SYLLABUS

RAMANUJAN SCHOOL OF SCIENCE

BACHLOR OF SCIENCE

(Chemistry, Biology, Zoology)

(B. Sc. (CBZ) – CKUG04B03)

(Effective from Academic Year 2023-24)

2023-24

AN ISO 9001:2015 CERTIFIED FOR QMS
DR. C.V. RAMAN UNIVERSITY
Madhya Pradesh, Khandwa AN AISECT GROUP UNIVERSITY
Approved by : MP. Govt., AICTE, NCTE, MP PARAMEDICAL COUNCIL, PCI Recognized by : UGC Member of : AIU

CVRU
विद्या परं देवता
DR. C.V.RAMAN UNIVERSITY

Preamble

The objective of any program at Higher Education Institute (HEI) is to prepare future professionals well equipped with attitude – skills and knowledge demanded by the growing society. The CVRUK envisions all its programs in the best interest of its students and in this endeavor, it offers a new vision to all its under graduate courses. It Imbibes Learning Outcome - Based Curriculum Framework (LOCF) for all its under graduate programs. The LOCF approach is envisioned to provide focused, outcome – based syllabus at the undergraduate level with an agenda to structure the teaching – learning experiences in a more student - centric manner.

The LOCF approach has been adopted to strengthen students' experience as they engage themselves in the program of their choice. The under graduate programs will prepare the students both for academic pursuit as well as enhance her / his employability.

Each program vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programs also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice also skills for employability. In short, each program prepares students for sustainability and life-long learning.

The new curriculum of B.Sc. Biology offers the students to gain the requisite knowledge, skills, and aptitude for the field of life science. The efforts are made to measure cognitive as well as applied learning. Students are not only trained on the core components but also in areas which are need based, innovative, and relevant keeping in pace with the fast-growing industry. The course is internationally competitive.

The CVRUK hopes the LOCF approach of the program B.Sc. Biology will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

1.Introduction to B.Sc. Biology S. Ramanujan School of Science

The Life Science course at the bachelor's level is being offered at CVRUK in its 3rd year of operation and introduced by setting up / or continuing at School of life Science. from the academic year 2023- 24. The course is being prepared keeping in view, the unique requirements of region, GOI' new policy initiatives like "One District One Commodity" or start – up policy / skill enhancement policy / new education policy. The policies of GOI and Go MP enshrine the spirit of dealing with the job creation and rapid growth in economy, ceasing the opportunity of setting up of new industries in the region. This necessitates the need of technically trained, educated human resources having knowledge, skills, and attitude to deal with the emergent needs of the "New Sun Shine" industry. The graduate level degree of B.Sc. Biology would help develop a cadre of professionals to provide necessary human resource.

The Life Science (CBZ) course in Choice Based Credit System is of 3 - year duration which comprises of 6 semesters, divided into 60 CC (Major) + 28 (MINOR) +9 (IDC) +8 (AEC) + 9 (SEC) +6 (VAC) =120 CREDIS Core. This course has been prepared keeping in view, the unique requirements of S. Ramanujan School of science of Biology students.

The objectives of the program are:

- To provide students with a broad knowledge base in various sub disciplines of biology including cell biology, genetics, microbiology, ecology, physiology, evolution, and biochemistry.
- To develop practical laboratory skills and techniques necessary for conducting biological research including data collection analysis interpretation and scientific writing.
- To foster critical thinking and analytical skills enabling students to evaluate hypotheses design experiments and draw evidence-based conclusions.
- To prepare students for further studies of careers in biology related fields by providing them with a solid academic foundation and introducing them to the diverse range of career paths available in the biological sciences.
- To cultivate an understanding of ethical considerations and responsible conduct in biological research including the responsible use of animals, human subjects, and genetic information.
- The course contents have been so designed that it can keep pace with the rapidly growing Science filed Since, Biology is an interdisciplinary science it is recommended that subjects like Biochemistry, Biology, Chemistry, Zoology etc. be preferably chosen as the inter discipline course (IDC) by the students as they are synergistic to the curriculum. However, students are free to pick up any of the inter discipline course offered by other departments.

2. Learning Outcome Based Curriculum Framework

2.1 Nature and Extent of the Program in B.Sc. Biology

The learning outcomes-based curriculum framework is based on the premise that every student and graduate is unique. Each student or graduate has his/her own characteristics in terms of previous learning levels and experiences, life experiences, learning styles and approaches to future career related actions. The quality, depth and breadth of the learning experiences made available to the students while at the higher education institutions help develop their characteristic attributes.

2.2 Aims of Bachelor Degree Program in B.Sc. Biology

The key objectives that underpin curriculum planning and development at the undergraduate level include Program Learning Outcomes, and Course Learning Outcomes. For the B.Sc. Biology course, it includes:

- A Bachelor of Science (B.Sc.) in Biology program provides students with a strong foundation in the biological sciences. Upon completion of the program, graduates acquire a range of knowledge, skills, and competencies that enable them to pursue various career paths or further education in related fields. Here are some common program outcomes for a B.Sc. in Biology.
- Knowledge of Biological Concepts: Graduates will have a solid understanding of fundamental biological concepts, including cell biology, genetics, ecology, evolution, physiology, and biochemistry.
- Scientific Methodology: Students will be proficient in applying the scientific method, including designing and conducting experiments, collecting and analyzing data, and drawing valid conclusions.
- Laboratory Skills: Graduates will have acquired essential laboratory skills, such as using scientific instruments, performing techniques like microscopy, DNA analysis, and culturing microorganisms, and accurately documenting experimental procedures and results.
- Critical Thinking: Students will develop strong critical thinking and problem-solving abilities, allowing them to analyses complex biological phenomena, evaluate scientific literature, and propose hypotheses or solutions.
- Research Skills: Graduates will be familiar with research methodologies and techniques used in biology. They will be capable of conducting independent research, writing scientific reports, and presenting findings in a clear and organized manner.
- Communication Skills: Students will enhance their written and oral communication skills, enabling them to effectively communicate scientific concepts, research findings, and ideas to both scientific and non-scientific audiences.
- Ethical Awareness: Graduates will have a solid understanding of ethical considerations and responsible conduct in scientific research, including issues related to animal and human subjects, data integrity, and professional integrity.
- Teamwork and Collaboration: Students will develop the ability to work collaboratively in group projects and interdisciplinary teams, understanding the value of cooperation and effective communication within scientific research and other professional settings.
- Information Literacy: Graduates will be skilled in locating, evaluating, and utilizing scientific information from a variety of sources, including academic databases, scientific journals, and online resources.
- Adaptability and Lifelong Learning: B.Sc. Biology graduates will be prepared to adapt to new challenges and advances in the field of biology throughout their careers. They will have developed a mind-set of continuous learning and the ability to stay updated with the latest scientific research and technologies to demonstrate the ability to acquire, analyses, interpret, and appropriately present laboratory data.

2. Graduate Attributes in Disciplinary knowledge

Students can demonstrate comprehensive knowledge and understanding of one or more disciplines such as chemistry, bio-chemistry, mathematics, statistics, microbiology, engineering, management; regulations with support of different allied subjects of Life Science, Physical Science.

Communication Skills

Development of student's communication skills is planned through an AEC paper (English) which is compulsory for each student. Besides that, the students do various assignments that enable them to develop skills in public speaking writing and effective's interpersonal skills. Presentations in each paper enhances their confidence, ability to express themselves; presentation skills.

Research-related skills

Students develop a scientific temper and a sense of enquiry through various Life Science papers. They have capabilities in asking relevant questions relating to current issues and themes and state hypothesis and rationale for inquiry. Students can use appropriate research methodology especially for understanding issues in Life Science and reporting the results in different formats.

Cooperation/Team work

Students are capable of effective working in diverse contexts and teams in class rooms laboratories, student societies, industry, and the community. They have basic management skills for independently organizing events, resource mobilization and leading community-based projects, initiatives, cultural shows.

Self-directed learning

Students can work independently and are able to apply the concepts of Life Science in an original; creative manner to solve and manage real life issues for the customers and industry. Students develop customized processes and or products as per the requirements of society.

Multicultural competence

Students are confident of working in diverse socio-cultural contexts. They can effectively engage with multicultural groups and teams. They have sensitivities of cross cultural and ethnic diversity which they can apply to different settings. College through a student and faculty exchange program with foreign university helps them to acquire multicultural competency. They are competent to seek higher education in foreign universities.

Moral and ethical awareness/reasoning

Student has awareness of ethical conduct in different situations (academic and personal). They have skills in understanding and avoiding unethical behavior such as misrepresentation, plagiarism and environmental misuse and violence. They are formally taught ethics of research and human interventions.

Leadership readiness/qualities

Students have leadership qualities in organizing teams and their mobilization for effective problem solving in different life science aspects. Students apply creative leadership for realization of various goals. As a leader, they are trained to have greater customer sensitivity and connect.

Lifelong learning

Students acquire ability to gain knowledge and skills which are necessary in life for the holistic development for meeting their professional and personal needs in varying environment and changing contexts.

4. Qualification Descriptors for B.Sc. Biology

The following descriptors indicate the expectations from B.sc Biology

- The students will have a sound knowledge of life science.
- They will understand the science and technologies of life science.
- They will understand the type of stimulus in the receptive field and the relative intensity of the stimulus aspects.
- They will understand biological safety and standards, both nationally and internationally.
- They will be versant with key principles of biological engineering.

5. Program Learning Outcome in B.Sc. Biology

The learning outcome of the course are-

- The learning outcomes of a Bachelor of Science (B.Sc.) in Biology program can vary depending on the specific institution and curriculum. However, here are some common learning outcomes that you can expect from a B.Sc. program in Biology.

- Knowledge of Biological Concepts: Graduates of a B.Sc. in Biology program should have a solid understanding of fundamental concepts in biology, including cell biology, genetics, evolution, ecology, physiology, and biochemistry.
- Scientific Inquiry and Critical Thinking: Students should develop the ability to critically evaluate scientific literature, design and conduct experiments, and analyses and interpret data using scientific methods and principles.
- Laboratory and Research Skills: B.Sc. in Biology programs typically include laboratory courses where students gain hands-on experience in various techniques and methodologies used in biological research. Graduates should be proficient in laboratory skills such as microscopy, molecular biology techniques, data analysis, and scientific writing.
- Quantitative and Analytical Skills: Students should develop strong quantitative and analytical skills, including the ability to apply mathematical and statistical concepts to biological problems, analyses complex data sets, and interpret results.
- Communication Skills: Effective communication is essential in the field of biology. Graduates should be able to communicate scientific information effectively through written reports, oral presentations, and visual aids. They should also be able to collaborate with other scientists and work in interdisciplinary teams.
- Ethical and Professional Conduct: B.Sc. in Biology programs often emphasize the importance of ethical and responsible conduct in scientific research. Students should understand the ethical considerations involved in biological research, including the use of human subjects, animal welfare, and the proper handling of data.
- Integration of Knowledge: Graduates should be able to integrate knowledge from different sub-disciplines within biology and apply it to real-world problems and challenges.
- Lifelong Learning: The field of biology is constantly evolving, and graduates should possess the skills and motivation for lifelong learning, including staying updated with new scientific advancements and technologies.

6. Structure of B.Sc. Biology

The B.Sc. Biology program will be of three years' duration. Each year will be called an academic year and will be divided into two semesters, thus there will be a total of six semesters. Each semester will consist of sixteen weeks.

The program will consist of core papers, and discipline electives of 6 credits, 4 credits theory and 2 credits practical courses. Skill enhancement courses are 2 credits courses which comprise of practical or theory 1 credits and Practical 1 credits. For theory classes 1 credit indicates a one hrs. Lecture per week while for Practical 1 credit indicates a two-hour session per week.

The program includes Core Courses (CC) and elective courses. The core courses are all compulsory courses. There are three kinds of elective courses: Inter Discipline-Course Elective (IDC), Skill Enhancement Course (SEC). In addition, there are two compulsory Ability Enhancement Courses (AEC), and Value-added courses (VAC).

To acquire a degree in life science. A student must study 11 Core Courses, 3 Inter Discipline-Course Electives, 4 Skill Enhancement Courses and 4 compulsory Ability Enhancement Courses. The Core Courses, credit Inter Discipline-Course Elective and 6 Value – Added Courses (VAC). The Skill Enhancement Courses are 9 credit courses while the Ability Enhancement Courses are 8 credit-courses. A student must earn a minimum of 80 credits to get a degree in B.Sc. Biology.

There will be 11 Core Courses which are to be compulsorily studied to complete the requirements for a degree in B.Sc. Biology. The students will study two Core Courses each in Semesters I, II and III. Three Core Courses each in Semesters IV, and V. Four Core Courses in Semesters VI. The Core Courses will be of four credits each (four credits theory and two credits Practical).

The program offers 3 Inter Discipline-Course Electives (IDC), of which the student must choose any two in each of the Semester I, II and III will be of 9 credits each. A particular option of AEC course will be offered in Semesters I To IV semesters only if the minimum number of students opting for that course is 8 credits. A particular option of VAC will be offered in semester I and II semesters opting for that course in 6 credits.

The students will undertake 4 Skill Enhancement (SE) courses of two credits in I, II, V and 3 credit III, which they can choose from the list of SE courses offered by their respective school or other schools within CVRUK. The Department of Life science is offering five such courses. The 4 compulsory Ability Enhancement Courses (AECs): AE1 (Hindi language) and AE2 (English language) AE3 (Communication Skill) AE4 (Culture Heritage) will be of 8 credits each (theory only). The student will take one each in Semesters I, II, III and IV.

The teaching learning will involve theory classes of one hour duration and practical classes. The curriculum will be delivered through various methods including chalk and talk, power point presentation, audio, video tools, e-learning/e-content, field trips/ industry visits, seminars, workshops, projects, and class discussions. The assessment broadly will comprise of internal assessment (40%) and End Semester examination (60%). The internal assessment will be through MCQs, test, assignment, oral presentation, quizzes, and worksheets. Each practical paper will be of 100 marks.

Credit Distribution in B.Sc. Biology (CBZ)

Semester	Course Code	Course Name (Major)	Credits (L+T +P)
I	3SICC103	Zoology –I (Invertebrates and Cell Biology)	6(4 +0+2)
	3SDMC103	Botany – I (Diversity of Microbes and Cryptogams)	6(4 +0+2)
	3SPIC103	Chemistry- I (Physical, Inorganic and Organic Chemistry)	6(4 +0+2)
II	3SVDC203	Zoology –II (Vertebrates and Developmental Biology)	6(4 +0+2)
	3SCBC203	Botany – II (Cell Biology and Genetics)	6(4 +0+2)
	3SPCC203	Chemistry –II (Physical Chemistry)	6(4 +0+2)
III	3SGEC303	Zoology –III (Genetics)	6(4 +0+2)
	3SBSC303	Botany – III (Biodiversity and Systematic of Seed Plant)	6(4 +0+2)
	3SPIC303	Chemistry- III (Physical, Inorganic and Organic Chemistry)	6(4 +0+2)
IV	3SAPC403	Major I -Zoology –IV (Animal Physiology)	6(4 +0+2)
	3SIMC403	Major II (Immunology)	6(4 +0+2)
	3SSDC403	Major I -Botany – IV (Structure Development and Reproduction in Flowering Plant)	6(4 +0+2)
	3SPPC403	Major II –(Plant Pathology)	6(4 +0+2)
	3SPOC403	Major I -Chemistry –IV (Physical, Organic and Inorganic Chemistry)	6(4 +0+2)
	3SAMC403	Major II – (Analytical Methods in Chemistry)	6(4 +0+2)
V	3SAZC503	Major I -Zoology –V (Applied Zoology)	6(4 +0+2)
	3SWLC503	Major II – (Wild Life Conservation)	4(2+0+2)
	3SABC503	Major III – (Aquatic Biology)	4(2+0+2)
	3SPPC503	Major I -Botany – V (Plant Physiology and Biochemistry)	6(4+0+2)
	3SEEC503	Major II – (Evolutionary and Economic Botany)	4(2+0+2)
	3SIBC503	Major III – (Industrial Botany)	4(2+0+2)
	3SPOC503	Major I -Chemistry –V (Physical, Organic and Inorganic Chemistry)	6(4+0+2)
	3SRMC503	Major II – (Research Methodology for Chemistry)	4(2+0+2)
	3SGCC503	Major III – (Green Chemistry)	4(2+0+2)

Semester	Course Code	Course Name (Major)	Credits (L+T +P)
VI	3SEBC603	Major I -Zoology –VI (Environmental Biology and Evolution)	6(4+0+2)
	3SAQC603	Major II – (Aquaculture)	6(4+0+2)
	3SEZC603	Major III – (Economic Zoology)	4(2+0+2)
	3SPEC603	Major I -Botany – VI (Plant Ecology and Biodiversity and Phytogeography)	6(4+0+2)
	3SEBC603	Major II – (Ethno Botany)	6(4+0+2)
	3SPRC603	Major III – (Plant Reproduction)	4(2+0+2)
	3SPOC603	Major I -Chemistry –VI (Physical, Organic and Inorganic Chemistry)	6(4+0+2)
	3SNCC603	Major II – (Nano Chemistry)	6(4+0+2)
	3SBIC603	Major III – (Biochemistry)	4(2+0+2)

Semester	Course Code	Course Name (Minor)	Credits (L+T +P)
I	3SICM104	Zoology –I (Invertebrates and Cell Biology)	4(2+0+2)
	3SDMM104	Botany – I (Diversity of Microbes and Cryptogams)	4(2+0+2)
	3SPIM104	Chemistry- I (Physical, Inorganic and Organic Chemistry)	4(2+0+2)
II	3SVDM204	Zoology –II (Vertebrates and Developmental Biology)	4(2+0+2)
	3SCBM204	Botany – II (Cell Biology and Genetics)	4(2+0+2)
	3SPCM204	Chemistry –II (Physical Chemistry)	4(2+0+2)
III	3SGEM304	Zoology –III (Genetics)	6(4+0+2)
	3SBSM304	Botany – III (Biodiversity and Systematic of Seed Plant)	6(4+0+2)
	3SPIM304	Chemistry- III (Physical, Inorganic and Organic Chemistry)	6(4+0+2)
IV	3SAPM404	Zoology –IV (Animal Physiology)	6(4+0+2)
	3SSDM404	Botany – IV (Structure Development and Reproduction in Flowering Plant)	6(4+0+2)
	3SPOM404	Chemistry –IV (Physical, Organic and Inorganic Chemistry)	6(4+0+2)
V	3SABM504	Zoology –V (Aquatic Biology)	4(2+0+2)
	3SIBM504	Botany – V (Industrial Botany)	4(2+0+2)

Semester	Course Code	Course Name (Minor)	Credits (L+T +P)
	3SRMM504	Chemistry –V (Research Methodology for Chemistry)	4(2+0+2)
VI	3SEZM604	Zoology VI (Economic Zoology)	4(2+0+2)
	3SPRM604	Botany VI (Plant Reproduction)	4(2+0+2)
	3SBIM604	Chemistry-VI (Biochemistry)	4(2+0+2)

Value Added Course			
Semester	**Course Code**	**Course Name**	**Credits (L+T+P)**
1st	3IFAV106	Fundamentals of AI	3(3+0+0)
1st	3SEEV106	Environmental Education	3(3+0+0)
2nd	3ICSV206	Cyber Security	3(3+0+0)
2nd	3HCIV206	Contemporary India	3(3+0+0)
2nd	3HYEV206	Yoga Education	3(0+1+2)

Inter Discipline Course			
Semester	**Course Code**	**Course Name**	**Credits (L+T+P)**
1st	3SPHI102	Public Health and Hygiene	3(3+0+0)
2nd	3SATI202	Analytical Techniques	3(3+0+0)
3rd	3SMCI302	Mushroom Cultivation	3(0+1+2)

Skill Enhancement Elective Courses

Semester	Course Code	Course Name	Credits (L+T+P)
1st	3SIBS105	Introduction of Basic Instrument in Biology	2(0+1+1)
2nd	3SIPS205	Intellectual Property Right	2(2+0+0)
3rd	3SNGS305	Nursery and Gardening	3(0+1+2)
5th	3SAFS505	Aquarium Fish Keeping	2(0+1+1)

Ability Enhancement Course

Semester	Course Code	Course Name	Credits (L+T+P)
1st	3HHLA101	Hindi Language	2(2+0+0)
2nd	3HELA201	English Language	2(2+0+0)
3rd	3HCSA301	Communication Skill	2(2+0+0)
4th	3HCHA401	Cultural Heritage	2(2+0+0)

Semester-wise Distribution of Courses

Semester	Course Opted	Course Name	Credits
I	Value Added Course	Fundamentals of AI Environmental Education	3
	Ability Enhancement Course	Hindi Language	2
	Skill Enhancement Course	Introduction of Basic Instrument in Biology	2
	Inter Discipline Course	Public Health and Hygiene	3
	Major Core	Zoology/Botany/Chemistry	4
	Minor Core	Zoology/Botany/Chemistry	2
	Major Core Practical	Zoology/Botany/Chemistry	2
	Minor Core Practical	Zoology/Botany/Chemistry	2

Semester	Course Opted	Course Name	Credits
II	Value Added Course	Cyber Security Contemporary India Yoga education	3
	Ability Enhancement Course	English Language	2
	Skill Enhancement Course	Intellectual Property Right	2
	Inter Discipline Course	Analytical Techniques	3
	Major Core	Zoology/Botany/Chemistry	4
	Minor Core	Zoology/Botany/Chemistry	2
	Major Core Practical	Zoology/Botany/Chemistry	2
	Minor Core Practical	Zoology/Botany/Chemistry	2
III	Ability Enhancement Course	Communication Skill	2
	Skill Enhancement Course	Nursery and Gardening	3
	Inter Discipline Course	Mushroom Cultivation	3
IV	Major Core	Zoology/Botany/Chemistry	4
	Minor Core	Zoology/Botany/Chemistry	4
	Major Core Practical	Zoology/Botany/Chemistry	2
	Minor Core Practical	Zoology/Botany/Chemistry	2
	Ability Enhancement Course	Culture Heritage	2
	Major Core - I	Zoology/Botany/Chemistry	4
	Major Core - II	Zoology/Botany/Chemistry	4
	Minor Core	Zoology/Botany/Chemistry	4
	Major Core-I Practical	Zoology/Botany/Chemistry	2
	Major Core-II Practical	Zoology/Botany/Chemistry	2
	Minor Core Practical	Zoology/Botany/Chemistry	2
V	Skill Enhancement Course	Aquarium fish keeping	2
	Major Core – I	Zoology/Botany/Chemistry	4
	Major Core – II	Zoology/Botany/Chemistry	2
	Major Core – III	Zoology/Botany/Chemistry	2
	Minor Core	Zoology/Botany/Chemistry	2
	Major Core-I Practical	Zoology/Botany/Chemistry	2
	Major Core-II Practical	Zoology/Botany/Chemistry	2
	Major Core-III Practical	Zoology/Botany/Chemistry	2
	Minor Core Practical	Zoology/Botany/Chemistry	2
VI	Major Core - I	Zoology/Botany/Chemistry	4

Semester	Course Opted	Course Name	Credits
	Major Core - II	Zoology/Botany/Chemistry	4
	Major Core - III	Zoology/Botany/Chemistry	2
	Minor Core	Zoology/Botany/Chemistry	2
	Major Core- I Practical	Zoology/Botany/Chemistry	2
	Major Core-II Practical	Zoology/Botany/Chemistry	2
	Major Core-III Practical	Zoology/Botany/Chemistry	2
	Minor Core- Practical	Zoology/Botany/Chemistry	2
		Total	120 Credits

Total Credits: 60 CC + 28 MINOR + 09 IDE + 08 AEC + 09 SEC + 06 VAC = 120 Credits

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF FIRST SEMESTER

Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Theory Group											
3SICC103	**Major Core**	Zoology –I (Invertebrates & Cell Biology)	100	60	20	40	14	4	-	-	4
3SDMC103		Botany – I (Diversity of Microbes and Cryptogams)									
3SPIC103		Chemistry- I ((Physical, Inorganic & Organic Chemistry)									
3SICM104	**Minor Core**	Zoology –I (Invertebrates & Cell Biology)	100	60	20	40	14	2	-	-	2
3SDMM104		Botany – I (Diversity of Microbes and Cryptogams)									
3SPIM104		Chemistry –I (Physical, Inorganic & Organic Chemistry)									
3SPHI102	**Interdisciplinary Course**	Public Health and Hygiene	100	60	20	40	14	3	-	-	3
3HHLA101	**Ability Enhancement Course**	Hindi language	100	60	20	40	14	2	-	-	2
3SEEV106/ 3IFAV106	**Value Added Course**	Environmental Education/ Fundamentals of AI	100	60	20	40	14	3	-	-	3

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF FIRST SEMESTER

Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Practical Group				**Term End Practical Exam**		**Internal Assessment**		-			
3SIBS105	**Skill Enhancement Course**	Introduction of Basic Instrument in Biology	100	60	20	40	14	-	1	1	2
3SICC103	**Practical Major Core**	Zoology -I (Invertebrates & Cell Biology)	100	60	40	40	14		-	2	2
3SDMC103		Botany- I (Diversity of Microbes and Cryptogams)									
3SPIC103		Chemistry-I (Physical Inorganic & Organic Chemistry)									
3SICM104	**Practical Minor Core**	Zoology –I (Invertebrates & Cell Biology)	100	60	40	40	14	-	-	2	2
3SDMM104		Botany – I (Diversity of Microbes and Cryptogams)									
3SPIM104		Chemistry –I (Physical, Inorganic & Organic Chemistry)									
	Grand Total		**800**					**14**	**1**	**5**	**20**

Minimum Passing Marks are equivalent to Grade DL- Lectures T- Tutorials P- Practical

External theory & practical will carry 60 marks.

Internal Assessment (theory & practical will carry total of 40 marks.

Internal Assessment – Attendance 75% Pre-University Test (PUT)/ Assignments.

Note- 1. List of AEC, VAC, SEC, IDC, MAJOR and MINOR subjects are enclosed after the scheme.

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF SECOND SEMESTER

Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Theory Group											
3SVDC203	Major Core	Zoology –II (Vertebrates & Developmental Biology)	100	60	20	40	14	4	-	-	4
3SCBC203		Botany – II (Cell Biology and Genetics)									
3SPCC203		Chemistry –II (Physical Chemistry)									
3SVDM204	Minor Core	Zoology –II (Vertebrates & Developmental Biology)	100	60	20	40	14	2	-	-	2
3SCBM204		Botany – II (Cell Biology and Genetics)									
3SPCM204		Chemistry –II (Physical Chemistry)									
3SATI202	Interdisciplinary Course	Analytical Techniques	100	60	20	40	14	3	-	-	3
3HELA201	Ability Enhancement Course	English language	100	60	20	40	14	2	-	-	2
3SIPS205	Skill Enhancement Course	Intellectual Property Right	100	60	20	40	14	2	-	-	2
3ICSV206/ 3HYEV206/ 3HCIV206	Value Added Course	Cyber Security/ Yoga Education/ Contemporary India	100	60	20	40	14	3	-	-	3

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF SECOND SEMESTER											
Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Practical Group				Term End Practical Exam		Internal Assessment					
3SVDC203	Practical Major Core	Zoology –II (Vertebrates & Developmental Biology)	100	60	20	40	14		-	2	2
3SCBC203		Botany – II (Cell Biology and Genetics)									
3SPCC203		Chemistry –II (Physical Chemistry)									
3SVDM204	Practical Minor Core	Zoology –II (Vertebrates & Developmental Biology)	100	60	20	40	14	-	-	2	2
3SCBM204		Botany – II (Cell Biology and Genetics)									
3SPCM204		Chemistry –II (Physical Chemistry)									
	Grand Total		800					16	-	4	20

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF SECOND SEMESTER												
Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution

***For value added course yoga education credit distribution will be**

Practical Group			Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Total Credit
3HYEV206	Value Added Course	Yoga Education	100	60	20	40	14	-	1	2	3

Minimum Passing Marks are equivalent to Grade DL- Lectures T- Tutorials P- Practical

External theory & practical will carry 60 marks.

Internal Assessment (theory & practical will carry total of 40 marks.

Internal Assessment – Attendance 75% Pre-University Test (PUT)/ Assignments.

Note- 1. List of AEC, VAC, SEC, IDC, MAJOR and MINOR subjects are enclosed after the scheme.

After Second Sem Student exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline/Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship/ apprenticeship in addition to 6 credits from skill- based courses earned during first and second semester.

