T8. Ecology by Krebs, C. J. (6th Edition). Benjamin Cummings.
T9. Fundamentals of Ecology by Odum, E.P (5th Edition). Cengage Learning India
T10. Ecology and field biology by Smith and Smith (6th Edition). Benjamin- Cummings.

REFERENCE BOOKS:

R1: Genetics and Origin of Species by Dobzhansky, (Latest Edition). Columbia University press
R2: Evolution by Dobzhansky, Th. F.J.Ayala, I.L. Stebbines and J.M. valentine (Latest Edition). Surjeet Publication, Delhi.
R3: Species Evolution-The role of chromosomal Change by King, M. (Latest Edition). The Cambridge University Press, Cambridge.
R4: Evolution and genetics by Merrel, D. J. (Latest Edition). Holt, Rinchart and Winston, Inc.
R5: Animal Behaviour by M. P. Arora (Latest Edition). Himalaya Pub.House-New Delhi.
R6: Organic Evolution (Evolutionary Biology) by Veer Bala Rastogi (13th Edition). Medtech
R7: Animal Behaviour by Dustin R. Rubenstein (Eleventh Edition). Sinauer Associates Inc.
R8: Evolution and behaviour by Workman Lance (Latest Edition). Taylor and Francis Ltd.
R9: Ecological Concepts by Cherrett (Latest Edition) Blackwell Science Oxford, U.K.

OTHER LEARNING RESOURCES:

1. Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOME

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the theories of evolution.	**1**
2	Describe population genetics and phenomenon, mechanism, laws associated with it.	**1, 2**
3	Explain population and community ecology.	**1, 2, 8**
4	Discuss the working mechanisms of an ecosystem.	**1, 8**
5	Describe biodiversity, conservation and management including case studies of Indian origin	**1, 8**

SEMESTER – II									
Course Title	**APICULTURE (TECHNO PROFESSIONAL SKILL - I)**								
Course code	**24MSZO124R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To Understand the historical evolution of apiculture, identify honeybee species, and demonstrate the use of different equipment for effective bee rearing and colony management. 2. To Develop and implement seasonal management strategies for honeybee colonies, including planning for sustainable honey production and queen rearing. 3. To Identify and control common diseases and enemies of honeybees, and demonstrate effective techniques for maintaining healthy and productive apiaries.								
CO1	Explain historical evolution of apiculture, identify species of honeybees, and use of different equipments for bee rearing.								
CO2	Demonstrate bee colony handling techniques maintaining apiary records.								
CO3	Analyse and implement seasonal management strategies for honey bee colonies.								
CO4	Plan honey production and exhibit queen rearing for sustainable honey production.								
CO5	Identify enemies and diseases of honey bees and control them.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	• Introduction to apiculture: importance and history • Different species of honey bees • Bee keeping equipment	**15**	Students will be able to explain the importance and history of apiculture, identify different species of honey bees, and describe the essential equipment used in beekeeping.	1,2
II	• Handling of a honey bee colony and maintenance of apiary record • Collection and preservation of bee pasture	**15**	Students will be able to demonstrate the proper handling of a honey bee colony, maintain accurate apiary records, and effectively collect and preserve bee pasture to support sustainable beekeeping practices.	1,2
III	• Seasonal management of honey bee colonies • Miscellaneous management (dividing, uniting, queen management, supplementary feeding, shifting bee colonies, robbing, absconding)	**10**	Students will manage honey bee colonies seasonally and perform tasks like dividing, uniting, queen management, feeding, shifting, and addressing robbing or absconding.	1,2
IV	• Manipulations for honey production • Economics of beekeeping • Queen rearing	**10**	Students will optimize honey production, understand the economics of beekeeping, and apply techniques for successful queen rearing.	1,2
V	• Familiarization with enemies of honey bees and their control • Familiarization with diseases of honey bees and their control	**10**	Students will identify common enemies and diseases of honey bees and implement effective control measures to protect colonies.	1,2

TEXT BOOKS

T1: Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
T2: Sardar Singh, Beekeeping in India. ICAR, New Delhi.
T3: Principles of Insect Physiology by V.B. Wigglesworth, 1972, Springer
T4: Fundamentals of Entomology by Richard J. Elzinga, 2003, Pearson
T5: Hand book of Economic Entomology for South India by Ayyar, T.V.R, 1992, Narendra Publishing House, New Delhi

REFERENCE BOOKS

R1: Bisht D.S., Apiculture, ICAR Publication.
R2: Entomophagous Insect by Curtis Paul Clausen, 2010, McGraw-Hill book Company
R3: Insect and hygiene by Busvine, J.R. 1951, Published by Methuen & Co, London
R4: The Insects Structure and Function by R.F. Chapman, 2012, Cambridge University Press.
R5: Principles of Insect Physiology by V.B. Wigglesworth, 1972, Springer

OTHER LEARNING RESOURCES:

1. ERP notes
2. Online study materials

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOME

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain historical evolution of apiculture, identify species of honeybees, and use of different equipments for bee rearing.	**1, 6, 8**
2	Demonstrate bee colony handling techniques maintaining apiary records.	**1, 6, 8**
3	Analyse and implement seasonal management strategies for honey bee colonies.	**1, 6, 7, 8**
4	Plan honey production and exhibit queen rearing for sustainable honey production.	**1, 6, 7, 8**
5	Identify enemies and diseases of honey bees and control them.	**1, 6, 8**

SEMESTER – II									
Course Title	**MINI-RESEARCH (RESEARCH GAP ANALYSIS - R2)**								
Course code	**24MSZO125R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	To determine whether the objectives of review of literature gap analysis have been met, if not what steps can be taken accordingly.								
CO1	Create and implement a plan to bridge the gap								
CO2	Find the gap and evaluate solutions.								
CO3	Identify the ideal future state/action plan								
CO4	To analyse the current state/work of research								
CO5	To implement the strategies to meet the research gap under supervision.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	What is literature review.	**15**	Identify literary techniques and creative uses of language in literary texts. Adapt their texts to particular audiences and purposes.	1,2
II	How to Begin the literature Review	**10**	Adapt their texts to particular audiences and purposes.	1,2
III	How to write main body of literature review	**10**	The students will learn about the importance of ethical consideration in research writing	1,2
IV	How to write conclusion of literature Review	**15**	The students will be able to select one of the major key concepts and variables from the chosen research topic.	1,2
V	How to analyze gap in literature review.	**10**	The students will get practical exposure in writing research papers in proper APA format and styles.	1,2

TEXT BOOKS:

1. Multiple Stressors: Literature Review and Gap Analysis (WERF Research Report Series) by S.M. Swanson.

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOME

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Create and implement a plan to bridge the gap	1, 2, 3
2	Find the gap and evaluate solutions.	2, 3
3	Identify the ideal future state/action plan	2, 3
4	To analyse the current state/work of research	2, 3
5	To implement the strategies to meet the research gap under supervision.	2, 3, 8

SEMESTER – II									
Course Title	**RESEARCH METHODOLOGY AND STATISTICAL ANALYSIS**								
Course code	**24UMRM121R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 15T + 60S	**1**	**0**	**0**	**4**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. The course aims to enhances the students' a broad understanding of research methodology, including theory of science and qualitative and quantitative methods in research. 2. The course seeks to enhance the students' skills for developing critical thinking through research literature review in different domain. Consequently it aims to develop skills for preparation of a research proposal for a master' thesis project/Mini research. 3. To develop Students competency in planning, conducting, evaluating and presenting a research project.								
CO1	Explain research methodology, evaluate significance of research and identify research problems.								
CO2	Explain research design, sampling design and design experiment for research.								
CO3	Collection and representation of data and interpret the data with descriptive statistics.								
CO4	Explain to write report, article, reviews etc.								
CO5	Explain intellectual property right and related rights								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Research Methodology- An Introduction- meaning and objectives of research, motivation in research, types and significance of research, criteria of good research. Defining the Research Problems- definition of research problem, necessity of defining research problem	**2**	Knowledge on fundamental concepts of research methodology, including the meaning and objectives of research	1,2
II	Research Design- meaning and need of research design, features of a good design, different research designs, Sampling Design- steps in sampling design, Sample Size determination, criteria for selecting a sampling design, different types of sampling design, Experimental Design, Principles of Design of Experiment, One – way ANOVA, Two- Way ANOVA, CRD, RBD, LSD, 22, 23 Factorial Design	**4**	Able to understand and apply the fundamental principles of research design, including the meaning and necessity of research design	1,2
III	Types of data, sources of data collection, tools of data collection, Nominal, ordinal, interval and ratio – Attitude scale construction and measurement, rating scales, semantic differential (SD), Use of scale in statistical analysis, Schedules for interviews preparation and standardization, development of survey instruments and item analysis for the questionnaire	**3**	A good knowledge on different types of data and identify various sources and tools for data collection	1,2
IV	Planning and organizing research report, Format of research report, Different steps of writing	**3**	Able to organize and write a comprehensive	1,2

	report, lay out of the research report , How to organize thesis/Dissertation, mechanics of writing research report, standard methods of quoting- presenting the result, written and oral reports, Uses of abstract, format of research report, presentation of statistics - tabular and graphic references and uses of references, Bibliography and presentation of bibliography		research report	
V	Intellectual property right (IPR), Introduction and the need for IPR, IPR in India and worldwide, Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications, Patentable and non-patentable, patenting life, Filing of a patent application, The different layers of the international patent system, Case studies on Basmati rice, Turmeric, and Neem patents	**3**	Knowledge on importance of Intellectual Property Rights (IPR) both in India and globally	1,2
Practical	**Laboratory using R Software:** 1. Analysis of One way ANOVA; 2. Analysis of Two way ANOVA; 3. Analysis of CRD 4. Analysis of RBD 5. Analysis of 22 and 23 Factorial Experiment 6. Simulation-I using R (Bernoulli, Binomial, Poisson and Geometric distribution.). 7. Simulation-II using R (Exponential and Normal distribution). 8. Simple random Sampling 9. Stratified Random Sampling	**60**	Knowledge on various statistical experiments and simulations using R	1,2, 3,4

REFERENCES

R1: Boyle JS. Styles of ethnography. In: JM Morse, editor. Critical issues in qualitative research methods.. Thousand Oaks, CA: Sage, 1994:159–85.

R2: Coughlan M., Cronin P. and Ryan F. (2007). Step-by-step guide to critiquing research. Part 1: quantitative research. British journal of Nursing 16 (11).

R3: Creswell, JW. (1998). Qualitative Inquiry and Research Design Choosing Among Five Traditions. Thousand Oaks, CA: Sage Publications.

R4: Crotty, M. (1998). The Foundations of social research: Meaning and perspective in the research process. London: Sage.

R5: Denzin, NK. (1978). Sociological Methods. New York: McGraw-Hill.

R6: Hanson WE, JW Creswell, VL Plano Clark, KS Petska and JD Creswell. Mixed Methods Research Designs in Counseling Psychology. Journal of Counseling Psychology, 2005, Vol. 52, No. 2, 224–235. http://www.preciousheart.net/chaplaincy/Auditor_Manual/13casesd.pdf

R7: Johnson & Christensen. (2004). Educational Research: Quantitative, qualitative and mixes approaches, 2nd Ed. Boston: Allyn & Bacon.

R8: Kothari C., R. (2004). Research Methodology: Methods and Techniques. New Delhi. New Age International (P) Limited, Publishers.

R9: Krueger, A. R. (1994). Focus Groups: A Practical guide for Applied Research, Thousand Oaks, CA: Sage Publications

R10: L., L. Espinosa and M. Yamashita (2015). EvaluationToolkit. Evaluation Guide. Analyze Data. Retrieved from: http://toolkit.pellinstitute.org/evaluation-guide/analyze/analyze-qualitative-data/
R11: Neuman, W. L. (2000). Social research methods. Qualitative and Quantitative approaches (4th Ed.). Boston: Allyn and Bacon.
R12: Patton, MQ. (1999). "Enhancing the quality and credibility of qualitative analysis." HSR: Health Services Research. 34 (5) Part II. pp. 1189-1208.
R13: Patton, MQ. (2001). Qualitative Evaluation and Research Methods (2nd Edition). Thousand oaks, CA: Sage Publications.
R14: Strauss, A. & Corbin, J. (1994). "Grounded Theory Methodology." In NK Denzin & YS Lincoln (Eds.) Handbook of Qualitative Research (pp. 217-285). Thousand Oaks, Sage Publications.

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOME

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain research methodology, evaluate significance of research and identify research problems.	**1, 2, 3**
2	Explain research design, sampling design and design experiment for research.	**2, 3**
3	Collection and representation of data and interpret the data with descriptive statistics.	**2, 3**
4	Explain to write report, article, reviews etc.	**2, 3, 4**
5	Explain intellectual property right and related rights	**1, 8**

SEMESTER – II									
Course Title	**UNIVERSAL HUMAN VALUES (UHV) + PROFESSIONAL ETHICS**								
Course code	**24MSCE121R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings 2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of Existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way 3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature								
CO1	The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.								
CO2	It is free from any dogma or value prescriptions.								
CO3	It is a process of self-investigation and self-exploration, and not of giving sermons.								
CO4	Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation.								
CO5	This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self-evolution.								

Unit-No.	**Content**	**Contact Hour**	**KL**
I	Course Introduction - Need, Basic Guidelines, Content and Process for Value Education 1. Understanding the need, basic guidelines, content and process for Value Education 2. Self-Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration 3. Continuous Happiness and Prosperity- A look at basic Human Aspirations 4. Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority 5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario 6. Method to fulfill the above human aspirations: understanding and living in harmony at various levels.	**7**	1,2

II	Understanding Harmony in the Human Being - Harmony in Myself! 1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body' 2. Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha 3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) 4. Understanding the characteristics and activities of 'I' and harmony in 'I' 5. Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail 6. Programs to ensure Sanyam and Swasthya-Practice Exercises and Case Studies will be taken up in Practice Sessions.	**10**	1,2
III	Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship 1. Understanding Harmony in the family – the basic unit of human interaction 2. Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti;Trust (Vishwas) and Respect (Samman) as the foundational values of relationship 3. Understanding the meaning of Vishwas; Difference between intention and competence 4. Understanding the Meaning of Samman, Difference between respect and differentiation; the other salient values in relationship 5. Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals 6. Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj), Universal Order (Sarvabhaum Vyawastha)- from family to world family!-Practice Exercises and Case Studies will be taken up in Practice Sessions.	**10**	1,2
IV	Understanding Harmony in the Nature and Existence - Whole existence as Co-existence 1. Understanding the harmony in the Nature 2. Interconnectedness and mutual fulfillment among the four orders of nature-recyclability and self- regulation in nature 3. Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all-pervasive space 4. Holistic perception of harmony at all levels of existence-Practice Exercises and Case Studies will be taken up in Practice Sessions.	**8**	1,2
V	Implications of the above Holistic Understanding of Harmony on Professional Ethics 1. Natural acceptance of human values 2. Definitiveness of Ethical Human Conduct 3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order 4. Competence in professional ethics: a) Ability to utilize the professional competence for augmenting universal human order b) Ability to identify the scope and characteristics of people-friendly and eco- friendly production systems, c) Ability to identify and develop appropriate technologies and management patterns for above production systems.	**10**	1,2

	5.Case studies of typical holistic technologies, management models and production systems 6. Strategy for transition from the present state to Universal Human Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers b) At the level of society: as mutually enriching institutions and organizations		

TEXT BOOKS:

T1: R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2

T2: The teacher's manual: R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics – Teachers Manual, Excel books, New Delhi, 2010

T3: A set of DVDs containing

- Video of Teachers' Orientation Program
- PPTs of Lectures and Practice Sessions
- Audio-visual material for use in the practice sessions

REFERENCE BOOKS:

R1: B L Bajpai, 2004, *Indian Ethos and Modern Management*, New Royal Book Co., Lucknow. Reprinted 2008.

R2: PL Dhar, RR Gaur, 1990, *Science and Humanism*, Commonwealth Purblishers.

R3: Sussan George, 1976, *How the Other Half Dies,* Penguin Press. Reprinted 1986,1991

R4: Ivan Illich, 1974, *Energy & Equity,* The Trinity Press, Worcester, and HarperCollins,USA

R5: Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III,1972, limits to Growth, Club of Rome's Report, Universe Books.

R6: Subhas Palekar, 2000, *How to practice Natural Farming,* Pracheen(Vaidik) KrishiTantra Shodh, Amravati.

R7: A Nagraj, 1998, *Jeevan Vidya ek Parichay,* Divya Path Sansthan, Amarkantak.

R8: E.F. Schumacher, 1973, *Small is Beautiful: a study of economics as if people mattered*, Blond & Briggs, Britain.

R9: A.N. Tripathy, 2003, *Human Values*, New Age International Publishers.

OTHER LEARNING RESOURCES:

Relevant websites, movies and documentaries

1. Value Education websites, http://uhv.ac.in, *http://www.uptu.ac.in*
2. Story of Stuff, *http://www.storyofstuff.com*
3. Al Gore, *An Inconvenient Truth*, Paramount Classics, USA
4. Charlie Chaplin, *Modern Times*, United Artists, USA
5. IIT Delhi, *Modern Technology – the Untold Story*

RELATIONSHIP BETWEEN COURSE OUTCOME (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.	**1, 3**
2	It is free from any dogma or value prescriptions.	**1, 3**
3	It is a process of self-investigation and self-exploration, and not of giving sermons.	**1, 3**
4	Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation.	**1, 5**
5	This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self-evolution.	**1, 5, 8**

SEMESTER – II									
Course Title	**COMMUNICATION MASTERY (Communicative English & Soft Skills)**								
Course code	**24UMPD121R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To familiarize students with the transformation of sentences and the appropriate use of prepositions. 2. To enhance the writing skills in different areas including CV and cover letter writing. 3. To convey meaning by reinforcing, substituting for, or contradicting verbal communication.								
CO1	Explain prepositions, tag questions, and idioms correctly.								
CO2	Discuss and analyze different sentence types and voices.								
CO3	Explain effective paragraphs, precis, and professional documents.								
CO4	Describe SWOT analysis, goal setting, and personal hygiene principles.								
CO5	Illustrate non-verbal communication and body language concepts.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Grammar** • Use of Prepositions • Tag questions • Idioms, Phrases and Clauses • Simple, complex, compound sentences	**10**	Identify common errors and refine grammatical accuracy in communication.	1,2
II	**Grammar** • Active and Passive Voice • Direct and Indirect Speech	**10**	Learn when and how to use each voice effectively to suit the context and tone.	1,2
III	**Writing Skills** • The Basics of Writing; avoid ambiguity and vagueness • Paragraph Writing • Precis Writing • Letter Writing • Resume, CV and Cover Letter	**15**	Develop clarity in writing by eliminating ambiguity and vague expressions which helps to focus on precise and concise communication.	1,2
IV	**Self-Management Skills** • SWOT Analysis • Self-Regulation- Goal Setting • Personal Hygiene **Non- Verbal Communication-Sciences of Body Language** • What is Non-Verbal Communication & Body Language, • Elements of Communication, • Types of Body Language, • Importance and Impact of Body Language, • Types of Communication through Body Language, • Introduction to Haptic, Introduction to Kinesics, • Introduction to Proxemics, • Body Language Do's and Don'ts, Doubt Clearing Session.	**15**	Learn to identify personal strengths, weaknesses, opportunities, and threats for personal growth and self-improvement. Identify and interpret different forms of body language in personal and professional settings.	1,2

V	**Group Discussion (Theory)** • Importance, • Planning, Elements, and Skills assessed; • Effectively disagreeing, • Initiating, • Summarizing and Attaining the Objective	**10**	Understand the relevance of group discussions and develop strategies for starting group discussions confidently and effectively.	1,2

TEXT BOOKS:

T1: Barrett, Grant. 2016. Perfect English Grammar: The Indispensible Guide to Excellent Writing and Speaking, Zephyros Press.

T2: McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition).

REFERENCES:

R1: Communication Skills Training: A Practical Guide to Improving Your Social Intelligence, Presentation and Social Speaking, Ian Tuhovsky , 2019

R2: A Textbook for AECC English Communication: Interface, Dr. Kironmoy Chetia and PranamiBania Breez Mohan Hazarika, January 2019.

OTHER LEARNING RESOURCES:

https://youtu.be/x60GHpQ8gJk
https://youtu.be/Ke_oSN-BCaY
https://youtu.be/TDPDtrLxT-c
https://www.classcentral.com/report/toefl-preparation/

RELATIONSHIP BETWEEN COURSE OUTCOME (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain prepositions, tag questions, and idioms correctly.	**1, 2, 4, 8**
2	Discuss and analyze different sentence types and voices.	**1, 2, 4, 8**
3	Explain effective paragraphs, precis, and professional documents.	**1, 2, 4, 8**
4	Describe SWOT analysis, goal setting, and personal hygiene principles.	**1, 2, 4, 8**
5	Illustrate non-verbal communication and body language concepts.	**1, 2, 4, 8**

SEMESTER – III									
Course Title	**ORNAMENTAL FISH FARMING (TPS-II)**								
Course code	**24MSZO213R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To inculcate importance of ornamental fish farming in relation with entrepreneurship development. 2. To give students knowledge about ornamental fish rearing to make them self-sustainable. 3. To teach techniques of construction of glass aquarium and its maintenance.								
CO1	Identify ornamental fish and aquarium plants.								
CO2	Design setting up of aquaria and apply knowledge on farming for its maintenance.								
CO3	Demonstrate rearing of indigenous ornamental fish and estimate physico chemical characteristics of aquarium water.								
CO4	Analyse physico-chemical characteristics of aquarium water, design and construct biological filter for culturing plankton.								
CO5	Analyze ornamental fish farms through field visits.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Ornamental fishes and plants** • Identification of common ornamental fishes. • Identification of common aquarium plants.	**15**	Students will be able to identify common Ornamental Fishes and common aquarium plants	1,2
II	**Designing and setting up of aquarium** • Aquarium designing and equipments. • Setting up and maintenance of fresh water aquaria.	**10**	Students will be able to design and maintain aquaria	1,2
III	**Rearing and physico-chemical parameters of aquarium water** • Rearing of indigenous ornamental fish in aquarium. • Estimation of physico- chemical characteristics of aquarium water.	**15**	Students will be able to rear Indigenous ornamental fish in Aquarium and able to do estimation of Physico-chemical characteristics of Aquarium water	1,2
IV	**Biological filter and plankton culture** • Preparation of biological filter for removal of ammonia from aquarium. • Culture of planktons.	**10**	Students will be able to Construct biological filter and develop plankton culture	1,2
V	**Field study** Visit to ornamental fish farm.	**10**	It will help the students to get broad knowledge in ornamental fish farming	1,2

TEXT BOOKS:

T1: Ornamental fish farming by B. Andrews. (Latest Edition) Kindle Edition.
T2: Textbook of aquaculture by B. Ahilan, N. Felix and R. Santhanan (Latest Edition) Daya Publishing House.
T3: Aquarium Fish: A definite guide to identifying and keeping fresh water and marine species by
T4: M. Bailey and G. Sandford (Latest Edition)

REFERENCE BOOKS:

R1: The freshwater fishes of the Indian region by Jayaram, K.C. 1999. New Delhi: Narendra Publishing House. 551 pp.

R2: Fishes of northeast India by Vishwanath, W., W.S. Lakra and U.K. Sarkar. 2007. Lucknow: NationalBureau of Fish Genetic Resources. 264 pp.

R3: A textbook of Fish Biology and Fisheries by S.S. Khanna and H. R. Singh (3rd Edition). Narendra PublishingHouse, Delhi.

R4: Handbook of the freshwater fishes of India by Beaven C R (Latest Edition) Narendra Publishing House.

R5: Fish and Fisheries of India by Jhingran V. G. (4th Edition). Hindustan Publishing Corporation

R6: Ichthyology by Lagler et al. (2nd edition). Wiley Publication.

R7: Fish and Fisheries by Pandey (Latest Edition). Rastogi Publications.

R8: Fishes by Chandy, M. (1st Edition). National Book Trust, India.

OTHER LEARNING RESOURCES:

1. Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOME (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Identify ornamental fish and aquarium plants.	**1**
2	Design setting up of aquaria and apply knowledge on farming for its maintenance.	**1, 8**
3	Demonstrate rearing of indigenous ornamental fish and estimate physico chemical characteristics of aquarium water.	**1, 8**
4	Analyse physico-chemical characteristics of aquarium water, design and construct biological filter for culturing plankton.	**1, 8**
5	Analyze ornamental fish farms through field visits.	**1, 7**

SEMESTER – III									
Course Title	**RESEARCH ETHICS**								
Course code	**24UMRE214R**	**Total credits: 1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 15	**1**	**0**	**0**	**0**	**0**	**0**	**1**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	This course aims to lay a foundation for empirical research and make students aware of relevant guidelines, policies, and codes relating to ethical research, as well as to provide, via a study of ethical theories, concepts.								
CO1	Describe and apply research ethics theories and methods.								
CO2	Explain research ethics issues such as responsibility, vetting, and misconduct.								
CO3	Illustrate arguments and results in ethical research inquiries.								
CO4	Identify and apply procedures for sampling, data collection, and reporting.								
CO5	Apply ethical principles to research design and evaluation								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**ETHICS:** Introduction to the course and each other; an introduction to moral theory. Ethics: definition, moral philosophy, nature of moral judgements and reactions. Research regulation; self – regulation; research ethics. Honesty, candor, compromise and integrity. Data ownership and stewardship; conflicts of interest; collaboration. Human and Non-Human subjects. Research and researchers in society.	**3**	Understand and apply key ethical principles and moral theories in research contexts, critically evaluate issues related to research ethics.	1,2
II	**SCIENTIFIC CONDUCT-** Ethics with respect to science and research. Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data.	**2**	Understand and apply ethical principles related to scientific conduct, demonstrate intellectual honesty and research integrity, recognize and prevent scientific misconduct	1,2
III	**PUBLICATION ETHICS-** Publication ethics: definition, introduction and importance. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.	**3**	Understand the importance of publication ethics, recognize best practices and standards	1,2

IV	**OPEN ACCESS PUBLISHING-**Open access publications and initiatives**.** SHERPA/RoME0 online resource to check publisher copyright & self-archiving policies. Software tool to identify predatory publications developed by SPPU**.** Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.	**3**	Understand the concept and significance of open access publishing	1,2
V	**PUBLICATION MISCONDUCT** Group Discussions; Subject specific ethical issues, FFP, authorship. Conflicts of interest. Complaints and appeals: examples and fraud from India and abroad. Software tools; Use of plagiarism software like Turnitin, Urkund and other open-source software tools. **DATABASES AND RESEARCH METRICS–** Databases: Indexing databases. Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, I 10 index, altmetrics.	**4**	Gain proficiency in navigating indexing and citation databases	1,2

TEXT BOOKS:

T1: Bird, A(2006).Philosophy of Science. Routledge.

T2: Maclntyre, Alasdair (1967) A Short History of Ethics. London.

T3: Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance(2019)

REFERENCE BOOKS:

R1: National Academy of Science, National Academy of Engineering and Institute of Medicine (2009). On Being a Scientist: A Guide of Responsible Conduct in Research: Third Edition, National academics Press

R2: George R, (2011). Sociological Theory, Rawat Publication, New Delhi, India. George R, (2019).Post Modern Social Theory, Rawat Publication, New Delhi, India.

OTHER LEARNING RESOURCES:

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOME (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe and apply research ethics theories and methods.	**1, 3, 5**
2	Explain research ethics issues such as responsibility, vetting, and misconduct.	**1, 3, 5**
3	Illustrate arguments and results in ethical research inquiries.	**1, 3, 5**
4	Identify and apply procedures for sampling, data collection, and reporting.	**1, 3, 5**
5	Apply ethical principles to research design and evaluation	**1, 3, 5**

SEMESTER – III										
Course Title	**CORPORATE PROFICIENCY (Communicative English & Soft Skills)**									
Course code	**24UMPD211R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To acquaint students with the various tools of an effective presentation. 2. To acquire the speaking skill, instruct, influence, engage, educate, or appease the listeners. 3. To increase proficiency, presentability and quality of resume and provide guidance for self- promotion and self-evaluation in social media.									
CO1	It will prepare the learners to speak with greater control and charisma in front of others.									
CO2	It will have a positive impact in their thought process and problem-solving skills.									
CO3	It will arm the students with all the necessary tools and skillsets to prepare professional resume.									
CO4	They will learn to highlight and assess themselves in social media.									
CO5	It will impart in them techniques to solve critical problems in an interview, develop strategies to crack interviews, improve their communication skills, boost their confidence									

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Presentation Skills** • Introduction • Essential characteristics of a good presentation • Preparation of a good presentation	**4**	Understand the importance of presentation skills in personal and professional contexts. It also helps to recognize key elements that make a presentation effective, such as clarity, engagement, and structure.	1,2
II	**Public Skills** • Fear of Public Speaking, • Understanding and Overcoming Fear of Public Speaking, • Confidence and Control, • Physiology and Stress - Control/Process, • Tips for Presentations and Public Speaking, • Tips for Using Visual Aids in Presentations, • Process for Preparing and Creating Presentations, • Delivering Presentations Successfully, • Doubt Clearing and Summary of Main Points	**20**	Learn psychological and practical strategies to manage and reduce speaking anxiety.	1,2

III	**Practical session on Resume, Curriculum Vitae, Writing cover letter & LinkedIn Profile** • Preparation, submission & screening of Resume. • Practical session on cover letter screening session • Creating a profile on LinkedIn • How to utilize it	**10**	Gain expertise in drafting impactful cover letters and learn to create tailored resumes that highlight relevant skills and achievements.	1,2
IV	**Leadership & Management Skills** • Concepts of Leadership, • Leadership Styles, • Manager VS Leader, • How to be an Effective Leader, • Mock/ Practice Session, • Doubt Clearing Session. **Research Paper – Writing Skills** • How to write a research paper • Key point in Research Work	**20**	Understand the fundamental principles and importance of leadership in various contexts.	1,2
V	**Mock Interview** • Practical Mock Interview, • Feedback- Receiving Feedback, • Giving Feedback, • Advantages of effective Feedback, • How to deal with negative feedback.	**6**	Identify critical aspects of conducting research, including hypothesis formation and data analysis	1,2

TEXT BOOKS:

T1: Barrett, Grant. 2016. Perfect English Grammar: The Indispensible Guide to Excellent Writing and Speaking, Zephyros Press.

T2: McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition).