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF THIRD SEMESTER

Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Theory Group											
3SGEC303	**Major Core**	Zoology –III (Genetics)	100	60	20	40	14	4	-	-	4
3SBSC303		Botany – III (Biodiversity and Systematic of Seed Plant)									
3SPIC303		Chemistry- III (Physical, Inorganic & Organic Chemistry)									
3SGEM304	**Minor Core**	Zoology –III (Genetics)	100	60	20	40	14	4	-	-	4
3SBSM304		Botany – III (Biodiversity and Systematic of Seed Plant)									
3SPIM304		Chemistry- III (Physical, Inorganic & Organic Chemistry)									
3HCSA301	**Ability Enhancement Course**	Communication Skill	100	60	20	40	14	2	-	-	2

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF THIRD SEMESTER

Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Practical Group				**Term End Practical Exam**		**Internal Assessment**					
3SGEC303	**Practical Major Core**	Zoology –III(Genetics)	100	60	20	40	14		-	2	2
3SBSC303		Botany – III (Biodiversity and Systematic of Seed Plant)									
3SPIC303		Chemistry- III (Physical, Inorganic & Organic Chemistry)									
3SGEM304	**Practical Minor Core**	Zoology –III (Genetics)	100	60	20	40	14	-	-	2	2
3SBSM304		Botany – III (Biodiversity and Systematic of Seed Plant)									
3SPIM304		Chemistry- III (Physical, Inorganic & Organic Chemistry)									
	Grand Total		**700**					**10**	**2**	**8**	**20**

BACHELOR OF SCIENCE
Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF THIRD SEMESTER											
Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution

*For Interdisciplinary Course Mushroom Cultivation credit distribution will be

Practical Group			Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Total Credit
3SMCI302	Interdisciplinary Course	Mushroom Cultivation	100	60	20	40	14	-	1	2	3

Minimum Passing Marks are equivalent to Grade DL- Lectures T- Tutorials P- Practical
External theory & practical will carry 60 marks.
Internal Assessment (theory & practical will carry total of 40 marks.
Internal Assessment – Attendance 75% Pre-University Test (PUT)/ Assignments.
Note- 1. List of AEC, VAC, SEC, IDC, MAJOR and MINOR subjects are enclosed after the scheme

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF FOURTH SEMESTER

Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Theory Group											
3SAPC403	**Major Core - I**	Zoology –IV (Animal Physiology	100	60	20	40	14	4	-	-	4
3SSDC403		Botany – IV (Structure Development & Reproduction in Flowering Plant)									
3SPOC403		Chemistry –IV (Physical, Organic and Inorganic Chemistry)									
3SIMC403	**Major Core - II**	Zoology-IV (Immunology)	100	60	20	40	14	4	-	-	4
3SPPC403		Botany-IV (Plant Pathology)									
3SAMC403		Chemistry-IV (Analytical Methods in Chemistry)									
3SAPM404	**Minor Core**	Zoology –IV (Animal Physiology)	100	60	20	40	14	4	-	-	4
3SSDM404		Botany – IV (Structure Development & Reproduction in Flowering Plant)									
3SPOM404		Chemistry – IV (Physical, Organic and Inorganic Chemistry)									
3HCHA401	**Ability Enhancement Course**	Cultural Heritage	100	60	20	40	14	2	-	-	2

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF FOURTH SEMESTER

Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Practical Group				**Term End Practical Exam**		**Internal Assessment**					
3SAPC403	Practical Major Core-I	Zoology –IV (Animal Physiology	100	60	20	40	14		-	2	2
3SSDC403		Botany – IV (Structure Development & Reproduction in Flowering Plant)									
3SPOC403		Chemistry –IV (Physical, Organic and Inorganic Chemistry)									
3SIMC403	Practical Major Core-II	Zoology-IV (Immunology)	100	60	20	40	14	-	-	2	2
3SPPC403		Botany-IV (Plant Pathology)									
3SAMC403		Chemistry-IV (Analytical Methods in Chemistry)									
3SAPM404	Practical Minor Core	Zoology –IV (Animal Physiology)	100	60	20	40	14	-	-	2	2
3SSDM404		Botany – IV (Structure Development & Reproduction in Flowering Plant)									
3SPOM404		Chemistry – IV (Physical, Organic and Inorganic Chemistry)									
	Grand Total		**700**					**14**	-	**6**	**20**

Minimum Passing Marks are equivalent to Grade DL- Lectures T- Tutorials P- Practical

External theory & practical will carry 60 marks.

Internal Assessment (theory & practical will carry total of 40 marks.

Internal Assessment – Attendance 75% Pre-University Test (PUT)/ Assignments.

Note- 1. List of AEC, VAC, SEC, IDC, MAJOR and MINOR subjects are enclosed after the scheme.

After IV Sem - Student exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline/Subject provided they secure additional 4 credit in skill based vocational courses offered during first year or second year summer term.

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF FIFTH SEMESTER

Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Theory Group											
3SAZC503	**Major Core – I**	Zoology –V (Applied Zoology)	100	60	20	40	14	4	-	-	4
3SPPC503		Botany – V (Plant Physiology and Biochemistry)									
3SPOC503		Chemistry –V (Physical, Organic and Inorganic Chemistry)									
3SWLC503	**Major Core – II**	Zoology-V (Wild Life Conservation)	100	60	20	40	14	2	-	-	2
3SEEC503		Botany – V (Evolutionary and Economic Botany)									
3SRMC503		Chemistry –V (Research Methodology for Chemistry)									
3SABC503	**Major Core – III**	Zoology-V (Aquatic Biology)	100	60	20	40	14	2	-	-	2
3SIBC503		Botany – V (Industrial Botany)									
3SGCC503		Chemistry –V (Green Chemistry)									
3SABM504	**Minor Core**	Zoology –V (Aquatic biology)	100	60	20	40	14	2	-	-	2
3SIBM504		Botany – V (Industrial Botany)									
3SRMM504		Chemistry –V (Research methodology for chemistry									

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF FIFTH SEMESTER											
Course Details				**External Assessment**		**Internal Assessment**		**Credit Distribution**			**Allotted Credits**
Course Code	**Course Type**	**Course Title**	**Total Marks**	**Max Marks**	**Min Marks**	**Max Marks**	**Min Marks**	**L**	**T**	**P**	**Subject wise Distribution**
Practical Group				**Term End Practical Exam**		**Internal Assessment**					
3SAZC503	**Practical Major Core-I**	Zoology –V (Applied Zoology)	100	60	20	40	14		-	2	2
3SPPC503		Botany – V (Plant Physiology and Biochemistry)									
3SPOC503		Chemistry –V (Physical, Organic and Inorganic Chemistry)									
3SWLC503	**Practical Major Core-II**	Zoology-V (Wild Life Conservation)	100	60	20	40	14		-	2	2
3SEEC503		Botany – V (Evolutionary and Economic Botany)									
3SRMC503		Chemistry –V (Research Methodology for Chemistry)									
3SABC503	**Practical Major Core-III**	Zoology-V (Aquatic Biology)	100	60	20	40	14		-	2	2
3SIBC503		Botany – V (Industrial Botany)									
3SGCC503		Chemistry –V (Green Chemistry)									
3SABM504	**Practical Minor Core**	Zoology –V (Aquatic Biology)	100	60	20	40	14	-	-	2	2
3SIBM504		Botany – V (Industrial Botany)									
3SRMM504		Chemistry –V (Research Methodology for Chemistry)									

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF FIFTH SEMESTER											
Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Skill Course											
3SAFS505	**Skill Enhancement Course**	Aquarium fish keeping (Internship Base)	100	60	20	40	14	-	1	1	2
	Grand Total		**900**					**10**	**1**	**9**	**20**

Minimum Passing Marks are equivalent to Grade DL- Lectures T- Tutorials P- Practical

External theory & practical will carry 60 marks.

Internal Assessment (theory & practical will carry total of 40 marks.

Internal Assessment – Attendance 75% Pre-University Test (PUT)/ Assignments.

Note- 1. List of AEC, VAC, SEC, IDC, MAJOR and MINOR subjects are enclosed after the scheme

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF SIXTH SEMESTER

Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Theory Group											
3SEBC603	**Major Core - I**	Zoology –VI (Environmental Biology & Evolution)	100	60	20	40	14	4	-	-	4
3SPEC603		Botany – VI (Plant Ecology & Biodiversity & Phytogeography)									
3SPOC603		Chemistry –VI (Physical, Organic and Inorganic Chemistry)									
3SAQC603	**Major Core - II**	Zoology –VI (Aquaculture)	100	60	20	40	14	4	-	-	4
3SEBC603		Botany – VI (Ethno Botany)									
3SNCC603		Chemistry –VI (Nano Chemistry)									
3SEZC603	**Major Core - III**	Zoology –VI (Economic Zoology)	100	60	20	40	14	2	-	-	2
3SPRC603		Botany – VI (Plant Reproduction)									
3SBIC603		Chemistry –VI (Biochemistry)									
3SEZM604	**Minor Core**	Zoology VI (Economic Zoology)	100	60	20	40	14	2	-	-	2
3SPRM604		Botany VI (Plant Reproduction)									
3SBIM604		Chemistry-VI (Biochemistry)									

BACHELOR OF SCIENCE

Duration: 36 Months (3 Years) Eligibility: 12th Pass (Biology & Agriculture)

COURSE STRUCTURE OF SIXTH SEMESTER

Course Details				External Assessment		Internal Assessment		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Practical Group				**Term End Practical Exam**		**Internal Assessment**					
3SEBC603	Practical Major Core-I	Zoology –VI (Environmental Biology & Evolution)	100	60	20	40	14	-	-	2	2
3SPEC603		Botany – VI (Plant Ecology & Biodiversity & Phytogeography)									
3SPOC603		Chemistry –VI (Physical, Organic and Inorganic Chemistry)									
3SAQC603	Practical Major Core-II	Zoology –VI (Aquaculture)	100	60	20	40	14	-	-	2	2
3SEBC603		Botany – VI (Ethno Botany)									
3SNCC603		Chemistry –VI (Nano Chemistry)									
3SEZC603	Practical Major Core-III	Zoology –VI (Economic Zoology)	100	60	20	40	14	-	-	2	2
3SPRC603		Botany – VI (Plant Reproduction)									
3SBIC603		Chemistry –VI (Biochemistry)									
3SEZM604	Practical Minor Core-	Zoology VI (Economic Zoology)	100	60	20	40	14	-	-	2	2
3SPRM604		Botany VI (Plant Reproduction)									
3SBIM604		Chemistry-VI (Biochemistry)									
	Grand Total		**800**					**12**	-	**8**	**20**

Minimum Passing Marks are equivalent to Grade DL- Lectures T- Tutorials P- Practical

External theory & practical will carry 60 marks.

Internal Assessment (theory & practical will carry total of 40 marks.

Internal Assessment – Attendance 75% Pre-University Test (PUT)/ Assignments.

Note- 1. List of AEC, VAC, SEC, IDC, MAJOR and MINOR subjects are enclosed after the scheme

RAMANUJAN SCHOOL OF SCIENCE

BACHLOR OF SCIENCE

(Chemistry, Biology, Zoology)

(B. Sc. (CBZ) – CKUG04B03)

I Semester

CORE COURSES

3SICC103: Zoology-I (Invertebrates and Cell Biology)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SICC103	Invertebrates and Cell Biology	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objective

- This paper is aimed to introducing the students for the salient features of all invertebrates, cell organization and cell division.
- This paper aimed to identify the common and unknown species.
- Be able to collect and properly preserve organism.
- Be competent in the use of microscopes for dissection and identification.

Course Learning Outcome

- Student has a knowledge of classification and life cycle of invertebrates and cell division. Student will study the invertebrate phyla.
- They will be expected to be familiar with the names and characteristics of the phyla.
- Be able to identify specimens and their morphology, and discuss their ecology and evolution.
- Study of invertebrate will help the students understand the connecting link between the lower and higher invertebrate in the animal kingdom.

Syllabus Credits 4-0-2

Unit-I

Introduction: Taxonomy And Invertebrate

Taxonomy; Zoological nomenclature and international code, Classification of lower Invertebrates and higher invertebrates, Protozoa; Type study of plasmodium, Protozoan diseases. Porifera; Type study of Sycon, internal and external structure, development, reproduction, cellular organization. Types of canal systems; asconoid, syconoid, leuconoid and their variations, Water flow and filtration.

UNIT-II

Lower Invertebrate

Coelenterate; Type study of Obelia, physiology, development stage and life history, Corals and Coral reef formation, Platyhelminthes; Type study of Liver Fluke, External morphology and life history. Annelida; Type study of Earthworm, Metamerism, Trochophore Larva, structure and significance of Trochophore larva.

UNIT-III

Higher Invertebrate

Arthropoda; Type study of Prawn, Metamorphosis in the life cycle of prawns, Different developmental stages from larva to adult, Larval forms of crustacean, Insects as a vector of human disease, Mollusca; Type study of Pila, Larval forms of Mollusca, Echinodermata; External Features of Star Fish and water vascular system of Starfish (Asterias). Larval forms of Echinodermata.

UNIT-IV

Cell: Theory, Structure and Function

The Cell–Cell theory, Prokaryotic and Eukaryotic cell, Microscopy; Compound and Electron Microscopy, Plasma membrane and extranuclear organization of cell, Structure and functions of Golgi body, Mitochondria, Endoplasmic reticulum, Ribosome and Lysosome.

UNIT–V

Nuclear Organization and Cell Reproduction

Nuclear Organization of cell, Extra nuclear organization of cell, Cell reproduction; Amitosis, mitosis, meiosis, Cell division and their significance, Mitosis and meiosis in eukaryotic cells.

Practical Content **Credits: 2**

1. Study of Museum Specimens, slides relevant to the type study in theory
2. **Mounting (Temporary)**

a. Mouth parts of insects
b. Statocyst of Prawn
c. Ctenidium and Osphradium of Pila

3. **Major Dissection**

a. Earthworm: Digestive system, nervous system and reproductive system.
b. Prawn: Nervous System, Appendages.

4. **Minor Dissection**

a. Hastate plate and appendages of Prawn.
b. Salivary glands of Cockroach.
c. Radula of Pila.

5. **Cell Biology**

a. Study of Prokaryotic and eukaryotic cell.
b. Study of DNA and R NA models.
c. Squash preparation of chromosomes from onion root tip.

Textbook

- Textbook of Zoology by Ghose Dr. K. C. Manan, Publication London, New central.
- Modern Textbook of Zoology Invertebrate by R. L. Kotpal, Rastogi Publication.
- A textbook of Cell Biology and Genetics by Veer Bala Rastogi.
- Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P.S. Verma and V.K. Agrawal, S. Chand Publication.
- Invertebrate Zoology by R., Chand and Co., India, Dhami and Dhami.

Reference Books

- A Text Book of Zoology, VII edition, Vol. I and II Low Price Publications, Delhi by Parker, Haswell.
- Invertebrate Zoology, VII Edition, Cengage Learning, by Barnes, RD, India.
- Biology of the Invertebrates by Pechenik, McGraw-Hill Educations, VII Edition.

- A Students Text Book of Zoology, Vol. I, II and Vol. III. By Low Price Sedgwick.

Facilitating the achievement of course learning objectives

Unit No.	Course learning outcome	Teaching and learning activities	Assessment tasks
1	Identifying and describing the major groups of higher invertebrates. Exploring the diverse adaptations and specialized features of these organisms. Understanding their roles in various ecosystems and their interactions with other organisms.	Start with traditional lectures to provide foundational knowledge about the classification, anatomy, physiology, and ecology of both lower and higher invertebrates. Use multimedia presentations, diagrams, and images to illustrate key concepts. Encourage student participation through questions and discussions.	Class test focusing on and short questions and objectives.
2	Students should be able to identify and classify different coelenterate species based on their morphological characteristics.	Conduct hands-on laboratory sessions where students can observe and study live or preserved coelenterate specimens.	Class test focusing on definitions and long subjective questions.
3	Students should be able to classify arthropods into major classes and orders, and identify key characteristics that distinguish them. Students should be able to classify molluscs into major classes (e.g. Gastropods, Bivalvia, Cephalopoda) and describe distinguishing features.	Organize field trips or laboratory sessions where students collect and identify arthropods. Provide field guides and microscopes for closer examination.	Class test focusing on definitions and long subjective questions.
4	Compare and contrast the structure and properties of cell membranes in prokaryotic and eukaryotic cells. Explain the roles of cell membranes in maintaining cell integrity and regulating transport processes.	Utilize interactive online simulations or virtual labs that allow students to explore cell structures and functions in a virtual environment. These resources can provide visual reinforcement of concepts.	Class quizzes or short tests that assess your understanding of specific lecture topics.
5	Students should be able to explain the phases of the cell cycle, including G1, S, G2, and mitosis (M phase), and understand the key events that occur in each phase.	Traditional lectures to introduce and explain key concepts, phases of the cell cycle, and regulatory mechanisms. In-class discussions to encourage students to ask questions, share insights, and clarify doubts.	Class test, quiz and multiple-choice and long questions.

CORE COURSES

3SDMC103: Botany-I (Diversity of Microbes and Cryptogams)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SDMC103	Botany-I (Diversity of Microbes and Cryptogams)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- To make the student know the outline of origin and evolution of life.
- Understand the structure of bacteria and viruses and plant diseases caused by bacteria and viruses and their control.
- To make students learn the general characters and economic importance of algae and fungi.
- To make the students understand the vegetative and reproductive
- Features of different algae and fungi through the study of representative types of various classes.

Course Learning Outcome

- Study of Pteridophytes and Gymnosperms will help the students understand the connecting link between the lower and higher organisms in the plant kingdom.
- The anatomy imparts a thorough knowledge about the internal structure and relationship between tissues and evolution.
- Most of the techniques in biotechnology uses bacteria, viruses and fungi.
- This course will make the students adept in the structure and functions of these microbes which in turn will give them confidence to work using this org.

Syllabus **Credits: 4-0-2**

UNIT – I

Viruses and Prokaryotes: Characteristics of Viruses. General account of TMV and T4 bacteriophage. Bacterial structure, nutrition, reproduction and economic importance. General account of Mycoplasma, Cyanobacteria and Actinomycetes.

UNIT- II

Algae: General characters, classification and economic importance; important features and life history of Chlorophyceae-*Volvox*, *Oedogonium*, Charophyceae-*Chara* Xanthophyceae - *Vaucheria*, Phaeophyceae - *Ectocarpus*, *Sargassum*, Rhodophyceae -*Polysiphonia*.

UNIT- III

Fungi: General characters, classification and economic importance, important features and life history of Mastigomycotina: *Phytophthora*, Zygomycotiana: *Mucor*. Ascomycotina: *Aspergillus*, *Yeast Peziza*, Basidomycotina: *Puccinia*, Deurteromycotina: *Cercospora*, *Colletotrichum*. General account of lichens.

UNIT- IV

Bryophyta: General characters and classification, study of morphology, Anatomy, Reproduction of Hepaticopsida: *Riccia*, *Marchantia*, Anthrocerotopsida: *Anthoceros*, Bryopsida: *Polytrichum.*

UNIT-V

Pteridophyta: Important characters and classification. Stellar organization. Morphology and anatomy of *Rhynia*. Structure, anatomy and reproduction in *Lycopodium*, *Selaginella*, *Equisetum* and *Marsilea*.

Practical Content **Credits: 2**

1. Study of *volvox* by preparing temporary slide.
2. Study of *oedogonium* by preparing temporary slide.
3. Study of *chara* by preparing temporary slide.
4. Study of *polysiphonia* by preparing temporary slide.
5. Study of *mucor* by preparing temporary slide.
6. Study of *aspergillus* by preparing temporary slide.
7. Study of *peziza* by preparing temporary slide.
8. Study of *puccinia* by preparing temporary slide.
9. To study external morphology of *riccia thallus*.
10. To study external morphology of *marchantia thallus*.

Reference Book

- Hait. Bhattachary. Ghosh Vol 1st and Vol 2nd A Text Book of Botany.
- Gangulee and Kar Vol 1st and Vol 2nd College Botany.
- H.D. Kumar (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
- Botany for Degree Students Pteridophyta Dr. P.C. Vashishta and Dr. A.K. Sinha, Dr. Anil Kumar (2010). S. Chand. Delhi, India.

Text book

- Introduction to Bryophytes by- Alain Vanderpoorten and Bernard Goffinet - Focuses specifically on bryophytes, including mosses and liverworts.
- Introduction to Algae by- Graham. P. Harris - Offers insights into the diverse world of algae, spanning green, brown, and red algae.
- Introduction to Fungi by- John. Webster and Roland. W.S. Weber - Provides a comprehensive overview of fungal biology.
- S.B. Agrawal, V.K. Agrawal and Amit Agrawal, Unified. Vanaspati Vigyan.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment tasks
1	Understand the interactions between viruses and host cells, including viral tropism and host cell receptors. Explain how viruses evade host immune responses.	Explain the structure of viruses and their classification based on genetic material, shape, and other characteristics. Use visual aids, diagrams, and models to facilitate understanding.	Class test focusing on definitions and short questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment tasks
2	Understand the different modes of reproduction in algae, including asexual and sexual reproduction, and be able to describe the life cycles of common algal groups.	Conduct practical sessions where students can observe different types of algae under microscopes. Teach them how to prepare slides and identify algae based on their features.	Class test focusing on definitions and long subjective questions.
3	Analyse the ecological roles of fungi in various ecosystems, including decomposition, mycorrhizal associations, and symbiotic relationships with other organisms.	Students can observe fungi under microscopes. They can collect samples from different sources, like mouldy bread, soil, or mushrooms. This will help them learn about fungal structures and reproduction.	Class test focusing on definitions and long subjective questions.
4	Students should grasp the alternation of generations life cycle in bryophytes, including the roles of gametophytes and sporophytes. They should be able to explain how bryophytes reproduce both sexually and asexually.	Ask students to create models or diagrams of the bryophyte life cycle, including the gametophyte and sporophyte stages. This can be done individually or in small groups.	class quizzes and short tests that assess your understanding of specific lecture topics.
5	Describe the alternation of generations in pteridophytes, including the gametophyte and sporophyte phases. Explain the process of spore formation, release, and germination in pteridophytes.	Use props or drawings to simulate the process of fern reproduction. Students can act as gametophytes and sporophytes to demonstrate the alternation of generations. This hands-on activity can help students grasp the concept more effectively.	Class test, quiz and multiple-choice questions.

CORE COURSES

3SPIC103: Chemistry –I (Physical, Inorganic and Organic Chemistry)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SPIC103	Chemistry –I (Physical, Inorganic and Organic Chemistry)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Mastering math tools for problem-solving in chemistry.
- Understanding gas behavior and critical phenomena.
- Analyzing molecular structures and crystallography.
- Comparing properties and complexation tendencies.
- Grasping bonding, reactions, and stereochemistry principles.

Course Learning Outcomes

- Ability to apply logarithmic relations, differentiate functions, and calculate slopes for chemical applications.
- Understanding of gas laws, critical phenomena, and molecular dynamics.
- Proficiency in analyzing molecular structures, intermolecular forces, and crystallography.
- Competence in comparing properties, understanding complexation tendencies, and identifying key characteristics.
- Profound understanding of bonding, reaction mechanisms, and stereochemical principles in organic compounds.

Syllabus Credits: 4-0-2

Physical Chemistry

UNIT - I

Mathematical Concepts

Logarithmic relations, curves stretching, linear graphs, calculation of Slopes. Differentiation of functions like K_x, e^x, x^n, sin x, logx; maxima and minima, partial differentiation. Integration of some useful/relevant functions; Factorials, probability.

Gaseous States

Critical phenomenon: PV isotherms of ideal gases, continuity of states, the isotherms of van der Waals equations, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of states.

Molecular Velocities

Root mean square, average and most probable velocities. Qualitative discussion of the maxwell's distribution of molecular velocities, collision numbers, mean free path and collision diameter.

UNIT - II

Liquid State

Intermolecular forces, structure of liquids (a qualitative description) liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesteric phases. Thermography and seven segment cells.

Solid State

Definition of space lattice, unit cell. Laws of crystallography - (i) Law of constancy of interfacial angles (ii) Law of rationality of indices (iii) Laws of symmetry, symmetry elements in crystals. Diffraction: X-ray diffraction by crystals, derivation of Bragg's equation. Determination of crystal structure of NaCl, KCl and CsCl (Laue's method).

Inorganic Chemistry

UNIT – III

s-Block Elements

Comparative study Li and Mg, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls.

p-Block Elements Part-I

Comparative study Be and Al (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacid and halides of groups 13-16.

p-Block Elements Part-II

Hydrides of boron: diborane and higher boranes, borazine, borohydrides. fullerenes, carbides, fluorocarbons, silicates (structural principle), tetra Sulphur tetranitride, basic properties of halogens, interhalogens.

Organic Chemistry

UNIT - IV

Structure and Bonding

Hybridizations, bond lengths and bond angles, bond energy, localized and delocalized chemical bond, inclusion compounds, clathrates, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.

Mechanism of Organic Reactions

Homolytic and heterolytic bond breaking. Types of Reagents- electrophiles and nucleophiles. Types of organic reactions, energy consideration. Reactive intermediates (carbocations, carbanions, free radicals and carbenes). Methods of determination of reaction mechanism (active intermediate products).

UNIT - V

Stereochemistry of Organic Compounds

Concept of isomerism, types of isomerism. Optical isomerism, elements of symmetry, molecular chirality, enantiomers, stereo genic centers, optical activity, properties of enantiomers, chiral and achiral molecules with two stereo genic centers, diastereomers, mesocompounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configurations, sequence rule, D & L and R & S system of nomenclature. Geometrical isomerism- determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.

Practical Content **Credits: 2**

Physical Chemistry

- Calibration of thermometer.
- Determination of melting point.
- Determination of boiling point.
- Determination of surface tension / percentage composition of given organic mixture using surface tension method.

Inorganic Chemistry

- Separation of cations by paper chromatography.
- Preparation of ferrous alum.

Organic chemistry

- Distillation
- Crystallization
- Decolorization and crystallization using charcoal
- Sublimation

Text Books

- Unified Chemistry by Tandon, Rathore and Agarwal.
- Physical Chemistry by P. W. Atkins and Julio de Paula.
- Inorganic Chemistry by Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr.
- Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren.
- Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch.
- Solid State Chemistry and its Applications by Anthony R. West.

Reference Books

- Physical Chemistry Thermodynamics, Structure, and Change by Peter Atkins and Julio de Paula.
- Inorganic Chemistry by Catherine and Alan G. Sharpe.
- Organic Chemistry by Francis A. Carey and Richard J. Sundberg.
- Solid State Chemistry an Introduction by Leslie E. Smart and Elaine A. Moore.
- Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Developing critical thinking skills and an appreciation for the broader context of mathematics in various fields and basics concept of gaseous states and molecular velocities.	Conduct traditional lectures to introduce fundamental mathematical concepts such as moles, stoichiometry and gas laws. Use visuals, diagrams, and real-world examples to make these concepts relatable.	Homework assignments requiring calculations of slopes, integration of functions, and probability problems.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
2	Intermolecular forces (hydrogen bonding, dipole-dipole interactions, London dispersion forces) influence liquid properties.	Begin with traditional lectures to introduce the fundamental concepts of the liquid state, including properties, intermolecular forces, and phase transitions.	Lab report on the determination of molecular velocities and collision parameters.
3	Collision theory and explain how it relates to reaction rates and the role of reactant collisions in chemical reactions.	Provide examples of reactions and guide students through the derivation of rate laws from experimental data, emphasizing the determination of reaction order.	Written exam assessing understanding of liquid crystals, crystallography, and diffraction techniques.
4	The basic structure of an atom, including the nucleus, electrons, protons, and neutrons. Explain the significance of atomic number and mass number.	Begin with interactive lectures that introduce key concepts of atomic structure, electron configuration, and chemical bonding. Use visual aids, models, and demonstrations to engage students.	Class quizzes or short tests that assess your understanding of specific lecture topics.
5	Define stereochemistry as the study of the spatial arrangement of atoms or groups of atoms in molecules and its impact on chemical properties.	Conduct interactive workshops where students practice assigning R and S configurations to stereo centres using the Cahn-Ingold-Prelog rules. Provide practice problems and molecular models.	Lab report on the application of spectroscopic techniques in structural analysis.

MINOR CORE COURSES

3SICM104: Zoology-I (Invertebrates and Cell Biology)

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SICM104	Zoology-I (Invertebrates and Cell Biology)	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objective

- This paper is aimed to introducing the students for the salient features of all Invertebrates, cell organization and cell division.
- This paper aimed to identify the common and unknown species.
- Be able to collect and properly preserve organism.
- Be competent in the use of microscopes for dissection and identification.

Course Learning Outcome

- Student has a knowledge of Classification and life cycle of invertebrates and cell division.
- Study of invertebrate will help the students understand the connecting link between the lower and higher invertebrate in the animal kingdom.
- Student will study the invertebrate phyla. They will be expected to be familiar with the names and characteristics of the phyla.
- Be able to identify specimens and their morphology, and discuss their ecology and evolution.

Syllabus Credits 2-0-2

UNIT-I:

Taxonomy and Invertebrate

Taxonomy nomenclature, Classification of Invertebrates and character, Protozoa; Type study of Plasmodium, life cycle and protozoan diseases, Porifera; Type study of Sycon, canal systems; asconoid, syconoid, leuconoid and their variations, Water flow and filtration.

UNIT-II:

Lower Invertebrate

Coelenterate; Type study of Obelia, Platyhelminthes; Type study of Liver Fluke, Geographical distribution of Liver Fluke species, Annelida; Metamerism, Trochophore Larva.

UNIT-III:

Higher Invertebrate

Arthropods; Type study of Prawn, Metamorphosis in the life cycle, different developmental stages from larva to adult, Mollusca; Type study of Pila, larval forms, Echinodermata; External Features of Star Fish and water vascular system of starfish.

UNIT-IV

The Cell

The cell; History of Cell Biology, Cell theory, Prokaryotic and Eukaryotic Cell, Complexity of internal structures in eukaryotic cells.

UNIT–V

Cell Reproduction and Nuclear Organization

Nuclear Organization of cell, Cell reproduction; Mitosis and meiosis in eukaryotic cells.

Practical Content **Credits: 2**

- Study of Museum Specimens, slides relevant to the type study in theory.
- Mouth parts of insects.
- Statocyst of Prawn.
- Ctenidium and osphradium of Pila.
- Major Dissection.
- Prawn: Nervous System.
- Cell Biology.

Textbook

- Textbook of Zoology, Publications London, New central by Ghose Dr. K. C. Manan.
- Modern Textbook of Zoology Invertebrate by R. L. Kotpal, Rastogi Publication.
- A textbook of Cell Biology and Genetics by Veer Bala Rastogi.
- Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P.S. Verma and V.K. Agrawal, S. Chand Publication.
- Invertebrate Zoology by R. Chand and Co. Dhami and Dhami India.

Reference Books

- A Text Book of Zoology, VII edition, Vol. I and II by Parker, J, Haswell, WA, Low Price Publications, Delhi, 1990.
- Invertebrate Zoology, VII Edition by Barnes, RD, Cengage Learning, India.
- Biology of the Invertebrates by Pechenik, McGraw Hill Educations, VII Edition.
- A Students Text Book of Zoology, Vol. I, II and Vol. III. By Sedgwick, Low Price.

Facilitating the achievement of course learning objectives.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Identifying and describing the major groups of higher invertebrates. Exploring the diverse adaptations and specialized features of these organisms. Understanding their roles in various ecosystems and their interactions with other organisms.	Start with traditional lectures to provide foundational knowledge about the classification, anatomy, physiology, and ecology of both lower and higher invertebrates.	Class test focusing on and short questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
		Use multimedia presentations, diagrams, and images to illustrate key concepts. Encourage student participation through questions and discussions.	
2	Students should be able to identify and classify different coelenterate Species based on their morphological characteristics.	Conduct hands-on laboratory sessions where students can observe and study live or preserved coelenterate specimens.	Class test focusing on definitions and long subjective questions.
3	Students should be able to classify arthropods into major classes and orders, and identify key characteristics that distinguish them. Students should be able to classify Mollusca into major classes (e.g. Gastropod, Bivalvia, Cephalopoda) and describe distinguishing features.	Organize field trips or laboratory sessions where students collect and identify arthropods. Provide field guides and microscopes for closer examination.	Class test focusing on definitions and long subjective questions.
4	Compare and contrast the structure and properties of cell membranes in prokaryotic and eukaryotic cells. Explain the roles of cell membranes in maintaining cell integrity and regulating transport processes.	Utilize interactive online simulations or virtual labs that allow students to explore cell structures and functions in a virtual environment. These resources can provide visual reinforcement of concepts.	Class quizzes or short tests that assess your understanding of specific lecture topics.
5	Students should be able to explain the phases of the cell cycle, including G1, S, G2, and mitosis (M phase), and understand the key events that occur in each phase.	Traditional lectures to introduce and explain key concepts, phases of the cell cycle, and regulatory mechanisms. In-class discussions to encourage students to ask questions, share insights, and clarify doubts.	Class test, quiz and multiple-choice and long questions.

MINOR CORE COURSES

3SDMM104: Botany-I (Diversity of Microbes and Cryptogams)

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SDMM104	Botany-I (Diversity of Microbes and Cryptogams)	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- To make the student know the outline of origin and evolution of life.
- Understand the structure of bacteria and viruses and plant diseases caused by Bacteria and viruses and their control.
- To make students learn the general characters and economic importance of algae and fungi.
- To make the students understand the vegetative and reproductive.
- Features of different algae and fungi through the study of representative types of various classes.

Course Learning Outcome

- Study of Pteridophytes and Gymnosperms will help the students understand the connecting link between the lower and higher organisms in the plant kingdom.
- The anatomy imparts a thorough knowledge about the internal structure and relationship between tissues and evolution.
- Most of the techniques in biotechnology uses bacteria, viruses and fungi.
- This course will make the students adept in the structure and functions of these microbes which in turn will give them confidence to work using this org.

Syllabus **Credits: 2-0-2**

UNIT – I

Viruses and Prokaryotes: Characteristics of Viruses. General account of TMV and T4 bacteriophage. Bacterial structure, nutrition, reproduction and economic importance. General account of Mycoplasma, Cyanobacteria and actinomycetes.

UNIT- II

Algae: General characters, classification and economic importance; important features and life history of Chlorophyceae-*Volvox*, *Oedogonium*, Charophyceae-*Chara* Xanthophyceae - *Vaucheria*, Phaeophyceae - *Ectocarpus*, *Sargassum*, Rhodophyceae -*Polysiphonia*.

UNIT- III

Fungi: General characters, classification and economic importance, important features and life history of Mastigomycotina: *Phytophthora*, Zygomycotiana: *Mucor*. Ascomycotina: *Aspergillus*, *Yeast Peziza*, Basidomycotina: *Puccinia*, Deurteromycotina: *Cercospora*, *Colletotrichum*. General account of lichens.

UNIT- IV

Bryophyta: General characters and classification, study of morphology, Anatomy, Reproduction of Hepaticopsida: *Riccia*, *Marchantia*, Anthrocerotopsida: *Anthoceros*, Bryopsida: *Polytrichum.*

UNIT-V

Pteridophyta: Important characters and classification. Stellar organization. Morphology and anatomy of *Rhynia*. Structure, anatomy and reproduction in *Lycopodium*, *Selaginella*, *Equisetum* and *Marsilea*.

Practical Content **Credits: 2**

1. Study of *volvox* by preparing temporary slide.
2. Study of *oedogonium* by preparing temporary slide.
3. Study of *chara* by preparing temporary slide.
4. Study of *polysiphonia* by preparing temporary slide.
5. Study of *mucor* by preparing temporary slide.
6. Study of *aspergillus* by preparing temporary slide.
7. Study of *peziza* by preparing temporary slide.
8. Study of *puccinia* by preparing temporary slide.
9. To study external morphology of *riccia thallus*.
10. To study external morphology of *marchantia thallus*.

Reference Book

- Hait. Bhattachary. Ghosh Vol 1st and Vol 2nd A Text Book of Botany.
- Gangulee and Kar Vol 1st and Vol 2nd College Botany.
- H.D. Kumar (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
- Pelczar. M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
- Botany for Degree Students Pteridophyta Dr. P.C. Vashishta and Dr. A.K. Sinha, Dr. Anil Kumar (2010). S. Chand. Delhi, India.

Text book

- Introduction to Bryophytes by- Alain Vanderpoorten and Bernard Goffinet - Focuses specifically on bryophytes, including mosses and liverworts.
- Introduction to Algae by-Graham P. Harris - Offers insights into the diverse world of algae, spanning green, brown, and red algae.
- Introduction to Fungi by John Webster and Roland W.S. Weber - Provides a comprehensive overview of fungal biology.
- S.B Agrawal, V.K Agrawal and Amit Agrawal, Unified, Vanaspati Vigyan.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Understand the interactions between viruses and host cells, including viral tropism and host cell receptors. Explain how viruses evade host immune responses.	Explain the structure of viruses and their classification based on genetic material, shape, and other characteristics. Use visual aids, diagrams, and models to facilitate understanding.	Class test focusing on definitions and short questions.
2	Understand the different modes of reproduction in algae, including asexual and sexual reproduction, and be able to describe the life cycles of common algal groups.	Conduct practical sessions where students can observe different types of algae under microscopes. Teach them how to prepare slides and identify algae based on their features.	Class test focusing on definitions and long subjective questions.
3	Analyse the ecological roles of fungi in various ecosystems, including decomposition, mycorrhizal associations, and symbiotic relationships with other organisms.	Students can observe fungi under microscopes. They can collect samples from different sources, like mouldy bread, soil, or mushrooms. This will help them learn about fungal structures and reproduction.	Class test focusing on definitions and long subjective questions.
4	Students should grasp the alternation of generations life cycle in bryophytes, including the roles of gametophytes and sporophytes. They should be able to explain how bryophytes reproduce both sexually and asexually.	Ask students to create models or diagrams of the bryophyte life cycle, including the gametophyte and sporophyte stages. This can be done individually or in small groups.	class quizzes or short tests that assess your understanding of specific lecture topics.
5	Describe the alternation of generations in pteridophytes, including the gametophyte and sporophyte phases. Explain the process of spore formation, release, and germination in pteridophytes.	Use props or drawings to simulate the process of fern reproduction. Students can act as gametophytes and sporophytes to demonstrate the alternation of generations. This hands-on activity can help students grasp the concept more effectively.	Class test, quiz and multiple-choice questions.

MINOR CORE COURSES

3SPIM104: Chemistry –I (Physical, Inorganic and Organic Chemistry

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SPIM104	Chemistry –I (Physical, Inorganic and Organic Chemistry	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Mastering math tools for problem-solving in chemistry.
- Understanding gas behavior and critical phenomena.
- Analyzing molecular structures and crystallography.
- Comparing properties and complexation tendencies.
- Grasping bonding, reactions, and stereochemistry principles.

Course Learning Outcomes

- Ability to apply logarithmic relations, differentiate functions, and calculate slopes for chemical applications.
- Understanding of gas laws, critical phenomena, and molecular dynamics.
- Proficiency in analyzing molecular structures, intermolecular forces, and crystallography.
- Competence in comparing properties, understanding complexation tendencies, and identifying key characteristics.
- Profound understanding of bonding, reaction mechanisms, and stereochemical principles in organic compounds.

Syllabus Credits 2-0-2

Physical Chemistry

UNIT – I

Gaseous States

Critical phenomenon: PV isotherms of ideal gases, continuity of states, the isotherms of van der Waals equations.

Molecular Velocities

Root mean square, average and most probable velocities. Qualitative discussion of the maxwell's distribution of molecular velocities, collision numbers, mean free path and collision diameter.

UNIT –II

Liquid State

Intermolecular forces, structure of liquids (a qualitative description). Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesteric phases.

Inorganic Chemistry

UNIT – III

s-Block Elements

Comparative study Li and Mg, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls.

p-Block Elements

Comparative study Be and Al (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacid and halides of groups 13-16.

Organic Chemistry

UNIT – IV

Structure and Bonding

Hybridizations, bond lengths and bond angles, bond energy, Localized and delocalized chemical bond, van-der Waals interactions, inclusion compounds, clathrates, charge transfer complexes, resonance, hyper- conjugation, aromaticity, inductive and field effects, hydrogen bonding.

Mechanism of Organic Reactions

Homolytic and heterolytic bond breaking. Types of Reagents- electrophiles and nucleophiles. Types of organic reactions, energy consideration.

UNIT – V

Stereochemistry of Organic Compounds

Concept of isomerism, types of isomerism, optical isomerism, elements of symmetry, molecular chirality, enantiomers, stereo genic centers, optical activity, properties of enantiomers, diastereomers, mesocompounds, resolution of enantiomers, inversion, retention and racemization.

Practical Content — Credits :2

Physical Chemistry

- Calibration of thermometer.
- Determination of melting point.
- Determination of boiling point

Inorganic Chemistry

- Separation of cations by paper chromatography.
- Preparation of ferrous alum.

Organic Chemistry

- Distillation.
- Crystallization.
- Sublimation.

Text Books

- Unified Chemistry by Tandon, Rathore and Agarwal.
- Physical Chemistry by P. W. Atkins and Julio de Paula.
- Inorganic Chemistry by Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr.
- Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren.
- Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch.
- Solid State Chemistry and its Applications by Anthony R. West.

Reference Books

- Physical Chemistry Thermodynamics, Structure, and Change by Peter Atkins and Julio de Paula.
- Inorganic Chemistry by Catherine and Alan G. Sharpe.
- Organic Chemistry by Francis A. Carey and Richard J. Sundberg.
- Solid State Chemistry an Introduction" by Leslie E. Smart and Elaine A. Moore.
- Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Developing critical thinking skills and an appreciation for the broader context of mathematics in various fields and basics concept of gaseous states and molecular velocities.	Conduct traditional lectures to introduce fundamental mathematical concepts such as moles, stoichiometry and gas laws. Use visuals, diagrams, and real-world examples to make these concepts relatable.	Homework assignments requiring calculations of slopes, integration of functions, and probability problems.
2	Intermolecular forces (hydrogen bonding, dipole-dipole interactions, London dispersion forces) influence liquid properties.	Begin with traditional lectures to introduce the fundamental concepts of the liquid state, including properties, intermolecular forces, and phase transitions.	Lab report on the determination of molecular velocities and collision parameters.
3	Collision theory and explain how it relates to reaction rates and the role of reactant collisions in chemical reactions.	Provide examples of reactions and guide students through the derivation of rate laws from experimental data, emphasizing the determination of reaction order.	Written exam assessing understanding of liquid crystals, crystallography, and diffraction techniques.
4	The basic structure of an atom, including the nucleus, electrons, protons, and neutrons. Explain the significance of atomic number and mass number.	Begin with interactive lectures that introduce key concepts of atomic structure, electron configuration, and chemical bonding. Use visual aids, models, and demonstrations to engage students.	Class quizzes or short tests that assess your understanding of specific lecture topics.
5	Define stereochemistry as the study of the spatial arrangement of atoms or groups of atoms in molecules and its impact on chemical properties.	Conduct interactive workshops where students practice assigning R and S configurations to stereo centres using the Cahn-Ingold-Prelog rules. Provide practice problems and molecular models.	Lab report on the application of spectroscopic techniques in structural analysis.

Inter Disciplinary Course

3SPHI102: Public Health and Hygiene

(Credits: Theory- 3, Tutorials- 0)

Scheme of Examination

Course Code	Course Name	Credit	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SPHI102	Public Health and Hygiene (1st Sem)	3(3-0-0)	60	20	20	-	-	100	3hr	-

Course Objective

- To enlighten the non-major elective students about the general knowledge on their health and hygiene.
- To create general health awareness, the hazardous impacts and remedy.

Course Learning Outcomes

- These outcomes cover a wide range of topics related to public health, nutrition, environmental health, disease prevention, and health education.
- They aim to equip learners with essential knowledge and skills for promoting and maintaining community health.

Syllabus: Credits 3-0-0

Unit 1:

Scope of Public health and Hygiene – nutrition and health – classification of foods bases on nutritional value – Nutritional deficiency diseases Vitamin deficiency diseases.

Unit 2:

Environment and Health hazards: Environmental degradation – Pollution – Air (causes and prevention), Water– Air (causes and prevention), Land– Air (causes and prevention) and Noise associated health hazards.

Unit 3:

Communicable diseases. Measles diseases and their preventive and control measures, Malaria diseases and their preventive and control measures, Hepatitis diseases and their preventive and control measures, Cholera, Filariasis diseases and their preventive and control measures, HIV /AIDS.

Unit 4:

Non-Communicable diseases and their preventive measures. Genetic diseases, Cancer, Cardio vascular diseases, Chronic respiratory disease, Diabetes, Epilepsy,

Unit 5:

Health Education in India – WHO Programs – Government and Voluntary Organizations and their health services – Precautions, First Aid and awareness on epidemic/sporadic diseases.

Text Book

- Park and Park, 1995: Text Book of Preventive and Social Medicine – Banarsidas Bhanot Publ. Jodhpur – India.
- Text Book of Public Health and hygiene, zoology by Dr. A. P. Ekhande, Dr. N. G. Mahajan, Dr. M. C. Patil, Dr. Manojkumar Chopda, Dr. R. M. Chaudhari, Prashant Publication.
- "Public Health and Community Medicine" by Rajvir Bhalwar (Publisher: CBS Publishers & Distributors Pvt Ltd)

Reference Books

- Verma, S. 1998: Medical Zoology, Rastogi publ. – Meerut – India
- Singh, H.S. and Rastogi, P.: Parasitology, Rastogi Publ. India.
- Dubey, R.C and Maheshwari, D.K. 2007: Text Book of Microbiology S. Chand and Co. Publ. New Delhi – India.

Facilitating the achievement of course learning objectives

Unit no.	Course learning outcomes	Teaching and learning activities	Assessment tasks
1.	• Understand the scope and significance of public health and hygiene. • Recognize the role of public health in promoting community wellbeing.	• Explain the relationship between nutrition and health. Scope of Public Health and Hygiene	• Multiple choice questions, quiz, Class test and students' presentation.
2.	• Understand the concept of environmental degradation. Identify factors contributing to environmental degradation.	• Describe the types of pollution, including air, water, land, and noise pollution. • Explain the associated health hazards and their effects on human health.	• Multiple choice questions, quiz, Class test and students' presentation.
3.	• Knowledge of Identify key preventive and control measures for communicable diseases.	• Describe the causes, symptoms, and preventive strategies for diseases like measles, malaria, hepatitis, cholera, filariasis, and HIV/AIDS.	• Multiple choice questions, match
4.	• Understand noncommunicable diseases (NCDs) and their risk factors.	• Describe genetic diseases, cancer, cardiovascular diseases, chronic respiratory diseases, diabetes, and epilepsy. • Explain the importance of early detection and management of NCDs.	• the following, students' presentation, quiz, class test focusing on short notes and definitions.
5.	• Learn about the World Health Organization (WHO) programs and their impact on global health. Explore the methods and channels for effective health education in India.	• Describe the basics of first aid for common health emergencies.	• Class tests, assignments, quiz, student presentations.

Ability Enhancement Course (AEC)

3HHLA101: Hindi Language (हिन्दी आधार पाठ्यक्रम, हिन्दी भाषा और संरचना)

(Credit: Theory -2 Tutorial - 0)

Scheme of Examination

Course Code	Course Name	Credit	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End	Mid	Assign	End	Term Sem			
3HHLA101	**हिंदी भाषा और संरचना**	2(2-0-0)	60	20	20	-	-	100	2 hr	-

पाठ्यक्रम के उद्देश्यः

- विद्यार्थियों में राष्ट्र प्रेम की भावना का विकास करना।
- हिन्दी के समृद्ध साहित्य को नयी पीढ़ी तक पहुँचाना ।
- पत्र–लेखन, सार लेखन, भाव पल्लवन एवं साक्षात्कार के कौशल का विकास करना।
- डायरी,संस्मरण, लेखन, पारिभाषिक, शब्दावली, तत्सम, तद्भव, देशज, विदेशी शब्दों इत्यादि के ज्ञानका परिमार्जन करना।

अपेक्षित परिणामः

- विद्यार्थी भारत भूमि से प्रेम व स्नेह के भावों को बढ़ा सकेगें।
- विद्यार्थियों की हिन्दी की भाब्द संपदा में वृद्धि होगी।
- पत्र–लेखन,सार लेखन, भाव पल्लवन साक्षात्कार के कौ ाल का विकास होगा।
- डायरी एवं संस्मरण लेखन विद्या का परिमार्जन होगा।
- हिन्दी के समृद्ध साहित्य कोष से लाभान्वित होगें।

पाठ्यक्रमः

इकाई – 1 भारत वंदना (काव्य) सूर्यकांत त्रिपाठी निराला, जाग तुझको दूर जाना सुश्री महादेवी वर्मा, स्वतंत्रता पुकारती (काव्य) जयशंकर प्रसाद, हम अनिकेतन (काव्य) बालकृष्ण शर्मा नवीन, भाषा की महत्ता और उसके विविध रूप, भाषा–कौशल

इकाई – 2 करूणा (निबंध) आचार्य रामचन्द्र शुक्ल, समन्वय की प्रक्रिया (निबंध) रामधारी सिंह 'दिनकर' बिच्छी बुआ (कहानी) डॉ. लक्ष्मण बिष्ट 'बटरोही', अनुवाद परिभाषा प्रकार, महत्व, विशेषताएं, हिन्दी की शब्द–संपदा, पारिभाषिक शब्दावली

इकाई – 3 विलायत पहुंच ही गया (आत्मकथांश) महात्मा गांधी, अफसर (व्यंग्य) शरद जो ी, तीर्थयात्री (कहानी) डॉ. मिथिलेष कुमार मिश्र, मकड़ी का जाला (व्यंग्य) डॉ. रामप्रकाश सक्सेना वाक्य– संरचना :तत्सम, तद्भव देशज विदेशी

इकाई – 4 अप्प दीपो भव (वक्तृत्व कला) स्वामी श्रद्धानंद, भारत का सामाजिक व्यक्तित्व (प्रस्तावना) जवाहरलाल नेहरू, पत्र मैसूर के महाराजा को (पत्र–लेखन) स्वामी विवेकानंद, बनी रहेंगी किताबें (आलेख) डॉ. सुनीता रानी घोष, पत्र–लेखनः महत्व और उसके विविध रूप, सड़क पर दौड़ते ईहा मगृ (निबंध) डॉ. श्यामसुन्दर दुबे

इकाई – 5 योग की शक्ति (डायरी) डॉ. हरिवं ा राय बच्चन, कोष के अखाड़े में कोई पहलवान नहीं उतरता (साक्षात्कार) – भाषाविद् डॉ– हरिदेव, बाहरी से प्रो. – त्रिभुवननाथ शुक्ल, नीग्रो सैनिक से भेंट (यात्री–संस्मरण) डॉ. देवेन्द्र सत्यार्थी, यदि ''बा'' न होती तो शायद गांधी को यह ऊँचाई न मिलती (साक्षात्कार) कथाकार– गिरिराज किशोर से सत्येन्द्र शर्मा सार –लेखन, भाव–पल्लवन साक्षात्कार और कौशल

संदर्भ पुस्तकः

कथा साहित्य आईसेक्ट ग्रुप प्रकाशन

पाठ्यक्रम सीखने के उद्देश्यों की प्राप्ती को सुगम बनाना

इकाई	पाठ्यक्रम के उद्देश्य	पाठ्यक्रम से प्राप्त लाभ	शिक्षण और सीखने की गतिविधियां	मूल्यांकन कार्य
1	• भाषा के विभिन्न रूपों का अध्ययन और जानकारी प्राप्त करना।	• भाषा के विभिन्न रूपों के साथ परिचित होना।	• भाषाओं के रूपों का प्रदर्शन और उनके विशेषताओं का अध्ययन करना। भाषाओं के रूपों का प्रदर्शन और उनके विशेषताओं का अध्ययन करना।	• भाषाओं के रूपों का प्रदर्शन और उनके विशेषताओं की व्याख्या करना।
2	• तत्सम और तद्भव शब्दों के अंतर को समझना।	• तत्सम और तद्भव शब्दों के बीच का अंतर समझना।	• तत्सम और तद्भव शब्दों के उदाहरण प्रदान करना और समझाना।	• तत्सम और तद्भव शब्दों के अंतर को समझाने के लिए उपाय करना।
3	• नाटक और गद्य साहित्य के बारे में जानकारी प्राप्त करना।	• नाटक और गद्य साहित्य के अध्ययन से साहित्यिक ज्ञान में वृद्धि होना।	• नाटक और गद्य साहित्य के उदाहरण और उनके विशेषताओं का अध्ययन करना।	• नाटक और गद्य साहित्य के उदाहरणों की व्याख्या करना।
4	• रस, अलंकार, दोहा, सोरठा आदि के बारे में जानकारी प्राप्त करना।	• साहित्यिक उपकरणों के ज्ञान से भाषा का सुधार होना।	• विभिन्न रसों, अलंकारों, दोहों, सोरठों इत्यादि के उदाहरण और व्याख्या करना।	• रस, अलंकार, दोहा, सोरठा आदि के उदाहरणों की व्याख्या करना।
5	• काव्यांग विवेचन, रस, छंद, अलंकार, उपमा, रूपक, दोहा, सोरठा, चौपाई आदि के बारे में जानकारी प्राप्त करना।	• साहित्यिक उपकरणों के ज्ञान से भाषा का सुधार होना।	• विभिन्न काव्यांग और साहित्यिक उपकरणों के उदाहरण और व्याख्या करना।	• काव्यांग और साहित्यिक उपकरणों के उदाहरणों की व्याख्या करना।

Value added course (VAC)

3SEEV106: Environmental Education

(Credit: Theory -3 Tutorial - 0)

Scheme of Examination

Course Code	Course Name	Credit	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SEEV106	Environmental Education	3(3+0)	60	20	20	-	-	100	3 hr	-

Course Objective

Upon completion of the course, the student – teacher will be able to:

- Understand the concept, significance, scope and terminologies objectives and program of environmental education.
- Develop awareness about the various types of pollution ecological Imbalances and life and contributions of environmental activities.
- Interpret the environmental legislations in conservation and protection of the environment.
- Understand the role of governmental and non-governmental Agencies in environmental education.
- Apply the methods of teaching and evaluation in environmental education.

Course Outcomes

- Environmental education raises awareness about various environmental issues, such as pollution, climate change, habitat destruction, and resource depletion.
- It provides individuals with a deeper understanding of ecosystems, biodiversity, and the interconnections between living organisms and their environment.
- Environmental education can lead to changes in behavior, such as reducing waste, conserving energy and water, and adopting sustainable consumption patterns.
- Individuals become more inclined to take care of their surroundings, leading to increased community involvement in local environmental projects.
- It fosters critical thinking skills by encouraging individuals to analyze complex environmental problems and develop solutions.

Syllabus

Unit 1: Introduction to Environmental Education-

Environmental Education Concept, Importance and Scope, Objectives and Principles of Environmental Education. Basic Concepts in Environmental Education, Ecology, Eco-System, Food Chain, Natural Resources, Greenhouse Effect, Bio-Diversity.

Unit 2: Environment and Pollution-

Definition and Types of Environmental pollution, Air Pollution- Definition, Causes and Remedial Measures, Water Pollution: Definition, Causes and Remedial Measures, Soil Pollution: Definition, Causes and Remedial Measures, Sound Pollution: Definition, Causes and Remedial Measures, Ecological Imbalances -Deforestation, Soil Erosion.

Unit 3: Environmental Laws and Organization-

The Air Prevention and Control of Pollution Act 1977, The Water Prevention and Control of Pollution Act1974, Forest Conservation Act 1980, Environment Protection Act 1986, United Nations Environment Program (UNEP), International Union for Conservation of Nature and Natural Resources (IUCN), Central pollution control board (CPCB).

Unit 4: Environmental Ethics-

Role of Indian and other religions and cultures in environmental conservation. Green Politics, Earth Hour, Green Option Technologies, Environmental communication and public awareness, EIA Formulations, stages, Merits and demerits.

Unit 5: Methods of Teaching Environmental Education-

Project Work, Intellectual Meets-Seminars, Symposia, Workshops, Conferences, Group Discussions, Debates, Brain Storming Quiz, Poster Making, Models Making and Exhibitions.

Text Book

- Environmental science by Kamal Kant Joshi & Deepak Kumar, TechSar. 2019.
- Basics of Environmental science by Abhijit Mitra & Tanmay Ray Chaudhuri, New central book agency Pvt. Ltd. 2017.
- Essentials of Environmental Education by A.B. Saxena & V.V. Anand, Motilal Banarsidass publishing House, 2012.
- Environmental Studies by Dr. SM Saxena, Dr. Seema Mohan.

Reference Books

- Ecological Literacy: Educating Our Children for a Sustainable World, Michael K. Stone and Zenobia Barlow, Publication: Published by Sierra Club Books in 2005.
- Place-Based Education: Connecting Classrooms and Communities, David Sobel Publication: Published by The Orion Society in 2005.
- The Handbook of Environmental Education, Robert B. Stevenson, Michael Brody, Justin Dillon, and Arjen E.J. Wals, Publication: Published by Routledge in 2019.