REFERENCE BOOKS:

R1: Garg. Manoj Kr. (2018) *English Communication: Theory and Practice*

OTHER LEARNING RESOURCES:

https://brightlinkprep.com/10-best-toefl-prep-books/

https://files.eric.ed.gov/fulltext/EJ1132742.pdf

RELATIONSHIP BETWEEN COURSE OUTCOME (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	It will prepare the learners to speak with greater control and charisma in front of others.	**1, 4, 8**
2	It will have a positive impact in their thought process and problem-solving skills.	**1, 4, 8**
3	It will arm the students with all the necessary tools and skillsets to prepare professional resume.	**1, 4, 8**
4	They will learn to highlight and assess themselves in social media.	**1, 4, 8**
5	It will impart in them techniques to solve critical problems in an interview, develop strategies to crack interviews, improve their communication skills, boost their confidence	**1, 4, 8**

SEMESTER – III									
Course Title	**ANIMAL PHYSIOLOGY**								
Course code	**24MSZO216R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1) To provide knowledge of animal body system to reveal physiological homologies, pattern of physiological adaptation to various environments. 2) To introduce various principles that underlies higher level integrative bodily functions. 3) To provide a comprehensive knowledge of functional physiological pathways common to all animals ranging from molecular, biochemical, cellular processes.								
CO1	Explain the concepts of gas exchange in lungs and different types of respiratory pigments in humans and animals.								
CO2	Describe the function of heart as a pump and connecting tissues.								
CO3	Describe human response to different stimulus and ability of brain in understanding, storing information and controlling body.								
CO4	Illustrate the mechanism of breaking down of complex foods, assimilation and elimination of the nitrogenous wastes								
CO5	Discuss sensory organs (ear and eye) and the perception prepared by the brain.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Respiratory physiology** • Respiratory pigments: Haemoglobin, hemocyanin, erythrocruorin-chlorocruorin and haemerythrin • Pulmonary circulation: Gaseous exchange through membranes and tissues: Fick's Law, structure of respiratory membrane, diffusion and perfusion • Oxygen and carbon dioxide transport • Oxygen dissociation curve and Bohr effect • Chemical and neural regulation of respiration (briefly) • Aviation, space and deep-sea diving physiology	**7**	To understand the concepts of gas exchange in the lungs and different types of respiratory pigments in humans and animals.	1,2
II	**Cardiovascular physiology** •Composition of blood, Hemostasis, Haemopoiesis, Lymphatic system and Lymph •Circulation of blood in different animals (briefly), Origin and conduction of the cardiac impulse	**10**	To understand the function of heart as a pump and the blood and lymph as connecting tissues to carry gases and nutrients to and from the tissues and heart.	1,2

III	**Nerve and muscle physiology** • Sensory parts: Sensory receptors, Motor Parts: Effectors • Processing of information, Storage of information Synaptic transmission, neurotransmitters	**10**	To understand and analyze the ways in which we perceive the world around us and our response to stimuli along with the knowledge of how the brain stores and understands the information gathered to control our entire body.	1,2
IV	**Gastrointestinal and Renal physiology** • Digestion, absorption and assimilation; Energy balance and BMR: Definitions; • Patterns of nitrogenous excretion in different animals; Counter- current exchanger in the kidney; • Regulation of urine formation; Acid base balance (blood and kidney); Homeostasis	**8**	To understand the breaking down of complex foods into nutrients that are necessary for our body, assimilation and elimination of the nitrogenous wastes produced as a result of breakdown and utilization in the body.	1,2
V	**Special Senses** • Vision: The retina structure and photochemistry of vision and function of the visual cortex • Hearing: The organ of Corti: structure and function, auditory nervous pathways and function of the cerebral cortex in hearing, Bioluminescence	**10**	To understand that the eye and ear function as sensory organs and the visual and audio perception is done by the brain	1,2
Practical	• Estimation of free amino acid using ninhydrin reagent. • Blood glucose test. • Measurement of lung volume by spirometry. • Erythrocyte Sedimentation Rate (ESR). • Dissection to show the striated muscle structure of an invertebrate and vertebrate. • Dissection of a sample of goat spinal cord to demonstrate the structure of neurons.	**30**		1,2,3,4

TEXT BOOKS:

T1: Essentials of Animal Physiology by S. C. Rastogi (Latest Edition) Publisher New Age Internationals.

T2: Textbook of Medical Physiology by Guyton and Hall (Latest Edition). Elsevier.

T3: Animal Physiology Edn.5 Part II, Verma (P.S) Etc, Aul. H Ed.Nch (James) Himalaya, 2000.

T4: Chordate Zoology and Animal Physiology, Jordan(El); Verma(P.S), S Chand and Company, 1993.

T5: Introduction to Animal Physiology, Kay(Ian), Bios Scientific Publishers, 1998.

REFERENCE BOOKS:

R1: Eckert Animal Physiology: Mechanisms and Adaptations by Eckert and Randal (4th Edition).

W. H. Freeman.
R2: Animal Physiology by Hill, Wyse and Anderson (3rd Edition). Sinauer Associates,
R3: Inc. Publishers • Sunderland, Massachusetts
R4: Essentials of Medical Physiology by K. Sembulingam and Prema Sembulingam (7th Edition). Jaypee Brothers Medical Pub
R5: Physiology by Linda S. Costanzo (7th Edition.). Wolters Kluwer
R6: Animal physiology: mechanism and adaptations by Eckert R. and Randal D (2nd Edition) CBS publishers and Distributor, New Delhi
R7: General and Comparative physiology by Hoar W. S.(Latest Edition). Prentice Hall of
R8: India Pvt. Ltd.
R9: Animal physiology: Adaptation and Environment by Schmidt-Neilsen (Latest Edition), Cambridge Press.
R10: Comparative animal Physiology by Prosser C. L. (Latest Edition) Saunders, Philadelphia, USA

OTHER LEARNING RESOURCES:

1. Animal Physiology : https://swayam.gov.in/nd1_noc20_bt42/preview
2. Physiology and Biochemistry: https://swayam.gov.in/nd2_cec20_bt19/preview
3. Animal Physiology : https://www.classcentral.com/course/swayam-animal-physiology-12894
4. Respiration in the Human Body: https://www.classcentral.com/course/edx-respiration-in-thehuman-body-3050
5. Introduction to Brain & Behaviour : https://swayam.gov.in/nd1_noc20_hs33/preview
6. Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]
7. https://www.ncbi.nlm.nih.gov/books/NBK459327/
8. https://hearinghealthfoundation.org/how-hearing-works
9. https://www.ncbi.nlm.nih.gov/books/NBK50780

RELATIONSHIP BETWEEN COURSE OUTCOME (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the concepts of gas exchange in lungs and different types of respiratory pigments in humans and animals.	**1, 3**
2	Describe the function of heart as a pump and connecting tissues.	**1, 3**
3	Describe human response to different stimulus and ability of brain in understanding, storing information and controlling body.	**1, 3**
4	Illustrate the mechanism of breaking down of complex foods, assimilation and elimination of the nitrogenous wastes	**1, 3**
5	Discuss sensory organs (ear and eye) and the perception prepared by the brain.	**1, 3**

SEMESTER – III									
Course Title	**DEVELOPMENTAL BIOLOGY**								
Course code	**24MSZO217R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To provide the knowledge of pre and post embryonic development in organism. 2. To impart the knowledge of organogenesis in organism. 3. To impart knowledge on metamorphosis and regeneration.								
CO1	Explain the basic terminology of animal development, pre and post fertilization events and morphogenesis.								
CO2	Describe the gene regulations in axis and pattern formation in drosophila, amphibia and chick.								
CO3	Explain the process of organ formation (organogenesis).								
CO4	Explain the mechanism for regeneration of organs.								
CO5	Describe metamorphosis and types of cell death.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Modern concepts of development** • Potency • Commitment • Specification • Induction • Competence • Determination • Differentiation • Cell fate and cell lineages • Stem cells • Genomic equivalence • cytoplasmic determinants • Imprinting • Mutant • Transgenics in analysis of development. **Fertilization** • Pre and post fertilization events, • Activation of eggs • Gamete fusion • Prevention of phylogeny. **Morphogenesis and cell adhesion** • The thermodynamic model of cell interaction • Concept of morphogen gradients and morphogenetic fields • Cell adhesion molecules.	7	Students will be able to explain the key concepts of development, including potency, commitment, cell fate etc. with an understanding of how these processes contribute to organismal development.	1,2

II	**Morphogenesis in organism** • Cell aggregation and differentiation in Dictyostelium, • Axis and pattern formation in Drosophila: Maternal effect genes, gap genes, pair rule genes, segment polarity genes, homeotic genes and hox genes in development. • Axis and pattern formation in amphibian and chick.	**10**	Students will be able to describe the processes of morphogenesis.	1,2
III	**Organogenesis in animals** • Vulva formation in *Caenorhabditis elegans* • Eye lens induction • Limb development	**10**	Students will be able to explain the processes of organogenesis in animals.	1,2
IV	**Regeneration** • Epimorphic regeneration of Salamander limbs • Morphallactic regeneration in hydra • Compensatory regeneration in Mammalian liver	**8**	Students will be able to compare different types of regeneration, including epimorphic and morphallactic regeneration.	1,2
V	**Post embryonic development** • Larva formation • Metamorphosis • Chromosomal sex determination in mammals **Programmed cell death** • Apoptosis • Autophagy • Necrosis	**10**	Students will be able to describe post-embryonic development processes.	1,2
Practical	• Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole. • Study of whole mounts of developmental stages of chick through permanent slides/model/charts. • Preparation of whole mount of chick embryo of 13-18, 24-33, 36-48 and 48-72 hours and identification of the developmental stages. • Study of different types of invertebrate and vertebrate eggs from permanent slides/model/charts. • Study of developmental stages of fish from egg to hatching. • Study of regeneration in the tail of tadpoles. • Study of life cycle of *Drosophila melanogaster*.	**30**		1,2,3,4

TEXT BOOKS:

T1: Developmental Biology by Scott F, Gilbert (8th Ed.) NCBI Book self.

REFERENCE BOOKS:

R1: Human Embryology and Developmental Biology by Bruce, M. Carlson (6th Edition). Elsevier.
R2: Principles of Development by Lewis Wolpert, Cheryll Tickle and Alfonso Martinez Arias (5th Edition). Oxford University Press.
R3: Developmental Biology by Michael J F Barresi and Scott F, Gilbert (12th Edition). Oxford University Press.
R4: Vertebrates Comparative Anatomy, Function and Evolution by Kardong, K.V. (IV • Edition). McGraw-Hill Higher Education.
R5: Comparative Anatomy of the Vertebrates by Kent, G.C. and Carr R.K. (IX • Edition). The McGraw-Hill Companies.
R6: Analysis of Vertebrate Structure by Hilderbrand, M and Gaslow G.E.(6th Edition). John Wiley and Sons.
R7: Biology of Vertebrates by Walter, H.E. and Sayles, L.P. (Latest Edition) Khosla Publishing House.
R8: Developmental Biology by Carol A. Erickson, Leon W. Browder, William R. Jeffery. (3rd Edition), Saunders College Publishing, Philadelphia.
R9: Principles of Development 5e Hardcover by Lewis Wolpert (5th Edition), Oxford University Press.

OTHER LEARNING RESOURCES:

https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOME (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the basic terminology of animal development, pre and post fertilization events and morphogenesis.	**1, 3**
2	Describe the gene regulations in axis and pattern formation in drosophila, amphibia and chick.	**1, 3**
3	Explain the process of organ formation (organogenesis).	**1, 3**
4	Explain the mechanism for regeneration of organs.	**1, 3**
5	Describe metamorphosis and types of cell death.	**1, 3**

SEMESTER – III									
Course Title	**AQUACULTURE**								
Course code	**24MSZO218R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. This course is designed to provide in depth knowledge of different aquatic ecosystems and different types of fish cultures. 2. To develop theoretical knowledge on pre and post stocking management. 3. To impart knowledge on different aquaculture and fish identification.								
CO1	Explain concepts of different aquatic ecosystems.								
CO2	Describe types of aquaculture methods.								
CO3	Assess sites and identify species for aquaculture.								
CO4	Analyze pre stocking procedure and management.								
CO5	Analyze post stocking procedure and management.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Aquatic Ecosystems:** • Freshwater ecosystems - Lotic and Lentic ecosystems; • Marine ecosystems - oceans and seas, zonation of the seas - rocky, sandy and muddy shores; classification of marine habitat - pelagic, benthic, neritic, oceanic, littoral and abyssal.	**7**	Students will learn different aquatic systems	1,2
II	**Aquaculture systems and methods**: • Scope and definition; origins and growth of aquaculture; biological and technological basis; • Traditional, extensive, semi - intensive and intensive culture; monoculture, polyculture, composite culture, mixed culture, mono sex culture; cage culture, pen culture, raft culture, sewage – fed fish culture.	**10**	Students will learn different types of aquaculture methods	1,2
III	**Selection of Sites and species for aquaculture:** • Survey and location of suitable site – topography; soil characteristics; water source; hydrometerological data. • Biological characteristics of aquaculture species; economic and market considerations; seed resources, collection and transportation	**10**	It will help the students for site selection and selection of species for aquaculture	1,2
IV	**Pre-Stocking Management**: • Sun drying, ploughing / tilling, desilting, liming and fertilization, eradication of weed fishes. • Stocking: Acclimatization of seed and release; species combinations; stocking density; ratio.	**8**	It will help the students to learn about prestocking processes	1,2

V	**Post Stocking Management:** • Water and soil quality parameters required for optimum production, control of aquatic weeds and aquatic insects, algal blooms; • Specific food consumption, food conversion ratio (FCR), protein efficiency ratio, true net protein utilization, apparent net protein utilization, biological value of protein.	**10**	It will help the students to get the knowledge Regarding different post stocking management	1,2
Practical	• Determination of water temperature, pH, salinity, turbidity. • Analysis of total alkalinity of water. • Determination of total hardness of water. • Estimation of dissolved oxygen, BOD of water. • Estimation of phosphates and CO2. • Dissection of pituitary gland of fish. • Estimation of primary productivity using dark and light bottle.	**30**		1,2,3,4

TEXT BOOKS:

T1: Jhingran V.G. 1991. Fish and Fisheries of India. Hindustan Publ Corporation India, Pillay TVR. 1990

T2: Blackwell rath RK. 2000 freshwater aquaculture. Scientific publ.

T3: Landau M. 1992. Introduction to Aquaculture. John Wiley & Sons.

T4: A textbook of Fish Biology and Fisheries. S.S. Khanna and H. R. Singh. (3rd Edition) Narendra Publishing House, Delhi

REFERENCE BOOKS:

R1: Huet J. 1986. A text Book of Fish Culture. Fishing News Books Ltd.

R2: Mathew Landau. 1995. Introduction to Aquaculture. Daya Publishing House, New Delhi

R3: Jhingran, V. G. 1982. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.

R4: Chakrabarti, N. M. 1998. Biology, Culture and Production of Indian Major Carps. Narendra Publishing House, New Delhi.

R5: General and Applied Ichthyology by Gupta S.K., Gupta P.C. (Latest Edition). S Chand and Company

R6: Handbook of the freshwater fishes of India by Beaven C R. (Latest Edition). Narendra Publishing House.

OTHER LEARNING RESOURCES:

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites

RELATIONSHIP BETWEEN PROGRAM OUTCONE(CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain concepts of different aquatic ecosystems.	**1, 3**
2	Describe types of aquaculture methods.	**1, 3**
3	Assess sites and identify species for aquaculture.	**1, 3**
4	Analyze pre stocking procedure and management.	**1, 3, 8**
5	Analyze post stocking procedure and management.	**1, 3, 8**

SEMESTER – III										
Course Title	**ANIMAL DIVERSITY**									
Course code	**24MSZO219R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**	
Pre-requisite	**Nil**	**Co-requisite**	**Nil**							
Programme	**MASTER OF SCIENCE IN ZOOLOGY**									
Semester	**Fall/ I semester of first year of the programme**									
Course Objectives	1. To impart the knowledge on concept of biological diversity and its importance. 2. To provide the information regarding adaptation of animal diversity and their conservation approaches. 3. To provide knowledge on adaptation in animals and their conservation strategy.									
CO1	Describe animal kingdom and animal diversity.									
CO2	Explain animal diversity in Indian context.									
CO3	Describe salient features and composition of life forms.									
CO4	Analyse adaptations in animal diversity.									
CO5	Describe the conservation programs adopted in India for conservation of wildlife.									

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction to animal diversity:** • Biodiversity: Concept of biological diversity; • Global biodiversity hotspots; RAMSAR convention and RAMSAR sites. • Outline of Animal Kingdom Classification with examples.	**7**	Students will understand the importance Biological diversity	1,2
II	**Animal diversity in India:** • General profile of faunal resources, endemic and threatened species. • Protected areas: Biosphere reserve, national parks and sanctuaries	**10**	Students will be able to know overall faunal profile of India, concept of protected areas.	1,2
III	**Salient features and composition of life forms**: • Salient features and composition of life forms in terrestrial, desert and cavernicolous ecosystem • Salient features and composition of life forms in freshwater, estuarine and marine ecosystem	**10**	Students will know regarding salient features and composition of life forms.	1,2
IV	**Adaptations in animal diversity**: • Terrestrial, desert and aquatic adaptation • Animal diversity and human health: Important pathogenic life forms • Animal diversity and human society: Ethnozoology and Zootherapeutic	**8**	Students will have basic idea on adaptive capabilities of animal diversity.	1,2
V	**Conservation and management of wildlife:**	**10**	Students will have understanding on	1,2

	• Principles of conservation, biodiversity management approaches • Human wildlife conflict; Peoples participation in managing protected areas • Wildlife health and disease • Wildlife trade and laws: Wildlife Protection Act, 1972 • Red Data Book; Measure to control poaching and wildlife trade		different conservation programme adopted in India for the conservation of animal diversity.	
Practical	• Study of invertebrate museum specimen (two specimen from each phylum). • Study of invertebrate museum specimen (two specimen from each phylum). • Mounting of different types of scales of fish. • Mounting of mouthparts of insects. • Study of various types of social insects (honeybee/ants) and their nests.	**30**		1,2,3,4

TEXT BOOKS:

T1: Anna A. Sher and Richard B. Primack 2019. An Introduction to Conservation Biology, Oxford University press.

T2: Anon. 2004. Indian Wildlife Protection Act 1972. Natraj Publishers, Dehra Dun. 104p.

T3: Gopal, R. 1992. Fundamentals of Wildlife Management. Justice Home. Allahabad. 668p.

T4: Navjot S. Sodhi and Paul R. Ehrlich 2010. Conservation Biology for All. Oxford University press.

T5: Wilson, E. O., and D. Perlman. 2000. Conserving earth's biodiversity. Island Press, Washington, D.C.

REFERENCE BOOKS:

R1: Meffe, G. K. and C. R. Carroll 1994.Principles of Conservation Biology, Sinauer Associates, USA

R2: 2 Michael, P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata Mc Graw Hill Publishing Company Limited, New Delhi. 404 p.

R3: Peter H. Raven, Navjot S. Sodhi, Luke Gibson, 2013. Conservation Biology: Voices from the Tropics, Willey Online library.

R4: Odum, E.P. 1996. Fundamentals of Ecology. Natraj Publishers, Dehra Dun 574p. 19. Primack, R. B. 2006. Essentials of Conservation Biology, Sinauer Associates, USA.

R5: Soule, M. E. 1986. Conservation Biology: The Science of Scarcity and Diversity, Sinauer Associates Inc., USA.

OTHER LEARNING RESOURCES:

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe animal kingdom and animal diversity.	**1,3**
2	Explain animal diversity in Indian context.	**1, 3**
3	Describe salient features and composition of life forms.	**1, 3**
4	Analyse adaptations in animal diversity.	**1, 3**
5	Describe the conservation programs adopted in India for conservation of wildlife.	**1, 3, 8**

SEMESTER – IV									
Course Title	**RESEARCH/DATA ANALYSIS/DOCUMENTATION-R4**								
Course code	**24MSZO221R**	**Total credits: 12**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**20**	**8**	**4**	**0**	**12**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	Research Problems in Entomology/Fish Biology and Fisheries/Molecular Cell Biology is a project-based faculty supervised research course. This course aims to give students hands-on laboratory or field experience that can be translated into career fields in Entomology/Fish Biology and Fisheries/Molecular Cell Biology.								
CO1	Students should demonstrate critical thinking skills through establishing methods to test a hypothesis;								
CO2	Students can analyse and interpret results and discuss findings.								
CO3	Students should demonstrate technical competency and ethical laboratory conduct.								
CO4	Students should be able to synthesize scientific literature to their experiments.								
CO5	Students can effectively communicate their finding to a scientific audience.								

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students should demonstrate critical thinking skills through establishing methods to test a hypothesis;	**1, 2, 3**
2	Students can analyse and interpret results and discuss findings.	**1, 2, 3**
3	Students should demonstrate technical competency and ethical laboratory conduct.	**1, 2, 3**
4	Students should be able to synthesize scientific literature to their experiments.	**1, 2, 3**
5	Students can effectively communicate their finding to a scientific audience.	**1, 2, 3**

SEMESTER – IV									
Course Title	**ENTOMOLOGY I (INSECT BIOLOGY, ECOLOGY AND PEST MANAGEMENT)**								
Course code	**24MSZO222R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To provide the knowledge on morphological and 2. To know the anatomical structure of insects and their role in ecosystem. 3. To give knowledge on vector borne diseases, pest control and management.								
CO1	Explain Class Insecta and describe morphology of insects.								
CO2	Illustrate and plan pest management approaches.								
CO3	Describe role of insects in an ecosystem.								
CO4	Describe the diseases caused by insects and their control measures.								
CO5	Explain defense mechanism of insects.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**General morphology of insects and function:** • Structure of insect head, thorax and abdomen, insect integument, • Type of mouthparts, antennae, legs and their modifications & function, • Wings, wing structure, venations and wing coupling, • Insect eye: structure & function, • Receptor organs in insects (Chemo receptors, mechanoreceptors and Photoreceptors, • Sound and light producing organs in insects.	**7**	Students will acquire knowledge Regarding morphology of different appendages of insects	1,2
II	**Insect pest control and management:** • Primary control measures • Hormonal and Pheromonal control • Biological control • Plant resistance to insects • Biotechnological approach in pest management.	**10**	Students will able to know different methods of pest managements	1,2
III	**Major Ecological Role of Insects:** • Insects as herbivores • Insect as pollinators • Aquatic insects • Insects as parasites and predators • Role of insects in forensic sciences • Insect biotic potential and environmental resistance • Insect as human food.	**10**	Students will know regarding different role of insects in an ecosystem	1,2

IV	**Insects of medical Importance:** • Life cycle, Mode of transmission and epidemiology of major vector borne diseases such as Malaria, yellow fever, kalazar, typhus, plague, filiariasis.	**8**	Students will have basic idea on various diseases that are caused by insects and their control measures	1,2
V	**Defense Mechanism in Insects:** • Behavioural and structural defense, • Chemical defense, • Coloration defense • Mimicry. • Adaptation of insects in terrestrial and aquatic environment **Insect Behavior:** • Chemotropism, thigmotropism, hydrotropism, rheotropism, anemotropism, phototropism, thermotropism, geotropism, instinct **Protective behaviour:** mimicry. Crypsis, warning coloration. Behavioural defence, chemical defence. Breeding behaviour. **Insect associations:** Passive insect association, active associations, estivating aggregation, protective aggregation, swarming aggregation, sleeping aggregation, dissociation, social aggregations	**10**	Students will have understanding on different behavioural mechanism in insects	1,2

TEXT BOOKS:

T1: The Insects: Structure and Function. AUTHOR: R. F. Chapman, EDITORS: Stephen J. Simpson, University of Sydney Angela E. Douglas, Cornell University, New York. Cambridge University Press.

T2: Modern Entomology by D.B. Tembhare. Himalayan Publishing House.

REFERENCE BOOKS:

R1: IMMS' general text book of entomology by Richard's and Davies (Latest Edition) Chapman and Hall, UK.

R2: Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F.M (6^{th} Edition). Saunders College Publication, USA.

R3: Principles of Insect Morphology, Snodgrass, R. E. (Latest Edition). Cornell Univ. Press, USA.

R4: The Insect Societies, Wilson, E. O. (Latest Edition). Harvard Univ. Press, UK.

R5: Daly and Doyen's Introduction to Insect Biology and Diversity. Whitfield, J. B. and A. H. Purcell

R6: III. (3^{rd} Edition). Oxford University Press, Oxford, UK.

R7: Wigglesworth, V.B. (1976). Insect and the life of Man. London Chapman and Hall.

R8: Entomology and Pest Management by Pedigo, L.P. and Rics, M.E. (6^{th} Edition). PHI Learning Private Limited.

R9: Pests of Stored Grains and their Management by Bhargava, M.C. and Kumawat, K.C. (Latest Edition). New India Publishing Agency.

R10: Insect Pests of Stored Grains and Grains Products: Identification, Habits and Methods of Control by Cotton, R.T. (Latest Edition). Biotech Books, Delhi.

R11: Fundamentals of Agriculture Entomology by Haldhar and Deshwal. (Latest Edition) New Vishal Publication.

OTHER LEARNING RESOURCES:

1. Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]
2. Online study materials

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain Class Insecta and describe morphology of insects.	**1, 6**
2	Illustrate and plan pest management approaches.	**1, 6, 8**
3	Describe role of insects in an ecosystem.	**1, 6**
4	Describe the diseases caused by insects and their control measures.	**1, 6, 8**
5	Explain defense mechanism of insects.	**1, 3**

SEMESTER – IV									
Course Title	**ENTOMOLOGY II (INSECT PHYSIOLOGY AND TOXICOLOGY)**								
Course code	**24MSZO223R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To understand the basic concept of insect physiology and insect behaviour. 2. To provide the knowledge on pesticides and its toxicity. 3. To impart knowledge on different communication strategy in insects.								
CO1	Describe the endocrine system and their influence on physiology of insects.								
CO2	Explain physiological system of insects.								
CO3	Describe insect's communication and its significance.								
CO4	Describe the toxicity of pesticides and their effects on insects.								
CO5	Identify pesticides and explain their mode of action in controlling insects.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Insect Physiology:** Digestive system, Respiratory system, Circulatory system, Nervous System, Reproductive system, Excretory system.	**7**	Students will acquire knowledge regarding the endocrine system and their influence on physiology of insects.	1,2
II	**Endocrine system:** Insect hormones-with reference to metamorphosis and reproduction.	**10**	Students will able to know about Different physiological system of insects.	1,2
III	**Social insects and communication:** Social Insects, Social organization, Caste differentiation, Honey bees, Termites and ants as social insects **Insect communication:** Chemical communication, Audio and tactile communication, Visual communication, Luminescent insects	**10**	Students will acquire knowledge on insect communication and its significance.	1,2
IV	**Toxicology of pesticides:** LD50 and LC50, Dose-response relationship, Carcinogenic, Mutagenic and Teratogenic effects; Method of testing chemicals on insect and evaluation of toxicity.	**8**	Students will have basic idea on toxicology of pesticides and their effect on insects.	1,2
V	**Group characteristics and function of pesticides:** Organochlorines, Organophosphorus insecticides, Carbamates, Pyrethroids, other plant origin bio-insecticides, neonicotinoids and nitrogenous insecticides; fumigants; IGRs, attractants, repellents and anti-feedants. Properties of few individual insecticides i.e. DDT, HCH (BHC), Lindane, Endosulfan, Parathion, Malathion, Carbaryl, Cypermethrin etc.	**10**	Students will have understanding on different group of pesticides and their mode of action.	1,2
Practical	• Identification and classification of	**30**		1,2,3,4

	important organisms from different phylum of animal kingdom. • Collection, identification and preservation of insects. • Permanent slide preparation of mouthparts of mosquito, cockroach, butterfly and honeybee. • Study of various types of social insects (honeybee/ants) and their nests. • Mounting of legs, antennae and wings (at least of two types). • Dissection and display of sting apparatus in honey bee. • Dissection and display of male and female reproductive system of insects. • Dissection and display of nervous system of cockroach. • Dissection and display of digestive system of cockroach. • Dissection and display of Salivary gland of cockroach/ honey bee. • Dissection and display of Corpora cardiaca of cockroach. • Dissection and display of bacterial chamber of termite.			

REFERENCE BOOKS:

R1: The Principles of Insect Physiology by Wigglesworth, Vincent B. (7th Edition). Chapman and Hall Ltd. USA.

R2: Physiological system in Insects by Klowden, M. J. (3rd Edition). Academic Press, USA.

R3: The Insects, An outline of Entomology by Gullan, P. J., and Cranston, P. S. (5th Edition). Wiley Blackwell, UK.

R4: Insect Physiology and Biochemistry, Nation, J. L. (4th Edition). CRC Press, USA.

R5: Social Insects (Vol-III) by Hermann, H.R. (Latest Edition). Academic Press, London.

R6: Toxicology and Risk Assesssment: A Comprehensive Introduction by Greim H., and Snyder, R. (2nd Edition), John Wiley and Sons, UK.

R7: The Complete Book of pesticide management by Whitford, F. (Latest Edition). Wiley Interscience, John Wiley and Sons, UK.

R8: Pesticide Application Methods by Matthews, G, A. (4th Edition) Blackwell Science, London, UK.

R9: Insecticide Biochemistry and Physiology, Wilkinson, C. F. (Latest Edition). Plenum Press, New York, UK.

OTHER LEARNING RESOURCES:

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN PROGRAM OUTCONE(CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the endocrine system and their influence on physiology of insects.	**1, 3**
2	Explain physiological system of insects.	**1, 3**
3	Describe insect's communication and its significance.	**1, 3**
4	Describe the toxicity of pesticides and their effects on insects.	**1, 3, 8**
5	Identify pesticides and explain their mode of action in controlling insects.	**1, 3, 8**

SEMESTER – IV									
Course Title	**FISH BIOLOGY AND FISHERIES I (Fish physiology and Fish culture)**								
Course code	**24MSZO222R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To impart knowledge on the classification of major groups of fishes and their important characters. 2. Acquire knowledge on fish physiology and fishery management. 3. To provide knowledge on different fish diseases.								
CO1	Classify fish into appropriate groups based on their key characteristics.								
CO2	Describe respiration and excretion of fish.								
CO3	Discuss food and feeding habit of fishes and the digestive system of fishes								
CO4	Explain types of fish diseases, their symptoms and control.								
CO5	Identify ornamental fishes of North East India and describe fish farming, fishing gears and crafts.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Fish classification and skeletal system** • General characters and classifications, major fish groups (extant and extinct). • Epidermis, Exoskeleton, Skeletal system • Cardio vascular system of fishes.	**7**	Students will learn general characteristics of fish along with classification of major fish groups	1,2
II	**Respiratory and excretory system of fish** • Structure and function of gills, air breathing organs • Swim bladder and its modifications • Weberian ossicles and its function • Excretion: kidney, structure and function • Osmoregulation in fresh water and marine teleost.	**10**	Students will learn respiration and excretion in fishes	1,2
III	**Food and feeding habit of fishes** • Food and feeding habit of fishes. Digestive system • Alimentary canal and its modifications • Modifications of the Teeth • Gut content analysis: Index of fullness, Ponderal index, and Gastro-somatic index.	**10**	Students will learn feeding habit and digestion of fish	1,2
IV	**Fish diseases Disease** • Disease definition, Disease problems. • Types of Diseases: viral, bacterial, fungal, protozoan etc. • Symptoms and control measures, Immunoassay, Biochemical assay, • Serological techniques, vaccines.	**8**	Students will learn different types of fish diseases and their control measures	1,2

V	**Fish culture** • Ornamental fish, culture of ornamental fishes, Ornamental fishes of northeast India. • Fish farming: Integrated and composite fish culture • Fishing gears and Crafts. Preservation and processing of fishes. • Fisheries cooperative and their role in fish production and marketing.	**10**	Students will learn fisheries management	1,2

TEXT BOOKS:

T1: A textbook of Fish Biology and Fisheries by S.S. Khanna and H. R. Singh (3rd Edition). Narendra PublishingHouse, Delhi.