Facilitating the Achievement of Course Learning Objectives

Unit no.	Course Learning Outcomes	Teaching and Learning Activities	Assessment Tasks
1	● The students about this particular are intended to gain knowledge about the objectives and importance of environmental education. Enabling them to understand the composition of environment, greenhouse effect. Students will improve their understanding towards the factors governing the life on earth	● Lectures ● Group discussion ● Sight Seeing ● The teaching will be done through lectures and group discussion	● Assignment ● Homework
2	● Students will understand about the impacts of our unusual and destructive use of resources and their harmful effects. ● Students will understand about the destruction of environment and its	● Lectures ● Group discussion ● Visit to any industry or manufacturing site	● Assignment ● Poster making

Unit no.	Course Learning Outcomes	Teaching and Learning Activities	Assessment Tasks
	sustainability. Enhance the concern about this depletion among the students.	● The teaching will be done through lectures and group discussion.	
3	● Importance of government laws and agencies their interference to regulate pollution and harming the quality of environment. Methods to improve the quality of habitat and natural resources will be necessary for the students to have its knowledge and concern.	● Lectures ● Group discussion ● Visit to any law governing body ● The teaching will be done ● through lectures and group discussion	● Brain storming Quiz ● Assignment
4	● Students will know their ethics and responsibilities towards the improvement in quality of environment. Innovation, technologies, awareness through communication and various others measures through which a student can involve these practices in their lifestyle.	● Lectures ● Group discussion Sight Seeing ● The teaching will be done through lectures and group discussion	● Seminar ● Conferences
5	● The students will enhance the techniques to prepare a project on any of the issues regarding the environment pollution or the remedial measures. Students will find ways to present the issues through seminars, workshops, poster making, model making.	● Lectures ● Group discussion ● Seminars ● Poster making ● Model making	● Power point presentation Project work ● Debates ● Brain storming Quiz

Value added course (VAC)

3IFAV106: Fundamentals of AI

(Credit: Theory -3 Tutorial - 0)

Scheme of Examination

Course Code	Course Name	Credit	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3IFAV106	Fundamentals of AI	(3-0-0)	60	20	20	-	-	100	3 hr	-

Course Objective

Student will be able-

- To understanding the importance of AI and puzzle problem.
- To understanding the Search Techniques.
- To understanding the Symbolic and Statistical Reasoning.
- To understanding the frames and Structural Knowledge Representation.
- To understanding the expert system life cycle.

Course Outcomes

Upon completion of the course, students will be able to:

- Understand the fundamental concepts and scope of Artificial Intelligence.
- Describe the essential tools and techniques used in Machine Learning.
- Describe interface mechanisms and their role in knowledge representation.
- Understand the fundamentals of probability theory and its role in AI.

Syllabus:

Theory:

Unit 1: Introduction: Artificial Intelligence, AI Problems, AI Techniques, The Level of the Model, Criteria for Success. Defining the Problem as a State Space Search, Problem Characteristics, Production Systems, Search: Issues in The Design of Search Programs, Un-Informed Search, BFS, DFS; Heuristic Search Techniques: Generate-And- Test, Hill Climbing, Best-First Search, A*Algorithm, Problem Reduction, AO*Algorithm, Constraint Satisfaction, Means-Ends Analysis.

Unit 2: Introduction to Machine Learning: Applications of ML, Difference between Data Mining and Predictive Analysis, Tools and Techniques of Machine Learning. What is Machine Learning, Basic Terminologies of Machine Learning

Unit 3: Knowledge Representations First order predicate calculus, Skolemization, resolution principle and unification, interface mechanisms, horn's clauses, semantic networks, frame systems and value inheritance, scripts, conceptual dependency.

Unit 4: Natural Language processing Parsing techniques, context free grammar, recursive transitions nets (RNT), augmented transition nets (ATN), case and logic grammars, semantic analysis. Game playing Minimax search procedure, alpha-beta cut offs, additional refinements. Planning Overview an example domain the block word, component of planning systems, goal stack planning, nonlinear planning.

Unit 5: Probabilistic Reasoning and Uncertainty Probability theory, bayes theorem and Bayesian networks, certainty factor. Expert Systems Introduction to expert system and application of expert systems, various expert system shells, vidwan frame work, Knowledge acquisition, case studies, MYCIN. Learning Rote learning, learning by induction, explanation-based learning

Reference Books

- Elaine Rich and Kevin Knight, "Artificial Intelligence," Tata McGraw-Hill. "Artificial Intelligence," 4th Edition, Pearson.
- Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems," Prentice India.
- Nils J. Nilson, "Principles of Artificial Intelligence," Narosa Publishing House. Clocksin and C.S. Melish, "Programming in PROLOG," Narosa Publishing House.
- M. Sasikumar, S. Raman, etc., "Rule-based Expert System," Narosa Publishing House.

Facilitating the Achievement of Course Learning Objectives

Unit no.	Course learning outcomes	Teaching and learning activities	Assessment tasks
1	• Understand the fundamentals of Artificial Intelligence (AI). Identify AI problems and techniques. Learn about the levels of AI models and criteria for success. Explore state space search and production systems. Understand search algorithms such as BFS, DFS, and heuristic search techniques. Learn about problem reduction and constraint satisfaction. Familiarize with means ends analysis.	• Problem solving exercises on state space search. Group discussions on production systems and search algorithms. Handson exercises with BFS, DFS, and heuristic search algorithms. Case studies on problem reduction and constraint satisfaction. Practical demonstrations of means end analysis.	• Quizzes on AI fundamentals and problem-solving techniques. Written assignments on state space search. Group presentation on search algorithms.
2	• Learn about applications of Machine Learning (ML). Differentiate between Data Mining and Predictive Analysis. Explore tools and techniques of Machine Learning. Understand basic ML terminologies.	• Lectures on ML applications and differences from Data Mining. Discussions on ML tools and techniques. Handson experience with ML terminology. Case studies on real world ML applications.	• Written assignments on ML applications and differences from Data Mining. Quizzes on ML tools and terminology. Case study analysis of ML applications. Final examination on unit II content.
3	• Understand knowledge representations in AI. Learn about first order predicate calculus, Skolemization, and resolution principles. Explore interface mechanisms, horn's clauses, semantic networks, frame systems, and value inheritance. Familiarize with scripts and conceptual dependency.	• Practical exercises on resolution principles and interface mechanisms. Group discussions on semantic networks, frame systems, and scripts. Handson sessions with conceptual dependency. Case studies on real world knowledge representation systems.	• Problem solving assignments on predicate calculus and resolution. Quizzes on knowledge representation techniques.
4	• Explore Natural Language Processing (NLP) techniques. Learn about parsing techniques, context free grammar, and semantic analysis. Understand	• Lectures on NLP, parsing techniques, and semantic analysis. Coding practice for parsing and grammar. Problem solving exercises on	• Implementation and testing of parsing and semantic analysis. Problem solving assignments on game playing and planning.

Unit no.	Course learning outcomes	Teaching and learning activities	Assessment tasks
	gameplaying strategies and Minimax search procedures. Familiarize with alpha beta cutoffs and planning components. Apply these concepts to an example domain.	gameplaying strategies. Practical demonstrations of planning components. Handson sessions with an example domain.	Quizzes on NLP and gameplaying concepts. GD, Unit Test and Quizzes.
5	• Understand probabilistic reasoning and uncertainty in AI. Learn about probability theory, Bayes' theorem, and Bayesian networks. Explore certainty factors and expert systems. Familiarize with expert system shells, knowledge acquisition, and case studies. Learn about various learning techniques, including rote learning, induction, and explanation-based learning.	• Bayesian networks, and expert systems. Practical exercises on probability theory and Bayes' theorem. Group discussions on expert systems and knowledge acquisition. Handson sessions with learning techniques. Case studies on expert systems and learning methods.	• Problem solving assignments on probability theory and expert systems. Quizzes on probabilistic reasoning and learning techniques. Group presentation on expert system case studies.

Skill Enhancement Course (SEC)

3SBIS105: Introduction of Basic Instrument in Biology (1st Sem)

(Credits: Theory- 0, Tutorials-1, Practical-1)

Scheme of Examination

Course Code	Course Name	Credits	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign.	End Sem	Term work			
3SBIS105	Introduction of Basic Instrument in Biology (1st Sem)	2(0-1-1)	-	-	-	60	40	100	-	2 hr

Course Objective

To enable the students to:

- Understand the Principles of microscopy.
- Understand the structure and functioning of various biological instruments.
- Get enlighten their knowledge in various biochemical methods;

Course Learning Outcomes

- Learn how to interpret and use information on reagent bottle labels.
- Understand the concepts of molarity and normality.
- Master the skills of preparing solutions, dilutions, and percentage solutions.
- Develop proficiency in scientific writing and communication.

Syllabus: **Credits 011**

Unit 1: Imaging and related techniques Principles of microscopy; Light microscopy; Fluorescence microscopy; Electron Microscopy, Transmission and Scanning electron microscopy – sample preparation for electron microscopy,

Unit 2: pH and Centrifugation pH meter: Principles and instrumentation, Centrifugation: Principles, types of centrifuges, types of rotors, differential and density gradient centrifugation, application. Sonication, Freeze drying.

Unit 3: Spectrophotometry Principle involved in Spectrophotometer; Spectrophotometric techniques, Instrumentation: ultraviolet and visible spectrophotometry (application in Biology.

Unit 4: Chromatography Chromatographic techniques: Principle and applications – Column thin layer paper, affinity and Gel filtration Ion exchange and High-performance liquid chromatography techniques.

Unit 5: Preparation of molar, molal and normal solutions, buffers, the art of scientific writing Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions.

Practical **Credit: 1**

- Microscopy – Light microscopy: principles, parts and function.
- Camera Lucida drawing with magnification and scale.
- Principle and working of phase contrast microscope.
- Principle and operation of Centrifuge.
- Preparation of various solutions (normal, molar, and percent) and ppm/ppb by serial dilutions.
- Study of principle and working of pH meter and Measurement of pH of Milk, Pepsi, Lemon juice etc. using pH paper and pH meter.
- Study of principle of Chromatography and separation of amino acids mixture by ascending Paper Chromatography.
- Principle and operation of Colorimeter.
- Principle and operation of Spectrophotometer.
- PCR The Polymerase Chain Reaction (protocol) demonstration.

Text Book And Reference Books

- Bajpai, P.K. 2006. Biological Instrumentation and methodology. S. Chand and Co. Ltd.
- K. Wilson and J. Walker Eds. 2005. Biochemistry and Molecular Biology. Cambridge University Press.
- K. Wilson and KH Goulding. 1986. Principles and techniques of Practical Biochemistry.3rd edc Edward Arnold, London.
- Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
- Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
- Ruzin, S.E. (1999). Plant micro technique and microscopy. Oxford University Press, New York, U.S.A.

Facilitating the achievement of course learning objectives

Unit no.	Course learning outcomes	Teaching and learning activities	Assessment tasks
1.	• Understand the fundamental principles of microscopy. Explore advanced applications such as chromosome banding, FISH (Fluorescence in Situ Hybridization), and chromosome painting in fluorescence microscopy.	• Explain the principles of electron microscopy. • Describe sample preparation techniques for transmission and scanning electron microscopy. Define flow cytometry and its applications in biological research.	• Multiple choice questions, quiz, Class test and students' presentation.
2.	• Understand the principles of centrifugation. knowledge of differential and density gradient centrifugation in various applications.	• Demonstrate the use of pH meters for accurate pH measurements. Differentiate between types of centrifuges and rotors.	• Multiple choice questions, quiz, Class test and students' presentation.
3.	• Understand the instrumentation of ultraviolet and visible spectrophotometers, as well as infrared spectrometers.	• Explain the principle behind spectrophotometry. • Explain the application of mass spectrometry in biological analysis.	• Multiple choice questions, match.

Unit no.	Course learning outcomes	Teaching and learning activities	Assessment tasks
4.	• Understand the principles of chromatography and various chromatographic techniques, including column, thinlayer, paper, affinity, and gas chromatography.	• Explain the principles of gel filtration, ion exchange, and high-performance liquid chromatography (HPLC). • Provide examples of applications for each chromatographic system.	• The following, students' presentation, quiz, class test focusing on short notes and definitions.
5.	• Understand the concept of buffers. student also know Calculate and prepare molar, molal, and normal solutions.	• Theory classes and discussion on Master the skills of preparing solutions, dilutions, and percentage solutions.	• Class tests, assignments, quiz, student presentations.

RAMANUJAN SCHOOL OF SCIENCE

BACHLOR OF SCIENCE

(Chemistry, Biology, Zoology)

(B. Sc. (CBZ) – CKUG04B03)

II Semester

MAJOR CORE COURSES

3SVDC203 Zoology-II (Vertebrates and Developmental Biology)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SVDC203	Zoology-II (Vertebrates and Developmental Biology)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objective

- This paper is aimed to introducing the students for the salient features of all Vertebrates, and developmental biology.
- Recognize common local vertebrates.
- Identify common and unknown species of vertebrates.
- Have an understanding of the ecological relationships of the vertebrae.
- Be competent in the use of microscopes for dissection and identification.

Course Learning Outcome

- The student has a knowledge of Classification and life cycle of Vertebrates, gametogenesis and formation of three germinal layers
- Learn structural and functional diversity in different groups of animals.
- Gain knowledge and skill in the fundamentals of animal sciences.
- Understand the complex interactions among various living organism.

Syllabus Credits 4-0-2

UNIT–I

Origin of Chordata

Origin of Chordates; Classification of phylum Chordata, features notochord, dorsal hollow nerve cord, pharyngeal slits, and post-anal tail, Hemichordate; External features and affinities of Balanoglossus, Urochordata; Type study of Herdmania, tunic, siphons, and other structures, Balanoglossus; External morphology, proboscis, collar, and trunk. Difference of Balanoglossus with chordates, Evolutionary significance of Hemichordate, Cephalochordate; Type study of Amphioxus, Affinities of Amphioxus and Internal structures; pharynx, digestive system, and gonads.

UNIT–II

Comparative Study of Vertebrates

Comparison between Petromyzon and Myxine, Comparative account of limb bones and girdles of vertebrates, Comparative account of aortic arches and heart of vertebrates, Comparative account of respiratory system of vertebrates.

UNIT –III

Organ System of Vertebrae

Comparative account of urinogenital system of fish; the urinogenital system of kidneys, Amphibians; kidneys for excretion by cloacae and reproduction, Reptiles; advanced kidneys and reproductive organs. Birds; efficient kidney, excretion and reproduction, Mammals; kidneys and reproductive system, Sense organ of mammals.

UNIT–IV

Developmental Biology

Placentation in mammals, Parthenogenesis, Autonomous Parthenogenesis, Induced Parthenogenesis, Gametogenesis; spermatogenesis and oogenesis. Regenerations Type Epimorphosis, Compensation, Morphallaxis, Fertilization; Cleavage, Blastulation, Gastrulation.

UNIT–V

Embryology

Frog and chick embryology up to the formation of three germinal layers, Fate map construction in frog and chick; Gastrulation up to the formation of germinal layers, Extra embryonic membranes in chick, Concept of regeneration, Embryology membrane; Amnion, Chorion, Yolk Sac, Allantois.

Practical Content **Credits: 2**

- Study of museum specimens and slides relevant Osteology.
- Girdles and limb bones of Frog, Varanus, Fowl and Rabbi.t
- Cell Biology: Study of DNA and RNA Models.
- Preparations of Polytene chromosome in *Chironomus larva.*
- Squash preparation of chromosome from Onion root tip.
- Study of Meiosis in *Grass hopper* testis.
- Embryology: Study of different developmental stages of frog and chick whole mounts and sections.

Text Book

- Text book of Zoology by Ghose Dr. K.C. Manan Publication London, New central.
- Modern Textbook of Zoology vertebrate by R.L. Kotpal, Rastogi Publication.
- Introduction to Embryology by Belinsky.
- Textbook of Zoology by Saxena Dr. S.M., Ramprasad and sons Publication.

Reference Book

- Comparative Anatomy of the Vertebrates by Kent, G. C. and Carr R. K. 2000 IX Edition.
- Analysis of Vertebrate Structure by John Wiley and Sons Hilderbrand, M and Gaslow.
- An Introduction to Embryology, V Edition by Balinsky B. I. and Fabian B.C. (1981).
- Analysis of Biological Development, II Edition by International Thompson Computer Press Kalthoff (2008).
- Principles of Development by Lewis Wolpert. II Edition, Oxford University Press.
- Biology of Vertebrates, Khosla Publishing House Walter by H.E. and Sayles.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
	Students should be able to demonstrate a thorough understanding of the diversity of chordates, including their	Start with introductory lectures to provide students with the basic	Class test focusing on definitions and short questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	various subphyla (e.g. vertebrates, tunicates, and lancelets) and the key characteristics that define this phylum.	concepts and an overview of the phylum Chordata. Use multimedia presentations, diagrams, and visual aids to illustrate key points and anatomical features.	
2	Students should be able to demonstrate a comprehensive understanding of the diversity of cephalochordates, including their different species, habitats, and ecological roles.	Conduct a hands-on laboratory session where students dissect preserved lancelet specimens. This activity allows students to observe and identify key anatomical features, such as the notochord, dorsal nerve cord, and pharyngeal gill slits.	Class test focusing on definitions and short subjective questions.
3	Students should possess a detailed knowledge of the anatomy and morphology of lampreys and hagfish, including their distinctive features like the lack of jaws, cartilaginous skeletons, and unique mouthparts.	Organize a hands-on laboratory session where students dissect preserved lamprey specimens to observe and identify key anatomical features. Provide students with anatomical diagrams and models to reinforce their understanding of lamprey anatomy.	Class test focusing on definitions and long subjective questions.
4	Students should demonstrate a comprehensive understanding of parthenogenesis as a reproductive strategy, including the various forms it can take (e.g., automixis, apomixis).	Present case studies of parthenogenetic organisms, such as the whiptail lizard or aphids, and have students analyse and discuss the reproductive strategies and adaptations of these species.	Class quizzes or short tests that assess your understanding of specific lecture topics.
5	Define gastrulation and explain its significance in embryonic development. Compare and contrast gastrulation in different species, particularly focusing on frogs and chicks.	Ask students to create physical or digital models of gastrulation in frogs and chicks. This can be a collaborative project where students work in groups to construct models representing the key stages and structures involved in gastrulation.	Class test, quiz and multiple-choice questions.

MAJOR CORE COURSES

3SCBC203: Botany-II (Cell Biology and Genetics)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SCBC203	Botany-II (Cell Biology and Genetics)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Outline the structure of the bio molecules found in all living organisms.
- Describe the function and structure of cells including the metabolic reactions that occur in cells.
- Explain the process of inheritance.
- Describe how RNA, DNA and proteins are synthesized.
- Explain the process of cell division in both somatic and germ cells.

Course Learning Outcome

- The course aims to develop students understanding of three areas of widely used and advanced scientific methods – spectroscopic tools, molecular imaging and bioinformatics.
- This is achieved through lectures, classes, seminars and a bioinformatics problem-based learning exercise.
- To help students develop successful strategies for learning how to learn and communicate complex information in cell biology, we developed a quarter-long cell biology class based on team projects.
- Each team researches a particular human disease and presents information about the cellular structure or process affected by the disease, the cellular and molecular biology of the disease, and recent research focused on understanding the cellular mechanisms of the disease process.

Syllabus **Credits: 4-0-2**

UNIT – I

The cell envelops and organelles: Techniques of cell biology Prokaryotic and Eukaryotic cell structure and plasma membrane lipid bilayer structure, function of the cell wall. Structure and function of cell organelles: Golgi bodies, ER, Peroxisome, Vacuole, Chloroplast and Mitochondrion. Cell signaling and cell receptors, signal transduction.

UNIT – II

Chromosomal Organization: Structure and function of chromosome centromere and telomere. Nucleosome model, Special types of chromosomes, Mitosis and Meiosis. Variation in chromosome Structure: Deletions, Duplication Translocations and Inversions. Variation in chromosome number, Euploidy, Aneuploidy, DNA: The genetic material, DNA Structure and replication.

UNIT – III

Genetic inheritance: Mendelism; Law of dominance, laws of segregation and independent assortment. Linkage analysis, Interactions of genes. Cytoplasmic inheritance, Mutations: spontaneous and induced, Transposable elements, DNA damage and repair.

UNIT – IV

Gene: Development of genetics structure of gene, gene verses alleles, genetic code, transfer of genetic information. Transcription, translation, protein synthesis, tRNA, and ribosomes. Regulation of gene expression in prokaryotes and eukaryotes. Organic evolution role of RNA and evolution.

UNIT – V

Plant Breeding: Introduction, Methods Selection and Hybridization. (Pedigree, backcross, mass selection and bulk method)

Biotechnology: Definition; basic aspects of plant tissue culture; Cellular totipotency, Differentiation and morphogenesis important achievements of biotechnology in agriculture.

Genetic Engineering: Tools and techniques of recombinant DNA technology; Cloning vectors; biology of Agro bacterium; Vectors for gene delivery and marker genes, DNA fingerprinting genomic and cDNA library: Gene mapping and chromosome walking.

Biostatistics: Introduction and application.

Practical Content **Credits: 2**

- To examine the electron micrograph of a eukaryotic cell.
- To examine the electron micrograph of a chloroplast.
- To examine the electron micrograph of an endoplasmic reticulum.
- To examine the electron micrograph of a Golgi body.
- To examine the electron micrograph of a Ribosome.
- To examine the electron micrograph of a Nucleus.
- To make a temporary acetocarmine stained slides of root tip of onion and to study various stages of mitosis.
- To make a temporary acetocarmine stained slides of Floral bud of onion and to study various stages of meiosis.
- Cytological examination of chromosome.
- To demonstrate the independent assortment by various type of pea seeds.

Reference Book

- Vol. 1st and Vol. 2nd A Text Book of Botany Hai, Bhattachary, Ghosh.
- Vol. 1st and Vol. 2nd College Botany Gangulee and Kar.
- Genetics: Classical to modern –P.K. Gupta.
- Cell Biology and Genetics Molecular Biology- P.S. Verma 2001.
- Cell Biology and Genetics -Ralph Taggart 1992.

Text Book

- A Text Book of Cell Biology and Genetics -Dr Veer Bala Rastogi.
- S.B Agrawal, V.K Agrawal and Amit Agrawal Unified Vanaspati Vigyan.
- A Text Book of Cell Biology Genetics and Evaluation-Surya Prakash Mishra.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Students should be able to explain the mechanisms of passive and active transport across the cell membrane, including diffusion, osmosis, facilitated diffusion, and active transport processes.	Practical sessions using microscopes can be highly effective. Provide students with microscope slides containing stained bacterial cells and ask them to observe and identify cell	Class test focusing and long questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
		envelopes under different magnifications.	
2	Students should be able to describe the central role of the nucleus in controlling gene expression and maintaining genetic information. Students should understand the processes of DNA replication, transcription, and mRNA processing that occur within the nucleus.	If physical lab resources are limited, consider using virtual labs that allow students to virtually manipulate and experiment with cellular structures. Some online platforms offer simulations specifically focused on cell biology.	Class test focusing on definitions and short questions.
3	Students should understand the underlying molecular processes that lead to chromosome structural changes, such as unequal crossing over, non-disjunction, and chromosomal breakage and repair.	Start with a brief lecture explaining the basic concepts of chromosomes and their structure. Engage students in a discussion about the importance of chromosome structure in inheritance and variation.	Class test focusing on definitions and short and long questions.
4	Students should have a deep understanding of Mendelian inheritance patterns, including dominant and recessive traits, Punnett squares, and the principles of segregation and independent assortment.	Introduce Punnett squares to help students understand how genes are inherited and the probability of certain traits appearing in offspring. Provide practice problems for them to solve.	Class test focusing on and short and mcq questions.
5	Students should be able to describe non-Mendelian inheritance patterns such as incomplete dominance, codominance, and multiple alleles and understand how these patterns deviate from Mendelian genetics.	Assign students a genetic disorder (e.g. sickle cell anaemia, Huntington's disease) and have them create informative presentations or posters. They can explain the genetic basis of the disorder, its symptoms, and its inheritance patterns.	Class test focusing on and long questions.

MAJOR CORE COURSES

3SPCC203: Chemistry –II (Physical Chemistry)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SPCC203	Chemistry –II (Physical Chemistry)	6(4-0-2)	60	20	10	60	40	200	3 hr	2 hr

Course Objectives

- Understanding reaction rates and factors influencing them.
- Grasping atomic properties and periodic trends.
- Exploring bonding theories and molecular shapes.
- Analyzing properties and reactions of alkanes, cycloalkanes, and alkenes.
- Understanding key reactions and synthesis pathways.

Course Learning Outcomes

- Ability to analyze reaction rates and factors affecting them.
- Understanding atomic properties and periodic trends.
- Proficiency in bonding theories and molecular shapes.
- Mastery of properties and reactions of specific organic compounds.
- Competence in understanding and predicting key organic reactions.

Syllabus **Credits 4-0-2**

Physical Chemistry

UNIT – I

Chemical Kinetics

Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction- concentration, temperature, pressure, solvent, light and catalyst. Concentration dependence of rates, mathematical characteristics of simple chemical reactions- zero order, first order, second order, pseudo-order, half-life and mean life. Determination of the order of reaction, differential method, method of integration, method of half-life period and isolation method. Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis).

Inorganic Chemistry

UNIT – II

Atomic Structure

Idea of de Broglie's matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrödinger wave equation, significance of φ , quantum numbers, radial and angular wave functions and probability distribution curves, effective nuclear charge.

Periodic Properties

Atomic and ionic radii, ionization energy, electron affinity and electronegativity: definition, method of determination, trends in periodic table and applications.

UNIT – III

Chemical Bonding

Covalent Bond: Valence bond theory and its limitations, directional characteristic of covalent bond, various type of hybridization and shapes of simple inorganic molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory to NH_3, SF_4, ClF_3, and H_2O. Molecular Orbital theory for homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and the bond energy, percentage ionic character of covalent bond.

Organic Chemistry

UNIT – IV

Alkanes and Cycloalkanes

IUPAC nomenclature of alkanes, classification, isomerism in alkanes, sources and methods of preparation, physical properties and chemical reactions of alkanes, mechanism of free radical halogenation of alkanes.

Cycloalkanes

Nomenclature, methods of preparations, chemical reactions. Baeyer's strain theory and its limitations, ring strain in cyclopropane and cyclobutene, theory of strain less rings.

UNIT – V

Cycloalkenes, Dienes, Alkenes

Methods of formation, conformation and chemical reactions of cycloalkenes. Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions - 1,2 and 1,4 additions, Diels-Alder reaction. Nomenclature, structure and bonding in alkenes. Methods of formation. Chemical reactions of alkenes- electrophilic and free radical addition. hydroboration oxidation and polymerization of alkenes.

Alkynes and Alkyl Halides

Nomenclature, structure and bonding in alkynes, method of formation, chemical reaction, acidity of alkynes. Nomenclature and classes of alkyl halides, methods of formation, chemical reactions; mechanism of nucleophilic substitution reaction of alkyl halides, SN^1 and SN^2 reactions with energy profile diagrams, elimination reaction.

Polyhalogeno Compounds

Method of preparation and properties chloroform, carbon tetrachloride.

Practical Content — Credits 2

Physical Chemistry

- Determination of mixed melting point.

- Preparation of solutions of various concentrations, NaOH, HCl, H_2SO_4.
- Determination of viscosity / percentage composition of given organic mixture using viscosity method.

Inorganic chemistry

- Inorganic mixture analysis.
- Macro/Semi-micro-Analysis- Cation analysis, separation and identification of ions from group I-VI, anion analysis.

Organic Chemistry

- Detection of elements (N, S and Halogens) 2 elements.
- Functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and aniline) in simple organic compounds.

Text Books

- Unified Chemistry by Tandon, Rathore and Agarwal.
- Chemical Kinetics by Keith J. Laidler and John H. Meiser.
- Principles of Physical Chemistry by Peter Atkins and Julio de Paula.
- Inorganic Chemistry by Gary L. Miessler and Paul J. Fischer.
- Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren.
- Fundamentals of Molecular Spectroscopy by C.N. Banwell.

Reference Books

- Chemical Kinetics and Reaction Dynamics by Paul L. Houston.
- Advanced Inorganic Chemistry by F. Albert Cotton and Geoffrey Wilkinson.
- Organic Chemistry by Francis A. Carey and Richard J. Sundberg.
- Physical Chemistry by Robert J. Sibley, Robert A. Alberty, and Moungi G. Bawendi.
- Organic Reaction Mechanisms by V.K. Ahluwalia.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Understand chemical kinetics and its scope, including factors affecting reaction rates. Analyse the mathematical characteristics of simple chemical reactions and methods to determine reaction orders.	Organize a scavenger hunt where students explore the periodic table to locate and identify s-block elements. This activity helps familiarize them with the elements in this block.	Quiz assessing understanding of chemical kinetics and factors affecting reaction rates.
2	Describe the historical development of atomic models from Dalton's to the modern quantum mechanical model. Explain the limitations and strengths of each atomic model.	Organize a timeline activity where students create a visual representation of the historical development of atomic models, starting from Dalton's model to the modern quantum mechanical model.	Written exam on periodic properties and trends.
3	Define ionic bonding and explain how it differs from covalent bonding. Describe the transfer of electrons	Provide students with model kits or digital simulations to build and visualize the crystal lattice structures of common ionic compounds.	Presentation on the comparison between Valence Bond and

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
	between atoms to form ions in ionic compounds.		Molecular Orbital theories.
4	Understand and apply Huckell's rule to determine whether a compound is aromatic, antiaromatic, or non-aromatic based on its number of electrons.	Assign research projects where students investigate the environmental impact of polycyclic aromatic hydrocarbons (PAHs) and their relevance in air pollution and carcinogenicity.	Class quizzes or short tests that assess your understanding of specific lecture topics.
5	Describe the general methods for the halogenation of organic compounds, including free-radical halogenation, electrophilic halogenation, and nucleophilic halogenation.	Conduct laboratory experiments where students synthesize alkyl and aryl halides using various methods such as halogenation reactions or substitution reactions. Emphasize safety protocols.	Homework assignments on alkynes and alkyl halides.

MINOR CORE COURSES

3SVDM204: Zoology-II (Vertebrates and Developmental Biology)

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SVDM204	Zoology-II (vertebrates and developmental biology)	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objective

- This paper is aimed to introducing the students for the salient features of all Vertebrates, and developmental biology.
- Recognize common local vertebrates.
- Identify common and unknown species of vertebrates.
- Have an understanding of the ecological relationships of the vertebrae.
- Be competent in the use of microscopes for dissection and identification.

Course Learning Outcome

- The student has a knowledge of Classification and life cycle of Vertebrates, gametogenesis and formation of three germinal layers.
- Learn structural and functional diversity in different groups of animals.
- Gain knowledge and skill in the fundamentals of animal sciences.
- Understand the complex interactions among various living organism.

Syllabus Credits 2-0-2

UNIT–I

Origin Of Chordata

Origin of Chordates; Classification of phylum, features notochord, dorsal hollow nerve cord, pharyngeal slits, and post anal tail, Hemichordate; External features and affinities of Balanoglossus, Urochordata; Type study of Herdmania, tunic, siphons, and other structures, External morphology of Balanoglossus. Urochordata; External feature habit and habitat of Herdmania, Cephalochordate; Affinities of Amphioxus.

UNIT–II

Comparative Study of Vertebrates

Comparison between Petromyzon and Myxine, Comparative account of limb bones and girdles of vertebrates, Comparative account of respiratory system of vertebrates.

UNIT–III

Comparative account of urinogenital system in fish; the urinogenital system kidneys for excretion and gonads for reproduction, Amphibians; kidneys for excretion by cloacae for both excretory and reproduction, Reptiles; advanced kidneys and reproductive organs, Birds; efficient kidneys, excretion and reproduction, Mammals; kidneys and reproductive system.

UNIT -IV

Developmental Biology

Sense organ of mammals, Placentation in mammals, Parthenogenesis; Autonomous Parthenogenesis, Induced Parthenogenesis, Gametogenesis; spermatogenesis and oogenesis, Regenerations; Epimorphosis, Compensation, morphollus. Fertilization; Blastulation, gastrulation.

UNIT–V

Embryology

Frog and chick embryology up to the formation of three germinal layers, Fate map construction in frog, Extra embryonic membranes in chick, Embryology membrane; Amnion, Chorion, Yolk Sac, Allantois.

Practical Content Credits :2

- Study of museum specimens and slides relevant to theory paper.
- Osteology
- Girdles and limb bones of: Frog, Varanus, Fowl and Rabbit.
- Cell Biology: Study of DNA and RNA Models.
- Preparations of Polytene chromosome in *Chironomus larva*
- Squash preparation of chromosome from Onion root tip.
- Study of Meiosis in Grasshopper testis.
- Embryology: Study of different developmental stages of frog and chick – whole mounts and sections.

Text Book

- Textbook of Zoology by Ghose Dr. K.C. Manan Publications London, New central
- Modern Textbook of zoology vertebrate by R. L. Kotpal, Rastogi Publication
- Introduction to Embryology by Belinsky
- Textbook of Zoology, Saxena Dr. S.M., Ramprasad and sons Public

Reference Book

- Comparative Anatomy of the Vertebrates by Kent, G.C. and Carr R.K.
- Analysis of Vertebrate Structure by John Wiley and Sons.
- An Introduction to Embryology, V Edition by Balinsky B. I. and Fabian B. C. (1981).
- Analysis of Biological Development, II Edition, by McGraw-Hill Publishers
- Principles of Development by Lewis Wolpert (2002) II Edition, Oxford University Press.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Students should be able to demonstrate a thorough understanding of the diversity of chordates, including their various subphyla (e.g., vertebrates, tunicates, and lancelets) and the key characteristics that define this phylum.	Start with introductory lectures to provide students with the basic concepts and an overview of the phylum Chordata. Use multimedia presentations, diagrams, and visual aids to illustrate key points and anatomical features.	Class test focusing on definitions and short questions.
2	Students should be able to demonstrate a comprehensive understanding of the diversity of cephalochordates, including their different species, habitats, and ecological roles.	Conduct a hands-on laboratory session where students dissect preserved lancelet specimens. This activity allows students to observe and identify key anatomical	Class test focusing on definitions and short subjective questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
		features, such as the notochord, dorsal nerve cord, and pharyngeal gill slits.	
3	Students should possess a detailed knowledge of the anatomy and morphology of lampreys and hagfish, including their distinctive features like the lack of jaws, cartilaginous skeletons, and unique mouthparts.	Organize a hands-on laboratory session where students dissect preserved lamprey specimens to observe and identify key anatomical features. Provide students with anatomical diagrams and models to reinforce their understanding of lamprey anatomy.	Class test focusing on definitions and short subjective questions.
4	Students should demonstrate a comprehensive understanding of parthenogenesis as a reproductive strategy, including the various forms it can take.	Present case studies of parthenogenetic organisms, such as the whiptail lizard or aphids, and have students analyse and discuss the reproductive strategies and adaptations of these species.	Class quizzes or short tests that assess your understanding of specific lecture topics.
5	Define gastrulation and explain its significance in embryonic development. Compare and contrast gastrulation in different species, particularly focusing on frogs and chicks.	Ask students to create physical or digital models of gastrulation in frogs and chicks. This can be a collaborative project where students work in groups to construct models representing the key stages and structures involved in gastrulation.	Class test, quiz and multiple-choice questions.

MINOR CORE COURSES

3SCBM204: Botany -II (Cell Biology and Genetic)

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SCBM204	Botany -II (Cell Biology and Genetic)	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Outline the structure of the bio molecules found in all living organisms.
- Describe the function and structure of cells including the metabolic reactions that occur in cells.
- Explain the process of inheritance.
- Describe how RNA, DNA and proteins are synthesized.
- Explain the process of cell division in both somatic and germ cells.

Course Learning Outcome

- The course aims to develop students understanding of three areas of widely used and advanced scientific methods – spectroscopic tools, molecular imaging and bioinformatics.
- This is achieved via lectures, classes, seminars and a bioinformatics problem-based learning exercise.
- To help students develop successful strategies for learning how to learn and communicate complex information in cell biology, we developed a quarter-long cell biology class based on team projects.
- Each team researches a particular human disease and presents information about the cellular structure or process affected by the disease, the cellular and molecular biology of the disease, and recent research focused on understanding the cellular mechanisms of the disease process.

Syllabus **Credits: 2-0-2**

UNIT – I

The cell envelops and organelles: Techniques of cell biology Prokaryotic and Eukaryotic cell structure and plasma membrane lipid bilayer structure, function of the cell wall. Structure and function of cell organelles: Golgi bodies, ER, Peroxisome, Vacuole, Chloroplast and Mitochondrion. Cell signaling and cell receptors, signal transduction.

UNIT – II

Chromosomal Organization: Structure and function of chromosome centromere and telomere. Nucleosome model, Special types of chromosomes, Mitosis and Meiosis. Variation in chromosome Structure: Deletions, Duplication Translocations and Inversions. Variation in chromosome number, Euploidy, Aneuploidy, DNA: The genetic material, DNA Structure and replication,

UNIT – III

Genetic inheritance: Mendelism; Law of dominance, laws of segregation and independent assortment. Linkage analysis, Interactions of genes. Cytoplasmic inheritance, Mutations: spontaneous and induced, Transposable elements, DNA damage and repair.

UNIT – IV

Gene: Development of genetics structure of gene, gene verses alleles, genetic code, transfer of genetic information. Transcription, translation, protein synthesis, tRNA, and ribosomes. Regulation of gene expression in prokaryotes and eukaryotes. Organic evolution role of RNA and evolution.

UNIT – V

Plant Breeding: Introduction, Methods Selection and Hybridization (Pedigree, backcross, mass selection and bulk method)

Biotechnology: Definition; basic aspects of plant tissue culture; Cellular totipotency, Differentiation and morphogenesis important achievements of biotechnology in agriculture.

Genetic Engineering: Tools and techniques of recombinant DNA technology; Cloning vectors; biology of Agro bacterium; Vectors for gene delivery and marker genes, DNA fingerprinting genomic and cDNA library: Gene mapping and chromosome walking.

Biostatistics: Introduction and application.

Practical Content **Credits: 2**

- To examine the electron micrograph of a eukaryotic cell.
- To examine the electron micrograph of a chloroplast.
- To examine the electron micrograph of an endoplasmic reticulum.
- To examine the electron micrograph of a Golgi body.
- To examine the electron micrograph of a Ribosome.
- To examine the electron micrograph of a Nucleus.
- To make a temporary acetocarmine stained slides of root tip of onion and to study various stages of mitosis.
- To make a temporary acetocarmine stained slides of Floral bud of onion and to study various stages of meiosis.
- Cytological examination of chromosome.
- To demonstrate the independent assortment by various type of pea seeds.

Reference Book

- Vol. 1st and Vol. 2nd A Text Book of Botany Hai, Bhattachary, Ghosh.
- Vol. 1st and Vol. 2nd College Botany Gangulee and Kar.
- Genetics: Classical to modern –P.K. Gupta.
- Cell Biology and Genetics Molecular Biology- P.S. Verma 2001.
- Cell Biology and Genetics -Ralph Taggart 1992.

Text Book

- A Text Book of Cell Biology and Genetics -Dr Veer Bala Rastogi.
- S.B Agrawal, V.K Agrawal and Amit Agrawal Unified Vanaspati Vigyan.
- A Text Book of Cell Biology Genetics and Evaluation-Surya Prakash Mishra.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Students should be able to explain the mechanisms of passive and active transport across the cell membrane, including diffusion, osmosis, facilitated diffusion, and active transport processes.	Practical sessions using microscopes can be highly effective. Provide students with microscope slides containing stained bacterial cells and ask them to observe and identify cell envelopes under different magnifications.	Class test focusing and short questions.
2	Students should be able to describe the central role of the nucleus in controlling gene expression and maintaining genetic information. Students should understand the processes of DNA replication, transcription, and mRNA processing that occur within the nucleus.	If physical lab resources are limited, consider using virtual labs that allow students to virtually manipulate and experiment with cellular structures. Some online platforms offer simulations specifically focused on cell biology.	Class test focusing on definitions and short questions.
3	Students should understand the underlying molecular processes that lead to chromosome structural changes, such as unequal crossing over, non-disjunction, and chromosomal breakage and repair.	start with a brief lecture explaining the basic concepts of chromosomes and their structure. Engage students in a discussion about the importance of chromosome structure in inheritance and variation.	Class test focusing on definitions and short and questions.
4	Students should have a deep understanding of Mendelian inheritance patterns, including dominant and recessive traits, Punnett squares, and the principles of segregation and independent assortment.	Introduce Punnett squares to help students understand how genes are inherited and the probability of certain traits appearing in offspring. Provide practice problems for them to solve.	Class test focusing on and short questions.
5	Students should be able to describe non-Mendelian inheritance patterns such as incomplete dominance, codominance, and multiple alleles and understand how these patterns deviate from Mendelian genetics.	Assign students a genetic disorder (e.g., sickle cell anaemia, Huntington's disease) and have them create informative presentations or posters. They can explain the genetic basis of the disorder, its symptoms, and its inheritance patterns.	Class test focusing on and short questions.

MINOR CORE COURSES

3SPCM204: Chemistry-II (Physical Chemistry)

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SPCM204	Chemistry-II (Physical Chemistry)	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Understanding reaction rates and factors influencing them.
- Grasping atomic properties and periodic trends.
- Exploring bonding theories and molecular shapes.
- Analyzing properties and reactions of alkanes, cycloalkanes, and alkenes.
- Understanding key reactions and synthesis pathways.

Course Learning Outcomes

- Ability to analyze reaction rates and factors affecting them.
- Understanding atomic properties and periodic trends.
- Proficiency in bonding theories and molecular shapes.
- Mastery of properties and reactions of specific organic compounds.
- Competence in understanding and predicting key organic reactions.

Syllabus

Credits 2-0-2

Physical Chemistry

UNIT – I

Chemical Kinetics

Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction- concentration, temperature, pressure, solvent, light and catalyst. Concentration dependence of rates, mathematical characteristics of simple chemical reactions- zero order, first order, second order, pseudo-order, half-life and mean life. Determination of the order of reaction, differential method, method of integration, method of half-life period and isolation method. Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy.

Inorganic Chemistry

UNIT – II

Atomic Structure

Idea of de Broglie's matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrödinger wave equation, significance of φ , quantum numbers, radial and angular wave functions and probability distribution curves, effective nuclear charge.

UNIT – III

Chemical Bonding

Covalent Bond: Valence bond theory and its limitations, directional characteristic of covalent bond, various type of hybridization and shapes of simple inorganic molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory to NH_3, SF_4, ClF_3, and H_2O. Molecular Orbital theory for homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and the bond energy, percentage ionic character of covalent bond.

Organic Chemistry

UNIT – IV

Alkanes and Cycloalkanes

IUPAC nomenclature of alkanes, classification, isomerism in alkanes, sources and methods of preparation, physical properties and chemical reactions of alkanes, mechanism of free radical halogenation of alkanes.

Cycloalkanes

Nomenclature, methods of preparations, chemical reactions. Baeyer's strain theory and its limitations, ring strain in cyclopropane and cyclobutene, theory of strain less rings.

UNIT – V

Cycloalkenes, Dienes, Alkenes

Methods of formation, conformation and chemical reactions of cycloalkenes. Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions - 1,2 and 1,4 additions, Diels-Alder reaction. Nomenclature, structure and bonding in alkenes. Methods of formation. Chemical reactions of alkenes- electrophilic and free radical addition. hydroboration oxidation and polymerization of alkenes.

Practical Content **Credits :2**

Physical Chemistry

- Determination of boiling point.
- Preparation of solutions of various concentrations, NaOH, HCl, H2SO4.

Inorganic Chemistry

- Inorganic mixture analysis.
- Macro/Semi-micro-Analysis- Cation analysis, separation and identification of ions from group I-VI, anion analysis.

Organic Chemistry

- Detection of elements (N, S and Halogens) 2 elements.
- Functional groups (phenolic, carboxylic, carbohydrates, amines, and aniline) in simple organic compounds.

Text Books

- Unified Chemistry by Tandon, Rathore and Agarwal.
- Chemical Kinetics by Keith J. Laidler and John H. Meiser.
- Principles of Physical Chemistry by Peter Atkins and Julio de Paula.

- Inorganic Chemistry by Gary L. Miessler and Paul J. Fischer.
- Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren.
- Fundamentals of Molecular Spectroscopy by C.N. Banwell

Reference Books

- Chemical Kinetics and Reaction Dynamics by Paul L. Houston.
- Advanced Inorganic Chemistry by F. Albert Cotton and Geoffrey Wilkinson.
- Organic Chemistry by Francis A. Carey and Richard J. Sundberg.
- Physical Chemistry by Robert J. Silbey, Robert A. Alberty, and Moungi G. Bawendi.
- Organic Reaction Mechanisms by V.K. Ahluwalia.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Understand chemical kinetics and its scope, including factors affecting reaction rates. Analyse the mathematical characteristics of simple chemical reactions and methods to determine reaction orders.	Organize a scavenger hunt where students explore the periodic table to locate and identify s-block elements. This activity helps familiarize them with the elements in this block.	Quiz assessing understanding of chemical kinetics and factors affecting reaction rates.
2	Describe the historical development of atomic models from Dalton's to the modern quantum mechanical model. Explain the limitations and strengths of each atomic model.	Organize a timeline activity where students create a visual representation of the historical development of atomic models, starting from Dalton's model to the modern quantum mechanical model.	Written exam on periodic properties and trends.
3	Define ionic bonding and explain how it differs from covalent bonding. Describe the transfer of electrons between atoms to form ions in ionic compounds.	Provide students with model kits or digital simulations to build and visualize the crystal lattice structures of common ionic compounds.	Presentation on the comparison between Valence Bond and Molecular Orbital theories.
4	Understand and apply Huckell's rule to determine whether a compound is aromatic, antiaromatic, or non-aromatic based on its number of electrons.	Assign research projects where students investigate the environmental impact of polycyclic aromatic hydrocarbons (PAHs) and their relevance in air pollution and carcinogenicity.	Class quizzes or short tests that assess your understanding of specific lecture topics.
5	Describe the general methods for the halogenation of organic compounds, including free-radical halogenation, electrophilic halogenation, and nucleophilic halogenation.	Conduct laboratory experiments where students synthesize alkyl and aryl halides using various methods such as halogenation reactions or substitution reactions. Emphasize safety protocols.	Homework assignments on alkynes and alkyl halides.

Inter Disciplinary Course

3SATI202: Analytical Techniques

(Credits: Theory-3 Practical-0)

Scheme of Examination

Course Code	Course Name	Credit	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SATI202	Analytical Techniques	3(3-0-0)	60	20	20	-	-	100	3hr	-

Course Objective

- Gain a comprehensive understanding of various analytical techniques used in scientific research, industry, or specific fields such as chemistry, biology, environmental science, or materials science.
- Develop skills in collecting, processing, and interpreting analytical data. Emphasize the importance of accuracy, precision, and reliability in analytical measurements.
- Explore qualitative analysis methods, including the identification of unknown substances and the interpretation of spectra or chromatograms.
- Stay updated on the latest developments in analytical techniques and technologies. Explore emerging trends in the field and their potential applications.

Course Learning Outcomes

- Students will be able to apply a variety of analytical techniques to solve scientific problems in their respective fields.
- Students will demonstrate the ability to operate and troubleshoot common analytical instruments with precision and accuracy.
- Students will implement and adhere to quality assurance and quality control practices to ensure the reliability and validity of analytical results.
- Students will adhere to laboratory safety protocols, recognizing and mitigating potential hazards associated with analytical techniques.

Syllabus: **Credits: 3(3-0-0)**

Unit 1: Introduction to Analytical Techniques

Chemical Measurements and Analytical tools, Experimental Error, Statistics and Quality Assurance, Chemical Equilibrium, Sample Preparation, Importance of analytical techniques in various fields, Classification of analytical methods

Unit 2: Spectroscopic Techniques

Introduction to spectroscopy, UV Visible Spectroscopy and applications, Infrared Spectroscopy (IR) and applications, Nuclear Magnetic Resonance Spectroscopy (NMR) and applications, Mass Spectrometry (MS) applications

Unit 3: Chromatographic Techniques

Introduction to chromatography (Principle, Instrumentation, working and Application), Gas Chromatography (Principle, Instrumentation, working and Application), Liquid Chromatography (Principle, Instrumentation, working and Application), High-performance Liquid Chromatography (Principle, Instrumentation, working and Application), Thin Layer Chromatography (Principle, Instrumentation, working and Application)

Unit 4: Electrochemical Techniques

Introduction to electrochemistry, Potentiometry (Principle, theory and types) Voltammetry (Principle, Instrumentation, working and Application), Conductometry (Principle, Instrumentation, working and Application), Applications in environmental analysis

Unit 5: Microscopy and Imaging Techniques

Introduction to microscopy, Optical microscopy, Electron microscopy (SEM and TEM), Scanning Probe Microscopy (SPM), Imaging techniques in biological and materials analysis, Applications and advancements.

Text Book

- Quantitative Chemical Analysis" by Daniel C. Harris.
- Principles of Instrumental Analysis" by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch.
- Fundamentals of Analytical Chemistry" by Douglas A. Skoog, Donald M. West, and F. James Holler
- Instrumental Methods of Analysis" by Willard, Merritt, Dean, and Settle.

Reference Books

- Handbook of Analytical Techniques" by D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch.
- Analytical Chemistry: A Modern Approach to Analytical Science" by Robert Kellner, JeanMichel Mermet, Matthias Otto, and Miguel Valcárcel.
- Comprehensive Analytical Chemistry" Series.
- Modern Methods of Chemical Analysis" by Arthur I. Vogel.

Facilitating the achievement of course learning objectives

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
1	• Students will understand the principles of chemical measurements and demonstrate proficiency in using various analytical tools.	• Organize discussions on the principles behind the classification of analytical methods. • Students work in groups to categorize and present different analytical methods, highlighting their principles and applications.	• Presentation, Exam and quiz
2	• Understand the principles and techniques of various spectroscopic methods.	• Provide an overview of spectroscopy, its principles, and the different types.	• Presentation, Exam and quiz
3	• Understand various chromatographic techniques, emphasizing the importance of understanding molecular interactions and their impact on separation.	• Provide lectures and interactive workshops.	• Presentation, Exam and quiz
4	• Provides students with a foundational understanding of the principles governing the interaction between chemical systems and electricity	• Introduce students to the basic principles of electrochemistry and its significance in chemical analysis.	• Presentation, Exam and quiz

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
5	• Providing students with a comprehensive introduction to the principles and techniques of microscopy. It covers the fundamental concepts behind microscopy, highlighting its pivotal role in observing and analysing structures at various scales.	• Theoretical lectures cover the basics of microscopy, including historical developments and key concepts	• Presentation, Exam and quiz

Ability Enhancement Course

3HELA201: English Language

(Credit: Theory -2 Tutorial - 0)

Scheme of Examination

Course Code	Course Name	Credit	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3HELA201	English Language and Indian culture	2(2+0)	60	20	20	-	-	100	2 hr	-

Course Objective

- To Study the basic concept and Language Skills of English Language.
- Comprehensive study of different kinds of vocabulary in English Language
- To Study the different era in every story and moos in poems.

Course Outcomes

- Students will be able to understand the basic concept and Language Skills of English Language.
- Students will be able to understand the different use of vocabulary in their sentences.
- Students will be able to understand the varieties of stories on different issues and on different format.

Syllabus:

Unit 1:

- Amalkanti: Nirendranth Chakrabarti
- Sita: Toru Dutt
- Preface to the Mahabharata: C. Rajagopalachari
- Satyagraha: M.K. Gandhi
- Toasted English: R.K. Narayan
- The Portrait of a lady: Khushwant Singh

Unit 2: Comprehension (unseen passages, summary, note making)

Unit 3: Composition and Paragraph Writing (Based on expansion of an idea)

Unit 4: Basic Language Skills: Vocabulary – Synonyms, Antonyms, Word Formation. Prefixes and Suffixes, Words likely to be confused and Misused, Words similar in Meaning or Form, Distinction between Similar Expressions, Speech Skill.

Unit 5: Basic Language Skills: Grammar and usage – The Tense Forms, Propositions, Determiners and Countable/Uncountable Nouns, Verb, Articles Adverbs.

Reference Books

- English language & Indian Culture – Dr. Pankaj Kumar Singh, Dr. Ashwin Joshi - Thakur Publication, Bhopal.
- Indian Art & Culture – Dr. Manish Rannian (IAS) – Prabhat Prakashn
- Indian Culture & Heritage – Romila Thapar – Kindle Unlimited

Facilitating the Achievement of Course Learning Objectives

Unit	Learning Outcome	Teaching-Learning Activities	Assessment Tasks
1	● Understand the historical context of English in India and its impact on Indian culture.	● Lecture on the history of English in India. ● Group discussions on the cultural influences of English. ● Readings and analysis of relevant texts.	● Research paper on the historical development of English in India. ● Group presentation on cultural assimilation.
2	● Analyze the influence of literature in English on Indian culture and identity.	● Close reading of select literary works by Indian authors writing in English. ● Comparative analysis of Indian and Western literary traditions. ● Guest lectures by Indian authors.	● Essay on the impact of Indian English literature on cultural identity. ● In-class quizzes on literary analysis.
3	● Explore the role of English in contemporary Indian society and media.	● Case studies on the use of English in Indian media. ● Group projects on language in advertising. ● Guest speakers from the media industry.	● Media analysis report on the use of English in Indian news outlets. ● Group presentation on language in advertising campaigns.
4	● Investigate the intersection of English and Indian languages and their cultural significance.	● Language workshops on common Indian languages and their influence on English. ● Interviews with bilingual/multilingual individuals. ● Analysis of code-switching in communication.	● Research paper on language convergence and divergence in bilingualism. ● Oral presentations on code-switching in real-life contexts.
5	● Reflect on the challenges and opportunities of bilingualism and multiculturalism in India.	● Group discussions on identity and language choices. ● Debates on language policy and diversity in India. ● Field visits to multilingual communities.	● Final reflective essay on personal experiences and insights regarding bilingualism and multiculturalism in India. ● Participation in debates and discussions.

Skill Enhancement Course

3SIPS205: Intellectual Property Right

(Credits: Theory-2 Practical-0)

Scheme of Examination

Course Code	Course Name	Credits	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign.	End Sem	Term work			
3SIPS205	Intellectual Property Right	2(2-0)	60	20	20	-	-	100	2 hr	-

Course Objectives

- Introduce students to various forms of intellectual property, including copyrights, trademarks, patents, trade secrets, and industrial designs.
- Provide an overview of the differences between these types of IPR.
- Explore the national and international legal frameworks and treaties governing intellectual property rights.
- Examine the obligations and protections under these legal frameworks.
- Discuss the principles of copyright law, including the scope of protection, duration, and fair use.
- Explain how copyright applies to various forms of creative works, such as literature, music, and software.
- Provide an understanding of trademark law, including the registration process and enforcement of trademark rights.

Course Learning Outcomes

- Understand the foundational concepts of intellectual property, including its nature, significance, and historical development.
- Differentiate between various types of intellectual property rights, such as copyrights, trademarks, patents, trade secrets, and industrial designs.
- Explain the rights and protections afforded by intellectual property laws, including the scope and duration of protection.

Syllabus **Credits :2-0-0**

Unit 1: Introduction to intellectual property right, Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

Unit 2: Patents objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement.

Unit 3: Copyrights Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.

Unit 4: Trademarks Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name: Industrial Designs Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

Unit 5: Protection of Traditional Knowledge Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio Prospecting and Bio Piracy, Alternative ways, protect ability, Need for a Sui Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

Reference Books

- N.S. Gopalakrishnan and T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company, Lucknow.
- Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet and Maxweel.
- Ajit Parulekar and Sarita D' Souza, (2006) Indian Patents Law – Legal and Business Implications; Macmillan India Ltd.
- B.L. Wadehra (2000) Law Relating to Patents, Trade Marks, Copyright, Designs and Geographical Indications; Universal law Publishing Pvt. Ltd., India.
- P. Narayanan (2010) Law of Copyright and Industrial Designs; Eastern law House, Delhi.

Facilitating the achievement of course learning objectives

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
1	• Understand the concept and importance of IPR in various fields. • Identify different types of IPR and their applications. • Recognize the economic significance of IPR for individuals, businesses, and economies. • Understand the genesis, scope, and impact of IPR in India and globally. • Analyse real world examples of IPR in action. • Comprehend the role of TRIPS, WIPO, and WTO in shaping global IPR norms	• Copyright protects original literary, artistic, and musical works, such as books, music, paintings, and software. It grants the creator exclusive rights to reproduce, distribute, and display their work.	• Class text and short and long questions
2	• Students should understand the rights granted to patent holders, the objectives of the patent system (e.g., encouraging innovation and knowledge sharing), and the limitations of patent protection.	• Analyse historical and contemporary patent case studies to illustrate the importance and implications of patents. • Discuss landmark patent disputes to highlight the legal aspects of patent rights and infringement.	• Class text and short and long questions
3	• Students will acquire a fundamental understanding of what copyrights are, their purpose, and their significance in protecting creative works.	• Provide students with a scenario where they need to seek copyright clearance for a specific project, such as using copyrighted music in a film.	• Class text and short questions and definitions
4	• Students should be able to describe the primary objectives of trademarks, including their role in brand identification, consumer protection, and preventing unfair competition.	• Have students classify various trademarks into different types (e.g., word marks, design marks) based on provided examples.	• Class text and short and long questions

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
5	• The protection of GIs is recognized under international agreements like the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) administered by the World Trade Organization (WTO).	• Provide case studies of TK holders and instances of bioprospecting and biopiracy. Analyse these cases to understand the complexities and ethical dilemmas involved	• Class text and short questions and definitions

VALUE ADDED COURSE

3ICSV206 Cyber Security

(Credit: Theory -3 Tutorial - 0)

Scheme of Examination

Course Code	Course Name	Credits	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign.	End Sem	Term work			
3ICSV206	Cyber Security	3-0-0	60	20	20	-	-	100	3 hr	-

Course Objective

- Learn to analyze the security of in-built cryptosystems.
- Know the fundamental mathematical concepts related to
- security.
- Develop cryptographic algorithms for information security.
- Understand cybercrimes and cyber security.