T2: The freshwater fishes of the Indian region by Jayaram, K.C. 1999. New Delhi: Narendra Publishing House. 551 pp.

REFERENCE BOOKS:

R1: Handbook of the freshwater fishes of India by Beaven C R (Latest Edition) Narendra Publishing House.

R2: Fishery by-products technology by Brody (Latest Edition) AVI, Westport.

R3: Fish and Fisheries of India by Jhingran V. G. (4th Edition). Hindustan Publishing Corporation.

R4: Ichthyology by Lagler et al. (2nd edition). Wiley Publication.

R5: Fish and Fisheries by Pandey (Latest Edition). Rastogi Publications.

R6: Fishes by Chandy, M. (1st Edition). National Book Trust, India.

R7: Inland fishes of the India and adjacent countries by Talwar, P.K. and A.G. Jhingran. 1991. Volume 1and 2. New Delhi: Oxford and IBH Publishing Co.

R8: Fishes of northeast India by Vishwanath, W., W.S. Lakra and U.K. Sarkar. 2007. Lucknow: National Bureau of Fish Genetic Resources. 264 pp.

OTHER LEARNING RESOURCES:

1. Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]
2. Online study materials

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Classify fish into appropriate groups based on their key characteristics.	**1, 3**
2	Describe respiration and excretion of fish.	**1, 3**
3	Discuss food and feeding habit of fishes and the digestive system of fishes	**1, 3, 6**
4	Explain types of fish diseases, their symptoms and control.	**1, 6**
5	Identify ornamental fishes of North East India and describe fish farming, fishing gears and crafts.	**1, 6, 8**

SEMESTER – IV									
Course Title	**FISH BIOLOGY AND FISHERIES II (Fish reproductive biology, endocrinology and fish genetics)**								
Course code	**24MSZO223R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. This course is designed to provide in depth knowledge of reproductive and sensory organ of fishes. 2. To develop theoretical knowledge on fishery genetics and fish biotechnology. 3. To provide knowledge on endocrine system and different modifications in fish.								
CO1	Explain concepts of sensory organs, pattern, and mechanism of fish migration.								
CO2	Describe the reproductive organs of fish.								
CO3	Explain Endocrine system in fishes.								
CO4	Compare the modifications of hill stream and deep-sea fishes.								
CO5	Explain fish genetics and apply bioinformatics methods for managing data and retrieving meaningful information in connection to fishes.								

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Chemoreceptors and migration** • Structure of olfactory system, morphology of peripheral olfactory organ, cellular composition of olfactory epithelium, olfactory bulb and central projections. Structure and functions of taste buds. • Migration in fishes: Types Anadromous, Catadromous, Amphidromous, factors responsible for migration (Intrinsic and environmental), periodicity of migration. Role of hormones in migration, Orientation and Navigation during migration.	**7**	Students will learn Sensory organs and Migration of fish	1,2
II	**Reproductive system of fish** • Structure of male reproductive system. Stages of maturation. • Mechanism of spermatogenesis and its hormonal control. Gonado- somatic index, Modified Gonado-somatic index and Dobriyal index. • Structure of female reproductive system. Stages of maturation. Oogenesis, egg development, hormonal control of oogenesis.	**10**	Students will learn Reproductive Biology of fishes	1,2
III	**Endocrine system** • Structure, hormones and functions of pituitary gland in fishes. Structure, hormones and functions of other endocrine glands. • Structure of Hypothalamo- hypophysial system in fishes. Neurohormones and their functions.	**10**	Students will acquire knowledge on Endocrine system in fishes	1,2

IV	**Adaptation in fishes** • Adaptation in Hill Stream Fishes • Adaptations in deep sea fishes • Sexual dimorphism, mating and Parental care. Lateral line system infishes. • Larvivorous and exotic fishes.	**8**	Students will learn Modifications of hill stream and deep sea in fishes	1,2
V	**Genetics and bioinformatics** • Genetics, Biotechnology and Aquaculture. • Introduction to Bioinformatics: FASTA, BLAST, Databases • Application of Bioinformatics in Fishery, Barcoding, Genetic diversity and phylogenetics	**10**	It will help the students to get the knowledge Fish Genetics and Bioinformatics	1,2
Practical	• Identification of important indigenous and exotic fishes of NE India representing all fish groups. • Biological analysis of fish samples for gut contents (GASI), maturity stages (Gonado-somatic index (GSI), hepato-somatic index (HIS)). • Determination of length-weight and length-length relationships. • Determination of Condition Factor (CF), Absolute and Relative fecundity. • Identification of fishing gears. • Analysis of water samples for various physico-chemical parameters – pH, Free CO_2, Dissolved Oxygen, Hardness. • Histological study of the fish gonads for stages of maturity study. • Identification of important fish parasites (external and internal). • Fish osteology: Alizarin preparation of fish skeleton. • DNA extraction from fish tissues, gel electrophoresis. • Analysis of gene sequences from databases for phylogenetic and genetic diversity study.	**30**		1,2,3,4

TEXT BOOKS:

T1: A Text Book of Fish, Fisheries and Technology by Biswas K P. (2nd Edition) Narendra Publishing House.

T2: A textbook of Fish Biology and Fisheries. S.S. Khanna and H. R. Singh. (3rd Edition) Narendra Publishing House, Delhi.

REFERENCE BOOKS:

R1: Handbook of fish biology and fisheries by (Volume I and II) by Hart P. and Reynold J. D (Latest Edition). Blackwell publishing U.S.A.

R2: Fish Endocrinology by Matty A. J. (Latest Edition). Croom Helm Ltd., Australia.

R3: Fishes: An introduction to ichthyology by Moyle P.B. and Cech J. J. Jr (5th Edition). Prentice Hall, New Jersy, U.S.A.

R4: General and Applied Ichthyology by Gupta S.K., Gupta P.C. (Latest Edition). S Chand and Company

R5: Handbook of the freshwater fishes of India by Beaven C R. (Latest Edition). Narendra Publishing House.

R6: Biology of Fishes, Bone, Q. and Moore, R. (3rd Edition) Talyor and Francis Group.

R7: The Physiology of Fishes, Evans, D. H. and Claiborne, J. D. (5th Edition) CRC Press.

R8: The Senses of Fish: Adaptations for the Reception of Natural Stimuli. von der Emde, R., Mogdans, J. andKapoor, B. G., (Latest Edition) Narosa Publishing House, New Delhi, India, 2004.

OTHER LEARNING RESOURCES:

1. Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain concepts of sensory organs, pattern, and mechanism of fish migration.	**1, 3**
2	Describe the reproductive organs of fish.	**1**
3	Explain Endocrine system in fishes.	**1**
4	Compare the modifications of hill stream and deep sea fishes.	**1, 6**
5	Explain fish genetics and apply bioinformatics methods for managing data and retrieving meaningful information in connection to fishes.	**1, 6, 8**

SEMESTER – IV									
Course Title	**MOLECULAR CELL BIOLOGY I**								
Course code	**24MSZO222R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30T	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**MASTER OF SCIENCE IN ZOOLOGY**								
Semester	**Fall/ I semester of first year of the programme**								
Course Objectives	1. To Understand and explain the processes of mitosis, meiosis, and the eukaryotic cell cycle, highlighting their roles in cellular division and organismal development. 2. To Investigate and compare the mechanisms of gene regulation in prokaryotic and eukaryotic cells, focusing on molecular pathways and their implications for cellular function. 3. To Analyze the molecular basis of cellular processes, including cell proliferation, cell death, and the role of cell-cell adhesion and the extracellular matrix in the evolution of multicellular organisms.								
CO1	Describe mitosis, meiosis and eukaryotic cell cycle.								
CO2	Explain the processes of gene regulation in prokaryotic and eukaryotic cells.								
CO3	Describe the molecular basis of cellular processes and the mechanisms that govern cell proliferation and cell death.								
CO4	Explain cell-cell adhesion and the extracellular matrix in the evolution of multicellular organisms.								
CO5	Describe cell progression and death.								

Unit-No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Cell division and cell cycle** • Mitosis and meiosis, their regulation • Steps in cell cycle • Control of cell cycle	**7**	Learners would be able to understand how cell undergoes division and regulation	1,2
II	**Gene Expression** • Control of gene expression at Transcription and translation levels • Regulation of phages, viruses, prokaryotic and eukaryotic gene expression • Role of chromatin in regulating gene expression and gene silencing	**10**	The learners will become be able to draw parallels between gene expression in prokaryotic and eukaryotic	1,2
III	**Cellular Communication** • General principles of cellular communication • Cell adhesion and roles of different adhesion molecules • Gap junctions, extra cellular matrix, integrins, neurotransmission and its regulation.	**10**	Learners will be able to understand inherited genetics and diseases associated to gene alteration	1,2

IV	**Biology of Cancer** • Normal and cancer cells, • Cell transformation • DNA and tumour viruses • Chromosomal basis of human cancer • Regulation of cell cycle in cancer progression	**8**	Students would learn the importance of cell-cell adhesion and the extracellular matrix in the evolution of multicellular organisms.	1,2
V	**Cell Proliferation and Death** • Factors for cell proliferation • Different types of cell death (apoptosis, necrosis and autophagy)	**10**	Students would learn how cell undergoes progression and death	1,2

TEXT BOOKS:

T1: Cell and Molecular Biology, Lohar (Prakash S), 1st Edition, Mjp Publishers.
T2: Cell Biology, De Robertis (Edp) & Others, 5th Edition.
T3: Cell Biology, Genetics, Evolution and Ecology, Edn.3 Part Ii Verma (P.S), Aul. H) Ed. Nch (James); Agarwal (V.K.).
T4: Cell and Molecular Biology: Concepts and Experiments. Carp Gerald, 1996. John Wiley & Sons Publishers.
T5: Concept of Cell Biology, Verma (P S); Agarwal (V K), S. Chand & Co Publishers.

REFERENCE BOOKS:

R1: Cell Biology, Power (C.B), 3rd Edition, Himalaya Publishers.
R2: Cell Biology, Gupta (M L); Jangir (M L), 1st Edition.
R3: Cell Biology, Rastogi (S C), 1st Edition, New Age International Limited Publishers.
R4: A Textbook of Cell Biology, Shukla (R M), 1st Edition, Dominant Publishers.
R5: Cytogenetics, Swanson (Carl. P) Etc. Prentice Hall Publishers.

OTHER LEARNING RESOURCES:

1. Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]
2. Molecular Cell Biology: https://nptel.ac.in/courses/102/106/102106025/
3. Cell Biology: https://nptel.ac.in/courses/102/103/102103012/
4. Molecular Cell Biology: https://nptel.ac.in/courses/102/106/102106025/
5. Molecular Biology: https://swayam.gov.in/nd2_cec20_ma13/preview

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe mitosis, meiosis and eukaryotic cell cycle.	**1, 3**
2	Explain the processes of gene regulation in prokaryotic and eukaryotic cells.	**1, 3**
3	Describe the molecular basis of cellular processes and the mechanisms that govern cell proliferation and cell death.	**1, 3**
4	Explain cell-cell adhesion and the extracellular matrix in the evolution of multicellular organisms.	**1, 3**
5	Describe cell progression and death.	**1, 3**

SEMESTER – IV										
Course Title	**MOLECULAR CELL BIOLOGY II**									
Course code	**24MSZO223R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**	
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**	
Pre-requisite	**Nil**	**Co-requisite**	**Nil**							
Programme	**MASTER OF SCIENCE IN ZOOLOGY**									
Semester	**Fall/ I semester of first year of the programme**									
Course Objectives	1.To understand and explain the molecular processes underlying the functions of eukaryotic cells, with a focus on cellular mechanisms and signaling pathways. 2.To Explore and apply techniques in cell and tissue culture, drug delivery systems, and molecular biology, emphasizing their role in research and therapeutic applications. 3.To Investigate cell culture techniques, cancer therapies, and immunomodulation strategies, with an emphasis on their molecular basis and clinical relevance.									
CO1	Explain processes at the molecular level for understanding functions of a eukaryotic cell.									
CO2	Outline the molecular mechanisms of cell signalling pathways.									
CO3	Apply techniques and methods in cell/tissues culture and drug delivery.									
CO4	Describe the techniques used in molecular biology.									
CO5	Explain cell culture techniques and cancer therapies and immunomodulation.									

Unit-No.	Content	Contact Hour	Learning Outcome	KL
I	**Molecular mutagenesis** • Site directed mutagenesis • Sequence tagged sites • DNA microarrays • hromosome painting	7	Learners would be able to understand basic concepts DNA interaction with chemical agents	1,2
II	**Cancer genetics** • Progenitor cells • Oncogenes • Tumour suppressor genes and their role in cancer • Genes for apoptosis • Intrinsic and extrinsic pathways	10	To study DNA interaction with chemical agents, cancer therapies and immunomodulation.	1,2
III	**Cell signaling pathways** • GPCR signalling • MAPkinse • Receptor tyrosine kinase (RTK) • JAK-STAT • Ras • NO pathways	10	Learners will be familiar with the molecular pathways	1,2
IV	**Techniques in molecular biology** • c-DNA library • Gene expression analysis (PCR, RT-PCR and DNA microarray), RFLP, RAPD, AFLP, SSCP, SNP. DNA Fingerprinting	8	Students will be familiar with scientific competencies that will allow them to investigate the molecular mechanisms important for the structure and function of the living cells through modern techniques.	1,2

V	**Methods of cell and tissue culture** • Monolayer and Suspension culture, • Co-culture, • Cell freezing • Biology and applications of stem cells **Recent trends in therapy** • Biomolecules as diagnostic markers and therapeutic agents • Gene technology • Gene therapy • Drug delivery and targeting	**10**	Students will learn animal cell culture techniques and cancer therapies and immunomodulation.	1,2
Practical	• Isolation of DNA from goat spleen • Estimation of DNA (diphenyl method) • Estimation of RNA (Orcinol method) • UV absorption spectra of native and denatured DNA • Agarose gel Electrophoresis of DNA • DNA amplification by PCR • Isolation and analysis of proteins • Gel Documentation	**30**		1,2,3,4

TEXT BOOKS:

T1: Cell and Molecular Biology, Lohar (Prakash S), 1st Edition, Mjp Publishers.
T2: Cell Biology, De Robertis (Edp) & Others, 5th Edition.
T3: Cell Biology, Genetics, Evolution and Ecology, Edn.3 Part Ii Verma (P.S), Aul. H) Ed. Nch (James); Agarwal (V.K.).
T4: Cell and Molecular Biology: Concepts and Experiments. Carp Gerald, 1996. John Wiley & Sons Publishers.
T5: Concept of Cell Biology, Verma (P S); Agarwal (V K), S. Chand & Co Publishers.

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R2: Cell Biology, Gupta (M L); Jangir (M L), 1st Edition.
R3: Cell Biology, Rastogi (S C), 1st Edition, New Age International Limited Publishers.
R4: A Textbook of Cell Biology, Shukla (R M), 1st Edition, Dominant Publishers.
R5: Cytogenetics, Swanson (Carl. P) Etc. Prentice Hall Publishers.

OTHER LEARNING RESOURCES:

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. NOC: Cell Culture Technologies: https://nptel.ac.in/courses/102/104/102104059/
2. Molecular Cell Biology: https://nptel.ac.in/courses/102/106/102106025/
3. Cell Biology: https://nptel.ac.in/courses/102/103/102103012/
4. Molecular Cell Biology: https://nptel.ac.in/courses/102/106/102106025/

RELATIONSHIP BETWEEN COURSE OUTCOME(CO) AND PROGRAM OUTCOMES

CO PO Mapping		
SN	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain processes at the molecular level for understanding functions of a eukaryotic cell.	**1, 3**
2	Outline the molecular mechanisms of cell signalling pathways.	**1, 3**
3	Apply techniques and methods in cell/tissues culture and drug delivery.	**1, 3**
4	Describe the techniques used in molecular biology.	**1, 3, 8**
5	Explain cell culture techniques and cancer therapies and immunomodulation.	**1, 3, 8**

Assam down town University

Curriculum and Syllabus

Master of Science

in

Microbiology

OUTCOME BASED EDUCATION FRAMEWORK

CHOICE BASED CREDIT SYSTEM

Version: 2.2

FACULTY OF SCIENCE

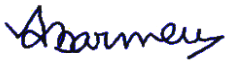
July, 2024

PREAMBLE

Assam down town University is a premier higher educational institution which offers Bachelor, Master, and Ph.D. degree programmes across various faculties. These programmes, collectively embodies the vision and mission of the university. In keeping with the vision of evolutionary changes taking place in the educational landscape of the country, the university has restructured the course curriculum as per the guidelines of National Education Policy 2020. This document contains outline of teaching and learning framework and complete detailing of the courses. This document is a guidebook for the students to choose desired courses for completing the programme and to be eligible for the degree. This volume also includes the prescribed literature, study materials, texts, and reference books under different courses as guidance for the students to follow.

Recommended by the Board of Studies (BOS) meeting of the Faculty of Science held on dated 16th and 17th July, 2024 and approved by the 51st Academic Council (AC) meeting held on dated 26/07/2024.

Chairperson, Board of Studies



Member Secretary, Academic Council

Vision

To become a Globally Recognized University from North Eastern Region of India, Dedicated to the Holistic Development of Students and Making Society Better

Missions

1. Creation of curricula that address the local, regional, national, and international needs of graduates, providing them with diverse and well-rounded education.

2. Build a diverse student body from various socio-economic backgrounds, provide exceptional value-based education, and foster holistic personal development, strong academic careers, and confidence.

3. Achieve high placement success by offering students skill-based, innovative education and strong industry connections.

4. Become the premier destination of young people, desirous of becoming future professional leaders through multidisciplinary learning and serving society better.

5. Create a highly inspiring intellectual environment for exceptional learners, empowering them to aspire to join internationally acclaimed institutions and contribute to global efforts in addressing critical issues, such as sustainable development, Climate mitigation and fostering a conflict-free global society.

6. To be renowned for creating new knowledge through high quality interdisciplinary research for betterment of society.

7. Become a key hub for the growth and excellence of AdtU's stakeholders including educators, researchers and innovators

8. Adapt to the evolving needs and changing realities of our students and community by incorporating national and global perspectives, while ensuring our actions are in harmony with our foundational values and objectives of serving the community.

Programme Details

Programme Overview

Master of Science in Microbiology is a 2-year postgraduate programme which deals with more detailed and advanced study of the microorganisms, including microbial cellular processes, their harmful and beneficial aspects, microbes for human welfare, molecular details of microbial cells and develops knowledge and understanding for applying it for societal benefits which may include sectors such as healthcare, agriculture, soil and environment, food processing, pharmaceutical etc. The objective of this programme is to produce intellectual and proficient microbiologists by enhancing the abilities and skills of students for application of microbiology theories and expertise in the live problems faced by the society and various industrial sectors.

I. Specific Features of the Curriculum

The Master of Microbiology curriculum features core courses in microbial physiology, genetics, molecular biology, and biotechnology, with electives in medical, environmental, and industrial microbiology. It emphasizes hands-on laboratory skills and bioinformatics, and includes a substantial research thesis project along with seminars, workshops, and industry or clinical internships. The program incorporates interdisciplinary approaches, regulatory and ethical training, and develops essential soft skills such as scientific communication and project management. Additionally, it offers global perspectives on health issues and international standards, preparing graduates for diverse careers in research, industry, and healthcare.
The curriculum provides skill enhancement and value-added courses along with the core papers.

II. Eligibility Criteria:

Minimum 45% B.Sc. in (Microbiology/ Biotechnology/ Biochemistry/ Life Science/ Botany/ Zoology/ Agriculture/ Veterinary), MBBS/ Human Genetics etc. 5% relaxation for SC/ST, EWS, and specially abled candidates.

III. Program Educational Objectives (PEOs):

PEO 1: Graduates will be prepared for successful careers in broader aspects of Microbiology in both government and private sectors as microbiologists, QA/QC officers, food analysts, public health officers, food microbiologists, food product developers, food inspectors and allied areas.

PEO 2: Graduates will cultivate adept problem-solving skills, fostering innovative research ideas with a sense of social responsibility.

PEO 3: Graduates will be skilled professionals in microbiology aiding in the holistic development of knowledge creation contributing to the sustainability and progress of science and society at large.

PEO 4: Graduates will be successful in higher education and research in the field of microbiology and interdisciplinary fields if pursued

IV. Program Specific Outcomes (PSOs):

PSO1 Experiential Learning and Applied Knowledge: Exhibit an in-depth understanding of the concept of life science specifically in the field of Microbiology and apply the skills and proficiency to address challenges within the domains enabling employment opportunities in the relevant field.

PSO2 Innovation and Entrepreneurship: Demonstrate scientific temperament and ability to promote a multidisciplinary approach for research exploration and collaboration with professionals across diverse disciplines contributing to innovation and entrepreneurship.

PSO3 Global certification: Post-graduates gain global recognition through online courses offered by prestigious universities worldwide.

V. Program Outcome (PO):

PO1: Comprehensive Knowledge: Apply comprehensive knowledge of microbial sciences, biochemistry, immunology, biostatistics, molecular and computational biology, ecological principles and microbiological processes to solve biological problems.

PO2: Problem-Solving: Identify, formulate, review the literature and evaluate complex biological issues using critical thinking for designing sustainable solutions.

PO3: Modern Techniques Usage: Apply standardized protocols, modern analytical techniques, and appropriate tools to execute experiments and conduct rigorous analyses.

PO4: Investigation and Research: Leverage research-based knowledge and research methods to design experiments, analyse and interpret data, and synthesize information to draw valid conclusions.

PO5: Communication: Communicate proficiently among peers and diverse communities through effective documentation, reports, presentations, talks etc.

PO6: Professional Ethics: Integrate professional values and ethics to demonstrate ethical decision-making in the workplace.

PO7: Leadership and Teamwork: Contribute effectively as an individual, and as a member within multidisciplinary teams, demonstrating strong leadership abilities in diverse settings.

PO8: Environment and Sustainability: Exhibit a sense of environmental responsibility to develop sustainable solutions that prioritize preserving the ecosystem.

PO9: Lifelong Learning: Ability to engage in independent and lifelong learning in the broadest context of technological advancement.

VI. Total Credits to be Earned: 89

VII. Career Prospects:

Upon completing the program, graduates can pursue careers in various fields, including roles as research scholars in R&D laboratories, microbiologists in hospital laboratories, and health officers. They are also well-prepared for positions in food processing industries as microbiologists and quality control officers. Additionally, opportunities abound in the beverage and pharmaceutical industries, as well as in various biotechnological sectors. Graduates can also explore careers in environmental microbiology, bioinformatics, regulatory affairs, and academic or industrial research.

EVALUATION METHODS

The student performance shall be evaluated through In-semester (Sessional) and semester-end examinations. A weightage of 40% or as prescribed by the Programme shall be added to the score of the end-semester examination.

A. INTERNAL ASSESSMENT:

The teacher who offers the course shall be responsible for internal assessment by conducting in-semester (sessional) examination and evaluating the performance of the students pursuing that course. The components for internal assessment are illustrated in the table given below.

S.N.	Components/ Examinations	Marks Allotted
1.	In-Sem Exam – I (ISE-I) (Written Examination)*	30
2.	In-Sem Exam – II (ISE-II) (Written Examination)*	30
3.	Assignment	10
4.	Presentation (SP)	10
5.	Quiz	5
6.	Class Performance based score*	5

are compulsory

Note: *Total Internal assessment should be out of 40*

INSTRUCTION

1. If a student fails to appear in the any of the component without any valid reason he/she shall be marked zero in that component. However, the course teacher at his discretion may arrange for the missed test on an alternate date for the absentee students after determining ground with genuine/valid reasons for the absent.
2. The report of evaluation of an activity towards the in-semester (sessional) component of a course shall be duly notified by the concerned course teacher within a week of completion.
3. The program coordinators should upload the in-semester marks to the ERP and forward acknowledgement of all the courses of the program to the Controller of Examinations before the start of the End-semester examination.

B. SEMESTER END EXAMINATION:

Time table for end semester examination is published at least 25 days prior to the start of Examination.

I. Pre-Examination:

Eligibility Criteria for a student to appear in University Examinations:

The student shall only be allowed to appear in a University Examination, if:

i) He/ She is a registered student of the University;
ii) He/ She is of good conduct and character;
iii) He/ She has completed the prescribed Programme of study with minimum percentage of attendance as laid down in the Regulations of the Programme concerned.

Under special cases, a student may be allowed to appear for an examination without being registered in the University but the result of the said student will be kept on hold till the registration of the concerned student is completed.

II. Admit Card:

Admit card for the examination may be downloaded through ERP where the system will generate a Unique ID Cards through online.

The University shall have the right to cancel admission for examination of any candidate on valid grounds.

III. Pattern of Question Papers:

The question paper shall follow the principles of Bloom's Taxonomy.

Table

S. N.	Level	Questions /verbs for test
1	Remember	List, Define, tell, describe, recite, recall, identify, show who, when, where, etc.
2	Understand	Describe, explain, contrast, summarize, differentiate, discuss, etc.
3	Apply	Predict, apply, solve, illustrate, determine, examine, modify
4	Analyze	Classify, outline, categorize, analyze, diagrams, illustrate, infer, etc.
5	Evaluate	Assess, summarize, choose, evaluate, recommend, justify, compare etc.
6	Create	Design, Formulate, Modify, Develop, integrate, etc.

Note: No course is to be evaluated on basis of **all 6 knowledge levels.**

The format of the question paper across all the program follow a unique pattern and the total marks is 60

Table 1: Question paper pattern for End semester examination

Sl. No.	Question pattern	Total marks
1	MCQs (10 Questions)	10
2	2 Marks questions (10 Questions)	20
3	4 Marks questions (5 Questions)	20
4	10 Marks questions (1 Question)	10

IV. Examination Duration:

Each paper of 60 marks shall ordinarily be of two hours duration.

V. Practical Examinations, Viva-Voce etc.:

i) Practical examination shall be conducted in the presence of one external expert and one or more internal examiners.

ii) Viva-Voce, Oral examinations of the Project report, Dissertation etc. shall be undertaken by a Board of Examiners constituted by the respective Dean of Program with the advice of Supervisor(s).

VI. Procedure of Expulsion:

If any candidate is found to be using any unfair-means during the examination, the invigilator may cease his/her answer sheet and report it directly to the Officer-in-Charge. The Office-in-Charge of the center may take appropriate decisions as per the rules and procedure of the examination. The Officer-in-Charge may allow the students to write the exam with new answer sheet or may expel the student from appearing the paper depending on the nature of unfair-means. In case of Computer based test, the students may be directed to write an apology letter and sign in the prescribe expulsion form. The student may not be allowed to write that examination.

VII. Instruction to the Students:

(i) The students shall not bring to the Examination Hall, any electronic gadget used as a means of communication or record except electronic calculator, if required.

(ii) The students shall not receive any book or printed or hand written or photo copy (Xerox) or blank-paper from any other person while he/she is in the examination-room or in laboratory or in any other place to which he/she is allowed to have access during course of examination.

(iii) The students shall not communicate with any other candidate in the examination room or with any other person in and outside the examination-room.

(iv) The students shall not see, read or copy anything written by any other candidate, nor shall he/she knowingly or negligently permit any other candidate to see, read or copy anything written by him/her or conveyed by him/her.

(v) The students shall not write anything on the Question Paper or in other paper or materials during the examination, or pass any kind of paper to any other candidate in the examination-room, or to any person outside the room.

(vi) The students shall not disclose his/her identity to the examiner by writing his/her name or putting any sign / symbol in any part of his answer-script.

(vii) The students shall not use any abusive language or write any objectionable remark or make any appeal to examiner by writing in any part of his answer-script.

(viii) The students shall not detach any page from the answer-script or insert any authorized or unauthorized loose sheet into it. He /she shall also not insert any other answer-script / loose sheet by removing the pins of the origin answer-scripts and re-fixing it.

(ix) The students shall not resort to any disorderly conduct inside the examination-room or misbehave with the invigilator or any other examination official.

VIII. Provision for an Amanuensis (writer):

(i) A candidate may be provided with an Amanuensis (writer) to write down on dictation on his / her behalf on ground of his / her physical disability to write down by himself / herself due to accident or any other reason. The amanuensis may be provided till he / she recovers from the physical disability. The physical disability to write down by himself / herself must be supported by Medical Certificate from a competent Medical Officer.

(ii) The qualifications of the amanuensis so provided must not be equal or higher than that of the candidate. This is also to be supported by Certificate from the Faculty of Study where the Amanuensis is provided.

(iii) Such candidates are to be accommodated in a separate room under the supervision of an invigilator so that the fellow candidates are not disturbed in the process.

C. Credit Point:

It is the product of grade point and number of credits for a course, thus, CP = GP x CR

i. Credit:

A unit by which the course work is measured. It determines the number of hours of instructions required per week. 'Credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. Credits assigned for a single course always pay attention to how many hours it would take for an average learner to complete a single course successfully.

ii. Grade Point:

Grade Point is a numerical weight allotted to each Grade Letter on a 10-point scale.

iii. Letter Grade:

Letter Grade is an index of the performance of students in a said paper of a particular course. Grades are denoted by letters O, A+, A, B+, B, C, P, F and Abs. Student obtaining Grade F / Grade Abs shall be considered failed/ absent and, will be required to appear in the subsequent ESE. The UGC recommends a 10-point grading system with the following (Table: 1) Letter Grades:

(i) A Letter Grade shall signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point shall indicate the numerical weight of the Letter Grade on a 10-point scale.