Course Outcomes

Understand the fundamentals of networks security, security architecture, threats and vulnerabilities. Apply the different cryptographic operations of symmetric cryptographic algorithms. Apply the different cryptographic operations of public key cryptography. Apply the various Authentication schemes to simulate different applications. Understand various cybercrimes and cyber security.

Syllabus:

Theory:

Unit 1: Introduction to Cyber Security Introduction,

Computer Security, Threats, Harm, Vulnerabilities, Controls, Authentication, Access Control and Cryptography. Web attack: Browser Attacks, Web Attacks Targeting Users, Obtaining User or Website Data, Email Attacks. Network Vulnerabilities: Overview of vulnerability scanning, Open, Port / Service Identification, Banner /Version Check, Traffic Probe, Vulnerability Probe, Vulnerability Examples, OpenVAS, Metasploit. Networks Vulnerability Scanning (Netcat, Socat), Network Sniffers and Injection tools.

Unit 2: Network Défense tools Firewalls and Packet Filters:

Firewall Basics, Packet Filter Vs Firewall, how a Firewall Protects a Network, Packet Characteristic to Filter, Stateless Vs Stateful Firewalls, Network Address Translation (NAT) and Port Forwarding. VPN: the basic of Virtual Private Networks. Firewall: Introduction, Linux Firewall, Windows Firewall. Snort: Introduction Detection System.

Unit 3: Web Application Tools Scanning for web vulnerabilities tools:

Nikto, W3af, HTTP utilities - Curl, OpenSSL and S-tunnel. Application Inspection tools – Zed Attack Proxy, Sql-map, DVWA, Web goat. Password Cracking and Brute-Force Tools: John the Ripper, L0htcrack, PW dump, HTC-Hydra.

Unit 4: Introduction to Cyber Crime, law and Investigation:

Cyber Crimes, Types of Cybercrime, Hacking, Attack vectors, Cyberspace and Criminal Behavior, Clarification of Terms, Traditional Problems Associated with Computer Crime, Introduction to Incident Response, Digital Forensics, Computer Language, Network Language, Realms of the Cyber world. Internet crime and Act: A Brief History of the Internet, Recognizing.

Unit 5: Defining Computer Crime, Contemporary Crimes, Computers as Targets, Contaminants and Destruction of Data, Indian IT ACT Page 3 of 23 2000. Firewalls and Packet Filters, password Cracking, Keyloggers and Spyware, Virus and Warms, Trojan and backdoors, Steganography, DOS and DDOS attack, SQL injection, Buffer Overflow, Attack on wireless Networks.

Reference Books

- Behrouz A. Ferouzan, Deb deep Mukhopadhyay, "Cryptography and Network Security", 3rd Edition, Tata McGraw Hill, 2015.
- Charles Pfleeger, Shari Pfleeger, Jonathan Margulies, "Security in Computing", Fifth Edition, Prentice Hall, New Delhi, 2015.

Facilitating the Achievement of Course Learning Objectives

Unit no.	Course Learning Outcomes	Teaching and Learning Activities	Assessment Tasks
1	• Understand the fundamentals of Cyber Security • Explore Computer Security and its importance • Learn about authentication, access control, and cryptography • Understand various web attacks and how to protect against them • Explore network vulnerabilities and scanning techniques	• Lecture on the introduction to Cyber Security • Explanation of computer security, threats, vulnerabilities, and controls • Practical exercises on authentication, access control, and cryptography • Explanation of web attacks, browser attacks, and email attacks • Introduction to vulnerability scanning, network sniffers, and injection tools	• Quiz on Cyber Security basics • Writing a short essay on the importance of Cyber Security • Implementing authentication and access control measures • Identifying and mitigating web vulnerabilities • Conducting network vulnerability scans
2	• Learn about network defense tools and techniques • Understand the role of firewalls and packet filters • Explore VPNs and their basic concepts • Learn about intrusion detection systems (IDS) • Explore web application scanning and security tools • Learn about scanning tools like Nikto and W3af	• Lecture on firewalls, packet filters, and VPNs • Practical exercises on configuring firewalls and packet filters • Explanation of Virtual Private Networks (VPNs) • Introduction to intrusion detection systems (IDS) • Lecture on web application security, scanning tools, and password cracking • Practical exercises with Nikto, W3af, and HTTP utilities	• Configuring firewalls and VPNs • Implementing packet filtering rules • Setting up a VPN for secure communication • Configuring and using Snort IDS • Conducting web vulnerability scans • Identifying and addressing web vulnerabilities

Unit no.	Course Learning Outcomes	Teaching and Learning Activities	Assessment Tasks
3	• Understand application inspection tools like ZAP and Sqlmap • Learn about password cracking and brute-force tools	• Explanation and hands on practice with Zed Attack Proxy (ZAP) • Introduction to password cracking tools and techniques	• Conducting application security assessments • Cracking passwords and evaluating password security
4	• Gain insights into Cyber Crime, laws, and investigation • Understand the types of Cybercrime and attack vectors • Learn about cyber laws and regulations	• Lecture on Cyber Crime, types, and incident response • Explanation of hacking, attack vectors, and digital forensics • Practical exercises on Indian IT Act 2000 and cyber laws	• Quiz on Cyber Crime and laws • Investigating a simulated cybercrime incident • Analyzing legal aspects of Cyber Security incidents
5	• Explore various contemporary Cyber Security threats and attacks • Understand the risks associated with different types of attacks Learn about SQL injection, buffer overflow, and wireless network attacks	• Introduction to contemporary Cyber Security threats and attacks • Explanation of password cracking, keyloggers, viruses, and malware • Practical exercises on SQL injection, buffer overflow, and wireless attacks	• Identifying and mitigating Cyber Security threats and attacks • Evaluating and mitigating security risks associated with attacks Conducting simulated attacks and defending against them

VALUE ADDED COURSE

3HYEV206: Yoga Education

(Credit: Practical -2 Tutorial - 1)

Scheme of Examination

Course Details				End Term Practical Exam		Lab Performance		Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor Sessional ***		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max Marks	Min Marks				
Practical Group											
3HYEV206	Value added course	Yoga Education	100	60	20	40	14	-	1	2	3

Objectives:

- To provide an understanding of the meaning and definition of Yoga.
- To identify the aims and objectives of Yoga.
- To analyze the role of Yoga in Early Upanishads.
- To understand the Yoga Sutra: General Consideration.
- To recognize the need and importance of Yoga in Physical Education and Sports.

Outcomes:

- Understand the definitions and concepts of Yoga.
- Describe the historical development of Yoga in India.
- Know the major schools of Yoga.
- Demonstrate the different stages of the Surya Namaskar.
- Name the different types of Asanas.
- Analyze the preventive and curative effects of Yoga.

Syllabus:

Unit 1: Introduction

- Meaning, History and Development of Yoga.
- Aims and Objectives of Yoga, Time and food.
- The Yoga Sutra: General Consideration.
- Need and Importance of Yoga.

Unit 2: Foundation of Yoga

- Various kind of Yoga (Bhakti yoga, karma yoga, hatha yoga, and Ashtang yoga).
- General guidelines for yoga practice.
- Yoga practice for health and wellness.

Unit 3: Asanas

- Effect of Asanas and Pranayama on various system of the body Classification of asanas.
- Influences of relatives, meditative posture on various system of the body.
- Types of Bandhas, mudras and kriyas.

Unit 4: Yoga Education

- Basic, applied and action research in Yoga.
- Difference between yogic practices and physical exercises.
- Yoga education centers in India and abroad.

Unit 5: Yoga and Holistic Health

- Holistic Health and Yoga- Explore the concept of holistic health and how yoga contributes to overall well-being, including physical, mental, and emotional health.
- Yoga for Stress Management - Examine the role of yoga in managing stress and promoting relaxation, with a focus on specific techniques and practices.
- Yoga and Nutrition - Discuss the connection between yoga and nutrition, emphasizing the importance of a balanced diet for a healthy lifestyle.
- Yoga Philosophy and Ethics - Delve into the ethical and philosophical aspects of yoga, including concepts like Ahinsa (non-violence) and Dharma (duty), and how they can be applied in daily life.

Practical:

- Prayer: Concept and recitation of pranava.
- Surya Nasmaskar
- Aasana- (Uttanpadasan, Halasan, Pawanmuktasan, Makrasan, Bhujangasan Shaslabhasan, Dhanurasan, Ardha-Mastsyendrasan, Janushirasan, Supta-Vajrasan, Chakrasan, Tadasa, Uktatasan, Padamsan, Gomukhasan, Vajrasan, Pashchimottasan, Sarvangasan, Matsyasan.)
- Chalana kriya/ Loosening Practice
  - Neck Movement
  - Shoulder movement
  - Bhuja Valli shakti vikasaka
  - Purna Bhuja shakti vikasaka
  - Knee Movement
- Yogasana Standing Posture – Tadasana, vrikshasana, Ardha Chakrasana, sarwangasana, trikonasana Sitting posture – Bhadrasana, vajrasana, Ardha- ushtrasana, shashankasana, vakrasana Prone Posture- Makarasana, bhujangasana, Shalabhasana Supine posture- Ardhasana, Setubandhasana, pawanmuktasana, shavasana.
- Pranayam (Anulom-vilom, Nadi-Shodhan, Surya, Bhedi Ujjayi, Shitkari, Sheetali, Bhastrika, Bhramri.)
- Shat-Karma (Cleansing process) (Jal-Neti, Sutra Neti, Kunjal, Trataka, Kapalbhati)
- Mudra (Mahamudra, Mahabandha, Viparitkarani, Shambhri, Kaki)
- Dhyan (Meditation): "OM" recitation, Body Awareness, Breath Awareness, yoga nidra.
- Viva
- Practical work

Reference Books

- Gupta S.N. Dass Yoga Philosophy Dr. Bhardwaj Ishwar Upnishdhik & Adhyatmik Yigyan.
- Swami Kuvalayananda Hathyog Preedipika Mukherjee, Wishvananth Bharat Ke Mahaan Yogies.
- Swami Tirth, Omanand Patanjali Yog Pradeep Swami Kuvalayananda Pranayam.
- Swami Saraswati Sataya Nand Asan Pranayam and Mudra Bandh Bharamchari, Swami Dhirender Yogic Suksham Vigyan.
- Dr. Nagendra H.R. Pranayama the Arts & Science.
- Swami Kuvalayananda Yogic Chikitisa Ananda Swamy Shankaradev Yogic management & Common.

Facilitating the Achievement of Course Learning Objectives

Unit no.	Learning Outcome	Teaching and Learning Activities	Achievements
1	Understand the meaning and definition of yoga.	Lecture and discussion on the concept and definition of yoga. - Reading assignments on the history and evolution of yoga.	Define yoga and its historical context.
2	Identify the aims and objectives of yoga practice.	Group discussions on the purposes of practicing yoga. - Research projects on the benefits of yoga in various aspects of life.	List the aims and objectives of yoga.
3	Trace the presence of yoga in early Upanishads.	Analysis of select Upanishadic texts with references to yoga. Group presentations on the historical development of yoga.	Summarize the influence of Upanishads on yoga.
4	Summarize the Yoga Sutra and its general considerations.	In depth study of Patanjali's Yoga Sutras and their significance. Group debates on the key principles in the Yoga Sutra.	Explain the fundamental concepts in the Yoga Sutra.
5	Recognize the need and importance of yoga in physical education and sports.	Guest lectures by yoga experts in sports and physical education. Practical sessions of yoga for athletes and physical education students.	Identify the benefits and relevance of yoga in sports and physical education.

Value Added Course
3HCIV206: Contemporary India

(Credit: Theory -3 Tutorial - 0)

Scheme of Examination

Course Code	Course Name	Credit	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3HCIV206	Contemporary India	3(3+0)	60	20	20	-	-	100	3 hr	-

Course Objective

- Develop a clear and comprehensive understanding of the definition and scope of Contemporary India.
- Identify and critically analyze the key elements that define the contemporary period.
- Trace and summarize the post-independence historical background, highlighting major events and their significance.
- Evaluate the impact of historical developments on the current socio-political and economic landscape.
- Examine India's demographic profile, including population distribution, age structure, and regional diversity.
- Analyze the cultural and linguistic diversity within India and its implications for national identity.
- Understand the trajectory of economic growth in India, including key sectors and challenges.
- Analyze the role of economic policies in shaping India's growth and development.
- Evaluate social indicators such as education, health, and poverty, understanding their significance in measuring societal well-being.
- Examine the interconnections between social indicators and their impact on the overall quality of life.

Course Outcome

- Students will articulate a precise definition of Contemporary India, demonstrating an understanding of its multidimensional nature.
- Students will categorize and interpret key aspects defining the scope of Contemporary India.
- Students will construct a chronological timeline of post-independence events, demonstrating an understanding of their historical context.
- Students will assess the significance of historical events in shaping the contemporary landscape.
- Students will analyze India's demographic landscape, producing insights into population distribution and diversity.
- Students will recognize and appreciate the cultural diversity within India, linking it to the nation's identity.
- Students will explain the trajectory of economic growth in India, illustrating their understanding of key economic sectors.
- Students will critically assess economic challenges, demonstrating an understanding of their complexities.
- Students will interpret social indicators, showcasing their ability to evaluate education, health, and poverty metrics.
- Students will demonstrate an understanding of the interconnectedness of social indicators and their implications for societal well-being.

Syllabus:

Unit 1: Introduction to Contemporary India

- Definition and scope of Contemporary India
- Historical background: post-independence period
- Demographic profile and diversity
- Economic overview: Growth, sectors, and challenges
- Social indicators: Education, health, and poverty

Unit 2: Political Landscape

- Constitution of India: Features and amendments
- Political institutions: Parliament, President, Prime Minister, Judiciary
- Electoral system: Elections, political parties, and regional dynamics
- Major political issues and challenges

Unit 3: Economic Development

- Economic planning and policies
- Agriculture: Green Revolution, challenges, and reforms
- Industry and services sector
- Infrastructure development
- Economic inequality and inclusive growth

Unit 4: Social Issues and Cultural Dynamics

- Social diversity: Caste, religion, ethnicity, and language
- Gender issues: Women empowerment, equality, and challenges
- Cultural heritage: Art, literature, music, and cinema
- Urbanization and changing lifestyles

Unit 5: Contemporary Challenges and Future Prospects

- Environmental challenges: Climate change, pollution, and conservation
- Technological advancements and their impact
- Globalization and India's role in the international community
- Future prospects: Opportunities and challenges

Recommended Texts:

- "India After Gandhi" by Ramachandra Guha
- "India Unbound" by Gurcharan Das
- "The Argumentative Indian" by Amartya Sen
- "Pax Indica" by Shashi Tharoor
- Articles and research papers on contemporary issues

Reference Books

- Author: Ramachandra Guha, Book Title: "India After Gandhi: The History of the World's Largest Democracy", Publication Year: 2007
- Author: Bipan Chandra, Mridula Mukherjee, Aditya Mukherjee, and Sucheta Mahajan, Book Title: "India Since Independence", Edition: 1st Edition Publication Year: 2008
- Author: Amartya Sen, Book Title: "The Argumentative Indian: Writings on Indian History, Culture and Identity", Edition: 1st Edition, Publication Year: 2005
- Author: Shashi Tharoor, Book Title: "Pax Indica: India and the World of the 21st Century", Edition: 1st Edition, Publication Year: 2012
- Author: Arvind Panagariya, Book Title: "India: The Emerging Giant", Edition: Updated and Expanded Edition Publication Year: 2011

Facilitating the Achievement of Course Learning Objectives

Unit no.	Learning Outcome	Teaching and Learning Activities	Achievements
1	● Introduction to Contemporary India ● Definition and scope of Contemporary India ● Historical background: post-independence period ● Demographic profile and diversity ● Economic overview Growth, sectors, and challenges ● Social indicators Education, health, and poverty	● Lectures and discussions Case studies on demographic trends Analysis of economic indicators Research projects on social issues	● Increased understanding of Contemporary India Enhanced analytical skills
2	● Political Landscape ● Constitution of India: Features and amendments ● Political institutions: Parliament, President, Prime Minister, Judiciary Electoral system: Elections, political parties, and regional dynamics ● Major political issues and challenges	● Interactive sessions on constitutional features Role-playing exercises on political processes Debates on major political issues	● Improved understanding of India's political landscape Enhanced debating and critical thinking skills ●
3	● Economic Development ● Economic planning and policies ● Agriculture: Green Revolution, challenges, and reforms ● Industry and services sector ● Infrastructure development ● Economic inequality and inclusive growth	● Guest lectures from economists Case studies on economic policies Field visits to industries and farms	● Increased awareness of economic policies Practical insights into economic sectors
4	● Social Issues and Cultural Dynamics ● Social diversity: Caste, religion, ethnicity, and language ● Gender issues: Women empowerment, equality, and challenges ● Cultural heritage: Art, literature, music, and cinema ● Urbanization and changing lifestyles	● Group discussions on social diversity Workshops on gender equality Cultural events and presentations	● Improved sensitivity to social issues Enhanced understanding of cultural diversity
5	● Contemporary Challenges and Future Prospects ● Environmental challenges: Climate change, pollution,	● Seminars on environmental challenges Analysis of technological impacts	● Heightened awareness of global issues Improved diplomatic and negotiation skills

Unit no.	Learning Outcome	Teaching and Learning Activities	Achievements
	and conservation Technological advancements and their impact ● Globalization and India's role in the international community ● Future prospects: Opportunities and challenges	Model United Nations (MUN) simulations	

RAMANUJAN SCHOOL OF SCIENCE

BACHLOR OF SCIENCE

(Chemistry, Biology, Zoology)

(B. Sc. (CBZ) – CKUG04B03)

III Semester

MAJOR CORE COURS

3SGEC303: Zoology-III (Genetics)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SGEC303	Zoology-III (Genetics)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- This paper is aimed to introducing the students for Genetics and applied Genetics.
- To bring awareness to human society on various genetic disorders, its inheritance patterns and to develop the methods, and techniques of fighting against the diseases.
- Applications of genetics in to various fields of life science like Statistics, Chemistry, Physics, Computer Science, Developmental Biology, Biotechnology, Genetics and Society, Genetics and Evolution.
- To develop the application of software skills related to Bioinformatics. Designing and executing the programs related to structural and functional aspects of genes and proteins.

Course Learning Outcomes

- The student has a knowledge of Gene, genetic code, diseases and treatment.
- Outline the structure of the biomolecules found in a living organism.
- Describe the function and structure of cells including the metabolic reactions that occur in cells.
- Explain the process of inheritance.
- Describe how RNA, DNA and protein are synthesized.

Syllabus Credits 4-0-2

UNIT - I:

Heredity and Variation, Gene and Genetic Material

Chromosome; Types of chromosomes, Lamp brush, salivary gland and Beta Chromosomes, Nucleocytoplasmic interactions; Ultra structure of nucleus, nucleolus, Role of nucleus and nucleolus in nucleocytoplasmic interactions, including Synthesis and Export of RNA, transport of Proteins, Heredity and Variation; Sources of variation, Genotype, phenotype and environmental variations Mendel's laws of heredity, Kinds of variations, Genetic basis of variation.

UINT-II:

Cytoplasmic Inheritance, Gene Expression and Regulation

Chemistry of Gene; Nucleic Acids and structure, DNA replication, Nucleosome (Solenoid model), Split genes, overlapping genes and Pseudo genes, Genetic Code, Cytoplasmic inheritance; Kappa particles in Paramecium, Transcription in Prokaryotes and Eukaryotes, Translation in Eukaryotes, Gene Expression; Regulation of protein synthesis, transcription in Prokaryotes and Eukaryotes.

UNIT-III:

Linkage and Chromosomal Aberrations

Gene Linkage; Kinds and Theories of linkage, significance of linkage, Gene linkage, Mechanism of genetic recombination, Sex Chromosomes System; Sex differentiation, chromosome theory of sex determination. Sex linked inheritance; Hemophilia, Colour blindness, Structural changes in chromosomes, Numerical changes in chromosomes.

UNIT-VI:

Mutation and Applied Genetics

Types of Mutation, Causes of mutation, Mutagens; classification, Types and effects, Gene therapy, DNA fingerprinting, Gene Expression; Operon model.

UNIT-V:

Human Genetics and Genetic Engineering

Human chromosomes, Human Genome Project, Common genetic diseases in man; Autosomal syndromes, sex chromosome syndromes, mutation diseases; Sickle cell anemia, Albinism and Alkaptonuria, Multiple factors and blood groups, Techniques used in recombinant; DNA technology, Construction of Chimeric DNA, plasmids and vectors, Gene cloning and Polymerase Chain Reaction (PCR), Gel Electrophoresis, Northern and Southern Blotting.

Practical Content **Credits :2**

- Identification of spots related to theory.
- Squash preparation of onion root tip/Chironomus larva salivary gland/grass hopper testis.
- Study of instruments techniques related to applied genetics PCR,
- Gel electrophoresis, DNA fingerprinting etc.
- Problems based on genetics.

Textbook

- A textbook of Cell Biology and Genetics by Veer Bala Rastogi.
- Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P.S. Verma and V.K. Agrawal, S. Chand Publication.
- Biotechnology-2 Including cell biology and Genetics, by Setty Rajeshwari S. New Age International Publications.
- Cell biology, Genetics and Cell Biology, Kar Dr. Deepak Kumar Haldez Dr. Soma, London, New central book agency.

Reference Book

- an introduction of genetic resolving Cengage Learning by Balinsky 2012.
- Cell and Molecular Biology, Eighth edition by Lippincott, De Robertis, EDP, De Robertis, EMF.
- Human reproduction at a glance by Haffner BWL Publication, 2001.
- Human inheritance disease, by Larsen Churchill Livingstone, 2001.
- Endocrinology and Reproductive Biology by Sastry Rastogi, Publications, 2018.
- A Cell and Developmental Biology, Pardesi, K and Dubey, Akhand publishing.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Understand the fundamental principles of heredity, including the transmission of genetic traits from one generation to the next.	Assign case studies that involve analysing real-world examples of heredity and variation in animal populations. Have students present their findings.	Class test focusing on long and short questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
2	Describe the concept of cytoplasmic inheritance and how genetic traits are transmitted through extranuclear genetic elements such as mitochondria and chloroplasts.	Assign case studies that explore real-world examples of cytoplasmic inheritance, such as mitochondrial diseases, and have students analyse inheritance patterns and their impact on health.	Class test focusing on definitions and long subjective questions.
3	Understand the distinction between structural chromosomal aberrations (alterations in chromosome structure) and numerical chromosomal aberrations (changes in chromosome number, e.g., aneuploidy and polyploidy).	Assign case studies related to specific chromosomal aberrations (e.g., Down syndrome, Turner syndrome) and have students research and present the genetic basis, clinical manifestations, and inheritance patterns.	Class test focusing on definitions and long subjective questions.
4	Understand the genetic consequences of mutations, including silent mutations, missense mutations, nonsense mutations, and frameshift mutations.	Organize a simulation where students are exposed to "mutagens" (simulated) to understand the concept of mutation induction and the factors that contribute to it.	Class test focusing on definitions and long questions.
5	Understand the chromosomal basis of inheritance, including the roles of sex chromosomes and autosomes.	Provide pedigrees representing various genetic traits and disorders, and have students analyse and interpret them to determine inheritance patterns and genotype probabilities.	Class test, quiz and multiple-choice questions.

MAJOR CORE COURS

3SBSC303: Botany-III (Biodiversity and Systematic of Seed Plant)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SBSC303	Botany-III (Biodiversity and Systematic of Seed Plant)	6(4-0-2)	60	20	20	60	40	200	3hr	2hr

Course Objectives

- Discuss the type of seeds produced by gymnosperms, as well as other characteristics of gymnosperms.
- State which period saw the first appearance of gymnosperms and explain when they were the dominant plant life.
- List the four groups of modern-day gymnosperms and provide examples of each.
- To appreciate the fantastic commonness existing among organisms.
- The student will be able to appreciate the uniqueness of different groups and the way they are classified.

Course Learning Outcome

- Study of gymnosperms will help the students understand the connecting link between the lower and higher organisms in the plant kingdom.
- The anatomy imparts a thorough knowledge about the internal structure and relationship between tissues and evolution.
- An appreciation of seed plant diversity.
- A basic understanding of the principles of phylogenetic systematic.
- An overview of the diagnostic characters of the main lineages of seed plants.
- An understanding of the methods and principles of classification and nomenclature.

Syllabus **Credits: 4-0-2**

UNIT – I

Gymnosperm: General characteristics and classification of gymnosperms, Heterospory and origin of seed habit, Evolution and diversity of gymnosperms, Geological time scale and fossilization. Fossil gymnosperms: *Lyginopteris* and *Williamsonia.*

UNIT – II

Gymnosperm: General account of Cycadodiofilicales, Bennettitales and *Gnetales*. General account of *Ginkgoales*. Morphology, anatomy, reproduction and life cycle of *Cycas*, *Pinus* and *Ephedra*.

UNIT – III

Taxonomy: Origin and evolution of angiosperms, Fundamental components of 6, 7, 8 taxonomy, Plant Identification, Principles and rules of botanical nomenclature, Museum, Herbarium and botanical gardens. Classification of angiosperms: Bentham and Hooker, Hutchinson, Modern trends in taxonomy including molecular taxonomy.

UNIT – IV

Taxonomy: Terminology for plant description in semi technical language: Diagnostic characteristics and economic importance of families -*Ranunculaceae*, *Brassicaceae*, *Malvaceae*, *Rutaceae*, *Fabaceae*, and *Apiaceae*. *Rosaceae Cucurbitaceae.*

UNIT – V

Taxonomy: Diagnostic characteristics and economic importance of families – *Rubiaceae, Asteraceae*, *Musaceae, Asclepiadaceae*, *Solanaceae*, *Lamiaceae*, *Euphorbiaceae*, *Liliaceae* and *Poaceae*.

Practical Content

Credits :2

- Study of microscope.
- Study of prepared slide of T.S. of young root *Cycas*.
- Study of prepared slide of V.S of leaf let *Cycas*.
- Study of prepared slides of T.S of young root *Pinus*.
- Study of prepared slide of T.S. of young stem *Pinus*.
- Study of prepared slide of T.S. of root *Ephedra*.
- Study of prepared slide of V.S of leaf *Ephedra*.
- Study of *Brassicaceae* family (*Brassica Campestris var. sarson*) up to family level.
- Study of *Malvaceae* family (*Hibiscus rosasinensis*) up to family.
- Study of family *Solanaceae* (*Solanum nigrum*) up to family level.

Reference Book

- Plant Taxonomy and Biodiversity – N.D Paria.
- Plant Taxonomy – Dr. Prithipal Singh festschrift.2012.
- Characteristics and Systematic of Seed Plants – Singh, Pande, Jain.
- Biodiversity Conservation and Systematics – Dr. Prithipal Singh.

Text Book

- A Text Book of Botany Diversity and Systematic of Seed Plant – Singh, Pande, Jain.
- A Text Book of Systematic Botany 7th Edition – Raj Kumar Gupta.
- A Text Book of Botany – Dr. R.K. Singh.

Facilitating the achievement of course learning objectives

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
1	Understand the anatomical and morphological features of gymnosperms, including leaf types, stem structures, and root systems. Students should be able to recognize and explain the adaptations of gymnosperms for various environments.	Provide students with gymnosperm specimens or cones. Have students examine and dissect the specimens to observe and document reproductive structures. Discuss the significance of these structures in gymnosperm reproduction.	Class test focusing and short questions.
2	Understand the anatomy of *Cycas Pinus Ephedra*. plants, including their unique reproductive structures such as cones and seeds. Explain the *cycas* life cycle and reproductive strategies.	Begin with an introductory lecture on gymnosperms, their evolutionary history, and their significance in ecosystems.	Class test focusing on definitions and short questions.