(ii) There shall be 08 (eight) Letter Grades bearing specific Grade Points as listed in Table 1, where the Letter Grades ‘O’ to ‘P’ shall indicate successful completion of a course.

(iii) Apart from the 08 (eight) regular Letter Grades listed in Table 1, there shall be 03 (three) additional Letter Grades, which shall be awarded if a Course is withdrawn or spanned over the next Semester or remains incomplete as stated in Table 2.

Table 2: Letter Grades and Grade Points

Letter Grade	Grade Points	Description
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Abs	0	Absent
UFM	0	Unfair Means

iv. Grade Point Average:

a. SGPA (Semester Grade Point Average)

The SGPA of a student in a Semester shall be the weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered in that Semester, irrespective of whether he/she could or could not complete the Courses. More specifically, the calculation of SGPA shall take into account the Courses graded with Letter Grades 'O' to 'F' as given in Table 1.

$$\text{SGPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad (1.1)$$

The SGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.1) up to two decimal places, where n is the total number of Credit Courses registered by the student in that Semester, Gi is the Grade Point secured in the i^{th} registered Course and Ci is the Credit (weight) of that Course.

b. CGPA (Cumulative Grade Point Average)

(i) The CGPA of a student in a Semester of a Programme shall be the accumulated weighted average of the Grade Points secured by the student in all the Credit Courses (both Core and Elective Courses) he/she registered and successfully completed so far starting from the enrollment in the Programme. In other words, taking into account all the Courses graded with 'O' to 'P' as given in Table 1.1, generally the CGPA of a student shall be calculated starting from the first Semester of his/her enrolled Programme, while the CGPA of a lateral-entry student shall be calculated starting from the Semester of his/her enrollment.

(ii) The CGPA of a student in a Semester shall be calculated on a 10-point scale using Equation (1.2) up to two decimal places, where N is the total number of Credit Courses registered and successfully completed so far by the student, Gi is the Grade Point secured in the ith completed Course and Ci is the Credit (weight) of that Course.

$$\text{CGPA} = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i} \qquad (1.2)$$

(iii) The CGPA shall be convertible into equivalent percentage of marks using Equation Conversion of CGPA to percentage marks: = CGPA*10

D. Post-Examination

i. Transcript or Grade Card or Certificate:

A marking certificate shall be issued to all the registered students after every Semester. The Semester mark sheet will display the course details (code, title, number of credits, grade secured) along with total credit earned in that Semester.

ii. Grievance Readdress Mechanism:

Students with any dissatisfaction or grievance regarding the marks awarded in any of the Papers / Courses may appeal to the Controller of Examinations for remedial action such as Re-evaluation within 10 days of the declaration of result.

(i) A student has options to appeal for re-evaluation of his /her answer script to the Controller of Examination.

(ii) Application for re-evaluation / re-scrutiny of answer scripts shall be made in the definite proforma available with the Examination Office through the head of the respective departments within 10 days of declaration of the results of the respective examinations.

(iii) The Controller of Examination may appoint an examiner for re-evaluation and will consider and recognize the evaluation done by a University appointed examiner.

(iv) There shall be no provision for re-evaluation of the Practical Papers, Project Work, and Dissertation etc. However, the students fail in practical examination or viva voce and wish to appear again may apply to be evaluated can do so with the next schedule.

(v) After screening the application for re-evaluation, the CoE may send the answer scripts of the student to the examiners appointed by the CoE with the approval of Vice Chancellor.

(vi) The marks/grades achieved by the students after the re-evaluation shall be final and binding.

(vii) Fresh Marks – sheets / Grade Card shall be issued only if the candidate secures pass marks / passing grade in the re-evaluated paper.

(viii) Revaluation of answer scripts shall be deemed to be an additional facility provided to the students with a view to improving upon their results at the preceding examination result for any reason whatsoever shall not confer any right upon them for admission to next higher class which matters always be regulated in accordance with the relevant rules or regulations framed by the University.

(ix) If as a result of revaluation of the candidate attracts the provision of condonation of deficiency, the same may be applied to his/her only for fresh attempt.

INSTRUCTION TO TEACHERS AND STUDENTS

(Teaching and Learning Methods)

In all the courses the teacher has to select topics for teacher-method which should not be less than 20 percent. The approach will be direct classroom teaching through a series of lectures delivering concepts using ITC facilities, white or blackboard. Notes may also be circulated to the students; however, the students are to be involved in the preparation of the notes. The teacher will be responsible for selecting the best note for circulation. The teacher-centric methodology has recently fallen out of favour because this strategy for teaching is seen to favour passive students.

1. Student- centric / Constructivist Approach:

The topics of the courses may be selected at the start of the class and assigned one topic to each of the students for studying by themselves, prepare presentations, notes, etc., and present at respective class time after consultation and discussion with the course teachers. The teacher facilitates the learning of the students by guiding and providing input and explaining concepts. 60 percent of the course contents may be selected for this purpose. To avoid behaviour problems, teachers must lay a lot of groundwork in student-centric classrooms. Typically, it involves instilling a sense of responsibility in students. In addition, students must learn internal motivation.

a. Project-Based Learning: The teacher may select 5 percent of topics for the purpose and may conduct visits to the laboratory for experiments or field surveys. The selection of the topic may be done considering the available facility for the purpose. However, in the final semester of each of the programme the student has to undergo project-based learning at least 4 months duration. This approach will help the student to think critically, evaluate, analyse, make decisions, collaborate, and more.

b. Inquiry-Based Learning: The teacher/ students are supposed to list at least five questions in each contact hour and student solve these question or search for answer which becomes the home work for the students "question-driven" learning approach. The teacher may look for the correctness of the solution or the best possible answer and discuss in the successive class. This will help in the preparation for various competitive examination and develop a habit for search for solutions.

c. Flipped Classroom: About 10 percent of the course content has to be completed by this method. In this approach the students are asked to watch video or lecture prepared by the teacher or any video available (relevant to the course). A set of questions may be given to the students for searching answers by the students. The idea is that students should have more time in-classroom focusing on achieving these higher levels of thinking and learning. The Flipped classroom is also an acronym. The letters FLIP represent the four pillars included in this type of learning: Flexible environment, Learning culture shift, Intentional content, and Professional educator. As you can see, the second pillar refers to a culture shift from the traditional approach where students are more passive to an approach where students are active participants. As a result, this approach is also a student- centric teaching method.

d. Cooperative Learning: The remaining five percent has to be completed by cooperative learning approach. In this approach, the students are allotted problems. During library hours the students along with the teacher visit the library and search for probable solutions for the assigned problem. The same has to be done in groups so that the students discuss among themselves for the appropriate answers. Essentially, cooperative learning believes that social interactions can improve learning. In addition, the approach recreates real-world work situations in which collaboration and cooperation are required.

The percentage categorization for the completion of a theory course

Teacher-centric or Direct Classroom Teaching: Delivery by series of lectures	20%
Student-centric Approach, Students present and deliver lectures in the presence of teacher and supervised by teacher	60%
Students visit fields or perform experiments or teachers perform demonstration	05%
Flipped Classroom approach	10%
Cooperative learning approach	05%

Inquiry-based approach has to be followed in all of the classes

The teacher has to distribute the topics to be considered for teaching by the above-mentioned approaches and prepare a lesson plan for execution and maintain a file.

SEMESTER WISE COURSE DISTRIBUTION

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester I	1.	24MSMB1101R	Introduction to Microbiology & Microbial Diversity	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	2	24MSMB1102R	Biochemistry	**DSC Minor**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSMB1103R	Bioinstrumentation	**DSC Minor**	3	0	2	0	0	0	4	40	60	100	200
	4	24UMFS1101R	Fundamental of Statistics	**MDC**	2	0	0	0	0	0	2	40	60	0	100
	5	24UMPD1101R	Effective Communication (PDP)	**AEC**	0	0	4	0	0	0	2	0	0	100	100
	6	24UMEC1101	Extra-curricular	**Co and extra-Curricular**	0	0	0	0	0	0	1	0	0	100	100
	Total										**17**				**900**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester II	1.	24MSMB1201R	Immunology	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	2	24MSMB1202R	Molecular biology, Genomics and Genetic Engineering	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	3	24MSMB1203R	Microbial Genetics and Physiology	**DSC Major**	3	0	2	0	0	0	4	40	60	100	200
	4	24UMPD1201R	Advanced Communication	**AEC**	0	0	4	0	0	0	2	0	0	100	100
	5	24MSMB1204R	Postgraduate Practice Teaching	**SEC**	0	0	2	0	0	0	1	0	0	100	100
	6	24MSMB1205R	Research Methodology and Statistical Analysis	**SEC**	2	0	2	0	0	0	3	40	60	100	200
	7	24FSDA1201R	Data analysis using MS Excel	**VAC**	0	0	4	0	0	0	2	0	0	100	100
	8	24MSMB1206R	Field Visit	**Field Training**	0	0	0	0	0	8	1	0	0	100	100
	9	24UMCC1201	Co-curricular	**Co and extra Curricular**	0	0	0	0	0	0	1	0	0	100	100
	Total										**22**				**1300**

	S. N.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester III	1.	24MSMB2101R	Bioinformatics	**DSC Major**	2	0	2	0	0	0	3	40	60	100	200
	2	24UMPD2101R	(PDP)	**AEC**	0	0	4	0	0	0	2	0	0	100	100
	3	24MSMB2102R	Internship	**Internship**	0	0	0	0	0	32	4	0	0	100	100
	4	24MSMB2103R	Field Visit	**Field Training**	0	0	0	0	0	8	1	0	0	100	100
	5	24MSMB2104R	Research Project I	**Research/ Industry Internship**	0	0	8	0	0	0	4	0	0	100	100
	6	24MSMB2105R	Indian knowledge system	**VAC**	0	0	0	0	0	0	2	0	0	100	100
	Discipline specific Elective (Any three subjects to be selected)														
	7	24MSMB2106R	Medical Microbiology	**DSE**	3	0	2	0	0	0	4	40	60	100	200
	8	24MSMB2107R	Microbial Ecology and Environmental Microbiology	**DSE**	3	0	2	0	0	0	4	40	60	100	200
	9	24MSMB2108R	Soil and Agricultural Microbiology	**DSE**	3	0	2	0	0	0	4	40	60	100	200
	10	24MSMB2109R	Clinical and Diagnostic Microbiology	**DSE**	3	0	2	0	0	0	4	40	60	100	200
	11	24MSMB2110R	Organic Farming	**DSE**	3	0	2	0	0	0	4	40	60	100	200
	Total										**28**				**1300**

	S. No.	Course Code	Course Title	Course Category	Engagement							Maximum Marks for			
					L	T	P	S	R	O	C	IA*	SEE*	PE*	Total
Semester IV	1.	24MSMB2201R	Research Project II	**Research/ Industry Internship**	0	0	32	0	0	0	16	0	0	100	100
	Discipline specific Elective (Any two subjects to be selected)														
		24MSMB2202R	Industrial Microbiology and Fermentation Technology	**DSE**	2	0	2	0	0	0	3	40	60	100	200
		24MSMB2203R	Food and Dairy Microbiology	**DSE**	2	0	2	0	0	0	3	40	60	100	200
		24MSMB2204R	Pharmaceutical Microbiology	**DSE**	2	0	2	0	0	0	3	40	60	100	200
		24MSMB2205R	Marine Microbiology	**DSE**	2	0	2	0	0	0	3	40	60	100	200
	Total										**22**				**500**
	Grand Total										**89**				**4000**

***IA: Internal Assessment, SEE: Semester End Examination, PE: Practical Examination**

SEMESTER – I									
Course Title	**Introduction to Microbiology & Microbial Diversity**								
Course Code	**24MSMB1101R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ I semester of first year of the Programme**								
Course Objectives	1. To familiarize the students with those concepts those are basic to prokaryotic and eukaryotic cells. 2. To emphasize on distribution, morphology and physiology of microorganisms in addition to skills in aseptic procedures, isolation and identification. 3.To study the structure, function, diversity of microorganisms in different habitats, ecosystem, and microbial associations, microbial interactions								
CO1	Describe the fundamentals of microbiology including historical prospective, classification of microorganisms, microscopy, and structure of prokaryotic cell organelles.								
CO2	Demonstrate different sterilization techniques, application of microbial culture media, and staining techniques								
CO3	Explore microbial diversity in different habitats including extreme environments and space.								
CO4	Apply the microorganisms for Bioleaching, bioremediation, and bio deterioration.								
CO5	Explain microbial indicators of wastewater, microbial interactions, and biogeochemical cycles.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	History of microbiology: Theory of spontaneous generation, germ theory of disease, Contribution of Antony Van Leeuwenhoek, Louis Pasture, Robert Koch, Edward Jenner, Alexander Fleming; The Three Kingdom Concept, The Five Kingdom concept and the three-domain concept. Microscopy: Principle of microscopy, Prokaryotic cell, Bacterial cell wall, plasma membrane, capsule, outer membrane, cytoplasm, fimbriae, pilli, flagella, endospore, ribosome, inclusion bodies	**8**	Summarize the historical events in the development of microbiology and the role of key contributors. Explain the principle and functioning of microscopes. Describe the structure and function of prokaryotic cell components.	1,2,3
II	Sterilization technique, Microbial Culture & Media: Physical and chemical methods of sterilization; Staining technique: Simple staining, Differential staining, Structural Staining, Aerobic and anaerobic culture. Concept of mixed culture and pure culture. Techniques of pure culture isolation,	**10**	Apply appropriate sterilization methods for various microbial cultures and equipment. Explain the principles and applications of different staining techniques. Understand the concept of	1,2,3,4

	Enrichment culture techniques, Preservation, and maintenance of pure culture. Definition of media, types of media, uses of different types of media, basal media, differential media, selective media, transport media. Cultural & Un-culturable microbes: Culture- dependent approaches for diversity study and their limitations, Exploration of Un-culturable bacteria: Culture independent molecular methods for identifying uncultivable bacteria, metagenome concept		mixed cultures and pure cultures and be able to isolate pure culture. Define media and describe the different types. Explore culture dependent and culture independent methods for study of microorganisms.	
III	**Environmental microbiology & Diversity: Concept of microbial ecology,** Diversity of microbes in terrestrial (agricultural and desert soil), aquatic (fresh water and marine water) and animal (cattle, termite and human being), **Microbes in extreme environments –** thermophiles, psychrophiles, barophiles, acidophiles, alkaliphiles and halophiles, organic solvent and radiation tolerant, and their potential applications. Microbiology of air and space.	**10**	Explain the concept of microbial ecology and the interactions between microorganisms and their environments. Identify and describe the diversity of microbes. Describe the characteristics and adaptations of extremophiles. Explain the presence and significance of microorganisms in the air and space.	1,2,3,4,5
IV	Bioleaching – copper, gold and uranium, Microbial degradation of xenobiotics – petroleum, oil spills, biomagnifications. Bioremediation- in-situ and ex-situ, Biodeterioration- paper, textile, wood, metal, Corrosion: – methods of protection	**10**	Discuss the microbial mechanisms involved in bioleaching. Describe the microbial processes involved in the degradation of xenobiotics. Understand the concept of bio magnify-cation and its environmental implications. Differentiate in-situ and ex-situ bioremediation techniques. Explain the microbial causes of bio deterioration. Understand the microbial role in corrosion and methods for its prevention.	2,3,5
V	**Wastewater treatment**, Bacterial indicators – DO, BOD, COD, water purification; **Microbial interaction**: Competition, ammensalism, parasitism, mutualism, commensalism, synergism,	**7**	Explain the stages of wastewater treatment. Understand the importance and function of bacterial indicators such as DO, BOD, and COD. Identify and	1,2,3,4.5

	Biogeochemical cycles – Carbon, Nitrogen, Phosphorus		explain different types of microbial interactions. Explain the roles of microbes in the Biogeochemical Cycles.	
Practical	1. Study of effective Sterilization by physical and chemical method 2. Preparation of bacterial smear and staining (Simple, Grams, negative and acid fast) 3. Preparation of culture media, Measurement of pH 4. Isolation of pure culture – serial dilution, Pour plate Technique, spread plate technique, types of streaking. 5. Fungal staining: KOH Mounting, LPCB 6. Isolation of air microbes by gravity settle method 7. Study of Biochemical test: IMViC, Starch hydrolysis test, catalase test, Oxidase test 8. Bacteriological examination of water	**30**	Proficiency in various biochemical tests, isolation and staining techniques for bacterial and fungal identification.	1,2,3,4,5,6

TEXT BOOKS:

T1. Gerard J. Totora, Berdell R. Funke, Christine L. Case (2008). Microbiology: An Introduction. 8th Edition, 2004, Publisher. Pearson, Benjamin Cummings,

T2. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company

T3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology.

T4. Ananthanarayanan R. and C.K. Jayaram Panicker. Text of Microbiology. Twelfth Edition, 2022. Orient Longman.

T5. Jennifer C. Stearns, Michael G. Surette, Julie Kaiser (2019). Microbiology. J Wiley &Sons

REFERENCE BOOKS:

R1. Dr. R.C. Dubey & Dr. D. K. Maheshwari. (2012). Third Revised Edition. Practical Microbiology. S. Chand and Company Ltd.

R2. Mette Prætorius Ibba & Katherine Elasky (2018). Basic and Practical Microbiology Lab Manual Practical. Cognella, Incorporated.

R3. C.P. Baweja. (2012) 4th Edition. Textbook of Microbiology. Arya Publishers

R4. Subhash Chandra Parija. (2019). Second Edition. Textbook of Practical Microbiology. Ahuja Book Company Pvt. Limited

R5. Joanne Willey, Kathleen Sandman, Dorothy Wood. (2020). 11th Edition. McGraw-Hill Professional

OTHER LEARNING RESOURCES:

1. https://www.edx.org/learn/microbiology
2. https://www.futurelearn.com/courses/introduction-to-microbiology

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the fundamentals of microbiology including historical prospectives, classification of microorganisms, microscopy, and structure of prokaryotic cell organelles.	1, 3, 9
2	Demonstrate different sterilization techniques, application of microbial culture media, and staining techniques	1, 3, 4, 7
3	Explore microbial diversity in different habitats including extreme environments and space.	1, 2, 3, 4, 8, 9
4	Apply the microorganisms for Bioleaching, bioremediation, and bio deterioration.	1, 2, 3, 8
5	Explain microbial indicators of wastewater, microbial interactions, and biogeochemical cycles.	1, 3, 4, 8

SEMESTER – I									
Course Title	**Microbial Genetics and Physiology**								
Course code	**24MSMB1102R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ I semester of first year of the Programme**								
Course Objectives	1. To teach the biological processes that ensures a balance between stability and variability of genetic material. 2. To discuss the application of the knowledge of microbial genetics and genetic engineering techniques in order to produce strains applicable in biotechnology. 3. To study the structure, function, energy metabolism, growth and regulatory mechanisms of microorganisms.								
CO1	Discuss the historical prospect and overview of DNA, its structure, types, and replication and gene transfer mechanisms.								
CO2	Describe plasmids, bacteriophage life cycles, DNA mutation, damage, and repair, including detection techniques like the Ames test and replica platting. Describe genetic code, RNA types, and structure; its role in protein synthesis.								
CO3	Analyze the mechanism of transcription and translation, associated enzymes and factors, and the regulation of gene expression.								
CO4	Explain bacterial and fungal growth kinetics and cell cycle.								
CO5	Explore microbial response to environmental challenges								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Developments in genetics: Discovery of DNA, primary, secondary, tertiary and quaternary structures of DNA, Watson and Crick model of dsDNA, the law of DNA consistency, and C value paradox. Detailed structure of DNA, A DNA, B DNA, Z DNA, Genome organization of prokaryotes and eukaryotes, enzymes in DNA replication – detailed mechanism of semi-conservative replication, rolling circle method and bidirectional method of replication. Recombination: reciprocal and non-reciprocal, mechanisms of recombination, Holliday model. Transposons: Classes of transposable elements, nomenclature of transposable elements, Insertion sequences, mechanism of transposition. Effects of transposition in bacteria. Genetic requirements for transposition. Gene transfer mechanisms: bacterial transformation, conjugation, transduction –generalized, specialized and abortive, sexduction, mapping of recombination, Molecular mechanism of gene transfer byconjugation – genes and proteins involved.	**12**	Knowledge of DNA structure, replication, and types. Knowledge on recombi-nation and transposons.	1,2,3, 4,5,6

II	Plasmid: definition and types – F, R, Col, Vir, Ti, Plasmid, plasmid incompatibility. Ti plasmid transfer system and its application in creating transgenics. Bacteriophages – Lytic development cycle using phages T4 and T7 as models. Lysogenic phage – lambda and P1, M13 and phi X 174, Genetic analysis of phages –complementation and recombination tests with phages. Mutation – spontaneous and induced, mutagenic agents, replica plating, Ame's test. DNA damage and repair: factors affecting DNA bases, identification and molecular characterization of repair enzymes in photoreactivation, excision, recombination and SOS pathways. Importance and uses of mutation analysis. Genetic code – their nature, codon, anticodon, Wobble's hypothesis. Structural features of RNA (rRNA, m RNA and tRNA),polycistronic and monocistronic mRNA.	**12**	Knowledge on Plasmid and its types, Bacteriophages and their life cycle, Knowledge on mutation and Genetic code	1,2,3 4,5
III	Prokaryotic Transcription and Translation: Organisation of transcriptional units and regulation of gene expression, Mechanism of transcription in prokaryotes – structure and function of RNA polymerase, (DNA foot printing), termination and anti-termination – N protein and nut sites in DNA binding proteins, enhancer sequences and control of transcription, ribonucleoprotein, direction of protein synthesis, RNA template, direction with experimental proof, t RnA as adaptor, ribosomes and their organization in prokaryotes, polycistronic m RNA in bacteria, initiation of translation in bacteria, small subunits, accessory factors, SD sequence in bacteria, initiator tRNA, elongation of translation, translocation and termination mechanisms	**10**	Knowledge on prokaryotic transcription and translation and associated factors	1,2,3 4,5
IV	Cell Growth and Nutrition: Nutrient requirements, growth factors, nutritional categories, physical factors affecting growth. Bacterial Growth: Bacterial growth curve, growth kinetics, batch, continuous and synchronized culture. Cell cycle in microbes and generation time, fungal growth patterns	**7**	Knowledge on bacterial growth patterns and nutrient requirements	1,2,3 4,
V	Physiological Adaptations and signalling: Quorum sensing, Heat- Shock responses, Chaperones proteins, pH homeostasis, osmotic homeostasis.	**4**	Knowledge on cell signalling by microbes	1,2,3 4,

Practical	1. Gel casting and gel loading 2. Isolation of DNA (plasmid DNA, Chromosomal DNA, Fungal DNA) 3. Agarose Gel Electrophoresis 4. Preparation of competent cell Transformation (Blue-white-screening, Antibiotics resistance screening)	**30**	Proficiency in DNA isolation and separation, preparation of competent cell, transformation experiment and screening	

TEXTBOOKS:

T1. Microbial genetics by Maloy et al. 1994, Jones and Bartlett Publishers
T2. Modern Microbial Genetics. 1991 by Streips and Yasbin. Niley Ltd.
T3. Microbial genetics by Stanly R. Maloy, John E. Cronan and David Freifelder.

REFERENCE BOOKS:

R1.Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology.
R2.Molecular Biology of the Gene 4th edition by J D Watson, N H Hopkins, Roberts, Steitz and Weiner.1987. The Benjamin Cummings Publication Co. Inc California.
R3. Gene VII by Lewin Oxford University Press. 2000
R4. Molecular Genetics of Bacteria by J W Dale, 1994, John Wiley and Sons

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss the historical prospect and overview of DNA, its structure, types, and replication and gene transfer mechanisms.	**1, 9**
2	Describe plasmids, bacteriophage life cycles, DNA mutation, damage, and repair, including detection techniques like the Ames test and replica platting. Describe genetic code, RNA types, and structure; its role in protein synthesis.	**1, 3, 4, 9**
3	Analyse the mechanism of transcription and translation, associated enzymes and factors, and the regulation of gene expression.	**1, 3, 4, 6, 9**
4	Explain bacterial and fungal growth kinetics and cell cycle.	**1, 2, 3, 4, 9**
5	Explore microbial response to environmental challenges	**1, 2, 3, 4, 8, 9**

SEMESTER – I										
Course Title	**Biochemistry**									
Course Code	**24MSMB1103R**	**Total Credits: 4** **Total Hours: 45T+30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Microbiology**								
Semester	**Fall/I Semester of First Year of the Program**								
Course Objectives:	1. To study the structure of biomolecules, such as proteins, nucleic acids, carbohydrates and lipids 2. To know the functions and interactions of biomolecules, which will provide the knowledge of the structure of cells and the various functions performed by them which are associated with life? 3. To study the metabolic pathways of biomolecules like carbohydrate, amino acids etc.								
CO1	Improve the concept of chemical interactions and molecular organization of micro and macromolecules								
CO2	Understand the composition, structure and function of the biomolecules								
CO3	Enhance the understanding on metabolism and physiology of cell.								
CO4	Analyse the concepts of secondary metabolites for human benefits.								
CO5	Prepare the base for understanding courses such as molecular biology and cellular functioning at molecular level.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Concept of biomolecules (composition, structure and functions):** Carbohydrates, Proteins, Lipids, Nucleic acids, Vitamins and Minerals.	10	Knowledge on the concept of biomolecules, differentiating the various biomolecules with thorough understanding on their types and functions	1,2
II	**Bioenergetics:** Concept of thermodynamics (entropy, enthalpy and free energy), reaction kinetics: Substrate phosphorylation and oxidative phosphorylation, **Enzymology:** Principle of catalysis, enzyme and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, Importance of enzymes in diagnosis and therapy.	10	Demonstrate the fundamental knowledge of bioenergetics and enzyme and its kinetics for understanding of metabolism and learning its applications in clinical and therapeutics.	1,2
III	**Metabolism of biomolecules:** **Carbohydrate metabolism**: Glycolysis and its regulation, Gluconeogenesis, Glycogenolysis TCA cycle, Pentose phosphate pathway, glyoxalate pathway. **Lipid metabolism**: oxidation of saturated and unsaturated fatty acid, odd chain fatty acid, regulation of fatty acid metabolism.	10	Build knowledge of the biochemical pathways of synthesis and degradation of the carbohydrate and lipids with its regulatory concept	1,2
IV	**Amino acid metabolism**: Transamination, Deamination and its types, urea cycle **Nucleotide metabolism**: biosynthesis and	8	Understandthe amino acid and nucleotide synthesis and degradation with its	1,2,3

	degradation of purines and pyrimidines		biochemical and regulatory concept	
V	**Heme Metabolism and Photosynthesis and Secondary metabolites:** Heme synthesis and degradation**,** Photosynthesis: Structure of chloroplast, light reaction and dark reaction, Brief concept on the secondary metabolites (Flavonoids, terpenoids, phenolic acids and alkaloids)	7	Learn the synthesis and breakdown of heme, gain knowledge on the mechanism of photosynthesis and apply the concept of secondary metabolites for mankind.	1,2,3, 4
Practical	Buffers: Preparation of acetate buffer, citrate buffer, tris buffer, phosphate buffer; Estimation of protein by Lowry's/Bradford method. Estimation of reducing sugar by DNS method. Estimation of RNA by orcinol method. Estimation of DNA by diphenyl amine method, Extraction and estimation of chlorophyll. Determination of total activity of amylase. Determination of total activity of protease, Qualitative analysis for protein, carbohydrate and its types, amino acid.	**30**	To apply the practical knowledge of biochemistry in various fields	1,2, 3, 4

TEXT BOOKS:

T1. U Satyanarayana. Biochemistry. 13th edition. Elsevier Health Sciences; 2017.

REFERENCE BOOKS:

R1. David L. Nelson, Michael Cox. Lehninger Principles of Biochemistry. 7th Edition. WH Freeman; 2017.
R2. Rodwell et al. Harper's Illustrated Biochemistry. 29th edition. McGraw Hill; 2012.
R3.Voet and Voet. Biochemistry. 3rd edition. John Wiley & Sons, 2004.

OTHER LEARNING RESOURCES:

1. https://pubmed.ncbi.nlm.nih.gov/34809432/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve the concept of chemical interactions and molecular organization of micro and macromolecules	1,3
2	Understand the composition, structure and function of the biomolecules	1, 4
3	Enhance the understanding on metabolism and physiology of cell.	1,3,4
4	Analyse the concepts of secondary metabolites for human benefits.	1, 2, 7
5	Prepare the base for understanding courses such as molecular biology and cellular functioning at molecular level.	1, 9.

SEMESTER – I									
Course Title	**Bioinstrumentation**								
Course code	**24MSMB1104R**	**Total credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ I semester of first year of the Programme**								
Course Objectives	1. To impart knowledge about the working of different Biomedical Instruments. 2. Basic working principle of different instruments. 3. Working principle of chromatography, centrifugation								
CO1	Discuss Chromatography techniques including history, classification, principles, operation, analysis and application.								
CO2	Define Centrifugation techniques, classification, principles, operation and its application.								
CO3	Explain and investigate Electrophoresis, its categorization, underlying principle, operational methods, pH meter functionality, dialysis, and blotting methodologies.								
CO4	Discuss radioisotope dating principles, including detection, measurement, isotopes, radiation, units and decay.								
CO5	Develop the comprehensive understanding of principles, and practical application skills in various spectroscopic methods for scientific analysis.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Chromatography:** History; Classification; Types, principles, operation, application & analysis (Paper, Column, Adsorption column, Partition, Thin layer, Ion exchange, quantitative Ion exchange, and Gel Chromatography):	10	Able to describe, illustrate and explain the chromatography and their applications	1,2
II	**Centrifugation:** Types; Application; Principle; rotors; density gradient & analytical centrifugation.	10	Able to describe, illustrate and explain the centrifuge	1,2
III	**Gel Electrophoresis:** Application; Types; Principle; pH meter (Principle); Dialysis, **Blotting technique:** Southern, Western, & Northern blot	8	Able to describe, illustrate and explain the electrophoresis	1,2
IV	**Radio- isotope dating technique:** Introduction, nature, detection & measurement of radioactivity, radioisotopes & radiation, units, radioactive decay.	7	Able to describe, illustrate and explain the radio isotopes.	1,2
V	**Spectroscopic techniques:** Introduction, Principle and application of spectroscopy	10	Able to describe, illustrate and explain the spectroscope	1,2
Practical	Operation of molecules from given sample by 1. Paper chromatography 2. Column chromatography 3. Thin layer chromatography 4. Separation of DNA and protein molecules by gel electrophoresis	30	Able to use various instruments for analysis	1,2,3,4

TEXT BOOKS:

T1. Upadhyay. Biophysical chemistry: principle and technique. 12th edition. Himalaya Publishing House Pvt. Ltd; 2017.

REFERENCE BOOKS:

R1. Kakkar. Atomic and Molecular Spectroscopy. 1st edition. Cambridge English; 2017.
R2. Evans. Handbook of Chromatography. 2nd Edition, Willford Press; 2019.
R3. Holme and Peck. Analytical biochemistry. 3rd edition. Longman, 1983.

OTHER LEARNING RESOURCES:

1. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/chromatography

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss Chromatography techniques including history, classification, principles, operation, analysis and application.	**1, 3, 4**
2	Define Centrifugation techniques, classification, principles, operation and its application.	**1, 3**
3	Explain and investigate Electrophoresis, its categorization, underlying principle, operational methods, pH meter functionality, dialysis, and blotting methodologies.	**1, 3, 4**
4	Discuss radioisotope dating principles, including detection, measurement, isotopes, radiation, units and decay.	**1, 3, 4**
5	Develop the comprehensive understanding of principles, and practical application skills in various spectroscopic methods for scientific analysis.	**1, 3, 4**

SEMESTER – I										
Course Title	**Fundamental of Statistics**									
Course code	**24UMFS1101R**	**Total Credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 30T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course Objectives	1. Help to understand the role of statistics in data analysis, decision-making, and scientific research 2. Introduce students to descriptive statistics, including measures of central tendency (mean, median, and mode) and measures of dispersion (range, variance, standard deviation). 3. Teach students how to summarize and present data effectively using tables, charts, and graphs									
CO1	Improve understanding of Descriptive Statistics and Demography.									
CO2	Develop knowledge to understand the Probability theory, Distribution, and sampling methods.									
CO3	Develop knowledge to understand the methods for hypothesis testing and Biological data analysis.									
CO4	Develop knowledge to understand the principles of various statistical analyses of data.									
CO5	Develop knowledge on R language for data analysis									

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Statistical Methods**: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio.	5	Foundational Understanding of Statistical Concepts	1,2
II	**Presentation**: tabular and graphical, including histogram and ogives. Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, skewness and kurtosis.	5	Proficiency in Data Presentation and Analysis	1,2
III	**Bivariate data**: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, fitting of polynomials and exponential curves.	5	Knowledge on Analysing Bivariate Data and Relationships	1,2
IV	**Random experiment**: trial, sample point and sample space, event, Operations of Events, concepts of mutually exclusive and exhaustive events. Definition of probability: classical and relative frequency approach. Discrete probability space, Properties of probability, Independence of events, Conditional probability, total and compound probability rules, Normal probability Distribution, Bionomial probability Distribution, Poisson Probability Distribution, Bayes' theorem and its applications.	8	Understanding of Probability and Distributions	1,2

V	**Testing of hypothesis**, parametric test: t-test, z-test, chi-square test. Non-Parametric test: One sample Kolmogorov test, wilcoxon Signed test, Mann-Whitney Test, Kruskal walis test.	7	Application of Hypothesis Testing and Statistical Tests	1,2
Practical	1. Introduction to R - A programming language and environment for data analysis and graphics. Syntax of R expressions: Vectors and assignment, vector arithmetic, generating regular sequence, logical vector, character vectors, Index vectors; selecting and modifying subsets of dataset 2. Data objects: Basic data objects, matrices, partition of matrices, arrays, lists, creating and using these objects; Functions- Elementary functions and summary functions, applying functions to subsets of data. Data frames: The benefits of data frames, creating data frames, combining data frames, Adding new classes of variables to data frames; Data frame attributes. 3. Importing data files: import. Data function, read. Table function; Exporting data: export. Data function, cat, write, and write. Table functions, function, formatting output - options, and format functions; Exporting graphs -export. Graph function. Graphics in R: creating graphs using plot function, box plot, histogram, line plot, steam and leaf plot, pie chart, bar chart, multiple plot layout, plot titles, formatting plot axes; Visualizing the multivariate data: Scatter plot, Q-Q plot, P-plot. 4. Performing data analysis tasks: Reading data with scan function, exploring data using graphical tools, computing descriptive statistics, one sample tests, two sample tests, Goodness of fit tests. 5. Parametric test and Non-Parametric test	30	A brief knowledge on using R for data analysis and visualization	1,2, 3,4

TEXT BOOKS:

T1. Methods in Biostatistics by K S Negi, ISBN: 9789374735053, 4th Edition, Year: 2023, AITBS Publishers, INDIA

REFERENCE BOOKS:

R1."Introduction to the Practice of Statistics" by David S. Moore, George P. McCabe, and Bruce A. Craig
R2. "Statistics" by David Freedman, Robert Pisani, and Roger Purves

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Improve understanding of Descriptive Statistics and Demography.	**1, 4**
2	Develop knowledge to understand the Probability theory, Distribution, and sampling methods.	**1, 4**
3	Develop knowledge to understand the methods for hypothesis testing and Biological data analysis.	**1, 4**
4	Develop knowledge to understand the principles of various statistical analyses of data.	**1, 4**
5	Develop knowledge on R language for data analysis	**1, 4, 9**

SEMESTER – I									
Course Title	**MINI RESEARCH (REVIEW OF LITERATURE-R1)**								
Course code	**24MSMB1105R**	**Total Credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 120 (S+R)	**0**	**0**	**0**	**4**	**6**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course Objectives	1. To develop the ability to conduct a comprehensive literature review and identify the relevant sources 2. To enhance students' ability to critically analyze existing literature and summarize it. 3. To develop students scientific writing skill								
CO1	Employ databases and library resources to gather original research, books, and articles effectively								
CO2	Summarize and differentiate between various types of reviews, specifically analytical and descriptive reviews.								
CO3	Identify research topics and employ appropriate methods for collecting and filtering information.								
CO4	Critically analyze the demonstrations and findings of previous authors to comprehend their contributions and insights.								
CO5	Compose a detailed review that explains the prospects and future directions of the chosen study.								

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Employ databases and library resources to gather original research, books, and articles effectively	1, 2, 3, 4
2	Summarize and differentiate between various types of reviews, specifically analytical and descriptive reviews.	1, 2, 3, 4
3	Identify research topics and employ appropriate methods for collecting and filtering information.	1, 2, 3, 4
4	Critically analyse the demonstrations and findings of previous authors to comprehend their contributions and insights.	1, 2, 3, 4
5	Compose a detailed review that explains the prospects and future directions of the chosen study.	1, 2, 3, 4,6

SEMESTER – I									
Course Title	**EFFECTIVE ENGLISH (Communicative English & Soft Skills)**								
Course code	**24UMPD1101R**	**Total Credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course Objectives	1. To introduce the types of sentences and their significance. 2. To strengthen the students' vocabulary to enhance their speaking and writing skills. 3. To familiarize the students with the importance of dress codes in various organizations.								
CO1	Analyze and identify the different types of sentences.								
CO2	Able to integrate the skills of reading and speaking in professional communication.								
CO3	Illustrate code Etiquette sessions will boost their confidence and morals.								
CO4	Describe about the effective and efficient utilization of time.								
CO5	Explain the concept of Phonetics and its importance will improve the learners 'pronunciation								

Unit No	Content	Learning Outcome	Contact Hour	KL
I	**Grammar:** Interchange of Interrogative and Assertive Sentences, Exclamatory and Assertive Sentences, Types of Tenses, Common Errors, Synonyms, Antonyms, Homonyms	Identify and understand the structure of interrogative and assertive sentences. Transform and enhance grammatical accuracy and sentence formation skills.	10	1,2
II	**Reading Skills:** Techniques of Effective Reading, Gathering ideas and information from a text The SQ3R Technique Interpret the text.	Develop strategies for faster reading with better comprehension and improve the ability to recall and organize textual information systematically.	15	1,2
III	**Listening Skills:** What is listening?, The Process of Listening, Factors that adversely affect Listening, Difference between Listening and Hearing, Purpose and Importance of Effective Listening, How to Improve Listening Process.	Understand the fundamental aspects and importance of listening. It also helps to enhance interpersonal and professional communication by practicing listening skills.	10	1,2
IV	**Conflict Management:** Definition**,** Type of Conflict Management**,** Effects of Conflict Management**,** Methods to deal with Conflicts (Negative)	Learn strategies to manage and resolve conflicts effectively to encourage a positive environment by turning conflicts into opportunities for growth.	10	1,2

V	**Time-Management Skills** Introduction To Time Management, Purpose And Importance of Time Management, Basic Tips to Maintain Time. **Activity: Problem solving activity**: A situation will be given to the students and they will have to tell us how to handle the situation or solve the problem.	Enhance productivity and stress management through effective time allocation and planning. It helps to understand the importance of time management in achieving personal and professional goals.	15	1,2

TEXT BOOKS:

T1. Wren, P.C and Martin, H. 1995. High School English Grammar and Composition, S Chand Publishing.
T2. English Grammar in Use, Raymond Murphy 4th edition, CUP.
T3. Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.

REFERENCE BOOKS:

R1. English Vocabulary in Use (Advanced), Michael McCarthy and Felicity, CUP.
R2. Effective Communication and Soft Skills, Nitin Bhatnagar, Pearsons.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Analyse and identify the different types of sentences.	**1, 5**
2	Able to integrate the skills of reading and speaking in professional communication.	**1, 5, 9**
3	Illustrate code Etiquette sessions will boost their confidence and morals.	**5, 6, 9**
4	Describe about the effective and efficient utilization of time.	**5, 9**
5	Explain the concept of Phonetics and its importance will improve the learners 'pronunciation	**1, 5, 9**

SEMESTER – II									
Course Title	**Immunology**								
Course Code	**24MSMB1201R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Microbiology**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course Objectives	1. To make students understand the Immune system and its components, immune response, antigen, antibody, immunity, Hypersensitivity, Autoimmunity etc. 2. To make students learn various immunological diagnostic techniques								
CO1	Describe the immune system and its components and their mode of action in defense mechanisms.								
CO2	Outline antigen and antibody structure, types, and properties including the processes of monoclonal and polyclonal antibody production								
CO3	Apply the knowledge of different immunological diagnostics tests, their principle, and interpretations aiding in the detection of the underlying cause of the diseases.								
CO4	Interpret transplantation and cancer immunology findings and their role in research.								
CO5	Discuss immunological disorders like autoimmunity and hypersensitivity, their prevention strategies, and management								

Unit No.	**Content**	**Contact Hours**	**Learning Outcome**	**KL**
I	**Introduction to immunology** – Definition, history, scope of immunology. Overview of the immune system-cells and organs of the immune system. Immune response- Humoral and cell mediated immune response. Immunity- types of immunity- Innate and acquired immunity, APC.	**7**	Knowledge of Immune system, Immunity, immune response	1,2
II	**Antigens** – General features, haptens, adjuvants, epitopes. Antibody – Structure, types, antibody mediated effector functions – opsonisation, antibody activated complement, ADCC, isotypes, allotypes, idiotypes, **Antibody production and purification** – production of monoclonal antibodies, immunotoxins, abzymes, extraction of antibodies. Expression of immunoglobulin genes- antibody diversity, class switching of Immunoglobulins	**10**	Knowledge on antigens and their properties and antibodies and their types along with their production and purification process	1,2
III	**Antigen-antibody interaction** – principle and application – RIA, ELISA, Western blotting, Immunofluorescence, Complement system – classical and alternative pathway, functions	**10**	Theoretical and practical knowledge on principle and process of different immunological diagnostic tests	1,2
IV	**HLA** – Theories of antibody formation, HLA typing, MHC, T cell receptors, Transplantation immunology – Graft rejection, immune suppressive therapy, immune tolerance, clinical transplantation	**8**	Knowledge on transplan-tation immunology and immune effectors.	1,2

	Immune effectors – Cytokines, IL and functions, cell mediated cytotoxicity, NK cells, TNF, Interferons, Inflammation, leukocyte activation, and migration			
V	Hypersensitivity and types, Autoimmunity, Cancer and immune system – tumor antigen, tumor evasion and immunotherapy of cancer, AIDS – primary and secondary immunodeficiency. Vaccines and its types	**10**	Knowledge on Hyper-sensitivity, Autoimmunity, cancer immunology, immunodeficiency and vaccines	1,2
Practical	Precipitation Reaction: i. Double Diffusion Reaction ii. Single Diffusion Reaction iii. Ouchterlony immunodiffusion iv. Immunoelectrodiffusion Agglutination Reaction: (Qualitative and quantitative) WIDAL, ASO, VDRL, RPR, CRP Blood grouping and Rh typing, ELISA	**30**	Able to operate ELISA, RIA	1,2, 3,4

TEXT BOOKS:

T1. Punt et al. Kuby Immunology 18th Edition. W H Freeman & Co (Sd); 2018.

REFERENCE BOOKS:

R1. Abbas. Cellular and Molecular Immunology. 10th edition. Elsevier; 2021.
R2. Martin et al. Roitt's Essential Immunology (Essentials). 13th edition. Wiley-Blackwell, 2017.
R3. Westwood. Practical Immunology. 4th edition. Wiley-Blackwell; 2002.

OTHER LEARNING RESOURCES:

1. https://pubmed.ncbi.nlm.nih.gov/28830733/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the immune system and its components and their mode of action in defense mechanisms.	**1, 2, 9**
2	Outline antigen and antibody structure, types, and properties including the processes of monoclonal and polyclonal antibody production	**1, 3, 4**
3	Apply the knowledge of different immunological diagnostics tests, their principle, and interpretations aiding in the detection of the underlying cause of the diseases.	**1, 2, 3, 4**
4	Interpret transplantation and cancer immunology findings and their role in research.	**1, 2, 4**
5	Discuss immunological disorders like autoimmunity and hypersensitivity, their prevention strategies, and management.	**1, 2, 3, 4**

SEMESTER – II										
Course Title	**Molecular Biology, Genomics And Genetic Engineering**									
Course code	**24MSMB1202R**	**Total Credits: 4** **Total Hours: 45T+30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			3	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Microbiology**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course Objectives	1. To teach in depth about genome and its arrangement in eukaryotes and microbes. 2. To teach the central dogma of life (replication, transcription, translation and post transcriptional modifications) with the best possible teaching tools (explanation/power point presentation/seminar/assignment) and with utmost attention. 3. Important topics like mutation, DNA damage and repair are explained.									
CO1	Explain the fundamental of genomics concepts such as genome, DNA structure, RNA, proteins and the central dogma.									
CO2	Explain the methods for mapping genomes, describe markers, linkage analysis with different types of organisms, physical mapping, and basics of genome sequencing, shotgun sequencing.									
CO3	Compare prokaryotic and eukaryotic genomes, including the presence of extra chromosomal DNA and examine the vital function of DNA binding proteins in gene expression and regulation.									
CO4	Illustrate the dynamics of genome access, encompassing aspects such as euchromatin, heterochromatin, chromosome painting, nucleosome modifications, histone acetylation, DNA modifications, DNA methylation-induced gene silencing, and gene regulation in both prokaryotes and eukaryotes.									
CO5	Discuss the mutation causes, types of DNA mutation and DNA repair mechanisms, crucial for maintaining genetic stability and impacting human health.									

Unit No.	**Content**	**CH**	**Learning Outcome**	**KL**
I	Introduction to genomics, definitions of genome, DNA structure and composition, RNA and the transcriptome, proteins and the proteome, the central dogma	**7**	Introductory knowledge and refreshing the existing understanding	1,2
II	Mapping of genomes, markers for genetic mapping, the basis to genetic mapping, linkage analysis with different types of organisms, physical mapping, basics of genome sequencing, shotgun sequencing	**10**	Sequencing techniques in detail followed by linkage mapping	1,2
III	Genomes of prokaryotes and eukaryotes, extra chromosomal DNA, role of DNA binding proteins in genome expression: methods for studying DNA binding proteins and their attachment sites, special features of DNA binding proteins, interaction between DNA and its binding proteins	**10**	Knowledge on DNA replication in prokaryotes and eukaryotes with special emphasis on the proteins and enzymes involved.	1,2
IV	Accessing the genome: euchromatin and heterochromatin, chromosome painting, nucleosome modifications and genome expression, histone modification, acetylation, DNA modifications and genome expression, gene silencing by DNA methylation, gene regulation in prokaryotes and eukaryotes	**8**	Genome organisation is discussed in detail with various post translational events along with regulatory mechanisms	1,2

V	Introduction to genetic engineering, Different DNA manipulating enzymes, methods for isolating DNA, vectors for bacteria, plant and animals, expression vectors, DNA libraries, application of genetic engineering.	**10**	Understand genetic engineering techniques, use vectors, evaluate expression vectors, and propose innovative applications.	1,2
Practical	Isolation of genomic DNA, Isolation of plasmid DNA, Polymerase chain reaction, and Endonuclease digestion of DNA and analysis of DNA fragments by agarose electrophoresis.	**30**	Knowledge on extraction of DNA and plasmid from biological samples followed by their in vitro amplification and studying RFLP profile	1,2, 3,4

TEXT BOOKS:

T1. Watson et al. The Molecular Biology of the Gene. 7th edition. Pearson Publication; 2013.

REFERENCE BOOKS:

R1. Alberts et al. The Molecular Biology of the Cell. 7th Edition. WW Norton & Co, 2022.
R2. Rastogi. Cell and Molecular Biology. 4th edition. New Age International Private Limited; 2020.
R3. Som. Practical Manual of Molecular Biology. 1st edition. KAAV Publications, 2018.

OTHER LEARNING RESOURCES:

1. https://pubmed.ncbi.nlm.nih.gov/28830733/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the fundamental of genomics concepts such as genome, DNA structure, RNA, proteins and the central dogma.	**1, 9**
2	Explain the methods for mapping genomes, describe markers, linkage analysis with different types of organisms, physical mapping, and basics of genome sequencing, shotgun sequencing.	**1, 2, 3, 4, 6, 9**
3	Compare prokaryotic and eukaryotic genomes, including the presence of extra chromosomal DNA and examine the vital function of DNA binding proteins in gene expression and regulation.	**1, 2, 3, 4, 6, 9**
4	Illustrate the dynamics of genome access, encompassing aspects such as euchromatin, heterochromatin, chromosome painting, nucleosome modifications, histone acetylation, DNA modifications, DNA methylation-induced gene silencing, and gene regulation in both prokaryotes and eukaryotes.	**1, 4, 9**
5	Discuss the mutation causes, types of DNA mutation and DNA repair mechanisms, crucial for maintaining genetic stability and impacting human health.	**1, 2, 7, 9**

SEMESTER – II									
Course Title	**Bioinformatics**								
Course code	**24MSMB1203R**	**Total Credits: 3** **Total Hours: 30T+30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			2	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Microbiology**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course Objectives	1. To search and retrieve biological information from different biological databases. 2. Knowledge on computational database management system and its application in Biology 3. A basic idea on the structural biology using computer.								
CO1	A basic concept on Bioinformatics and its significance in the field of biological data analysis								
CO2	Knowledge on database management system and its application in Biology								
CO3	A good knowledge on sequence submission tools as well as biological search engines								
CO4	Knowledge on sequence alignment and analysis.								
CO5	Learn the concept of computer aided drug designing								

Unit No.	**Content**	**Contact Hours**	**Learning Outcome**	**KL**
I	Introduction to Bioinformatics, Scope and Applications of Bioinformatics, Introduction to various molecular data and databases, Importance of Computers/IT in the field of Biology. Flatfile formats. Biological Database and its Types - General Introduction of Biological Databases: Nucleotide sequence databases (NCBI, DDBJ, and EMBL).Protein sequence databases(SWISS-PROT, PIR, GenPept) ,Specialized Genome databases: (SGD, TIGR etc).Structure databases (CATH, SCOP, and PDB, NDB, MMDB)	**7**	Knowledge on bioinformatics and its relation with molecular biology and its application.	1,2
II	Database Management System: Basic Concept of DBMS, Concepts of Entities, Attribute, Keys, Relationship. Three level architecture of a DBMS, Structure of a DBMS, Advantages & Disadvantages of a DBMS.File Based System, Traditional System, DBMS types Hierarchical, Network, Relational Data Model etc	**6**	Formation of a database and its application in biology	1,2
III	Bioinformatics Database search engines: Text-based search engines (Entrez, DBGET /LinkDB). Sequence similarity based search engines (BLAST and FASTA). Motif-based search engines (ScanProsite and eMOTIF). Structure similarity based search engines (Combinatorial Extension, VAST and DALI). Proteomics tools: - ExPASy server, EMBOSS.	**7**	Knowledge on different bioinformatics search engines and their applications in retrieving data	1,2

IV	Pairwise sequence alignments: Sequence similarity, identity, and homology. Global and local alignment, BLAST and PSI-Blast, Application of Blast tool, Multiple sequence alignments and Application of multiple sequence alignment.	**5**	A good knowledge on sequence alignment and its application	1,2
V	Computer assisted drug design- concept, methods and practical approaches, various computational methods applied to design the drugs, CADD software demonstration. Protein homology modelling	**5**	A brief knowledge on drug designing through computer as well as protein 3D modelling	1,2
Practical	Data retrieval from different biological database Sequence alignment through BLAST Protein homology modelling, Phylogenetic Analysis through MEGA software Demonstration of Drug designing.	**30**	Knowledge on different biological databases and sequence alignment tool.	1,2,3,4

TEXT BOOKS:

1. Harisha S. Fundamental of Bioinformatics. 3rd edition. Dreamtech Press, 2019.

REFERENCE BOOKS:

1. Sharma T. R. Genome Analysis and Bioinformatics: A Practical Approach (English) (Paperback). 1st edition. Dreamtech Press; 2019.

2. Orengo C.A. et al. Bioinformatics: Genes, proteins and computers. 1st edition. Taylor & Francis, 2002.

3. Kangueane P., Mathura V. Bioinformatics: A Concept-Based Introduction. 1st edition. Springer-Verlag New York Inc. 2009.

OTHER LEARNING RESOURCES:

1. https://pubmed.ncbi.nlm.nih.gov/28830733/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	A basic concept on Bioinformatics and its significance in the field of biological data analysis	**1, 4, 9**
2	Knowledge on database management system and its application in Biology	**1, 4, 5**
3	A good knowledge on sequence submission tools as well as biological search engines	**1, 4, 5**
4	Knowledge on sequence alignment and analysis.	**1, 4**
5	Learn the concept of computer aided drug designing	**1, 3, 4**

SEMESTER – II									
Course Title	**Mushroom Cultivation: Techno-Professional**								
Course code	**24MSMB1204R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 60	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ I semester of first year of the Programme**								
Course Objectives	1. To create awareness about the Mushroom among the people. 2. To strengthen the promotion of mushroom cultivation by establishing a well-equipped laboratory a nd offices. 3. To know and explore the cultivation in Assam								
CO1	Explain different classes of mushrooms.								
CO2	Describe the reproduction and growth of mushrooms.								
CO3	Explain mushroom spawn production								
CO4	Discuss the methods of cultivation of mushroom								
CO5	Apply the techniques for the utilization of mushrooms spent								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	Introduction: Background of mushroom (common feature, types and uses, edible mushroom, non- edible and poisonous mushroom common features on poisonous mushroom, uses of mushroom, important of mushroom, biological efficiency of mushroom)	**12**	Understand the key characteristics, types, and uses of mushrooms, including the distinction between edible and poisonous varieties, and their biological efficiency.	1,2,3,4
II	Biology of mushroom (reproduction, growth and nutrition), Oyster and Button mushrooms, Mushroom structure designed and maintenance	**12**	Grasp the biology, reproduction, and growth of mushrooms, focusing on Oyster and Button mushrooms, and understand their structural design and maintenance.	1,2,3
III	Laboratory techniques for production of mushroom spawn (seed)	**12**	Understand and apply the fundamental principles of mushroom spawn production	1, 2, 3
IV	Methods for cultivation and harvesting of mushroom	**12**	Understand and apply various techniques for mushroom cultivation.	1, 2, 3
V	Utilization of mushroom spent (waste).	12	Understand the environmental and economic benefits of utilizing spent mushroom substrate.	1, 2, 3, 4

TEXT BOOKS:

T1. Mushroom Cultivation Technology by Joy Sarkar, Krishnendu Acharya, Anirban Roy. Publisher: Techno World

T2. Handbook of Mushrooms 4th Edition by Bahl N, Oxford & Ibh Publishing

REFERENCE BOOKS:

R1. Mushroom Cultivation by Parveen Garg, Publisher: B.R. Publishing Corporation, ISBN: 9788193031421

R2. Mushrooms: A Manual for Cultivation by S. Biswas, M. Datta, S. V. Ngachan, PHI Learning.

OTHER LEARNING RESOURCES:

1. https://www.nhb.gov.in/pdf/Cultivation.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain different classes of mushrooms.	**1**
2	Describe the reproduction and growth of mushrooms.	**1**
3	Explain mushroom spawn production	**1, 3, 4**
4	Discuss the methods of cultivation of mushroom	**1, 3**
5	Apply the techniques for the utilization of mushrooms spent	**1, 2, 3, 4**

SEMESTER-II									
Course Title	**Generic Elective - Public Health And Hygiene**								
Course code	**24MSMB1205R**	**Total credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total hours: 30	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ I semester of first year of the Programme**								
Course Objectives	1. To understand the concepts, significance and relevance of public health and hygiene. 2. To understand the health hazards as associated with public health and hygiene. 3. To understand social health problems and health education in India.								
CO1	Explain the concepts of public health, evaluate India's health systems and policies, and assess the impact of nutrition, environment, and mental health on public well-being								
CO2	Analyse environmental health hazards, assess pollution impacts, and understand the importance of hygiene, waste management, and food safety.								
CO3	Describe key hygiene concepts across personal, medical, food, and industrial settings.								
CO4	Identify and understand the causes, prevention, and control measures of lifestyle-related non-communicable and communicable diseases.								
CO5	Analyse social health issues in India and evaluate the role of health education and programs in promoting dead diction and eco-friendly practices.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	INTRODUCTION Concept of Public Health Goals and Objectives of Public health and Hygiene, Public health system in India and in the rest of world HEALTH ASPECTS Introduction to National Health Policy - National Rural Health Mission (NRHM) and National Urban Health Mission (NUHM) Nutrition and health, Environmental health-sanitation, air, water pollution, Mental health	**7**	Knowledge about the Concepts, Goals, and Objectives of Public Health and Hygiene. NRHU and NUHM	1, 2
II	ENVIRONMENT AND HEALTH HAZARDS : Environmental degradation and Pollution: Sources, Impacts of wastes and treatment methods Environment & Health Relation Assessment - Concept, Steps and application, Personal and mental hygiene, Health destroying habits and addictions Need of Water Purification Adulteration of Food Undesirable Changes in Air, Radiation effects, e- waste, Solid waste and Excreta disposal	**5**	Knowledge on Environmental Pollution, degradation, Hygiene and Food adulteration	1, 2, 3
III	HYGIENE CONCEPTS Personal Hygiene Medical Hygiene Food Hygiene Industrial Hygiene	**5**	Knowledge on hygiene (personal, Medical, food and industrial)	1, 2
IV	LIFE STYLE RELATED NON-COMMUNICABLE DISEASES	**8**	Theoretical and practical knowledge on	1, 2, 3

	Hypertension Coronary Heart Diseases Stroke, Diabetes Mellitus Obesity COMMUNICABLE DISEASES AND THEIR CONTROL MEASURES: Air Borne Disease : Tuberculosis, Influenza Food and water Borne Disease: Amoebiasis, Jaundice, Vector Borne Disease: Malaria, Dengue Contact Disease : Venereal disease and AIDS		communicable and non-communicable diseases	
V	SOCIAL HEALTH PROBLEMS AND HEALTH EDUCATION IN INDIA: Smoking, Alcoholism, Drug Dependence and Their Dead diction. Eco-Friendly Environmental Practices, Effects of drug abuse, WHO programmes Government and voluntary Organizations – vaccination and awareness programme, First Aid	**5**	Knowledge on Indian Health Education and Social health problems	1, 2, 3

TEXT BOOKS:

T1. Introduction to Public Health, Raymond L. Goldsteen, Karen Goldsteen, David G. Graham, 2011, Springer publishing company

T2. Introduction to Community Health Nursing, Kasturi Sundar Rao, 4th edition, Bi Publications Pvt Ltd

T3. Concepts of Epidemiology, Raj S Bhopal, 2002, Oxford University press

T4. A Treatise n Hygiene and Public Health, Birendra Nath Ghosh, 9th edition, Calcutta Scientific Publishing Co

REFERENCE BOOKS:

R1. Park and Park, 1995: Text book of preventive and social medicine – Banarsidas Bhanot Publ. jodhpur-India

R2. Verma, S. 1998: Medical zoology, Rastogi Publ.- Meerut- India

R3. Jatin V. Modi and Renjith S. Chawan. Essentials of Public Health and Sanitation –Part I- IV

R4. Murray, C. J. L. and A.D. Lopez. (1996).The Global Burden Of Disease. World Health Organization.

R5. Park, J.E. and Park, K. Textbook of Community Health for Nurses.