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
		Discuss the distinct features of *Cycas* plants.	
3	Students should be able to explain the evolutionary history of angiosperms, including their origin and diversification. This may include discussing their relationships with other plant groups.	Start with a brief overview of what angiosperms are, highlighting their importance as the most diverse and abundant group of plants on Earth. Show images of different types of angiosperms to pique students' interest.	Class test focusing on definitions and short and long questions.
4	Understand the principles of taxonomy and classification, including the hierarchical organization of life forms into families, genera, species, and more. Appreciate the vast biodiversity on Earth and recognize the role of biological families in organizing and categorizing this diversity.	Assign each student or group a specific plant family to research and present to the class, including information on its economic significance.	Class test focusing on and short questions.
5	Recognize and describe plant families that are economically significant, such as *Poaceae, Solanaceae* and *Liliaceae* family.	Assign case studies on plant families like *Poaceae, Solanaceae*. Family Have students research and present the economic significance of these families in terms of crop production, medicinal plants, and more.	Class test focusing on and long questions.

MAJOR CORE COURS

3SPIC303: Chemistry –III (Physical, Inorganic and Organic Chemistry)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SPIC303	Chemistry –III (Physical, Inorganic and Organic Chemistry)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Grasp fundamental concepts and laws, understand entropy and its role in spontaneity and equilibrium.
- Learn enthalpy changes, Hess's law, and enthalpy of formation and neutralization reactions.
- Understand adsorption, catalysis, and surface area determination.
- Learn properties, compounds, complexes, and comparative treatment of transition elements.
- Understand coordination compounds, oxidation-reduction principles, and reactions of alcohols and phenols.

Course Learning Outcome

- Ability to apply thermodynamic principles to understand spontaneity and equilibrium in chemical systems.
- Proficiency in calculating enthalpy changes and understanding their applications in various reactions.
- Understanding adsorption phenomena, catalysis, and methods for determining surface area.
- Grasping the properties, compounds, and complexes of transition elements.
- Mastery of coordination compounds, oxidation-reduction principles, and reactions of alcohols and phenols.

Syllabus **Credits :4-0-2**

Physical Chemistry

UNIT – I

Thermodynamics

Basic concepts of thermodynamics. first law, second law of thermodynamics: Need for the law, different statements of the law, carnot cycle and its efficiency, carnot theorem. Thermodynamic scale of temperature. Concept of Entropy: Entropy as a function of P & T and T and T & V, entropy change in physical change. Clausius inequality, entropy as criteria of spontaneity and equilibrium. Entropy changes in ideal gases and mixing of gases. Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data Gibbs and Helmholtz functions. Gibbs function (G) and Helmholtz functions (H) as thermodynamic quantities. A and G as a criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change.

Thermochemistry

Standard state, standard enthalpy of formation: Hess's law of heat summation and its application. Enthalpy of neutralization.

UNIT – II

Surface Chemistry

Adsorption: Adsorption and absorption, type of adsorption, adsorption of gases and liquids in solid adsorption, Freundlich and Langmuir adsorption isotherms. Surface area and determination of surface area.

Catalysis: Characteristics of catalyzed reactions, classification of catalysis, application of catalysts, miscellaneous examples.

Inorganic Chemistry

UNIT – III

Chemistry of Elements of First Transition Series

Characteristic properties of d-block elements. Properties of the elements of the first transition series, their binary compounds such as carbides, oxides and sulphides. Complexes illustrating relative stability of their oxidation states, coordination number and geometry.

Chemistry of Elements of Second and Third Transition Series

General characteristics, comparative treatment with their 3d-analogues in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.

UNIT – IV

Coordination Compounds

Werner's co-ordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, VBT of transition metal complexes.

Oxidation and Reduction

Use of redox potential data: Analysis of redox cycle. Redox stability in water: Frost, latimer and pourbaix diagrams. Principles involved in the extraction of elements.

Organic Chemistry

UNIT – V

Alcohols

Classification and nomenclature. Monohydric alcohols: nomenclature, methods of formation, acidic nature and reactions of alcohols. Dihydric alcohols: Nomenclature, methods of formation, chemical reactions. Trihydric alcohols: Nomenclature and methods of formation, chemical reactions.

Phenols

Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols- Electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gattermann synthesis, Hauben- Hoesche reaction, Lederer-Manasse reaction and Riemer- Tiemann reaction.

Practical Content — Credits :2

Physical Chemistry

- Determination of transition temperature of give substance by thermometric method.
- Verification of beer's lambert law.
- To determine the strength of HCl with NaOH using potentiometer.

Inorganic Chemistry

- Determination of acetic acid in commercial vinegar using NaOH.
- Determination of alkali content- antacid tablet using HCl.
- Estimation of calcium content in chalk as calcium oxalate by permagnometry.
- Estimation of hardness of water by EDTA.

Organic Chemistry

- Thin layer chromatography Determination of Rf values and identification of organic compounds.
  a. Separation of green leaf pigments (spinach leaves may be used).
  b. Preparation and separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone, hexane-2 and 3-one using toluene and light petroleum (40:6).
  c. Separation of a mixture of dyes using cyclohexane and ethyl acetate (8:5:1.5).
- Paper chromatography: Ascending and Circular Determination of Rf values and identification of organic compounds.
  a. Separation of a mixture of phenylalanine and glycine, alanine and aspartic acid, leucine and glutamic acid. Spray reagent ninhydrin.
  b. Separation of a mixture of DL-alanine, glycine and L-Lucine using n butanol, acetic acid: water (4:1:5). Spray reagent ninhydrin.
  c. Separation of monosaccharides- a mixture of D-galactose and D fructose using n-butanol: acetone: water (4:1:5). Spray reagent-aniline hydrogen phthalate.

Text Books

- Unified Chemistry by Tandon, Rathore and Agarwal.
- Physical Chemistry by P. W. Atkins and Julio de Paula.
- Inorganic Chemistry by Gary L. Miessler and Paul J. Fischer.
- Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren.
- Surface Chemistry by Arne Östlund.
- Transition Metal Chemistry the Valence Shell in d-Block Chemistry by Malcolm S. Cresser.

Reference Books

- Chemical Kinetics and Reaction Dynamics by Paul L. Houston.
- Thermodynamics, Statistical Thermodynamics, and Kinetics by Thomas Engel and Philip Reid.
- Introduction to Catalysis by Robert J. Farrauto and Lucas Dorazio.
- Principles of Inorganic Chemistry by Brian W. Pfennig and Kimberly A. Pfennig.
- Advanced Organic Chemistry Reactions, Mechanisms, and Structure by Jerry March.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	The laws of thermodynamics, including the zeroth law, first law (conservation of energy), second law (entropy and the direction of processes), and third law (absolute zero and entropy).	Traditional lectures can be used to introduce and explain key thermodynamic concepts, laws, and principles. Visual aids, diagrams, and animations can enhance understanding.	Quiz assessing understanding of basic thermodynamic concepts.
2	Understanding the fundamental principles of surface chemistry, including surface tension, adsorption and interface phenomena.	Covering fundamental concept, theories and principles of surface chemistry. Showing surface phenomena using visual aids or experiments.	Homework assignments on catalytic mechanisms and examples.
3	Describe and compare the fundamental physical and chemical properties of the elements in the first transition series, including atomic and ionic radii, ionization energy,	Assign each student or group of students an element from the first transition series. Have them create profiles that include key information like electron configuration, physical	Written exam on the characteristic properties of transition elements.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
	electron affinity, and magnetic properties.	properties, and common uses. Present these profiles to the class.	
4	Coordination compounds and describe their distinctive features, including the central metal ion or atom, ligands, and coordination number.	Provide students with molecular modelling software or kits to build and visualize coordination complexes. This hands-on approach helps students understand three-dimensional structures.	Quiz on Werner's coordination theory and effective atomic number concept.
5	Classification and nomenclature and Chemical reaction of Alcohols and Phenols.	Begin with traditional lectures to introduce the basic concepts of Alcohols and Phenols.	Class test focusing on long questions.

MINOR CORE COURS

3SGEM304: Zoology-III (Genetics)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SGEM304	Zoology-III (Genetics)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objective

- This paper is aimed to introducing the students for Genetics and applied Genetics.
- To bring awareness to human society on various genetic disorders, its inheritance patterns and to develop the methods, and techniques of fighting against the diseases.
- Applications of genetics in to various fields of life science like Statistics, Chemistry, Physics, Computer Science, Developmental Biology, Biotechnology, Genetics and Society, Genetics and Evolution.
- To develop the application of software skills related to Bioinformatics.
- Designing and executing the program related to structural and functional aspects of genes and proteins.

Course Outcome

- The student has a knowledge of Gene, genetic code, diseases and treatment.
- Outline the structure of the biomolecules found in all living or organisms.
- Describe the function and structure of cells including the metabolic reactions that occurring cells.
- Explain the process of inheritance.
- Describe how RNA, DNA and proteins are synthesized.

Syllabus

Credits: 4-0-2

UNIT - I:

Heredity and Variation, Gene and Genetic Material

Chromosome; Types of chromosomes, Lamp brush, salivary gland and Beta Chromosomes, Nucleocytoplasmic interactions; Ultra structure of nucleus, nucleolus, Role of nucleus and nucleolus in nucleocytoplasmic interactions including Synthesis and Export of RNA, transport of Proteins, Heredity and Variation; Sources of variation, Genotype, phenotype and environmental variations Mendel's laws of heredity, Kinds of variations, Genetic basis of variation.

UNIT-II:

Cytoplasmic Inheritance, Gene Expression and Regulation

Chemistry of Gene; Nucleic Acids and their structure, DNA replication, Nucleosome (Solenoid model), Split genes, overlapping genes and Pseudo genes, Genetic Code, Cytoplasmic inheritance; Kappa particles in Paramecium, Transcription in Prokaryotes and Eukaryotes, Translation in Eukaryotes, Gene Expression; Regulation of protein synthesis, transcription in Prokaryotes and Eukaryotes.

UNIT-III:

Linkage and Chromosomal Aberrations

Gene Linkage; Kinds and Theories of linkage, significance of linkage, Gene linkage, Mechanism of genetic recombination, Sex Chromosomes System; Sex differentiation, chromosome theory of sex determination, Sex linked inheritance; Hemophilia, Colour blindness, Structural changes in chromosomes, Numerical changes in chromosomes.

UNIT-VI

Mutation and Applied Genetics

Types of Mutation, Causes of mutation, Mutagens; classification, Types and effects, Gene therapy, DNA fingerprinting, Gene Expression; Operon model.

UNIT-V:

Human Genetics and Genetic Engineering

Human chromosomes, Human Genome Project, Common genetic diseases in man; Autosomal syndromes, sex chromosome syndromes, mutation diseases; Sickle cell anemia, Albinism and Alkaptonuria, Multiple factors and blood groups, Techniques used in recombinant; DNA technology, Construction of Chimeric DNA, plasmids and vectors. Gene cloning and Polymerase Chain Reaction (PCR), Gel Electrophoresis, Northern and Southern Blotting.

Practical Content — Credits :2

- Identification of spots related to theory.
- Squash preparation of onion root tip / Chironomus larva salivary gland/grass hopper testis.
- Study of instruments techniques related to applied genetics PCR,
- Gel electrophoresis, DNA fingerprinting etc.
- Problems based on genetics.

Textbook

- A textbook of Cell Biology and Genetics by Veer Bala Rastogi.
- Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P.S. Verma and V.K. Agrawal, S. Chand Publication.
- Biotechnology-2 Including cell biology and Genetics, by Setty Rajeshwari S. New Age International Publications.
- Cell biology, Genetics and Cell Biology, Kar Dr. Deepak Kumar Haldez Dr. Soma, London, New central book agency.

Reference Book

- An Introduction of genetic resolving Cengage by Learning Balinsky 2012.
- Cell and Molecular Biology by Eighth edition Lippincott, Williams and Wilkins, Philadelphia, 2006.
- Human reproduction at a glance by Haffner BWL Publication, 2001.
- Human inheritance disease by Larsen Churchill Livingstone, 2001.
- Endocrinology and Reproductive Biology by Rastogi Publications, 2018.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Understand the fundamental principles of heredity, including the transmission of genetic traits from one generation to the next.	Assign case studies that involve analysing real-world examples of heredity and variation in animal	Class test focusing on long and short questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
		populations. Have students present their findings.	
2	Describe the concept of cytoplasmic inheritance and how genetic traits are transmitted through extra nuclear genetic elements such as mitochondria and chloroplasts.	Assign case studies that explore real-world examples of cytoplasmic inheritance, such as mitochondrial diseases, and have students analyse inheritance patterns and their impact on health.	Class test focusing on definitions and long subjective questions.
3	Understand the distinction between structural chromosomal aberrations (alterations in chromosome structure) and numerical chromosomal aberrations (changes in chromosome number, e.g., aneuploidy and polyploidy).	Assign case studies related to specific chromosomal aberrations (e.g., Down syndrome, Turner syndrome) and have students research and present the genetic basis, clinical manifestations, and inheritance patterns.	Class test focusing on definitions and long subjective questions.
4	Understand the genetic consequences of mutations, including silent mutations, missense mutations, nonsense mutations, and frameshift mutations.	Organize a simulation where students are exposed to "mutagens" (simulated) to understand the concept of mutation induction and the factors that contribute to it.	Class test focusing on definitions and long questions.
5	Understand the chromosomal basis of inheritance, including the roles of sex chromosomes and autosomes.	Provide pedigrees representing various genetic traits and disorders, and have students analyse and interpret them to determine inheritance patterns and genotype probabilities.	Class test, quiz and multiple-choice questions.

MINOR CORE COURS

3SBSM304: Botany-III (Biodiversity and Systematic of Seed Plant)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SBSM304	Botany-III (Biodiversity and Systematic of Seed Plant)	6(4-0-2)	60	20	20	60	40	200	3hr	2hr

Course Objectives

- Discuss the type of seeds produced by gymnosperms, as well as other characteristics of gymnosperms.
- State which period saw the first appearance of gymnosperms and explain when they were the dominant plant life.
- List the four groups of modern-day gymnosperms and provide examples of each.
- To appreciate the fantastic commonness existing among organisms.
- The student will be able to appreciate the uniqueness of different groups and the way they are classified.

Course Learning Outcome

- Study of gymnosperms will help the students understand the connecting link between the lower and higher organisms in the plant kingdom.
- The anatomy imparts a thorough knowledge about the internal structure and relationship between tissues and evolution.
- An appreciation of seed plant diversity.
- A basic understanding of the principles of phylogenetic systematic.
- An overview of the diagnostic characters of the main lineages of seed plants.
- An understanding of the methods and principles of classification and nomenclature.

Syllabus

Credits: 2-0-2

UNIT – I

Gymnosperm: General characteristics and classification of gymnosperms, Heterospory and origin of seed habit, Evolution and diversity of gymnosperms, Geological time scale, and fossilization. Fossil gymnosperms: *Lyginopteris* and *Williamsonia.*

UNIT – II

Gymnosperm: General account of Cycadodiofilicales, Bennettitales and *Gnetales*. General account of *Ginkgoales*. Morphology, anatomy, reproduction and life cycle of *Cycas*, *Pinus* and *Ephedra*.

UNIT – III

Taxonomy: Origin and evolution of angiosperms, Fundamental components of 6, 7, 8 taxonomy, Plant Identification, Principles and rules of botanical nomenclature, Museum, Herbarium and botanical gardens; Classification of angiosperms: Bentham and Hooker, Hutchinson, Modern trends in taxonomy including molecular taxonomy.

UNIT – IV

Taxonomy: Terminology for plant description in semi technical language: Diagnostic characteristics and economic importance of families -*Ranunculaceae*, *Brassicaceae*, *Malvaceae*, *Rutaceae*, *Fabaceae*, and *Apiaceae*. *Rosaceae Cucurbitaceae.*

UNIT – V

Taxonomy: Diagnostic characteristics and economic importance of families – *Rubiaceae, Asteraceae*, *Musaceae, Asclepiadaceae*, *Solanaceae*, *Lamiaceae*, *Euphorbiaceae*, *Liliaceae* and *Poaceae*.

Practical Content

Credits :2

- Study of microscope.
- Study of prepared slide of T.S. of young root *Cycas*.
- Study of prepared slide of V.S of leaf let *Cycas*.
- Study of prepared slides of T.S of young root *Pinus*.
- Study of prepared slide of T.S. of young stem *Pinus*.
- Study of prepared slide of T.S. of root *Ephedra*.
- Study of prepared slide of V.S of leaf *Ephedra*.
- Study of *Brassicaceae* family (*Brassica Campestris var. sarson*) up to family level.
- Study of *Malvaceae* family (*Hibiscus rosasinensis*) up to family.
- Study of family *Solanaceae* (*Solanum nigrum*) up to family level.

Reference Book

- Plant Taxonomy and Biodiversity – N.D. Paria.
- Plant Taxonomy – Dr. Prithipal Singh festschrift.2012.
- Characteristics and Systematic of Seed Plants – Singh, Pande, Jain.
- Biodiversity Conservation and Systematics – Dr. Prithipal Singh.

Text Book

- A Text Book of Botany Diversity and Systematic of Seed Plant – Singh, Pande, Jain.
- A Text Book of Systematic Botany 7th Edition – Raj Kumar Gupta.
- A Text Book of Botany – Dr. R.K. Singh.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Understand the anatomical and morphological features of gymnosperms, including leaf types, stem structures, and root systems. Students should be able to recognize and explain the adaptations of gymnosperms for various environments.	Provide students with gymnosperm specimens or cones. Have students examine and dissect the specimens to observe and document reproductive structures. Discuss the significance of these structures in gymnosperm reproduction.	Class test focusing and short questions.
2	Understand the anatomy of *Cycas, Pinus, Ephedra*. Plants, including their unique reproductive structures such as cones and seeds. Explain the *cycas* life cycle and reproductive strategies.	Begin with an introductory lecture on gymnosperms, their evolutionary history, and their significance in ecosystems. Discuss the distinct features of *Cycas* plants.	Class test focusing on definitions and short questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
3	Students should be able to explain the evolutionary history of angiosperms, including their origin and diversification. This may include discussing their relationships with other plant groups.	Start with a brief overview of what angiosperms are, highlighting their importance as the most diverse and abundant group of plants on Earth.	Class test focusing on definitions and short and long questions.
4	Understand the principles of taxonomy and classification, including the hierarchical organization of life forms into families, genera, species, and more. Appreciate the vast biodiversity on Earth and recognize the role of biological families in organizing and categorizing this diversity.	Assign each student or group a specific plant family to research and present to the class, including information on its economic significance.	Class test focusing on and short questions.
5	Recognize and describe plant families that are economically significant, such as *Poaceae, Solanaceae* and *Liliaceae* family	Assign case studies on plant families like *Poaceae*, *Solanaceae.* Family Have students research and present the economic significance of these families in terms of crop production, medicinal plants, and more.	Class test focusing on and long questions.

MINOR CORE COURS

3SPIM304: Chemistry –III (Physical, Inorganic and Organic Chemistry)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SPIM304	Chemistry –III (Physical, Inorganic and Organic Chemistry)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Grasp fundamental concepts and laws, understand entropy and its role in spontaneity and equilibrium.
- Learn enthalpy changes, Hess's law, and enthalpy of formation and neutralization reactions.
- Understand adsorption, catalysis, and surface area determination.
- Learn properties, compounds, complexes, and comparative treatment of transition elements.
- Understand coordination compounds, oxidation-reduction principles, and reactions of alcohols and phenols.

Course Learning Outcome

- Ability to apply thermodynamic principles to understand spontaneity and equilibrium in chemical systems.
- Proficiency in calculating enthalpy changes and understanding their applications in various reactions.
- Understanding adsorption phenomena, catalysis, and methods for determining surface area.
- Grasping the properties, compounds, and complexes of transition elements.
- Mastery of coordination compounds, oxidation-reduction principles, and reactions of alcohols and phenols.

Syllabus Credits: 4-0-2

Physical Chemistry

UNIT – I

Thermodynamics

Basic concepts of thermodynamics. first law, second law of thermodynamics: Need for the law, different statements of the law, carnot cycle and its efficiency, carnot theorem. Thermodynamic scale of temperature. Concept of Entropy: Entropy as a function of P & T and T and T & V, entropy change in physical change. Clausius inequality, entropy as criteria of spontaneity and equilibrium. Entropy changes in ideal gases and mixing of gases. Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data Gibbs and Helmholtz functions. Gibbs function (G) and Helmholtz functions (H) as thermodynamic quantities. A and G as a criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change.

UNIT – II

Surface Chemistry

Adsorption: Adsorption and absorption, type of adsorption, adsorption of gases and liquids in solid adsorption, Freundlich and Langmuir adsorption isotherms. Surface area and determination of surface area.

Catalysis: Characteristics of catalyzed reactions, classification of catalysis , application of catalysts, miscellaneous examples.

Inorganic Chemistry

UNIT – III

Chemistry of Elements of First Transition Series

Characteristic properties of d-block elements. Properties of the elements of the first transition series, their binary compounds such as carbides, oxides and sulphides. Complexes illustrating relative stability of their oxidation states, coordination number and geometry.

UNIT – IV

Coordination Compounds

Werner's co-ordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, VBT of transition metal complexes.

Oxidation and Reduction

Use of redox potential data, analysis of redox cycle. Redox stability in water: Frost, latimer and pourbaix diagrams. principles involved in the extraction of elements.

Organic Chemistry

UNIT – V

Alcohols

Classification and nomenclature. Monohydric alcohols: nomenclature, methods of formation, acidic nature and reactions of alcohols. Dihydric alcohols: Nomenclature, methods of formation, chemical reactions. Trihydric alcohols: Nomenclature and methods of formation, chemical reactions.

Practical Content — Credits: 2

Physical Chemistry

- Determination of transition temperature of give substance by thermometric method.
- Verification of beer's lambert law.

Inorganic Chemistry

- Calibration of the fractional weights, pipettes and burettes.
- Quantitative analysis -Volumetric analysis

a. Determination of acetic acid in commercial vinegar using NaOH.
b. Estimation of hardness of water by EDTA

- Gravimetric analysis: Barium as barium sulphate Organic Chemistry Laboratory Techniques.

Organic Chemistry

- Thin layer chromatography Determination of Rf values and identification of organic compounds.
  a. Separation of green leaf pigments (spinach leaves may be used).
- Paper chromatography: Ascending and Circular Determination of Rf values and identification of organic compounds.
  a. Separation of a mixture of phenylalanine and glycine, alanine and aspartic acid, leucine and glutamic acid. Spray reagent ninhydrin.

Text Books

- Unified Chemistry by Tandon, Rathore and Agarwal.
- Physical Chemistry by P. W. Atkins and Julio de Paula.

- Inorganic Chemistry by Gary L. Miessler and Paul J. Fischer.
- Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren.
- Surface Chemistry by Arne Östlund.
- Transition Metal Chemistry the Valence Shell in d-Block Chemistry by Malcolm S. Cresser.

Reference Books

- Chemical Kinetics and Reaction Dynamics by Paul L. Houston.
- Thermodynamics, Statistical Thermodynamics, and Kinetics by Thomas Engel and Philip Reid.
- Introduction to Catalysis by Robert J. Farrauto and Lucas Dorazio.
- Principles of Inorganic Chemistry by Brian W. Pfennig and Kimberly A. Pfennig.
- Advanced Organic Chemistry Reactions, Mechanisms, and Structure" by Jerry March.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	The laws of thermodynamics, including the zeroth law, first law (conservation of energy), second law (entropy and the direction of processes), and third law (absolute zero and entropy).	Traditional lectures can be used to introduce and explain key thermodynamic concepts, laws, and principles. Visual aids, diagrams, and animations can enhance understanding.	Quiz assessing understanding of basic thermodynamic concepts.
2	Understanding the fundamental principles of surface chemistry, including surface tension, adsorption and interface phenomena.	Covering fundamental concept, theories and principles of surface chemistry. Showing surface phenomena using visual aids or experiments.	Homework assignments on catalytic mechanisms and examples.
3	Describe and compare the fundamental physical and chemical properties of the elements in the first transition series, including atomic and ionic radii, ionization energy, electron affinity, and magnetic properties.	Assign each student or group of students an element from the first transition series. Have them create profiles that include key information like electron configuration, physical properties, and common uses. Present these profiles to the class.	Written exam on the characteristic properties of transition elements.
4	Coordination compounds and describe their distinctive features, including the central metal ion or atom, ligands, and coordination number.	Provide students with molecular modelling software or kits to build and visualize coordination complexes. This hands-on approach helps students understand three-dimensional structures.	Quiz on Werner's coordination theory and effective atomic number concept.
5	Classification and nomenclature and Chemical reaction of Alcohols and Phenols.	Begin with traditional lectures to introduce the basic concepts of Alcohols and Phenols.	Class test focusing on long questions.

ABILITY ENHANCEMENT COURSE (AEC)

3HCSA301: Communication Skill

(Credit: Theory - 2 Tutorial -0)

Scheme of Examination

Course Code	Course Name	Credit	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3HCSA301	Communication Skill	2(2-0-0)	60	20	20	-	-	100	2 hr	-

Course Objective

- Develop Effective Communication Skills Spoken and written.
- Develop Effective Presentation Skills.
- Conduct Effective business Correspondence, business reports, team management and all-round personality Development.

Course Outcomes

- Projects Role plays, quizzes and Various other participatory sessions. The emphasis will be on learning by doing.
- The student will learn the skills and attributes but also internalize them over a period of time.
- Internalization ensures that the skills and attributes become part of the student's nature. Thus, the changes will be genuine and positive.

Syllabus:

Unit 1: Introduction

General Introduction of self by students, Importance of the Training sessions, Importance of Presentation Skills, Public Speaking

Unit 2: Basic English Grammar

Vocabulary, Kinds of Sentences, Verb, Adverb, Tenses, Preposition, Conjunction, Formation of Sentences, Sentence Making, Translation

Unit 3: Communication Skills

Communication meaning, Function, Process, Types of communication, Guidelines for effective communication, Purpose of Good communication, Importance of right Pronunciation

Unit 4: Listening and Writing Skills

Importance of effective listening, Importance of effective writing skills, Conversation Practice, Guidelines for Effective writing

Unit 5: Body Language

Gestures, Voice Modulation, Eye Contact, Facial Expression, Posture, Dressing Sense, Attire, Hand, movements, General Etiquette, Mannerism, Smiling Gestures, Confidence building. Email Etiquette, Email Drafting

Reference Books

- English Communicative skill by Pramod Singla.
- English Language skill a Practical.
- Communicative skill by Sanjay Kumar & Pushpalata.

Facilitating the Achievement of Course Learning Objectives

Unit	Course Learning Outcome	Teaching-Learning Activities	Assessment Tasks
1	● Understand the basics of communication.	● Lecture on communication fundamentals ● Group discussion on the importance of effective communication ● Role-play exercises demonstrating different communication styles	● Quiz on communication basics Individual reflection on group discussion performance
2	● Develop active listening skills.	● Listening comprehension exercises Class debates with active listening requirements Peer feedback sessions	● Listening comprehension test Debate participation and assessment by peers
3	● Improve verbal communication skills.	● Public speaking workshops ● Mock interviews and feedback sessions. ● Impromptu speech exercises	● Public speaking assessment with feedback ● Mock interview performance evaluation
4	● Enhance non-verbal communication skills.	● Body language analysis and practice activities Group activities emphasizing non-verbal cues Video analysis of non-verbal communication	● Non-verbal communication assessment with peer feedback Written reflection on video analysis
5	● Develop effective written communication skills.	● Writing workshops on emails, reports, and proposals Collaborative document editing exercises Writing assignments on various topics	● Written assignments on emails, reports, and proposals with rubric assessment Peer review of collaborative document editing

SKILL ENHANCEMENT COURSE

3SNGS305: Nursery and Gardening

(Credits: Theory- 0 Tutorial- 1 Practical- 2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign.	End Sem	Term work			
3SNGS305	Nursery and Gardening (3rd Sem)	3(0-1-2)	-	-	-	60	40	100	-	2 hr

Course Objectives

- Students will learn to recognize various plant species, including trees, shrubs, flowers, and vegetables, and understand their characteristics.
- Students will grasp the basics of soil types, soil testing, and soil improvement techniques to create optimal growing conditions.
- Students will be able to create garden layouts, taking into account factors like aesthetics, functionality, and plant compatibility.
- Students will learn about plant propagation methods, including seeds, cuttings, and grafting, and choose appropriate techniques for different plant types.

Course Learning Outcomes

- Students will be able to recognize and categorize common plant species, including trees, shrubs, flowers, and vegetables.
- Understand different soil types, conduct soil tests, and apply soil improvement techniques to create optimal growing conditions.
- Develop the ability to plan and design gardens, considering factors such as aesthetics, functionality, and plant compatibility.
- Apply sustainable gardening practices, including composting, water conservation, and the use of native plants.

Syllabus: Credits: 3(0-1-2)

Unit: 1

***Nursery*:** Definition, objectives and scope and building up of infrastructure for *nursery*, planning and seasonal activities planting direct seeding and transplants.

Unit: 2

Seed: Structure and types seed dormancy; causes and methods of breaking dormancy, seed storage: Seed banks, factors affecting seed viability, genetic erosion. Seed production technology, seed testing and certification.