OTHER LEARNING RESOURCES:

1. https://www.cdcfoundation.org/what-public-health

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the concepts of public health, evaluate India's health systems and policies, and assess the impact of nutrition, environment, and mental health on public well-being	**1, 2, 4, 7**
2	Analyse environmental health hazards, assess pollution impacts, and understand the importance of hygiene, waste management, and food safety.	**1, 2, 4, 7, 8**
3	Describe key hygiene concepts across personal, medical, food, and industrial settings.	**1, 5, 7**
4	Identify and understand the causes, prevention, and control measures of lifestyle-related non-communicable and communicable diseases.	**1, 2, 4, 5, 7**
5	Analyse social health issues in India and evaluate the role of health education and programs in promoting dead diction and eco-friendly practices.	**1, 2, 4, 7**

SEMESTER-II									
Course Title	**Research Methodology and Statistical Analysis**								
Course code	**24UMRM1201R**	**Total Credits: 2** **Total Hours:15T+60S**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			1	**0**	**0**	**4**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Spring/II semester of First year of the Programme**								
Course Objectives	1. The course aims to enhance the students' a broad understanding of research methodology, includingtheoryofscienceandqualitativeandquantitativemethodsinresearch. 2. The course seeks to enhance the students' skills for developing critical thinking through research literature review in different domain. Consequently, it aims to develop skills for preparation of a research proposal for a master' thesis project/ Mini research. 3. To develop Students competency in planning, conducting, evaluating and presenting a research project.								
CO1	Students will have basic knowledge of Research methods.								
CO2	Students will gain the knowledge of Research Methodology.								
CO3	Students will be able to gain the Skill questionnaire development.								
CO4	Students will be able to acquire the knowledge of basic Report/dissertation Procedure.								
CO5	Knowledge on different IPR rights								

Unit No	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Research Methodology- An Introduction- meaning and objectives of research, motivation in research, types and significance of research, criteria of good research. Defining the Research Problems- definition of research problem, necessity of defining research problem	2	Knowledge on fundame-ntal concepts of research methodology, including the meaning and objectives of research	1,2
II	Research Design- meaning and need of research design, features of a good design, different research designs, Sampling Design- steps in sampling design, Sample Size determination, criteria for selecting a sampling design, different types of sampling design, Experimental Design, Principles of Design of Experiment, One – way ANOVA, Two- Way ANOVA, CRD, RBD, LSD, 22, 23 Factorial Design	4	Able to understand and apply the fundamental principles of research design, including the meaning and necessity of research design	1,2
III	Types of data, sources of data collection, tools of data collection, Nominal, ordinal, interval and ratio – Attitude scale construction and measurement, rating scales, semantic differential (SD), Use of scale in statistical analysis, Schedules for interviews preparation and standardization, development of survey instruments and item analysis for the questionnaire	3	A good knowledge on different types of data and identify various sources and tools for data collection	1,2

IV	Planning and organizing research report, Format of research report, Different steps of writing report, lay out of the research report , How to organize thesis/Dissertation, mechanics of writing research report, standard methods of quoting- presenting the result, written and oral reports, Uses of abstract, format of research report, presentation of statistics - tabular and graphic references and uses of references, Bibliography and presentation of bibliography	3	Able to organize and write a comprehensive research report	1,2
V	Intellectual property right (IPR), Introduction and the need for IPR, IPR in India and worldwide, Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications, Patentable and non-patentable, patenting life, Filing of a patent application, The different layers of the international patent system, Case studies on Basmati rice, Turmeric, and Neem patents	3	Knowledge on importance of Intellectual Property Rights (IPR) both in India and globally	1,2
Practical	Laboratory using R Software: 1 Analysis of One way ANOVA; 2 Analysis of Two way ANOVA; 3 Analysis of CRD 4 Analysis of RBD 5 Analysis of 22 and 23 Factorial Experiment 6 Simulation-I using R (Bernoulli, Binomial, Poisson and Geometric distribution.). 7 Simulation-II using R (Exponential and Normal distribution). 8 Simple random Sampling 9 Stratified Random Sampling	60	Knowledge on various statistical experiments and simulations using R	1,2,3,4

TEXT BOOKS:

T1: Methods in Biostatistics by K S Negi, ISBN: 9789374735053, 4th Edition, Year: 2023, AITBS Publishers, INDIA

REFERENCE BOOKS:

R1. Johnson & Christensen. (2004). Educational Research: Quantitative, qualitative and mixed approaches, 2nd Ed. Boston: Allyn & Bacon.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Students will have basic knowledge of Research methods.	**2, 4, 9**
2	Students will gain the knowledge of Research Methodology.	**2, 4, 9**
3	Students will be able to gain the Skill questionnaire development.	**2, 4, 5**
4	Students will be able to acquire the knowledge of basic Report/dissertation Procedure.	**4, 5**
5	Knowledge on different IPR rights	**6, 7**

SEMESTER – II									
Course Title	**MINI RESEARCH 2 (RESEARCH GAP ANALYSIS)**								
Course code	**24MSMB1206R**	**Total credits: 3** **Total hours: 192 (S+R)**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**0**	**4**	**12**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Fall/I Semester of First Year of the Programme**								
Course Objectives	1. To enable Students to comprehend various research methodologies and their applications in identifying research gaps. 2. To develop the ability to critically analyse existing literature and identify areas where further research is needed. 3. To enable students to formulate research questions or hypotheses based on identified gaps in the literature.								
CO1	Analyze existing literature								
CO2	Identify research gap								
CO3	Formulate research questions								
CO4	Formulate research objectives								
CO5	Prepare research synopsis								

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Analyse existing literature	**1, 2, 4**
2	Identify research gap	**1, 2, 4**
3	Formulate research questions	**1, 2, 4, 9**
4	Formulate research objectives	**1, 2, 4, 9**
5	Prepare research synopsis	**1, 2, 4**

<table>
<tr><th colspan="10">SEMESTER-II</th></tr>
<tr><td>Course Title</td><td colspan="9">UNIVERSAL HUMAN VALUES (UHV) + PROFESSIONAL ETHICS</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">24UUHV1201R</td><td rowspan="2">Total Credits: 2
Total Hours:15T+30P</td><td>L</td><td>T</td><td>P</td><td>S</td><td>R</td><td>O/F</td><td>C</td></tr>
<tr><td>1</td><td>0</td><td>2</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-Requisite</td><td>Nil</td><td>Co-requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Programme</td><td colspan="9">Master of Science in Microbiology</td></tr>
<tr><td>Semester</td><td colspan="9">Winter/II semester of First year of the Programme</td></tr>
<tr><td>Course Objectives</td><td colspan="9">1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of Existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature</td></tr>
<tr><td>CO1</td><td colspan="9">The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.</td></tr>
<tr><td>CO2</td><td colspan="9">It is free from any dogma or value prescriptions.</td></tr>
<tr><td>CO3</td><td colspan="9">It is a process of self-investigation and self-exploration, and not of giving sermons.</td></tr>
<tr><td>CO4</td><td colspan="9">Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation.</td></tr>
<tr><td>CO5</td><td colspan="9">This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self-evolution.</td></tr>
<tr><td>Unit No.</td><td colspan="9">Content</td></tr>
<tr><td>I</td><td colspan="9">• Understanding the need, basic guidelines, content and process for Value Education
• Self-Exploration–what is it? - its content and process; ‘Natural Acceptance’ and Experiential Validation- as the mechanism for self-exploration
• Continuous Happiness and Prosperity- A look at basic Human Aspirations
• Right understanding, Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority
• Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
• Method to fulfil the above human aspirations: understanding and living in harmony at various levels.</td></tr>
<tr><td>II</td><td colspan="9">• Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’
• Understanding the needs of Self (‘I’) and ‘Body’ - Sukh and Suvidha
• Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer)
• Understanding the characteristics and activities of ‘I’ and harmony in ‘I’
• Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail
• Programs to ensure Sanyam and Swasthya-Practice Exercises and Case Studies will be taken up in Practice Sessions.</td></tr>
</table>

III	• Understanding Harmony in the family – the basic unit of human interaction • Understanding values in human-human relationship; meaning of Nyaya and program for its fulfilment to ensure Ubhay-tripti; • Trust (Vishwas) and Respect (Samman) as the foundational values of relationship • Understanding the meaning of Vishwas; Difference between intention and competence • Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship • Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals • Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj), Universal Order (Sarvabhaum Vyawastha)- from family to world family!-Practice Exercises and Case Studies will be taken up in Practice Sessions.
IV	• Understanding the harmony in the Nature • Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and self-regulation in nature • Understanding Existence as Co-existence (*Sah-astitva*) of mutually interacting unitsin all-pervasive space • Holistic perception of harmony at all levels of existence-Practice Exercises and Case Studies will be taken up in Practice Sessions.
V	• Natural acceptance of human values • Definitiveness of Ethical Human Conduct • Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order • Competence in professional ethics: ➢ Ability to utilize the professional competence for augmenting universal human order ➢ Ability to identify the scope and characteristics of people-friendly and eco- friendly production systems, ➢ Ability to identify and develop appropriate technologies and management patterns for above production systems. • Case studies of typical holistic technologies, management models and production systems • Strategy for transition from the present state to Universal Human Order: ➢ At the level of individual: as socially and ecologically responsible engineers, technologists and managers ➢ At the level of society: as mutually enriching institutions and organizations
Guidelines and Content for Practice Sessions	UNIT 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education PS 1: Introduce yourself in detail. What are the goals in your life? How do you set your goals in your life? How do you differentiate between right and wrong? What have been your achievements and shortcomings in your life? Observe and analyse them. Expected outcome: the students start exploring themselves; get comfortable to each other and to the teacher and start finding the need and relevance for the course. PS 2: Now-a-days, there is a lot of voice about many techno-genic maladies such as

energy and natural resource depletion, environmental pollution, global warming, ozone depletion, deforestation, soil degradation, etc. – all these seem to be man-made problems threatening the survival of life on Earth – What is the root cause of these maladies & what is the way out in your opinion?

On the other hand, there is rapidly growing danger because of nuclear proliferation, arms race, terrorism, criminalization of politics, large scale corruption, scams, breakdown of relationships, generation gap, depression & suicidal attempts, etc – what do you think, is the root cause of these threats to human happiness and peace – what could be the way out in your opinion?

Expected outcome: the students start finding that technical education without study of human values can generate more problems than solutions. They also start feeling that lack of understanding of human values is the root cause of all problems and the sustained solution could emerge only through understanding of human values and value based living. Any solution brought out through fear, temptation or dogma will not be sustainable.

PS 3:

1. Observe that each one of us has Natural Acceptance, based on which one can verify right or not right for him. Verify this in case of
   i) What is Naturally Acceptable to you in relationship- Feeling of respect or disrespect?
   ii) What is Naturally Acceptable to you – to nurture or to exploit others? Is your living the same as your natural acceptance or different?
2. Out of the three basic requirements for fulfilment of your aspirations- right understanding, relationship and physical facilities, observe how the problems in your family are related to each. Also observe how much time & effort you devote for each in your daily routine.

   Expected outcome:

   1. The students are able to see that verification on the basis of natural acceptance and experiential validation through living is the only way to verify right or wrong, and referring to any external source like text or instrument or any other person cannot enable them to verify with authenticity; it will only develop assumptions.
   2. The students are able to see that their practice in living is not in harmony with their natural acceptance most of the time, and all they need to do is to refer to their natural acceptance to remove this disharmony.
   3. The students are able to see that lack of right understanding leading to lack of relationship is the major cause of problems in their family and not the lack of physical facilities in most of the cases, while they have given higher priority to earning of physical facilities in their life ignoring relationships and not being aware that right understanding is the most important requirement for any human being.

UNIT 2: Understanding Harmony in the Human Being - Harmony in Myself!

PS 4: List down all your desires. Observe whether the desire is related to Self (I) or Body. If it appears to be related to both, see which part of it is related to Self (I) and which part is related to Body.

Expected outcome: the students are able to see that they can enlist their desires and the desires are not vague. Also they are able to relate their desires to 'I' and 'Body' distinctly. If any desire appears related to both, they are able to see that the feeling is related to I while the physical facility is related to the body. They are also able to see that 'I' and 'Body' are two realities, and most of their desires are related to 'I' and not body, while their efforts are mostly centered on the fulfilment of the needs of the body

assuming that it will meet the needs of 'I' too.

PS 5:

1.

a. Observe that any physical facility you use, follows the given sequence with time: Necessary & tasteful→ unnecessary & tasteful → unnecessary & tasteless →intolerable

b. In contrast, observe that any feeling in you is either naturally acceptable or not acceptable at all. If naturally acceptable, you want it continuously and if not acceptable, you do not want it any moment!

2. List down all your activities. Observe whether the activity is of 'I' or of Body or with the participation of both 'I' and Body.

3. Observe the activities within 'I'. Identify the object of your attention for different moments (over a period of say 5 to 10 minutes) and draw a line diagram connecting these points. Try to observe the link between any two nodes.

Expected outcome:

1. The students are able to see that all physical facilities they use are required for a limited time in a limited quantity. Also they are able to see that in case of feelings, they want continuity of the naturally acceptable feelings and they do not want feelings which are not naturally acceptable even for a single moment.
2. the students are able to see that activities like understanding, desire, thought and selection are the activities of 'I' only, the activities like breathing, palpitation of different parts of the body are fully the activities of the body with the acceptance of 'I' while the activities they do with their sense organs like hearing through ears, seeing through eyes, sensing through touch, tasting through tongue and smelling through nose or the activities they do with their work organs like hands, legs etc. are such activities that require the participation of both 'I' and body.
3. The students become aware of their activities of 'I' and start finding their focus of attention at different moments. Also they are able to see that most of their desires are coming from outside (through preconditioning or sensation) and are not based on their natural acceptance.

PS 6:

1. Chalk out programs to ensure that you are responsible to your body- for the nurturing, protection and right utilisation of the body.
2. Find out the plants and shrubs growing in and around your campus. Find out their use for curing different diseases.

Expected outcome: The students are able to list down activities related to proper upkeep of the body and practice them in their daily routine. They are also able to appreciate the plants wildly growing in and around the campus which can be beneficial in curing different diseases.

UNIT 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

PS 7: Form small groups in the class and in that group initiate dialogue and ask the eight questions related to trust. The eight questions are:

1a. Do I want to make myself happy?
2a. Do I want to make the other happy?
3a. Does the other want to make him happy?
4a. Does the other want to make me happy?

What is the answer?

Intention (Natural Acceptance)

1b. Am I able to make myself always happy? 2b. Am I able to make the other always happy?

3b. Is the other able to make him always happy? 4b. Is the other able to make me always happy?

What is the answer?

Competence

Let each student answer the questions for himself and everyone else. Discuss the difference between intention and competence. Observe whether you evaluate your intention& competence as well as the others' intention & competence.

Expected outcome: The students are able to see that the first four questions are related to our Natural Acceptance i.e. Intention and the next four to our Competence. They are able to note that the intention is always correct, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention as a result we conclude that I am a good person and other is a bad person.

PS 8:

1. Observe on how many occasions you are respecting your related ones (by doing the right evaluation) and on how many occasions you are disrespecting by way of under- evaluation, over-evaluation or otherwise evaluation.
2. Also observe whether your feeling of respect is based on treating the other as yourself or on differentiations based on body, physical facilities or beliefs.

Expected outcome: The students are able to see that respect is right evaluation, and only right evaluation leads to fulfilment in relationship. Many present problems in the society are an outcome of differentiation (lack of understanding of respect), like gender biasness, generation gap, caste conflicts, class struggle, dominations through power play, communal violence, clash of isms, and so on so forth. All these problems can be solved by realizing that the other is like me as he has the same natural acceptance, potential and program to ensure a happy and prosperous life for him and for others though he may have different body, physical facilities or beliefs.

PS 9:

1. Write a note in the form of story, poem, skit, essay, narration, dialogue to educate a child. Evaluate it in a group.
2. Develop three chapters to introduce 'social science- its need, scope and content' in the primary education of children

Expected outcome: The students are able to use their creativity for educating children. The students are able to see that they can play a role in providing value education for children. They are able to put in simple words the issues that are essential to understand for children and comprehensible to them. The students are able to develop an outline of holistic model for social science and compare it with the existing model.

UNIT 4: Understanding Harmony in the Nature and Existence - Whole existence as Co-existence

PS 10: List down units (things) around you. Classify them in four orders. Observe and explain the mutual fulfilment of each unit with other orders.

Expected outcome: The students are able to differentiate between the characteristics and activities of different orders and study the mutual fulfilment among them. They are also able to see that human beings are not fulfilling to other orders today and need to take appropriate steps to ensure right participation (in terms of nurturing, protection and

	right utilization) in the nature. PS 11: 1. Make a chart for the whole existence. List down different courses of studies and relate them to different units or levels in the existence. 2. Choose any one subject being taught today. Evaluate it and suggest suitable modifications to make it appropriate and holistic. Expected outcome: The students feel confident that they can understand the whole existence; nothing is a mystery in this existence. They are also able to see the interconnectedness in the nature, and point out how different courses of study relate to the different units and levels. Also they are able to make out how these courses can be made appropriate and holistic. UNIT 5: Implications of the above Holistic Understanding of Harmony at all Levels of Existence PS 12: Choose any two current problems of different kind in the society and suggest how they can be solved on the basis of natural acceptance of human values. Suggest steps you will take in present conditions. Expected outcome: The students are able to present sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them. PS 13: 1. Suggest ways in which you can use your knowledge of Technology/ Engineering/ Management for universal human order, from your family to the world family. 2. Suggest one format of humanistic constitution at the level of nation from your side. Expected outcome: The students are able to grasp the right utilization of their knowledge in their streams of Technology/Engineering/ Management to ensure mutually enriching and recyclable productions systems. PS 14: The course is going to be over now. Evaluate your state before and after the course in terms of a. Thought b. Behaviour c. Workd. Realization Do you have any plan to participate in the transition of the society after graduating from the institute? Write a brief note on it. Expected outcome: The students are able to sincerely evaluate the course and share with their friends. They are also able to suggest measures to make the course more effective and relevant. They are also able to make use of their understanding in the course for a happy and prosperous society.

TEXT BOOKS:

T1. R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2

REFERENCE:

R1. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

R2. PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.

R3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991

OTHER LEARNING RESOURCES:

1. Value Education websites, http://uhv.ac.in, http://www.uptu.ac.in
2. Story of Stuff, http://www.storyofstuff.com
3. Al Gore, An Inconvenient Truth, Paramount Classics, USA
4. Charlie Chaplin, Modern Times, United Artists, USA
5. IIT Delhi, Modern Technology – the Untold Story

RELATIONSHIP BETWEEN COURE OUTCOMES (CO) AND PROGRAM OUTCOMES

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	The methodology of this course is exploration and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.	**1, 2, 3, 4, 7**
2	It is free from any dogma or value prescriptions.	**1, 3, 4**
3	It is a process of self-investigation and self-exploration, and not of giving sermons.	**1, 2, 3**
4	Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation.	**1, 3, 5**
5	This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self-evolution.	**3, 8**

SEMESTER-II									
Course Title	**COMMUNICATION MASTERY (Communicative English & Soft Skills)**								
Course Code	**24UMPD1201R**	**Total Credits: 2** **Total Hours: 60P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**4**	**0**	**0**	**0**	**2**
Pre-Requisite	**Effective English**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Spring/II semester of First year of the Programme**								
Course Objectives	1. To familiarize students with the transformation of sentences and the appropriate use of prepositions. 2. To enhance the writing skills in different areas including CV and cover letter writing. 3. To convey meaning by reinforcing, substituting for, or contradicting verbal communication. 4. Productivity and performance boosting activities for professional goal achievement.								
CO1	Explain prepositions, tag questions, and idioms correctly.								
CO2	Discuss and analyse different sentence types and voices.								
CO3	Explain effective paragraphs, precis, and professional documents.								
CO4	Describe SWOT analysis, goal setting, and personal hygiene principles.								
CO5	Illustrate non-verbal communication and body language concepts.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Grammar:** • Use of Prepositions • Tag questions • Idioms, Phrases and Clauses • Simple, complex, compound sentences	**8**	Identify common errors and refine grammatical accuracy in communication.	**1,2**
II	**Grammar:** • Active and Passive Voice • Direct and Indirect Speech	**6**	Learn when and how to use each voice effectively to suit the context and tone.	**1,2**
III	**Writing Skills:** • The Basics of Writing; avoid ambiguity and vagueness • Paragraph Writing • Precis Writing • Letter Writing, Resume, CV and Cover Letter	**6**	Develop clarity in writing by eliminating ambiguity and vague expressions which helps to focus on precise and concise communication.	**1,2**
IV	**Self-Management Skills:** • SWOT Analysis • Self-Regulation Goal Setting, Personal Hygiene	**15**	Learn to identify personal strengths, weaknesses, opportunities, and threats for personal growth and self-improvement.	**1,2**

V	**Non- Verbal Communication-Sciences of Body Language:** • What is Non-Verbal Communication & Body Language, • Elements of Communication, • Types of Body Language, • Importance and Impact of Body Language, • Types of Communication through Body Language, • Introduction to Haptic, Introduction to Kinesics • Introduction to Proxemics, • Body Language Do's and Don'ts, • Doubt Clearing Session. **Group Discussion (Theory):** • Importance, • Planning, Elements, and Skills assessed; • Effectively disagreeing, Initiating, Summarizing and Attaining the Objective	**25**	Identify and interpret different forms of body language in personal and professional settings.	**1,2**

TEXT BOOKS:

T1. Barrett, Grant. 2016. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking, Zephyros Press.

T2. McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition).

REFERENCE BOOKS:

R1. Communication Skills Training: A Practical Guide to Improving Your Social Intelligence, Presentation and Social Speaking, Ian Tuhovsky, 2019

R2. A Textbook for AECC English Communication: Interface, Dr. Kironmoy Chetia and Pranami Bania Breez Mohan Hazarika, January 2019.

OTHER LEARNING RESOURCES:

1. https://youtu.be/x60GHpQ8gJk
2. https://youtu.be/Ke_oSN-BCaY
3. https://youtu.be/TDPDtrLxT-c
4. https://www.classcentral.com/report/toefl-preparation/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain prepositions, tag questions, and idioms correctly.	**5**
2	Discuss and analyse different sentence types and voices.	**2, 5**
3	Explain effective paragraphs, precis, and professional documents.	**3, 5**
4	Describe SWOT analysis, goal setting, and personal hygiene principles.	**5**
5	Illustrate non-verbal communication and body language concepts.	**5**

SEMESTER-III									
Course Title	**Techno-Professional Skills II (Bio fertilizer production)**								
Course Code	**24MSMB2101R**	**Total Credits: 2** **Total Hours: 60P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**4**	**0**	**0**	**0**	**2**
Pre-Requisite	General Microbiology, Biochemistry	**Co-Requisite**	**NA**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ 3rd Semester of 2nd year of the Programme**								
Course Objectives	1. Appreciate the agronomic importance of beneficial micro-organisms 2. Formulate, produce and apply Bio fertilizers in a pilot scale 3. To provide knowledge on the various methods of bio fertilizer production, such as liquid culture, solid-state fermentation, and carrier-based formulations								
CO1	Explain the Importance of bio fertilizers in plant development.								
CO2	Describe mass cultivation and inoculation.								
CO3	Explain the importance of Azolla as a bio fertilizers.								
CO4	Describe the importance of phosphate in bio fertilizers.								
CO5	Apply the knowledge on the use of Fungi and Mycorrhiza.								

Unit No	Content	Contact Hour	Learning Outcome	KL
I	Biofertilizers - Introduction, scope. A general account of plant growth promoters and regulators – Cyanobacterial Biofertilizer: Algalization – mass cultivation of cyanobacterial biofertilizers	10	Importance of bio fertilizers in plant development	1,2
II	Nitrogen fixing Bacteria: Isolation, characterization, identification, mass cultivation and inoculation method of Rhizobium and Azospirillum. Mechanism of nitrogen fixation (free-living and symbiotic) - Biochemistry and molecular basis of nitrogen fixation.	15	Knowledge about mass cultivation and inoculation.	1,2
III	Azolla – Structure and Morphology – Mass cultivation method and Application. Economic and Ecological importance of Azolla.	10	Importance of Azolla	1,2
IV	Phosphate solubilizing Bacteria: Isolation, characterization, identification, mass cultivation and inoculation method of Phosphobacteria. Biochemistry of Phosphate solubilization and mobilization. Carrier based inoculum production methods and Field application References	15	Importance of phosphate in bio fertilizers	1,2
V	Mycorrhizal fungi as biofertilizers - Introduction, scope. A general account of Ecto, Endo and Arbuscular mycorrhizae (AM). Isolation and method of inoculation of Arbuscular mycorrhizae (AM), Legume - AM interactions	10	Importance of Fungi, Mycorrhiza	1,2

TEXT BOOKS:

T1: A text book of microbiology, second reprint. S. Chand and Company Ltd., New Delhi. Ann Larkin Hansen, 2010.

REFERENCE BOOKS:

R1. Kannaiyan, S. 2002 Biotechnology of Bio fertilizers. Narosa publishing house, New Delhi. Dubey, R.C. 2001.

R2. Dubey, R. C. 2008. A Textbook of Biotechnology. S. Chand & Co., New Delhi.

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the Importance of bio fertilizers in plant development.	**1, 2, 9**
2	Describe mass cultivation and inoculation.	**1, 2, 3**
3	Explain the importance of Azolla as a bio fertilizers.	**1, 2, 9**
4	Describe the importance of phosphate in bio fertilizers.	**1, 2, 9**
5	Apply the knowledge on the use of Fungi and Mycorrhiza.	**1, 9**

SEMESTER-III									
Course Title	**Generic Elective - Public Health And Hygiene**								
Course Code	**24MSMB2102R**	**Total Credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 30	**2**	**0**	**0**	**0**	**0**	**0**	**2**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ I semester of first year of the Programme**								
Course Objectives	1. To understand the concepts, significance and relevance of public health and hygiene. 2. To understand the health hazards as associated with public health and hygiene.								
CO1	Explain the concepts of public health, evaluate India's health systems and policies, and assess the impact of nutrition, environment, and mental health on public well-being								
CO2	Analyse environmental health hazards, assess pollution impacts, and understand the importance of hygiene, waste management, and food safety.								
CO3	Describe key hygiene concepts across personal, medical, food, and industrial settings.								
CO4	Identify and understand the causes, prevention, and control measures of lifestyle-related non-communicable and communicable diseases.								
CO5	Analyse social health issues in India and evaluate the role of health education and programs in promoting dead diction and eco-friendly practices.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	INTRODUCTION Concept of Public Health Goals and Objectives of Public health and Hygiene, Public health system in India and in the rest of world HEALTH ASPECTS Introduction to National Health Policy - National Rural Health Mission (NRHM) and National Urban Health Mission (NUHM) Nutrition and health, Environmental health-sanitation, air, water pollution, Mental health	**7**	Knowledge about the Concepts, Goals, and Objectives of Public Health and Hygiene. NRHU and NUHM	1, 2
II	ENVIRONMENT AND HEALTH HAZARDS: Environmental degradation and Pollution: Sources, Impacts of wastes and treatment methods Environment & Health Relation Assessment - Concept, Steps and application, Personal and mental hygiene, Health destroying habits and addictions Need of Water Purification Adulteration of Food Undesirable Changes in Air, Radiation effects, e- waste, Solid waste and Excreta disposal	**5**	Knowledge on Environmental Pollution, degradation, Hygiene and Food adulteration	1, 2, 3
III	HYGIENE CONCEPTS Personal Hygiene Medical Hygiene Food Hygiene Industrial Hygiene	**5**	Knowledge on hygiene (personal, Medical, food and industrial)	1, 2
IV	LIFE STYLE RELATED NON-COMMUNI-CABLE DISEASES Hypertension Coronary Heart Diseases Stroke Diabetes Mellitus Obesity COMMUNICABLE DISEASESAND THEIR CONTROL MEASURES: Air Borne Disease : Tuberculosis, Influenza	**8**	Theoretical and practical knowledge on communicable and non-communicable diseases	1, 2, 3

	Food and water Borne Disease : Amoebiasis, Jaundice Vector Borne Disease : Malaria, Dengue Contact Disease : Venereal disease and AIDS			
V	SOCIAL HEALTH PROBLEMS AND HEALTHEDUCATION IN INDIA: Smoking, Alcoholism, Drug Dependence and Their Dead diction. Eco-Friendly Environmental Practices, Effects of drug abuse, WHO programmes Government and voluntary Organizations – vaccination and awareness programme, First Aid	**5**	Knowledge on Indian Health Education and Social health problems	1, 2, 3

TEXT BOOKS:

T1. Introduction to Public Health, Raymond L. Goldsteen, Karen Goldsteen, David G. Graham, 2011, Springer publishing company

T2. Introduction to Community Health Nursing, Kasturi Sundar Rao, 4th edition, Bi Publications Pvt Ltd

T3. Concepts of Epidemiology, Raj S Bhopal, 2002, Oxford University press

T4. A Treatise n Hygiene And Public Health, Birendra Nath Ghosh, 9th edition, Calcutta Scientific Publishing Co

REFERENCE BOOKS:

R1.Park and Park, 1995: Text book of preventive and social medicine – Banarsidas Bhanot Publ. jodhpur-India

R2.Verma, S. 1998: Medical zoology, Rastogi Publ.- Meerut- India

R3.Jatin V. Modi and Renjith S. Chawan. Essentials of Public Health and Sanitation –Part I- IV

R4.Murray, C. J. L. and A.D. Lopez. (1996), The Global Burden of Disease. World Health Organization.

R5.Park, J.E. and Park, K. Textbook of Community Health for Nurses.

OTHER LEARNING RESOURCES:

1. https://www.cdcfoundation.org/what-public-health

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the concepts of public health, evaluate India's health systems and policies, and assess the impact of nutrition, environment, and mental health on public well-being	**1, 2, 4, 7**
2	Analyse environmental health hazards, assess pollution impacts, and understand the importance of hygiene, waste management, and food safety.	**1, 2, 4, 7, 8**
3	Describe key hygiene concepts across personal, medical, food, and industrial settings.	**1, 5, 7**
4	Identify and understand the causes, prevention, and control measures of lifestyle-related non-communicable and communicable diseases.	**1, 2, 4, 5, 7**
5	Analyse social health issues in India and evaluate the role of health education and programs in promoting dead diction and eco-friendly practices.	**1, 2, 4, 7**

SEMESTER-III									
Course Title	**Research Ethics**								
Course Code	**24UMRE2101R**	**Total Credits:1**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours:15	**1**	**0**	**0**	**0**	**0**	**0**	**1**
Pre-Requisite	**NA**	**Co-Requisite**	**NA**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ 3rd Semester of 2nd year of the program**								
Course Objectives	1. To instill a sense of integrity in data collection, analysis, and reporting, and to emphasize the need for honesty, transparency, and accountability in research practices. 2. To address issues related to authorship, publication ethics, peer review, and the importance of avoiding research misconduct like data fabrication, falsification, and plagiarism. 3. To develop critical thinking and ethical decision-making skills to navigate complex research scenarios, balancing scientific progress with respect for ethical norms.								
CO1	Describe and apply research ethics theories and methods.								
CO2	Explain research ethics issues such as responsibility, vetting, and misconduct.								
CO3	Illustrate arguments and results in ethical research inquiries.								
CO4	Identify and apply procedures for sampling, data collection, and reporting.								
CO5	Apply ethical principles to research design and evaluation								

Unit No.	Content	Contact Hours	Learning Outcome	KL
I	**ETHICS:** Introduction to the course and each other; an introduction to moral theory. Ethics: definition, moral philosophy, nature of moral judgements and reactions. Research regulation; self – regulation; research ethics. Honesty, candor, compromise and integrity. Data ownership and stewardship; conflicts of interest; collaboration. Human and Non-Human subjects. Research and researchers in society.	**3**	Understand and apply key ethical principles and moral theories in research contexts, critically evaluate issues related to research ethics.	**1,2**
II	**SCIENTIFIC CONDUCT-** Ethics with respect to science and research. Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data.	**2**	Understand and apply ethical principles related to scientific conduct, demonstrate intellectual honesty and research integrity, recognize and prevent scientific misconduct	**1,2**

III	**PUBLICATION ETHICS-** Publication ethics: definition, introduction and importance. Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.	**3**	Understand the importance of publication ethics, recognize best practices and standards	**1,2**
IV	**OPEN ACCESS PUBLISHING** Open access publications and initiatives**.** SHERPA/RoME0 online resource to check publisher copyright & self-archiving policies. Software tool to identify predatory publications developed by SPPU**.** Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.	**3**	Understand the concept and significance of open access publishing	**1,2**
V	**PUBLICATION MISCONDUCT** Group Discussions; Subject specific ethical issues, FFP, authorship. Conflicts of interest. Complaints and appeals: examples and fraud from India and abroad. Software tools; Use of plagiarism software like Turnitin, Urkund and other open source software tools. **DATABASES AND RESEARCH METRICS–** Databases: Indexing databases. Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, and Cite Score. Metrics: h-index, g index, I 10 index, altmetrics.	**4**	Gain proficiency in navigating indexing and citation databases	**1,2**

TEXT BOOKS:

T1. Bird, A (2006).Philosophy of Science Routledge.
T2. Maclntyre, Alasdair (1967) A Short History of Ethics London.
T3. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019)

REFERENCE BOOKS:

R1. National Academy of Science, National Academy of Engineering and Institute of Medicine (2009). On Being a Scientist: A Guide of Responsible Conduct in Research: Third Edition, National academics Press.
R2. George R, (2011). Sociological Theory, Rawat Publication, New Delhi, India.
R3. George R, (2019). Post Modern Social Theory, Rawat Publication, New Delhi, India.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe and apply research ethics theories and methods.	**6**
2	Explain research ethics issues such as responsibility, vetting, and misconduct.	**6**
3	Illustrate arguments and results in ethical research inquiries.	**5, 6**
4	Identify and apply procedures for sampling, data collection, and reporting.	**2, 3, 4**
5	Apply ethical principles to research design and evaluation	**4, 9**

SEMESTER – III									
Course Title	**MINI RESEARCH (SURVEY/EXPERIMENTS-R3)**								
Course Code	**24MSMB2103R**	**Total Credits: 2** **Total Hours: 120 (P+S)**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**6**	**4**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course Objectives	1. To learn the principles of designing effective surveys, including question formulation and sampling techniques. 2. To gain hands-on experience in designing and conducting research experiments to test hypotheses. 3. Develop skills to present research findings clearly and concisely through oral presentations or visual aids like posters and slides.								
CO1	Formulate research methodology								
CO2	Prepare research tool(s)								
CO3	Apply the knowledge of sampling methods in sample collection.								
CO4	Design experiment using scientific method								
CO5	Investigate the research Problem								

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Formulate research methodology	**1, 2, 4, 6, 7**
2	Prepare research tool(s)	**1, 3, 4**
3	Apply the knowledge of sampling methods in sample collection.	**1, 2, 3, 4**
4	Design experiment using scientific method	**1, 2, 3, 4, 6**
5	Investigate the research Problem	**1, 2, 3, 4, 7, 9**

SEMESTER-III									
Course Title	**CORPORATE COMPETENCY**								
Course Code	**24UMPD2101R**	**Total Credits: 2**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 60P	**0**	**0**	**4**	**0**	**0**	**0**	**2**
Pre-Requisite	**Communication Mastery**	**Co-Requisite**	**NA**						
Programmes	**Master of Science in Microbiology**								
Semester	**Fall/ 3rd Semester of 2nd year of the Programme**								
Course Objectives	1. To acquaint students with the various tools of an effective presentation. 2. To acquire the speaking skill instruct, influence, engage, educate, or appease the listeners. 3. To increase proficiency, present ability and quality of resume and provide guidance for self- promotion and self-evaluation in social media. 4. To prepare and train the students for the campus drives & walking interviews.								
CO1	Able to speak with greater control and charisma in front of others.								
CO3	Discuss the positive impact in their thought process and problem-solving skills.								
CO3	Illustrate with all the necessary tools and skill sets to prepare professional resume.								
CO4	Discuss the highlights and assess themselves in social media.								
CO5	Explain the impart in them techniques to solve critical problems in an interview, develop strategies to crack interviews, improve their communication skills, boost their confidence								

Unit No	Content	Contact Hour	Learning Outcome	KL
I	**Presentation Skills:** • Essential characteristics of a good presentation • Preparation of a good presentation	**4**	Understand the importance of presentation skills in personal and professional contexts. It also helps to recognize key elements that make a presentation effective, such as clarity, engagement, and structure.	**1,2**
II	**Public Skills:** • Fear of Public Speaking, • Understanding and Overcoming Fear of Public Speaking, • Confidence and Control, • Physiology and Stress - Control/ Process, • Tips for Presentations and Public Speaking, • Tips for Using Visual Aids in Presentations, • Process for Preparing and Creating Presentations, • Delivering Presentations Successfully, • Doubt Clearing and Summary of Main Points	**20**	Learn psychological and practical strategies to manage and reduce speaking anxiety	**1,2**

III	**Practical session on Resume, Curriculum Vitae, Writing cover letter & LinkedIn Profile:** • Preparation, submission & screening of Resume. • Practical session on cover letter screening session • Creating a profile on LinkedIn • How to utilize it **Leadership & Management Skills :** • Concepts of Leadership, • Leadership Styles, • Manager VS Leader, • How to be an Effective Leader, • Mock/ Practice Session, • Doubt Clearing Session.	**10**	Gain expertise in drafting impactful cover letters and learn to create tailored resumes that highlight relevant skills and achievements.	**1,2**
IV	**Research Paper – Writing Skills:** How to write a research paper Key point in Research Work **Interview Skills & Dress code Ethics:** • Types of the interview- telephonic, virtual & face to face • Online interview, personal interview, • Panel interview, • Group interview, • JAM session, • Types of interview questions- traditional/common interview questions, • Case interview questions, • General Strategies for answering questions, • Marketing your skills and experiences, • Preparation before the interview, • How to dress up for an interview, • How to maintain eye contact and positive body language, • How to be presentable, • Interview dos and don'ts, • Introduction to Dress Code Ethics, • Purpose and Importance • How to Make "FIRST IMPRESSION" • What to Wear During Interviews or Any Other Formal Meetings – Male & Female	**20**	Understand the fundamental principles and importance of leadership in various contexts.	**1,2**
V	**Mock Interview:** • Practical Mock Interview, • Feedback- Receiving Feedback, • Giving Feedback, • Advantages of Effective Feedback, • How to deal with negative feedback.	**6**	Identify critical aspects of conducting research, including hypothesis formation and data analysis.	**1,2**

TEXT BOOKS:

T1. Barrett, Grant.2016.Perfect English Grammar: The Indispensible Guide to Excellent Writing and Speaking, Zephyros Press.

T2. McDowell, Gayle Laakmann. 2008. Cracking the Coding Interview (Indian Edition).

REFERENCE BOOKS:

R1. Garg. Manoj Kr. (2018) English Communication: Theory and Practice

OTHER LEARNING RESOURCES:

1. https://brightlinkprep.com/10-best-toefl-prep-books/

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Able to speak with greater control and charisma in front of others.	**5**
2	Discuss the positive impact in their thought process and problem-solving skills.	**2**
3	Illustrate with all the necessary tools and skill sets to prepare professional resume.	**5**
4	Discuss the highlights and assess themselves in social media.	**5**
5	Explain the impart in them techniques to solve critical problems in an interview, develop strategies to crack interviews, improve their communication skills, boost their confidence	**5, 6, 8**

	SEMESTER-III								
Course Title	**PERSONAL FINANCIAL PLANNING**								
Course Code	**24UUFL2102R**	**Total Credits:1** **Total Hours:30P**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
			0	**0**	**2**	**0**	**0**	**0**	**1**
Pre- Requisite	**Introduction to Financial Budgeting And Planning**	**Co-Requisite**	**Nil**						
Programmes	**Master of Science in Microbiology**								
Semester	**Fall/ 3rd Semester of 2nd year of the Programme**								
Course Objectives	1. The course would offer an inclusive approach to understand the relevant concepts of money, borrowing, lending, taxes and their application to financial planning. 2. Assess the personal financial planning process, the life cycle of financial plans, and methods of goal achievement. 3. Formulate a budget, record-keeping system, and tax planning strategy based on current financial goals.								
CO1	Explain the cash management and buying plan for homes or automobiles.								
CO2	Discuss a diversified investment portfolio for different objectives.								
CO3	Compare mutual funds, ETFs, and real estate investment options.								
CO4	Develop a financial plan for retirement and estate protection.								
CO5	Describe financial products and strategies for long-term goals								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Unit 1- Fundamentals of Financial Planning –** Functions of money; Inflation-Meaning, causes, how it can be controlled; process official planning, Time value of money-simple and compound interest; Net Present Value and Future value, .Power of Compounding; Doubling period and Rule of 72.	**6**	Students will be able to comprehend the fundamentals of financial planning.	**2,3**
II	**Unit 2- Income Tax Planning**– Meaning of Income, Direct & Indirect Taxes, Taxable Income, various heads of Income for tax Calculation, Non-taxable Income, Tax evasion and tax avoidance, GST, Tax Planning Strategies.	**6**	Students will be able to understand and utilise the basic aspects of income tax and GST.	**1,2**
III	**Unit 3- Entrepreneurial planning** – Meaning of Entrepreneurship, prerequisites for becoming an entrepreneur, Entrepreneurship Support Systems in India, Institutional support systems for entrepreneurs, Financial support systems for	**6**	Students will be able to understand the concept, scope and prerequisites of entrepreneurship	**1,2**

	entrepreneurs; Venture Capital, Business Angels, Assistant of Government, Commercial Bank Loans and Overdraft.			
IV	**Unit 4- Planning for investing in securities market –** Investment avenues offered by Securities Markets, Primary Market and Secondary Market, Stock market-meaning, features, functions of NSE, BSE DEMAT trading account, Security repository, stockbrokers, Operational aspects of securities markets: placement of orders, contract note, pay-in and pay out, trading and settlement cycle, Various risks involved in investing in securities markets; Role of Financial Intermediaries; Stock indices. Mutual Funds- meaning concept, definition, types, importance and drawbacks of mutual funds, mutual funds in India, investing in mutual funds, Systematic Investment Plan (SIP) and its advantages.	**6**	Students will be able to analyse and interpret the different dimensions of stock market investment.	**3,4**
V	**Unit 5- Planning for debts and Retirement** Consumer credit - Introduction to consumer credit; choosing a source of credit, the cost of credit alternatives, Consumer Legal Protection; Housing Decision: Factors and Finance; Vehicle Decisions. Retirement planning - Meaning of cost of living; retirement need analysis; development of retirement plan, various retirement schemes, Estate Planning; Pension and Medicare Planning; Wills.	**6**	Students will be able to evaluate the aspects of retirement planning to formulate effective strategic financial plans.	1,2, 3

TEXT BOOKS:

T1. Sinha Pradeep K. and Priti Sinha. Computer Fundamentals: Concepts Systems &The Million-Dollar Financial Advisor: Powerful Lessons and Proven Strategies from Top Producers by David J. Mullen Jr

T2. Personal Finance and Planning by Dr.Rajni

T3. Peaceful Personal Finance: A Short Read on the Basics of Personal Finance and Planning Kindle Edition by Hema Singh

T4. Be Your Own Financial Advisor: Financial Planning, Investment Options, Risk Management, Tax Management, Succession Planning Kindle Edition y Sushil Bali

T5. The Dumb Things Smart People Do with Their Money: Thirteen Ways to Right Your Financial Wrongs Kindle Edition y Jill Schlesinger

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the cash management and buying plan for homes or automobiles.	**5**
2	Discuss a diversified investment portfolio for different objectives.	**9**
3	Compare mutual funds, ETFs, and real estate investment options.	**2, 5, 9**
4	Develop a financial plan for retirement and estate protection.	**9**
5	Describe financial products and strategies for long-term goals	**5**

SEMESTER-III									
Course Title	**Medical Microbiology**								
Course Code	**24MSMB2104R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 46T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ III semester of first year of the Programme**								
Course Objectives	1. To familiarize the students about the different diseases caused by bacteria & viruses, fungi and parasites and prevention and control measures of the diseases. 2. Explore the mechanisms by which microorganisms cause disease, including virulence factors, modes of transmission, and host-pathogen interactions. 3. To teach different diagnostic tests to identify the causative organisms								
CO1	Explain the normal flora of the human body, virulence factors of pathogens, epidemiology of infection, and host-pathogen interaction.								
CO2	Describe the general characteristics, biochemical traits, virulence factors, pathogenicity, clinical manifestations, laboratory diagnosis, prophylaxis, and treatment of various pathogenic bacteria.								
CO3	Describe the general properties, antigenicity, pathogenicity, laboratory diagnosis, treatment, and prophylaxis of various viruses.								
CO4	Characterize fungi with respect to epidemiology, pathogenesis, clinical features, laboratory diagnosis, and treatment of various fungal infections								
CO5	Summarize different types of parasites, their life cycle, pathogenesis and diagnosis.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Normal flora** - Skin, mouth, upper respiratory tract, intestinal tract, urogenital tract, eye. Transient flora. Infection process and Virulence factors of pathogenic bacteria –toxins, enzymes, capsular polysaccharides. Host pathogen interaction.	**6**	Understand the normal flora of different body sites. Learn the infection process and virulence factors of pathogenic bacteria. Explore host-pathogen interactions.	1,2,3
II	General characteristics, biochemical characteristics, virulence factors, pathogenicity, clinical manifestations, lab diagnosis, prophylaxis and treatment of Staphylococcus aureus, Streptococcus, Corynebacterium diphtheria, Bacillus, Clostridium, Vibrio cholera, E. coli, Salmonella spp, Shigella spp, Pseudomonas, Mycobacterium spp, Spirochaete, Mycoplasma, Rickettsiae, Chlamydiae, Listeria, Campylobacter, Helicobacter.	**10**	Understand the general characteristics, biochemical traits, virulence factors of bacterial pathogens. Analyze the pathogenicity, clinical manifestations, lab diagnosis, prophylaxis, and treatment of bacterial pathogens. Apply the knowledge for disease prevention and management	1,2,3,4

III	General properties, antigenicity, pathogenicity, laboratory diagnosis, treatment and prophylaxis of – Adenoviruses, Herpes viruses, Pox viruses, Hepatitis viruses, Oncogenic viruses, Polioviruses, Reoviruses, rotaviruses, arboviruses (togavirus and flavivirus, encephalitis, yellow fever, dengue). Influenza viruses, Mumps, Measles, Rubella, Rabies virus, HIV, Emerging and remerging viral diseases- Ebola, SARS, Corona, Chikungunya.	**10**	Analyse and evaluate the general properties, antigenicity, pathogenicity, laboratory diagnosis, treatment, and prophylaxis of various viruses. Examine emerging and re-emerging viral diseases, including Ebola, SARS, Corona, Chikungunya**,** and assess their impact on public health and control measures.	1,2,3,4,5
IV	Mycology, immunity, epidemiology, pathogenesis, clinical features, laboratory diagnosis and treatment of: Superficial cutaneous Mycoses- Dermatophytoses, Tinea nigra, Malassezia infection, Piedra Subcutaneous Mycoses - Mycetoma, Sporotrichosis, lobomycosis. Systemic Mycoses - Histoplasmosis, Blastomycosis, Coccidioidomycosis, paracoccidioidomycosis Opportunistic Mycoses -Candidiasis, Cryptococcosis, Aspergillosis, Zygomycosis Fungal toxins - Aflatoxins- Definition, major types of aflatoxins, symptoms and pathogenesis	**10**	Understand and Evaluate the mycology, immunity, epidemiology, pathogenesis, clinical features, laboratory diagnosis, and treatment of various mycoses. Understand fungal toxins, including aflatoxins—its definition, major types, symptoms, and pathogenesis.	1,2,3,4,5
V	Protozoology - Introduction toprotozoa, Amoebae – Entamoeba histolytica, Flagellates-Giardialamblia, Leishmania donovani.Sporozoa - Malarial parasites, Toxoplasma gondii, Blastocystishominis. Helminthology - Cestodes ortapeworms- Taenia saginata, Tinea solium, Trematodes or flukes- Fasciola hepatica, Fasciolopsis buski.Nematodes- Ascaris lumbricoides, Wuchereria bancrofti.	**10**	Gain knowledge on the fundamental concepts of protozoology and helminthology Understand the classification, biology, and medical significance of various protozoa and helminths.Top of Form Bottom of Form	1,2,3,4,5
Practical	1. Study of different Biochemical tests – Indole, methyl red, voges proskeaur, citrate, Catalase, coagulase, oxidase, Mannitol motility test, hydrogen sulphide production, urease test, gelatin liquefaction test, fermentation of carbohydrates, triple sugar iron	**30**	Perform and interpret various biochemical tests, Assess antibiotic sensitivity using the Kirby-Bauer method and broth dilution method. Apply and analyze different	1,2,3,4,5,6

	test, casein hydrolysis test. 2. Antibiotic sensitivity by Kirby-Bauer method 3. Antibiotic sensitivity by broth dilution method 4. Staining technique – Gram's, Acid fast, Capsular, Endospore, Flagellar, Metachromatic granular staining 5. Isolation of normal flora from skin, nail scrapings, nose, throat, oral cavity and ear 6. Fungal mounting by lacto phenol cotton blue and KOH 7. Leishman staining, Giemsa staining		staining techniques Isolate and identify normal flora from skin, nail scrapings, nose, throat, oral cavity, and ear samples. Use lacto phenol cotton blue and KOH for fungal mounting and identification Perform Leishman and Giemsa staining	

TEXT BOOKS:

T1. The Medical Microbiology by David Green Wood Richard slack & John Peuthrer. Churchill Livingston Company.
T2. Medical Microbiology by Jawelz, Melnick, Geo R.Brokes Me Graw-Hill Company.
T3. Medical Microbiology by Anantanarayan & Panekar, Orient Longman Limited.
T4. Textbook Virology by Rhodes & Van Royen
T5. Practical Microbiology by C.P. Baweja

REFERENCE BOOKS:

R1. Bacterial Diseases by Wilson & Topley. Medical Microbiology by Cruckshank- Vol.I&Vol.II.
R2. General Virology by Luria & Parnel Virology by Dimmock.

OTHER LEARNING RESOURCES:

1. **https://microbenotes.com/**
2. **https://www.youtube.com/**

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the normal flora of the human body, virulence factors of pathogens, epidemiology of infection, and host-pathogen interaction.	**1, 2, 4**
2	Describe the general characteristics, biochemical traits, virulence factors, pathogenicity, clinical manifestations, laboratory diagnosis, prophylaxis, and treatment of various pathogenic bacteria.	**1, 2, 3, 4, 9**
3	Describe the general properties, antigenicity, pathogenicity, laboratory diagnosis, treatment, and prophylaxis of various viruses.	**1, 2, 3, 4, 9**
4	Characterise fungi with respect to epidemiology, pathogenesis, clinical features, laboratory diagnosis, and treatment of various fungal infections	**1, 2, 3, 4, 9**
5	Summarize different types of parasites, their life cycle, pathogenesis, and diagnosis.	**1, 2, 3, 4, 9**

SEMESTER-III									
Course Title	**Microbial Ecology and Environmental Microbiology**								
Course code	**24MSMB2105R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ III semester of first year of the Programme**								
Course Objectives	1. To understand the role of microorganisms as agents of environmental change. 2. To recognize microorganisms as indicators of alteration of an ecosystem. 3. To understand microbial processes aimed to solve environmental problems.								
CO1	Discuss various ecosystems and inhabiting microbial diversity with special reference to ecological niches, limiting factors, ecological pyramid, energy flow, trophic levels, etc.								
CO2	Asses the microbial diversity in aquatic ecosystems, wastewater treatment techniques, and microbial water quality.								
CO3	Establish the role of microorganisms in soil fertility with reference to biological nitrogen fixation through leguminous plants and genes involved in nitrogen fixation.								
CO4	Describe microbial Bioremediation and their role in the degradation of environmental pollutants.								
CO5	Illustrate microbial interactions and various biogeochemical cycles								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Microbial Ecology:** Interaction between abiotic and biotic factors in an ecosystem, ecological niche, limiting factor, concept of community, fluctuation and succession. Ecological pyramid, energy flow, food chain, food webs and their dynamism, stability and complexity of ecosystem. Interactions Between microbes and organisms at other trophic levels: commensalism, mutualism, parasitism and predation with examples **Diversity of microbes**: Microbial communities in terrestrial (agricultural and desert soil), aquatic (fresh water and marine water) and animal (cattle, termite and human being), in extreme environments – thermophiles, psychrophiles, barophiles, acidophiles, alkaliphiles and halophiles, Role of decomposers, Microbiology of air, enumeration of air microflora.	**15**	Analyse microbial ecology by understanding interactions between abiotic and biotic factors in ecosystems, ecological niches, limiting factors, community concepts, fluctuation, and succession. Explore ecological pyramids, energy flow, food chains, food webs, and ecosystem dynamics, stability, and complexity. Examine microbial interactions at various trophic levels. Study the role of decomposers, air microbiology, and the enumeration of air microflora.	1,2,3,4

II	**Aquatic Microbiology:** The aquatic environment – major environmental conditions influencing microflora. Distribution of microorganisms in the aquatic environments - freshwater environment, estuaries and marine environment. Microbiology of drinking water, water pollution, purification of water for human consumption. Assessment of microbial status in water and waste water. Wastewater characteristics, Effluent treatment processes (like trickling filter, activated sludge, oxidative pond, anaerobic digestion and chemical disinfection), Bacterial indicators – DO, BOD, COD, water purification	**10**	Understand the impact of major environmental conditions on microflora in aquatic environments. Explore the distribution of microorganisms in freshwater, estuaries, and marine environments. Study the microbiology of drinking water, including water pollution and purification methods for human consumption. Assess the microbial status in water and wastewater. Understand wastewater treatment process. Evaluate bacterial indicators such as Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) in water purification.	1,2,3,4,5
III	**Soil Microbiology:** Soil microbes and soil fertility, Nitrogen fixation: Biochemistry of Nitrogen fixation - mechanism of nitrogenase -hydrogenase - Assay of nitrogen fixation -physiology of legume root nodule, leghemoglobin - Synthesis, Genes involved in nitrogen fixation	**7**	Understand the role of soil microbes in soil fertility and nitrogen fixation. Learn the biochemistry and mechanisms of nitrogenise and hydrogenase, assay methods for nitrogen fixation, and the physiology and genetics of legume root nodules and leghaemoglobin.	1,2,3,4,5
IV	**Bioremediation** – Factors affecting the bioremediation process, Bioremediation of toxic waste sites; Bioremediation practices and technologies; Bioleaching of copper, gold uranium Role of microbes; Microbial degradation of environmental pollutants- industrial solvents, pesticides, petroleum hydrocarbons, xenobiotic; Bio deterioration – paper, textile, wood, metal, Corrosion – methods of protection Bio magnification	**8**	Understand bioremediation. Study the bioremediation of toxic waste sites and the role of microbes in bioleaching copper, gold, and uranium. Learn about microbial degradation of environmental pollutants. Explore bio deterioration of materials like paper, textile, wood, and metal, methods for corrosion protection, and the concept of bio magnification.	1,2,3,4,5

V	**Microbial interaction**: Competition, ammensalism, parasitism, mutualism, commensalism, synergism, Biogeo-chemical cycles – Carbon, Nitrogen, Phosphorus, Sulphur.	**5**	Understand microbial interactions. Explore the roles of microbes in biogeochemical cycles of carbon, nitrogen, phosphorus, and sulphur.	1,2,3,4,5
Practical	1. Isolation of air microbes by gravity settle method 2. Measurement of Ph 3. Measurement of temperature 4. Measurement of acidity and alkalinity 5. Determination of DO 6. Determination of BOD 7. Determination of COD 8. Preparation of biofilms 9. Bacteriological examination of water 10. Isolation of microorganisms from soil and their application	**30**	Proficiency in various environmental microbiolo-gical experiments. Determine DO, BOD, COD Learn techniques for preparing biofilms. Conduct bacteriological examination of water. Isolate microorganisms from soil and explore their applications.	1,2,3,4,5,6

TEXT BOOKS:

T1. Environmental Microbiology by Eugene L Madsen
T2. Environmental Microbiology, Blackwell Synergy, Blackwell publishing
T3. Environmental Microbiology by P D Sharma, Alpha Science publishing
T4. Environmental Microbiology by Alan and Malcolm

REFERENCE BOOKS:

R1. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company
R2. Prescott, Harley and Klein's Microbiology.
R3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Discuss various ecosystems and inhabiting microbial diversity with special reference to ecological niches, limiting factors, ecological pyramid, energy flow, trophic levels, etc.	**1, 2, 4, 8**
2	Asses the microbial diversity in aquatic ecosystems, wastewater treatment techniques, and microbial water quality.	**1, 2, 3, 4, 8**
3	Establish the role of microorganisms in soil fertility with reference to biological nitrogen fixation through leguminous plants and genes involved in nitrogen fixation.	**1, 2, 4, 8, 9**
4	Describe microbial Bioremediation and their role in the degradation of environmental pollutants.	**1, 2, 4, 8, 9**
5	Illustrate microbial interactions and various biogeochemical cycles	**1, 2, 4, 8**

SEMESTER-III									
Course Title	**Soil and Agricultural Microbiology**								
Course Code	**24MSMB2106R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ III semester of first year of the Programme**								
Course Objectives	1. To familiarize the students about the different types of soil and soil profile. 2. To teach about the different types of microorganisms found in soil and their application in improvement of soil fertility. 3. Understand microbial involvement in biogeochemical cycles, such as the nitrogen, carbon, phosphorus, and sulfur cycles, and their importance in soil fertility.								
CO1	Describe soil profiles and dynamics of positive and negative interactions between microbes and plants.								
CO2	Explain the nitrogen cycle, the role of genes and enzymes in nitrogen metabolism								
CO3	Discuss the principles and applications of bio fertilizers, bio pesticides, and plant gene modification.								
CO4	Analyze host-parasite interactions, and the role of R and r genes in disease development in plants.								
CO5	Identify post-harvest diseases to implement effective control measures.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Soil profile, types of microorganisms found in soil and plant surfaces Microbe plant interaction –positive interaction and types, Negative interaction and types, role of siderophores	**7**	Understand the soil profile and identify the types of microorganisms found in soil and plant surfaces. Explore microbe-plant interactions. Study the role of siderophores in these interactions.	1,2,3,4
II	Nitrogen cycle, Symbiotic and Non symbiotic Nitrogen Fixation, Nitrogenase enzyme and nif genes	**7**	Comprehend the nitrogen cycle, focusing on symbiotic and non-symbiotic nitrogen fixation. Understand the role of the nitrogenase enzyme and the function of nif genes in these processes.	1,2,3,4
III	**Bio fertilizers** –types (free livin soil microbes fixing N2 (Azotobacter, Azospirillum), Rhizobium, Azorhizobium, Bradyrhizobiumin symbiotic association with leguminous plants. Free living cyanobacteria- Nostoc, Anabaena. Associative cyanobacteria (symbionts)- Anabaena azollae, Azollaas Biofertilizer) Biopesticides and types (Bacteria- *Bacillus thuringiensis*, Bt based commercial products, *Beauveria*	**15**	Understand the types and functions of bio fertilizers Learn about bio pesticides Explore plant transformation techniques, focusing on the importance of Ti plasmid and Agrobacterium-mediated gene transfer.	1,2,3,4,5

	bassiana, Trichoderma, Baculoviruses for insect pest control -Nuclear polyhedrosis virus) Plant transformation- Ti plasmid and its importance, Agrobacterium mediated gene transfer			
IV	**Host parasite interaction**, production of phytoalexins, involvement of elicitors, role of R and r genes in disease development, Plant disease –bacterial – blight of rice, citrus canker, viral – TMV, Banana bunchy top, fungal–wilt, downy mildew, powdery mildew, smut and rusts, mycoplasmal – sandal spike, grassy shoot of sugarcane	**8**	Understand host-parasite interactions, including the production of phytoalexins and the involvement of elicitors. Explore the role of R (resistance) and r (susceptibility) genes in disease development. Study plant diseases caused by various pathogens	1,2,3,4
V	Postharvest disease and control measures	**8**	Identify post-harvest diseases and their control measures, focusing on strategies to prevent and manage diseases affecting harvested crops and produce.	1,2,3,4
Practical	1. Isolation of nitrogen fixing bacteria from legume root nodules 2. Study of Rhizosphere and Phyllosphere 3. Isolation of Phosphorus solubilizing microorganisms 4. Observation of Anabaena from Azolla plants 5. Microscopic observations of root colonization by VAM fungi	**30**	Isolate nitrogen-fixing bacteria from legume root nodules. Isolate phosphorus-solubilizing microorganisms. Study the rhizosphere and phyllo sphere environments. Observe Anabaena from Azolla plants. Observe root colonization by VAM (Vesicular-Arbuscular Mycorrhizal) fungi.	1,2,3, 4,5,6

TEXT BOOKS:

T1. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley &Sons Inc. New York & London.

T2. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi

REFERENCE BOOKS:

R1. Microbiology – Michael J. Pelczar, JR. E.C.S.Chan Noel K. Krieg, Vth Edition (2005), Publisher – TATA McGraw Hill.

R2. Plant Diseases – R.S. Singh, IXth Edition, Oxford and IBH (N. Delhi)

OTHER LEARNING RESOURCES:

1. http://www.jnkvv.org/PDF/02042020180252Yogranjan_Lecture%20notes_Agricultural%20Microbiology.pdf

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe soil profiles and dynamics of positive and negative interactions between microbes and plants.	**1, 2, 4**
2	Explain the nitrogen cycle, the role of genes and enzymes in nitrogen metabolism	**1, 2, 3, 4**
3	Discuss the principles and applications of bio fertilizers, bio pesticides, and plant gene modification.	**1, 2, 3, 4, 9**
4	Analyse host-parasite interactions, and the role of R and r genes in disease development in plants.	**1, 2, 3, 4, 9**
5	Identify post-harvest diseases to implement effective control measures.	**1, 2, 4, 8**

SEMESTER-III									
Course Title	**Clinical and Diagnostic Microbiology**								
Course Code	**24MSMB2107R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ III semester of first year of the Programme**								
Course Objectives	1. To teach the importance of a microbiologist in diagnosis of microbial diseases. 2. To make students proficient in isolation and characterization of infectious organisms. 3. To analyse the nature of the agent, Study the sensitivity pattern to drugs.								
CO1	Apply the skills of handling clinical specimens, isolating and identifying microorganisms from clinical samples.								
CO2	Perform different immunological techniques using immunodiagnostic tools in clinical microbiology								
CO3	Describe the concept of vaccine and its effectiveness and safety concern								
CO4	Apply the advanced diagnostic tools and techniques for disease diagnosis								
CO5	Illustrate the concept of antimicrobial chemotherapy, mode of action, and sensitivity pattern.								

Unit No.	Content	Contact Hour	Learning Outcome	KL
I	**Introduction to clinical Microbiology**: Role of Microbiologist in Diagnostic laboratory, General concepts for specimen collection, handling, transportation, processing, specimen work up, Laboratory safety and infection control. Scientific and Laboratory basis for Clinical/ Diagnostic Microbiology: Microscopic examination of infectious diseases, Growth and biochemical characteristics, Rapid methods of identification	**10**	Understand the role of a microbiologist in a diagnostic laboratory and key concepts related to specimen collection, handling transportation, processing, and work up. Learn about laboratory safety and infection control. Gain insights into the scientific and laboratory basis of clinical microbiology, including microscopic examination of infectious diseases, growth and biochemical characteristics, and rapid methods of identification.	1, 2, 3
II	**Immunotechniques and Immunodiagnosis**: Antigens and Antibody reactions in vitro; Agglutination, complement fixation, ELISA, Western Blotting Immunodiffusion, Immuno-electrophoresis, Immunofluorescence, Immunoprecipitation, Radioimmuno-assay, and serotyping.	**7**	Understand and apply various immune techniques and immunodiagnostic methods	1, 2, 3, 4

III	**Vaccines and Vaccination**: Vaccines – definition, types, Antigens used as Vaccines, effectiveness of vaccines, Vaccine safety, current vaccines, adjuvants, active immunization and passive immunization.	**8**	Understand vaccines and vaccination by exploring types, antigens used, effectiveness, safety, current vaccines, adjuvants, and the differences between active and passive immunization. Top of Form , Bottom of Form	1, 2, 3, 4, 5
IV	**Recent Diagnostic tools and techniques**: Principle, working and application of a) Autoanalyser b) Biosensor glucometer/ labon chip/ microfluidics c) Diagnositic kits- ELISA, Western Blot d)Enzymes in Disease diagnosis and therapy: Lactate dehydrogenase, Aspartate aminotransferase, Alkaline phosphatase, Creatine kinase, Acid phosphotase, Cholinesterase	**10**	Understand recent diagnostic tools and techniques, including auto analysers, biosensors (glucometers, lab-on-a-chip, microfluidics), diagnostic kits (ELISA, Western Blot), and the role of enzymes (lactate dehydrogenase, aspartate aminotransferase, alkaline phosphatase, creatine kinase, acid phosphatase, cholinesterase) in disease diagnosis and therapy.	1, 2, 3, 4, 5
V	**Antimicrobial Chemotherapy:** Development of chemotherapy; General characteristics of drugs and their testing; Mechanism of action. Antibacterial drugs; antifungal drugs, antiviral and antiprotozoan drugs; antibiotic sensitivity testing, MIC, Drug resistance; mechanism of drug resistance; multi drug resistance.	**10**	Understand antimicrobial chemotherapy by exploring their mechanisms of action, and the specifics of antibacterial, antifungal, antiviral, and antiprotozoan drugs, including antibiotic sensitivity testing, MIC, and mechanisms of drug resistance, including multi-drug resistance.	1,2,3,4,5
Practical	1. Study of sample collection procedure, Storage protocol, Processing. 2. Isolation of pathogen from clinical sample and its antiprogram 3. Serological test, 4. Handling and working of rapid diagnostic kits. 5. Study of nature of antibiotics actions. Detection and analysis of antibiotic resistance	**30**	Learn sample collection, storage, and processing procedures. Isolate pathogens from clinical samples and perform antibiograms, conduct serological tests. Handle rapid diagnostic kits. Study the nature of antibiotic actions, and analyze antibiotic resistance.	1,2,3, 4,5,6

TEXT BOOKS:

T1. Medical Microbiology by Anantanarayan & Panikar Orient Longman Limited.
T2. Medical Parasitology by Arora and Arora, CBS Publishers & Distributors.

REFERENCE BOOKS:

R1. Medical Microbiology by David Green Wood Richard slack & John Peuthrer. Churchill Livingston Company.
R2. Parasitology by K. P. Chattergy Medical Microbiology by Jawelz, Melnick, Geo R. Brokes MeGraw-Hill Company.
R3. Medical Mycology by Jagedeese Chander
R4. Medical Microbiology by Jawetz

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Apply the skills of handling clinical specimens, isolating and identifying microorganisms from clinical samples.	**1, 3, 4, 6, 7**
2	Perform different immunological techniques using immunodiagnostic tools in clinical microbiology	**1, 3, 4, 6, 7**
3	Describe the concept of vaccine and its effectiveness and safety concern	**1, 3, 4, 6**
4	Apply the advanced diagnostic tools and techniques for disease diagnosis	**1, 3, 4, 6, 7**
5	Illustrate the concept of antimicrobial chemotherapy, mode of action, and sensitivity pattern.	**1, 3, 4, 6, 7, 9**

SEMESTER-III									
Course Title	**Organic Farming**								
Course code	**24MSMB2108R**	**Total Credits: 4**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 45T+30P	**3**	**0**	**2**	**0**	**0**	**0**	**4**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Fall/ III semester of first year of the Programme**								
Course Objectives	1. Introduction to Concept of Organic cultivation. 2. To discuss the Organic Farming System (OFS), its importance and benefits. 3. To discuss the methods associated with organic farming – mulching, crop rotation tillage, bio-fertilizer etc.								
CO1	Explain organic Farming, its principles, scope and benefits for the health and society.								
CO2	Illustrate the relation between organic farming and natural processes such as nutrient cycles, soil preparation and choice of crop varieties, planting material and seed treatment.								
CO3	Discuss crop protection methods, analyses scenarios, propose strategies and evaluate effectiveness, preparing to innovate in pest and weed management.								
CO4	Explain the organic production of rice, zinger, turmeric, banana and vegetables.								
CO5	Describe the concept of soil less farming system.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Introduction to Organic Farming (OF); Development of Organic Farming. Principles and types of Organic Farming; Biodynamic Farming; Need and Benefits of Organic Farming; Conventional Farming (CF) Vs (OF); Scope of Organic Farming.	**5**	Understand organic farming by exploring its development, principles, and types, including biodynamic farming, its benefits and needs, and comparing conventional farming (CF) with OF, along with the scope of organic farming. Top of Form Bottom of Form	1,2
II	OF System; Soil and Soil tillage, Choice of crop/ varieties, Propagation –Seed, planting material and seed treatments, Crop rotation, Intercropping, Water Management, Green Manuring, Mulching, Composting, Vermicomposting, Organic Manure, Bio fertilizer	**8**	Understand the organic farming system by exploring soil and tillage practices, crop selection and propagation, crop rotation, intercropping, water management, and techniques such as green manuring, mulching, composting, vermicomposting, organic manure, and bio fertilizers.	1, 2, 3, 4, 5
III	Cultural and Mechanical method of crop protection, Biopesticides and Botanical Pesticides, Bio- control agents, Weed Management	**9**	Understand and apply crop protection methods, including cultural and mechanical approaches, bio pesticides, botanical pesticides, bio-control agents, and weed management techniques.	1, 2, 3, 4, 5
IV	Organic crop production of Rice, Zinzer, Turmeric, Banana and Vegetables	**17**	Learn organic crop production practices for rice, ginger, turmeric, banana, and vegetables.	1, 2, 3

V	Concept on modern organic farming methods – Hydroponics, Aquaponics, Hydroponics	**6**	Explore modern organic farming methods, including hydroponics, aquaponics, and vertical farming.	1, 2, 3, 4, 5

TEXT BOOKS:

T1.The Market Gardener – A successful Grower's Handbook for Small- Scale OF (2014), Jean-Martin Fortier
T2. Profitable OF (2004), Jon Newton
T3.Organic Farming for Sustainable Agriculturs (2016) Dilip Nandwani (eds)

REFERENCE BOOKS:

R1. Organic Farming: Concepts and Principles (2011) G. K. Veeresh and G.K. Veerash
R2. Organic Farming: New Advances towards Sustainable Agriculture Systems (2019). C. Sarath Chandran, Sabu Thomas. M.R. Unni

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain organic Farming, its principles, scope and benefits for the health and society.	**1, 4, 9**
2	Illustrate the relation between organic farming and natural processes such as nutrient cycles, soil preparation and choice of crop varieties, planting material and seed treatment.	**1, 2, 3, 8, 9**
3	Discuss crop protection methods, analyse scenarios, propose strategies and evaluate effectiveness, preparing to innovate in pest and weed management.	**1, 2, 3, 4**
4	Explain the organic production of rice, zinzer, turmeric, banana and vegetables.	**1, 4**
5	Describe the concept of soil less farming system.	**1, 2, 3, 4, 8, 9**

SEMESTER – IV									
Course Title	**MINI RESEARCH - IV (RESEARCH DATA ANALYSIS AND DOCUMENTATION-R4)**								
Course Code	**24MSMB2201R**	**Total Credits: 12**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 360 (P+S+R)	**0**	**0**	**20**	**4**	**6**	**0**	**12**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programmes	**Master of Science in Biotechnology**								
Semester	**Spring/II Semester of First Year of the Programme**								
Course Objectives	1. To enable students to apply experimental methods to solve a given scientific task. 2. To be able to analyse research data 3. To be able to compile and document research data.								
CO1	Learn to tabulate research data								
CO2	Analyze research outcomes								
CO3	Correlate with exiting literature								
CO4	Prepare an effective dissertation report								
CO5	Able to communicate research outcome								

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Learn to tabulate research data	**1, 2, 3, 4, 6, 7, 9**
2	Analyse research outcomes	**1, 2, 3, 4, 6, 7, 9**
3	Correlate with exiting literature	**3, 4, 6, 7, 9**
4	Prepare an effective dissertation report	**1, 2, 3, 5, 6, 7, 9**
5	Able to communicate research outcome	**5, 6, 9**

SEMESTER-IV									
Course Title	**Industrial Microbiology and Fermentation**								
Course Code	**24MSMB2202R**	**Total Credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 33T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Spring/IV Semester of second year of the Programme**								
Course Objectives	1. To familiarize the students with the concept of fermentation processes & the use of different microorganisms in industries. 2. Understand the principles, types, and design of fermentation processes, including submerged and solid-state fermentation. 3. To teach the students about the different industrial products produced by microorganisms.								
CO1	Explain the principles of diverse bioreactors and their advantages								
CO2	Illustrate different microbial strain improvement strategies and the development of novel applications.								
CO3	Illustrate various fermentation products and the underlying biotechnological principles involved.								
CO4	Describe various downstream processes and their storage and packaging techniques.								
CO5	Explore the potential of using microbes to produce metabolites in industrial settings.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**General Principles of Fermentation:** Bioreactors: Bioreactor types, immobized bioreactors, types of fermentation. Fermentation kinetics and Monods Model:- Growth kinetics and Monod's Model, Substrate accelerated death, specific growth rate, stringent response, Ntr and Pho system, growth limiting substrate, maintenance energy, growth yield and product formation. Process optimization: factors of optimization, rheology of fermentation fluid, oxygenation, and oxygen transfer kinetics.	**8**	Understand various types of bioreactors and their applications. Comprehend growth kinetics and the principles of Monod's Model. Identify key factors influencing the optimization of fermentation processes.	1, 2, 3, 4, 5
II	**Microbial strain improvement** Isolation, selection and improvement of microbial cultures: Screening and isolation of micro-organisms, primary and secondary metabolites, enrichment, specific screening for the desired product. Strain improvement for the selected organism:	**6**	Learn techniques for screening and isolating microorganisms from various environments. Understand the production and importance of primary and secondary metabolites. Learn techniques to improve microbial strains for increased yield and efficiency of desired products.	1, 2, 3, 4, 5

III	**Industrial Fermentation Products** Biofuels:-Ethanol, Hydrogen, Methane Antibiotics:-β-lactum antibiotics (Synthetic Penicillin), Streptomycin, Cephalosporin. Bio preservative: Lactobacillus sakei. Biopolymers:-Xanthan, Polyhydroxyalkanoates. Thermostable enzymes:- Proteases. Biosurfactants: a comparative account.	**8**	Understand the process of fermentative production of biofuels, antibiotics, bio preservatives, biopolymer, enzymes, bio surfactants from microbial sources.	1, 2, 3, 4, 5
IV	**Downstream Processing and scale up:** Downstream processes: types of processing units and systems, Storage and packaging methods. Scale up: criteria involved in scale up, Productivity, power requirements, Basic control theory	**4**	Understand different types of processing units and systems used in downstream processing. Analyse factors affecting productivity and power requirements during scale-up.	1, 2, 3, 4, 5
V	**Food and Healthcare products:** SCP, various types and processes, SCO Aminoacids:-Lysine, Glutamic acid. Vitamins:-riboflavin, Vit.B12. Fatty acids (Palmetate, oleate). Organic acids Production of Fuels: Ethanol, Methanol Mushroom Cultivation and Wine production	**7**	Understand the various types of SCP and SCO, and the processes involved in their production. Gain knowledge on the biosynthesis and industrial production of vitamins, amino acids, organic acids, wine, fatty acids, and biofuels. Understand the techniques and processes involved in mushroom cultivation.	1, 2, 3, 4, 5
Practical	1. Yoghurt production 2. Yeast Fermentation 3. Wine preparation 4. Vinegar production 5. Single cell Protein and Single Cell Oil 6. Citric acid estimation 7. Lactic acid estimation	**30**	Perform fermentative produ-ction of yoghurt, wine, vinegar, SCO, SCP Estimate Citric acid and lactic acid produces through fermentation	1, 2, 3, 4, 5

TEXT BOOKS:

T1. Stanbury P.F., A. Whitaker, S.j. Hall, Principles of Fermentation Technology Publisher: Butterworth-Heinemann

T2. Shuler M.L. and F. Kargi: Bioprocess Engineering Basic Voncepts by Publisher Prentice Hall

REFERENCE BOOKS:

R1.Prescott and Dunn's Industrial Microbiology, Publisher: Gerald Reed: Books

R2.W. Crueger and A. Crueger: Biotechnology. A textbook of Industrial Microbiology, Publisher: Sinauer Associates.

OTHER LEARNING RESOURCES:

1. https://microbenotes.com/
2. www.youtube.com

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain the principles of diverse bioreactors and their advantages	**1, 3**
2	Illustrate different microbial strain improvement strategies and the development of novel applications.	**1, 2, 3, 4, 9**
3	Illustrate various fermentation products and the underlying biotechnological principles involved.	**1, 2, 3, 4, 9**
4	Describe various downstream processes and their storage and packaging techniques.	**1, 2, 3, 4, 9**
5	Explore the potential of using microbes to produce metabolites in industrial settings.	**1, 2, 3, 4, 8, 9**

SEMESTER-IV									
Course Title	**Food and Dairy Microbiology**								
Course Code	**24MSMB2203R**	**Total Credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 32T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Spring/IV Semester of second year of the Programme**								
Course Objectives	1. The course provides students with both a knowledge of general scientific methods and contents of the food microbiology field and specific professional skills 2. The course provides an integrated overview of the field of food microbiology covering issues of food safety, food preservation and food production. 3. The course provides insights concerning aspects of microbial ecophysiology, determination and control of food microorganisms, and the distribution of spoilage and pathogen microorganisms in plant- and animal-based food.								
CO1	Describe the significance of microorganisms in food and their relation to spoilage								
CO2	Apply the principles and techniques employed in the preservation of foods.								
CO3	Analyze the role of microbes in food production, and explore the concept of probiotics and prebiotics								
CO4	Characterize different food-borne illnesses and associated microorganisms.								
CO5	Demonstrate safety measures and control programs in food production								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Food & Microorganisms**- food as a substrate for microorganisms, important microorganisms in food microbiology, general principles underlying food spoilage **Food Contamination**- contamination, preservation, and spoilage of cereal products/ vegetables & fruits/ meat & meat products/ milk & milk products/ canned products	**7**	Understand the role of food as a substrate for microorganisms, identify key microorganisms in food microbiology, learn the principles of food spoilage, and gain knowledge on contamination, preservation, and spoilage prevention methods for various food products	1, 2, 3, 4, 5
II	**Principles of Food Preservation**- asepsis, removal, anaerobic condition, preservation by high temperature/ low temperature/ drying/ food additives/ radiation	**5**	Apply the principles of food preservation, including asepsis, removal of contaminants, creation of anaerobic conditions, and methods such as high temperature, low temperature, drying, use of food additives, and radiation.	1, 2, 3, 4, 5
III	**Foods & Enzymes Produced by Microorganism**s- productions of cultures, food fermentation, foods & enzymes from microorganisms **Probiotics & Prebiotics**- functions, types, acidophilus milks, yogurt, butter milk, solid formulas	**8**	Understand and apply the process of food fermentation learn about probiotics and prebiotics, their functions, types, and applications in products such as acidophilus milk, yogurt, buttermilk, and solid formulas.	1, 2, 3, 4, 5

IV	**Foods in Relation to Disease**- bacterial food borne illnesses, non- bacterial food poisoning/infections/ intoxication, food borne disease outbreaks	**5**	Correlate food borne disease and their causative agents and factors contributing to food poisoning	1, 2, 3, 4, 5
V	**Food Sanitation, Control & Inspection**- sterilization, microbiology in food sanitation, enforcement & control agencies- national/ international/ federal/ state/ private, Microbiological criteria for food	**7**	Understand the principles of food sanitation, including sterilization and the role of microbiology, and become familiar with the enforcement and control agencies at national, international, federal, state, and private levels, as well as the microbiological criteria for food safety.	1, 2, 3, 4, 5
Practical	1. MBRT of milk samples and their standard plate count. 2. Isolation of food-borne bacteria and fungi from food products. 3. Most Probable Number Analysis 4. Microbiological examination of canned foods 5. Isolation of spoilage bacteria from fruits and vegetables. 6. Adulterant test – formalin and starch test 7. Effect of temperature on the spoilage of food products. 8. Production of fermented food and their microbial examination	**30**	Assess milk quality, isolate food borne microorganisms. Estimate MPN Perform microbial examination of food. Perform adulterant test Able to produce fermented food	1, 2, 3, 4, 5

TEXT BOOKS:

T1. Frazier W.C. and West off D.C. (2008) Food Microbiology, 4th Edn. Tata McGraw Hill Publishing Co., New Delhi.

T2. Bamforth C.W. (2005) Food, Fermentation and Microorganisms, Blackwell Science

REFERENCE BOOKS:

R1. Doyle M.P. and Buchanan R.L. (Ed.) (2013) Food Microbiology: Fundamentals and Frontiers, 4th Edn. ASM press.

R2. Jay J.M., Loessner M.J. and Golden D.A. (2005) Modern Food Microbiology, 7th Edn. Springer Publishers

R3. Robinson R.K. (2002) Dairy Microbiology: Milk and Milk Products, 3rd Edn. Wiley Publishers.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the significance of microorganisms in food and their relation to spoilage	**1, 4**
2	Apply the principles and techniques employed in the preservation of foods.	**1, 2, 4**
3	Analyse the role of microbes in food production, and explore the concept of probiotics and prebiotics	**1, 2, 3, 4**
4	Characterize different food-borne illnesses and associated microorganisms.	**1, 2, 4, 9**
5	Demonstrate safety measures and control programs in food production	**1, 2, 4, 9**

SEMESTER-IV									
Course Title	**Pharmaceutical Microbiology**								
Course Code	**24MSMB2204R**	**Total Credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 32T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Spring/IV Semester of second year of the Programme**								
Course Objectives	1. To teach the basic definition of pharmacology and kinetics of drugs in human. 2. To understand the mechanism of action of antibiotics and the mode of spoilage of pharmaceutical products 3. To incorporate in depth knowledge of techniques, processes and strategies in order to avoid any potentially costly and life-threatening failures and consequences.								
CO1	Explain pharmacology and pharmacokinetics.								
CO2	Describe the mode of action of antimicrobial agents, pathogenicity, and resistance to antibiotics.								
CO3	Explore microbial pharmaceutical products, and their spoilage.								
CO4	Execute Good manufacturing practices, quality assurance, and quality control.								
CO5	Apply different physical and chemical sterilization techniques to ensure sterility in the pharmaceutical industry.								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	**Introduction to pharmacology**: Definitions, sources, terminology used, classification, Pharmacodynamics – Actions, Therapeutic, Adverse, toxic **Pharmacokinetics –** absorption, distribution, metabolism, interaction, excretion, Routes of drug administration, Storage of various drugs	**7**	Gain a foundational understanding of pharmacology, including definitions, sources, terminology, classification, pharmacodynamics (actions, therapeutic, adverse, toxic effects), pharmacokinetics (absorption, distribution, metabolism, interaction, excretion), routes of drug administration, and drug storage methods	1,2, 3,4, 5
II	**Mechanism of action of antibiotics:** Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Bacterial resistance to antibiotics. Mode of action of bacterial killing by quinolones. Bacterial resistance to quinolones.	**5**	Understand the mechanisms of action of antibiotic. Comprehend bacterial resistance to antibiotics and quinolones	1,2, 3,4, 5
III	**Microbial production and Spoilage of pharmaceutical Products**: Microbial contamination and spoilage of pharmaceutical products (sterile injectable, non-injectable, ophthalmic preparations and implants) and their sterilization. Manufacturing procedures and in process control of pharmaceuticals. Other pharmaceuticals	**7**	Understand microbial contamination and spoilage of pharmaceutical products Learn manufacturing procedures and in-process control of pharmaceuticals; Gain knowledge on pharmaceuticals produced by microbial fermentations Explore new vaccine technologies	1,2, 3,4, 5

	produced by microbial fermentations (streptokinase, streptodornase). New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials.		Understand the process of vaccine clinical trials.	
IV	**Principles and applications of GMP in pharmaceuticals and cosmetics:** Principles – Applications and Definitions, The concept of Quality, The regulatory factors QC, QA and GMP, Quality assurance beyond Good Manufacturing Practices (GMP), ISO, Sanitary practices in cosmetic manufacturing	**6**	Understand the principles, applications, and definitions related to quality in pharmaceutical and cosmetic manufacturing; Grasp the concept of quality and the regulatory factors involved, including Quality Control (QC), Quality Assurance (QA), and Good Manufacturing Practices (GMP); Explore quality assurance practices beyond GMP, learn about ISO standards. Understand sanitary practices in cosmetic manufacturing.	1,2, 3,4, 5
V	**Sterilization and sterility assurance:** Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization) Chemical and biological indicators. Design and layout of sterile product manufacturing unit. (Designing of Microbiology laboratory).	**7**	Understand sterilization control and sterility testing methods, Learn about chemical and biological indicators used in sterility testing; Comprehend the design and layout of sterile product manufacturing units, including the design principles for microbiology laboratories.	1,2, 3,4, 5
Practical	1. Antimicrobial assay of antibiotics - determine MIC 2. Sampling of pharmaceuticals for microbial contamination and load (syrups, suspensions, creams and ointments, ophthalmic preparations). 3. Determination of antimicrobial activity of a chemical compound (Phenol, resorcinol, thymol, formaldehyde) to that of phenol under Standardized experimental conditions. 4. Determination of D value, Z value for heat sterilization in pharmaceuticals. 5. Sampling of pharmaceuticals for microbial contamination and load (syrups, suspensions, creams and ointments, ophthalmic preparations).	**30**	Determine the Minimum Inhibitory Concentration (MIC) of antibiotics through antimicrobial assays. Perform microbial contamination and load testing of pharmaceuticals, including syrups, suspensions, creams, ointments, and ophthalmic preparations. Evaluate and compare the antimicrobial activity of chemical compounds (e.g., phenol, resorcinol, thymol, formaldehyde) against phenol under standardized experimental conditions. Measure D value and Z value for heat sterilization in pharmaceutical products to ensure effective sterilization.	1,2, 3,4, 5

TEXT BOOKS:

T1. Pharmaceutical Microbiology by Hugo & Russell, Blackwell Science Publication, 6th Edition

T2. Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control by Tim Sandle, Woodhead Publishing.

REFERENCE BOOKS:

R1.Pharmacology by Harvey and Champe, Wolters Kluwer Publication, 4Th Edition

R2. Principles of Pharmacology, Armstrong, Wolters Kluwer Publication

R3.Basic and Clinical Pharmacology, by Katzung, McGraw Hill, 10th edition

R4.Pharmacology, Principles and Practice, Bachmann, Hecker, Messer, AP Publication

R5.Analytical Microbiology –Edt by Frederick Kavanagh Volume I & II. Academic PressNew York.

R6.Quinolinone antimicrobial agents – Edt. by David C. Hooper, John S.Wolfson .ASMWashington DC.

R7.Quality control in the Pharmaceutical Industry - Edt. by Murray S.Cooper Vol.2.Academic Press New York.

OTHER LEARNING RESOURCES:

1. https://www.carewellpharma.in/B_Pharmacy/Notes/3rd_Sem/Microbiology/Unit1/ www.youtube.com

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Explain pharmacology and pharmacokinetics.	**1**
2	Describe the mode of action of antimicrobial agents, pathogenicity, and resistance to antibiotics.	**1, 2, 4**
3	Explore microbial pharmaceutical products, and their spoilage.	**1, 2, 3, 4, 9**
4	Execute Good manufacturing practices, quality assurance, and quality control.	**1, 6, 7, 9**
5	Apply different physical and chemical sterilization techniques to ensure sterility in the pharmaceutical industry.	**1, 3**

SEMESTER-IV									
Course Title	**Marine Microbiology**								
Course Code	**24MSMB2205R**	**Total Credits: 3**	**L**	**T**	**P**	**S**	**R**	**O/F**	**C**
		Total Hours: 32T+30P	**2**	**0**	**2**	**0**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Co-requisite**	**Nil**						
Programme	**Master of Science in Microbiology**								
Semester	**Spring/IV Semester of second year of the Programme**								
Course Objectives	1. To develop the knowledge about the biology of marine microbes and their distribution. 2. To understand the role of marine microorganisms. 3. To explore potential of marine microorganisms.								
CO1	Describe the distribution and significance of marine cyanobacteria and actinomycetes.								
CO2	Explain the marine eukaryotic microbial cell structure and functions.								
CO3	Discuss the role of marine microorganisms in ocean acidification and sedimentation.								
CO4	Characterize marine viruses and virus-like particles.								
CO5	Explore the role of marine microorganisms in the production of various bioactive compounds								

Unit No.	**Content**	**Contact Hour**	**Learning Outcome**	**KL**
I	Occurrence and distribution, structure and biology, ecological role and significance of marine cyanobacteria, marine actinomycetes	**5**	Understand the occurrence, distribution, structure, biology, ecological role, and significance of marine cyanobacteria and marine actinomycetes	1, 2, 3
II	Marine eukaryotic microbes: Introduction to the protists and fungi Overview of eukaryotic cell structure and Function Nanoplanktonic flagellates, Dinoflagellates, Bioluminescence and Biological clocks Ciliates, Diatoms.	**7**	Gain an introduction to marine eukaryotic microbes Understand eukaryotic cell structure and function; Explore nanoplanktonic flagellates, dinoflagellates, bioluminescence, biological clocks, ciliates, and diatoms.	1, 2, 3, 4
III	Role of microorganisms in ocean acidification, Marine microbes as a major component of the Plankton, Microbes play a key role in the formation of sediments	**7**	Understand the role of microorganisms in ocean acidification, Recognize marine microbes as a major component of plankton, Explore how microbes contribute to the formation of sediments.	1, 2. 3, 4, 5
IV	Marine virus: The nature of marine viruses, Viruses infecting prokaryotes, Enumerating viruses and virus-like particles, Morphology of marine viruses.	**6**	Understand the nature of marine viruses, including those infecting prokaryotes; Learn methods for enumerating viruses and virus-like particles; and explore the morphology of marine viruses.	1, 3, 4

V	Exploring potentials of marine microorganisms, Bioactive Marine Natural Products, Bioactive compounds, biofilms.	**7**	Explore the potential of marine microorganisms, including the discovery and applications of bioactive marine natural products, bioactive compounds, and the role of marine microorganisms in biofilm formation.	1, 2, 3, 4,5
Practical	1. Sampling techniques in marine microbiology 2. Estimation of bacterial population from marine samples 3. Isolation of marine actinobacteria 4. Enumeration of total heterotrophic bacteria in sea water 5. Hydrolytic enzyme profiling of the marine isolates.	**30**	Master sampling techniques for marine microbiological studies. Accurately estimate bacterial populations from marine samples. Isolate and identify marine action bacteria. Enumerate total heterotrophic bacteria in seawater samples. Perform hydrolytic enzyme profiling of marine bacterial isolates.	1, 2, 3, 4,5, 6

TEXT BOOKS:

T1. Munn, C.B., 2019. Marine microbiology: ecology & applications. CRC Press.3rd edtn

T2. Gasol, J.M. and Kirchman, D.L. eds., 2018. Microbial ecology of the oceans. John Wiley & Sons. 3rd edtn

T3. Stal, L.J. and Cretoiu, M.S., 2016. The marine microbiome. Springer International: Switzerland.

T4. Kim, S.K. ed., 2015. Springer handbook of marine biotechnology. Springer.

REFERENCE BOOKS:

R1. Mckane, L.and J.Kandel, 1996. Microbiology, Essentials and Applications. McGraw HillInc., New York, 843 pp

R2. Austin B. an D.A. Austin, 1996 Bacterial Fish Pathogens- Diseases of Farmed and Wild Fish, Springer Praxis Publishing, 457 pp.

R3. Stickney, B.R., 2000. Encyclopedia of Aquaculture. John Wiley & Sons, Inc,US. 1063pp.

R4. Munn, C.B.2004. Microbial ecology: ecology and applications.BIOS Sci., Pub., US, 282pp. 7. Kirchman, D. L., 2008. Microbial ecology of the oceans John Wiley & sons US 593pp.

RELATIONSHIP BETWEEN COURSE OUTCOMES (CO) AND PROGRAM OUTCOMES (PO)

CO PO Mapping		
S.N.	**Course Outcome (CO)**	**Mapped Program Outcome**
1	Describe the distribution and significance of marine cyanobacteria and actinomycetes.	**1, 4**
2	Explain the marine eukaryotic microbial cell structure and functions.	**1, 3, 4**
3	Discuss the role of marine microorganisms in ocean acidification and sedimentation.	**1, 3, 4**
4	Characterize marine viruses and virus-like particles.	**1**
5	Explore the role of marine microorganisms in the production of various bioactive compounds	**1, 2, 3, 4, 8, 9**