Unit: 3

Vegetative propagation: Air layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings hardening of plants, greenhouse, mist chamber, shed root, shade house and glass house.

Unit: 4

Gardening: Definition, objectives and scope, different types of gardening landscape and home gardening parks and its components. Plant materials and design, computer applications in landscaping. Gardening operations: Soil laying, manuring, watering, management of pests and diseases and harvesting.

Unit: 5

Sowing/Raising: Seeds and seedlings. Transplanting of seedlings. Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots. Storage and marketing procedures.

Practical **Credit: 2**

- Practice of grafting, budding, cutting and layering.
- Anatomical studies of rooting of cuttings and grafting and layout for commercial nursery.
- Sample seed testing, use of bio regulators in propagation, sterilization of equipment's and laboratory.
- Media preparation, selection and preparation of explants, meristem culture and micro grafting, planning and layout of experiments on various aspects of propagation.
- Visit to tissue culture labs and nurseries.
- Preparation of land for vegetable cultivation and sowing of vegetable crops.
- Preparation of nursery beds for raising healthy seedlings of different vegetable crops.
- Methods of training and pruning in tomato.
- Seed sowing methods in nursery.

Reference Books

- Bose T.K. and Mukherjee, D., 1972, Gardening in India, Oxford and IBH Publishing Co. New. Delhi.
- Sandhu. M.K. 1989. Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
- Kumar. N. 1997. Introduction to Horticulture. Rajalakshmi. Publications. Nagercoil.
- Edmond Musser and Andres, Fundamentals of Horticulture. McGraw Hill Book Co. New. Delhi.
- Agrawal. P.K. 1993. Hand Book of Seed Technology. Dept. of Agriculture and 87 Cooperation. National Seed Corporation Ltd. New Delhi.
- Janick. Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co. San Francisco. U.S.A.

Facilitating the achievement of course learning objectives

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
1	• Define what a nursery is in the context of horticulture. • Explain the significance of nurseries in plant propagation and cultivation.	• Start with a class discussion on what students think a nursery is. Afterward, present the formal definition of a nursery. For objectives, provide case studies of successful nurseries and discuss how they align with the objectives of plant propagation and sales.	• Class text and short and long questions.
2	• Describe the basic structure of a seed, including its key components. • Differentiate between various types of seeds, such as monocotyledonous and dicotyledonous seeds.	• Organize a visit to a local seed bank or invite a representative to discuss the role and importance of seed banks in conserving genetic diversity. Students can engage in discussions about the factors affecting seed viability and	• Class text and short and long questions.

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
		brainstorm solutions for long-term storage	
3	• Explain the principles and significance of vegetative propagation. • Describe different techniques, including air layering and cutting, and their applications.	• Organize a handson workshop on air layering. Provide students with a demonstration of the technique and then allow them to practice air layering on selected plants. Discuss the advantages and applications of air layering.	• Class text and short questions and definitions.
4	• Understand the principles of landscape design and its role in creating visually appealing outdoor spaces • Apply landscape design principles to plan and execute home gardening projects.	• Organize a field trip to a local botanical garden or community garden with various gardening types on display. Allow students to observe and document the characteristics of each type. Follow up with a group discussion and presentations on their findings.	• Class text and short and long questions.
5	• Analyze the growth and development stages of vegetables like cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots. • Apply appropriate cultivation techniques, including soil preparation, watering, fertilization, and pest control, for each vegetable.	• Start with a handson sowing workshop. Provide students with trays, seeds of different vegetables, and potting mix. Guide them through the process of sowing seeds at the correct depth and spacing, labelling trays, and providing proper care for seedlings. Monitor and discuss germination rates.	• Class text and short and long questions.

INTER DISCIPLINARY COURSE

3SMCI302: Mushroom Cultivation

(Credits: Theory-0 Tutorial-1 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign.	End Sem	Term work			
3SMCI302	Mushroom Cultivation	3(0-1-2)	-	-	-	60	40	100	-	3 hr

Course Objective

- Enable the students to identify edible and poisonous mushrooms.
- Provide hands on training for the preparation of bed for mushroom cultivation and spawn production.
- Give the students exposure to the experiences of experts and functioning mushroom farms.
- Help the students to learn a means of self-employment and income generation.

Course Learning Outcome

By successfully completing the course, students will be able to:

- Identify edible types of mushrooms
- Gain the knowledge of cultivation of different types of edible mushrooms and spawn production
- Manage the diseases and pests of mushrooms
- Learn a means of self-employment and income generation

Syllabus: **Credits: 3(0-1-2)**

Unit 1: Introduction to mushrooms Taxonomical rank History and Scope of mushroom cultivation Edible and Poisonous Mushrooms Vegetative characters.

Unit 2: Common edible mushrooms Button mushroom (Agaricus bisporus), Milky mushroom (Calocybe indica), Oyster mushroom (Pleurotus sajorcaju) and paddy straw mushroom (Volvariella volvcea).

Unit 3: Principles of mushroom cultivation Structure and construction of mushroom house. Sterilization of substrates. Spawn production culture media preparation production of pure culture, mother spawn, and multiplication of spawn. Composting technology, mushroom bed preparation. Spawning, spawn running, harvesting. Cultivation of oyster and paddy straw mushroom. Problems in cultivation diseases, pests and nematodes, weed moulds and their management strategies.

Unit 4: Health benefits of mushrooms Nutritional and medicinal values of mushrooms. Therapeutic aspects antitumor effect.

Unit 5: Post harvest technology: Preservation of mushrooms freezing, dry freezing, drying, canning, quality assurance and entrepreneurship. Value added products of mushrooms.

Practical Sessions

- Different parts of a typical mushroom and variations in mushroom morphology.
- Sterilization of glassware, equipment, and culture media used in mushroom cultivation.
- Preparation of culture media: Potato Dextrose medium, Richard's medium.
- Preparation of spawn: Grain spawn, Straw spawn, Sawdust spawn.
- Preparation of compost and known compost formulations.
- Mushroom bed preparation paddy straw, sugarcane trash, maize straw, banana leaves.
- Cultivation of White button mushroom.
- Cultivation of Paddy straw mushroom.
- Cultivation of Oyster mushroom.
- Cultivation of Milky mushroom.
- Nutrient profiling and Medicinal value of mushrooms.
- Hands on training in Mushroom cultivation farm.
- Diseases of Mushrooms.

Reference Books

- Marimuthu, T. et al. (1991). Oster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.
- Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
- Pandey R.K, S. K Ghosh, 1996. A Hand Book on Mushroom Cultivation. Emkey Publications.
- Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology

Facilitating the achievement of course learning objectives

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
1	• Mushrooms belong to the kingdom Fungi. Within the fungi kingdom, they are further classified into the phylum Basidiomycota and the class Agaricomycetes. Mushrooms encompass a wide variety of species, each with its unique characteristics and properties.	• Have students create a timeline of significant events in the history of mushroom cultivation, including key discoveries, cultivation methods, and cultural uses.	• Class text and short and long questions.
2	• Students will be able to identify and classify common edible mushrooms, including the Button mushroom, Milky mushroom, Oyster mushroom, and paddy straw mushroom, based on their morphological characteristics.	• In the classroom or lab, provide fresh specimens of the mushrooms and teach students how to identify them based on physical characteristics, such as cap shape, gill structure, spore colour, and stem features.	• Class text and short and long questions.
3	• Students will have a strong foundation in the fundamental principles of mushroom cultivation, including the life cycle of mushrooms and the key factors influencing their growth.	• Organize field visits to mushroom houses or facilities to demonstrate the design and construction of a mushroom house. allow students to participate in planning and	• Class text and short questions and definitions

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
		designing their own mushroom house as a group project.	
	• Analyse the nutritional components of mushrooms, including vitamins, minerals, proteins, fibre, and carbohydrates. discuss how mushrooms fit into a balanced diet.	• Conduct lectures to introduce students to various mushroom species, their classification, and general characteristics Engage students in discussions about the importance of mushrooms in human nutrition and health.	• Class text and short and long questions.
5	• Explain the significance of postharvest technology in preserving the quality and extending the shelf life of mushrooms.	• Conduct introductory lectures to explain the importance of postharvest technology in mushroom preservation. Engage students in discussions to explore the challenges and opportunities in the mushroom industry.	• Class text and short and long questions.

RAMANUJAN SCHOOL OF SCIENCE

BACHLOR OF SCIENCE

(Chemistry, Biology, Zoology)

(B. Sc. (CBZ) – CKUG04B03)

IV Semester

MAJOR CORE COURS-I

3SAPC403: Zoology-IV (Animal Physiology)

(Credits: Theory-4, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SAPC403	Zoology-IV (Animal Physiology)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objective

- Develop a solid understanding of the fundamental principles of physiology, including cellular and molecular processes, homeostasis, and the organization of physiological systems.
- Gain knowledge of the structure and function of major physiological systems in animals, including the nervous system, muscular system, circulatory system, respiratory system, digestive system, and endocrine system.
- Describe and explain the cellular and molecular mechanisms that underlie key physiological processes, such as membrane transport, enzymatic reactions, and cell signaling.
- Understand how different physiological systems work together and integrate to maintain overall homeostasis within the body.

Course Learning Outcomes

- Students should have a solid understanding of the fundamental principles of physiology, including how various systems in animal's function.
- Mastery of the cellular and molecular mechanisms that underlie physiological processes, such as cell signaling, ion transport, and enzyme kinetics.
- The ability to integrate knowledge from different physiological systems, such as the nervous, muscular, circulatory, respiratory, digestive, and endocrine systems, to understand how they work together to maintain homeostasis.
- An understanding of how physiological processes differ across different species and how evolution has shaped these differences.
- Knowledge of how physiological processes are regulated and controlled, including feedback mechanisms, hormone signaling, and neural regulation.

Syllabus **Credits: 4-0-2**

UNIT-I

Nutrition, Metabolism

Physiology of digestion in mammals, Protein Metabolism; Deamination, decarboxylation, Transamination of amino acids, and Ornithine cycle, Carbohydrate metabolism; Glycogenesis, Glycogenosis, glycolysis, The Citric acid cycle, Gluconeogenesis, Lipid Metabolism; Beta oxidation of fatty acids.

UNIT-II:

Respiration

Organs of respiration in mammals, Mechanism of respiration in mammal's inspiration and expiration, Physiology of respiration; transport of gases, chloride shift, Properties and function of respiratory Pigments Hemoglobin, Myoglobin, Hemocyanin, Structure and function of Lungs, Trachea, Bronchi Bronchioles and Alveoli.

UNIT-III:

Regulatory Mechanisms and Enzymes

Osmoregulation in vertebrae; In fresh water fish, marine water fish terrestrial vertebrae, Physiology of Excretion; urea and urine formation in mammals, Thermoregulation concept and mechanism and temperature regulation, Enzyme; Definition and nomenclature of enzymes, classification of enzymes, Mechanism of enzyme action.

UNIT-IV:

Neuromuscular Co-ordination.

Structure and properties of nervous tissue, Physiology of nerve impulse conduction, Resting Membrane Potential, Action Potential, Synaptic Transmission, Types of muscles skeleton muscles, smooth muscles, cardiac muscles and their properties, Theory of muscle contraction and its biochemistry, Sliding Filament Theory; Concept, Key Components, Biochemical Basis; Role of ATP, Calcium Ion Involvement. Role of Motor Neurons.

UNIT-V:

Endocrine system.

Structure and functions of Pituitary Gland, Structure and functions of Thyroid Gland, Structure and functions of Adrenal Gland, Structure and functions of Parathyroid, Thymus and Islets of Langerhans's.

Practical Content **Credits: 2**

- Detection of protein carbohydrate.
- Detection of nitrogenous waste products ammonia and urea.
- Estimation of hemoglobin in blood samples.
- Histological study of various endocrine glands T.S of thyroid T.S of pituitary gland T.S. of adrenal gland T.S of testis T.S of liver.
- Histological study of alimentary canal and various digestive organs T.S of stomach T.S of Intestine T.S of pancreas and of liver.
- Histological study of muscles striated untreated and cardiac muscle.

Text book

- Animal Physiology by Richard W. Hill, Gordon A, Wyse, and Margaret Anderson.
- Principles of Animal Physiology by Christopher D. Moyes and Patricia M. Schulte
- Comparative Animal Physiology by C. Ladd Prosser.
- Animal Physiology; From Genes to Organisms by Lauralee Sherwood.
- Animal Physiology; Adaptation and Environment by Knut Schmidt-Nielsen.

Reference book

- A Text Book of Medical Physiology by Arthur C. Guyton MD, Eleventh ed., John E. Hall, Harcourt Asia Ltd.
- A Review of Medical Physiology by William F. Ganong, 22 ed, McGraw Hill, 2005.
- Human Physiology by Sherwood, Klandrof, Yanc Thompson Brooks/Coole, 2005.
- Animal Physiology by Knut Scmidt-Neilson, 5th ed, Cambridge Low Price Edition.
- Animal Physiology by Roger Eckert and Randal, 4th ed, Freeman Co, New York.

- Animal Behavior by David McFarland, Pitman Publishing Limited, London, UK.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment tasks
1	Understand the factors that influence individual variations in nutrient needs, including genetics and activity level.	Organize a practical session where students learn to perform nutritional assessments, including dietary recall interviews and anthropometric measurements.	Class test focusing and short and long questions.
2	Demonstrate an understanding of the structure and function of the respiratory system, including the roles of the lungs, diaphragm, bronchi, and alveoli.	Conduct experiments or demonstrations to illustrate respiration processes, such as demonstrating the role of enzymes in cellular respiration or using simple models to show	Class test focusing on long and short questions.
3	Understand and apply concepts of enzyme kinetics, including Michaelis-Menten kinetics, Lineweaver-Burk plots, and the effects of substrate concentration on enzyme activity.	Use physical models or computer simulations to demonstrate enzyme regulation mechanisms, such as allosteric modulation and feedback inhibition.	Class test focusing on definitions and short and long questions.
4	Understand how nerve impulses are generated, propagated, and transmitted to muscle fibers including the role of action potentials and neurotransmitters.	Organize practical sessions where students can conduct neuromuscular assessments, such as measuring muscle strength, reflexes, and reaction times.	Class test focusing on long and short questions.
5	Understand the processes involved in hormone synthesis, storage, and release, as well as the mechanisms of hormonal feedback regulation.	Conduct virtual or physical dissections of endocrine glands to help students understand their structure and location within the body.	Class test focusing on and long questions.

MAJOR CORE COURS-II

3SIMC403: Zoology –IV (Immunology)

(Credits: Theory-4, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SIMC403	Zoology –IV (Immunology)	6(4-0-2)	60	20	20	60	40	200	3hr	2hr

Course Objective

- Student have knowledge of fundamental principle of immunology and to develop an appreciation of the importance of it.
- The course has been designed to impart knowledge regarding Components of Immune system.
- The course has been designed to impart knowledge regarding Innate and adaptive immunity.
- The course has been designed to impart knowledge regarding Role of immune system in health management.
- The course has been designed to impart knowledge regarding Immunological response and its regulation.

Course Learning Outcome

- Demonstrate the basic knowledge of immunological processes at a cellular and molecular level.
- The students being lifelong learners will be enthusiastic to update their knowledge for improving the human life.
- After completion of this learning course (immunology) students will able to investigate the causative factors of various diseases and disorders, pollutants, etc.
- To provide knowledge on essential features of antigens and antibodies and their types.
- To acquire knowledge on types of immunity, phagocytosis, interferons and complement system.

Syllabus Credits 4-0-2

UNIT - I

Basic Concept of Immunology

Overview of the Immune System; Introduction to basic concepts, components, principles of innate and adaptive immune system, Immunology; Scope of Immunology, Historical background of Immunology, Biological aspects of Immunology, Self and non-self-recognition, specificity, memory of immune system.

UNIT - II

Cells of Immune System

Cells and Organs of the Immune System Hematopoiesis, Cells of immune system and organs; primary and secondary lymphoid organs of the immune system, Cell mediated immunity, humoral immunity, immune response; primary and secondary response, Introduction of Phagocytosis, mechanism of phagocytosis.

UNIT - III

Antigens and Antibody

Antigens Basic properties of antigens, B and T cell epitopes, hap tens and adjuvants Antibodies Structure, classes and function of antibodies, monoclonal antibodies, antigen antibody interactions as tools for research and diagnosis.

UNIT – IV:

Major Histocompatibility Complex

Working of the immune system, Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, Basic properties and functions of cytokines, Complement system; Components and pathways, Major Histocompatibility Complex (MHC) MHC in mice and HLA in man fine structure and functions.

UNIT – V

Health and Disease

Immune system in health and disease Gel and Comb's classification and brief description of various types of hypersensitivities, Introduction to concepts of autoimmunity and immunodeficiency, Vaccines General introduction to vaccines, Various types of vaccines.

Practical Content **Credits: 2**

- Detection of protein, carbohydrate and lipid.
- Study of Human salivary enzyme activity in relation to pH.
- Exercise on Hematology – Counting of RBC /WBC and Blood grouping in blood samples.
- Estimation of Hemoglobin in blood samples.
- Histological study of various endocrine glands –T. S. of Thyroid, T. S. of Pituitary gland.
- T. S. of Adrenal gland, T. S. of Testis, T. S. of Ovary.
- Histological study of Alimentary canal and various digestive organs T.S of Stomach, T.S of Intestine, T.S of Pancreas, and T. S. of liver.
- Histological study of Visceral organs - T.S of Lungs, L.S. of Kidney.

Text Book

- A Textbook of Immunology, Prof. A. K. Berry, Emkay Publication.
- Immunology, An introductory Textbook, By Anil K. Sharma.
- Immunology by William L. Anderson, Blackwell Publication.
- Immunology by parker N. Watson, waster publication.

Reference Book

- Essential immunology by Ivan M. Roitt.
- Immunology by Elibezamini and Sidney Leskowitz, Alan R. Lisi Inc. New York.
- Immunology III. by Joseph A. Bellanti Shein Saunders International Edn.
- Immunology at a glance by J.H.L. Play feir 4th edn. Blackwell scientific publication.
- Aids to Immunology D.M. Weir Churchill, Livingstons.
- Fundamentals of Immunology by Myrvik and Weiser.
- Fundamentals of Immunology by Bier et al, Springer.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment tasks
1	Identify and describe the major components of the immune system, including white blood cells (leukocytes), antibodies, and antigens.	Enhance lectures with multimedia presentations, animations, and videos to visually explain immune processes.	Class test focusing and short and long questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment tasks
2	Understand key cellular processes, including cell division (mitosis and meiosis), cellular respiration, and photosynthesis.	Enhance lectures with multimedia presentations, animations, and diagrams to illustrate cellular and organ processes.	Class test focusing on long and short questions.
3	Students should be able to define what antigens and antibodies are and understand their basic roles in the immune system.	Use traditional lectures and multimedia presentations to introduce key concepts, definitions, and foundational knowledge about antigens and antibodies. Provide visual aids and diagrams to aid understanding.	Class test focusing on definitions and short and long questions.
4	Students should be able to clearly define and distinguish between the exogenous and endogenous pathways in antigen presentation.	Organize role-playing activities where students take on the roles of various immune cells and act out the processes involved in antigen presentation through exogenous and endogenous pathways.	Class test focusing on long and short questions.
5	Understand the concept of immunological tolerance and mechanisms that prevent the immune system from attacking self-tissues.	Provide challenging scenarios related to immunological issues and ask students to propose solutions or make decisions based on their understanding.	Class test focusing on and long questions.

MAJOR CORE COURS-I

3SSDC403: Botany-IV (Structure, Development and Reproduction in Flowering Plant)

(Credits: Theory-4, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SSDC403	Botany-IV (Structure, Development and Reproduction in Flowering Plant)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- The anatomy of a flower.
- The life cycle of flowering seed plants the anatomy of a seed.
- The role of pollination and seed dispersal in the angiosperm life cycle.
- Identify the characteristics of flowering plants.
- Describe the structure of a flower and the difference between perfect and imperfect flowers.
- Summarize the life cycle of a flowering plant.

Course Learning Outcomes

- Understand the anatomical features of roots, stems, leaves, and flowers in flowering plants.
- Identify and describe the different reproductive structures in flowering plants, including flowers, fruits, and seeds.
- Comprehend the life cycle of flowering plants, focusing on stages from germination through flowering to seed development.
- Explore the cellular and molecular processes involved in plant growth, development, and reproduction.
- Explain the processes of fertilization in flowering plants, covering both self-pollination and cross-pollination.

Syllabus

Credits :4-0-2

UNIT – I

The Root System: Root apical meristems, differentiation of primary and secondary tissues and their roles. Anatomy of monocot and dicot roots. Morphological modification of root for storage. Respiration. Interaction of root with microbes.

UNIT – II

The Shoot System: Shoot apical meristem and histological organization. Anatomy of Monocot and Dicot Stem. Vascular cambium and its functions. Secondary growth in stem, characteristics of growth rings: sapwood and heart wood. Secondary Phloem, Cork Cambium and Periderm. Anatomy of C_3 and C_4 Plants Anomalous Secondary growth in *Nyctanthus*, *Boerhhavia*, *Achyranthus*, *Leptadenia*, *Salvadora*, *Bignonia* and *Dracaena.*

UNIT – III

The Leaf System: Origin and development of leaf. Diversity in size, shape and arrangement. Internal structure of Dicot and Monocot leaf. Adaptations to photosynthesis and water stress. Senescence and abscission.

UNIT – IV

The Flower System: Concept of flower as a modified shoot. Structure of anther, Microsporogenesis and Male Gametophyte. Structure of pistil, Ovules, Megasporogenesis and Development of Female Gametophyte (Embryo Sac) and its types. Pollination – Mechanism and agencies of pollination, Pollen pistil interactions and self-incompatibility.

UNIT – V

Embryology: Double fertilization and triple fusion. Development and types of endosperms and its morphological nature, Development of Embryo in Monocots and Dicot plants. Polyembryony and Apomixis, Application of Palynology Experimental Embryology including pollen storage and test tube fertilization. Fruit development and maturation, seed structure and dispersal, Vegetative propagation.

Practical Content **Credits :2**

- Study of anatomy of t. s. of dicot root *helianthus* annus.
- Study of anatomy of t. s. of dicot root *Cicer* and *ranunculus*.
- Study of anatomy of t. s. of monocot roots *asparagus*.
- Study of anatomy of t. s. of monocot roots *zea mays* and *orchid*.
- Study of anatomy of t. s. of dicot stem *Cucurbita* and *xanthium*.
- Study of anatomy of t. s. of monocot stem *Triticum aestivum* and *asparagus*.
- Study of v. s. of isobilateral monocot leaf *Zea mays* and *bambusa*.
- Study of prepared slide of l. s. of shoot apex.
- Study of prepared slide of l. s. of root apex.
- Study of different types of ovules.
- Study of pneumatophore or respiratory root.

Reference Book

- Plant Physiology by -Lincoln Taiz and Eduardo Zeiger.
- Plant Development and Evolution by- Quentin Cronk and Richard M. Bateman.
- Botany: An Introduction to Plant Biology by- J. D. Mauseth.
- Plant Reproduction by- Shashi. Kumar.
- Reproductive Biology of Plants by- K.R. Shivanna and V.K. Sawhney.

Text Book

- Structure Development and Reproduction in Flowering Plants - Arun. K. Pandey.
- A Text Book of Botany- Structure Development and Reproduction in Angiosperm – Singh. V.
- Anatomy of Flowering Plants- Paula. J. Rudall.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment tasks
1	Students should be able to describe and differentiate between the various parts of a plant root, including the root cap, root hairs, primary and secondary roots, and the root apical meristem.	Provide students with plant specimens and encourage them to carefully observe and describe the root systems. Have them draw or document their observations in a lab note book.	Class test focusing and short questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment tasks
2	Upon completing this unit, students should be able to analyse and compare leaf morphology among different plant species, and understand the role of leaves in photosynthesis and transpiration.	Provide plant specimens with different types of stems (e.g. herbaceous, woody, rhizomes). Have students dissect and examine stem cross-sections under microscopes. Discuss how stem structure relates to its function.	Class test focusing on definitions and short questions.
3	Students should be able to explain the primary functions of leaves, including photosynthesis, transpiration, and gas exchange, and understand how leaf structures support these functions.	Start the unit with a discussion on the structure of leaves, including the different parts such as the blade, petiole, veins, and specialized structures like stomata. Discuss the primary functions of leaves, including photosynthesis, transpiration, and gas exchange.	Class test focusing on definitions and short and long questions.
4	Interpret and explain the meaning of information. Summarize ideas or concepts in your own words. Compare and contrast different concepts or theories.	world biological case studies and have students analyse and explain the underlying principles and mechanisms involved. Organize group discussions where students collaboratively explain and interpret challenging scientific papers or research findings.	Class test focusing on and short and long questions.
5	Students should be able to differentiate between the two fertilization events that occur during double fertilization: one involving the fusion of a sperm cell with the egg cell to form a zygote, and the other involving the fusion of a sperm cell with two polar nuclei to form the triploid endosperm nucleus.	Start with an introductory lecture explaining the significance of double fertilization in angiosperms. Break down the process of double fertilization into distinct steps and discuss each step-in detail during separate lectures.	Class test focusing on and long questions.

MAJOR CORE COURS-II

3SPPC403: Botany-IV (Plant Pathology)

(Credits: Theory-4, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SPPC403	Botany-IV (Plant Pathology)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- To introduce concepts and principles of plant pathology.
- Study of interaction between plant and pathogen in relation to the overall environment and mechanism of disease development by pathogens.

Course Learning Outcomes

- Students will know about concept of diseases, knowledge and awareness of diseases, causal agents of plant diseases.
- Identification methods and management of crop diseases.

Syllabus — Credits: 4-0-2

UNIT – I

Plant diseases definition of plant disease, nature and concept of diseases in plant. Importance of plant diseases and their effect on human affairs. Classification of plant diseases. Definition and terms in plant pathology history and development of plant pathology, methods of studying plant diseases (air born, soil born and water borne diseases) koch's postulates.

UNIT-II

Plant disease epidemiology detail study of symptoms, fungi, etiology, epidemiology and control of fungal disease of plants: Late blight of potato, damping of vegetables, taphrina leaf spot of turmeric, black rust of wheat, red rot of sugarcane, *tikka* disease of groundnut, *Powdery mildew* of apple, rust of linseed, rust of coffee, smut disease of grasses.

UNIT-III

Seed pathology principles of plant disease control, plant quarantine, seed treatment. Methods of studying seed born disease, collection, preservation, isolation of pathogens and biological control of plant diseases.

UNIT-IV

Host – pathogen interaction distribution on plant pathogens, mode of infection, entry of pathogen in to host, roles of enzymes, toxins, phytoalexins in plant pathogenesis, physiological changes in diseased plants.

UNIT- V

Plant bacteriology and virology nomenclature and classification of plant viruses, detail study of symptoms, symptoms caused by plant pathogenic bacteria and viruses, control of bacterial and viral disease: Bacterial leaf blight of rice, *Citrus canker*, little leaf of brinjal, tobacco mosaic disease, potato scab, crown gall of apple and grapes, leaf curl of papaya, bud blight disease.

Practical Content — Credits: 2

1. To study different sterilization technique.
2. To study preparations of culture media.
3. To study sterilization of seeds.
4. Explant preparations.
5. Study of different techniques in plant hybridization.
6. Preparation of synthetic seeds.

Reference Book

- Plant Pathology by- George N. Agrios.
- Introduction to Plant Pathology by- Richard. N. Strange.
- Principles of Plant Disease Management by- William E. Fry and Joseph. Alexander Verret.
- Fundamental of Plant Pathology – A.N. Chaubey.

Text Book

- Text Book of Plant Diseases- Ramesh Singh.
- Plant Pathology at a Glance – Utpal Kumar Bhattacharyya.
- Introduction to Principle of Plant Pathology 4th Edition – R.S. Singh.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment tasks
1	Identify and classify various types of plant pathogens, including fungi, bacteria, viruses, nematodes, and abiotic factors. Describe the life cycles and modes of transmission of different plant pathogens.	Identify and classify various types of plant pathogens, including fungi, bacteria, viruses, nematodes, and abiotic factors. describe the life cycles and modes of transmission of different plant pathogens.	Class test focusing and short questions.
2	Learn techniques for evaluating seed quality, including germination testing, Vigor testing, and seed health assessments. Identify the signs and symptoms of seed-borne diseases and disorders.	Traditional lectures to convey foundational concepts in seed pathology. Class discussions to encourage students to ask questions and engage with the material.	Class test focusing on definitions and short questions.
3	Students should be able to identify and categorize different types of pathogens that can affect seeds, including fungi, bacteria, viruses, nematodes, and seed-borne diseases.	Demonstrate various seed treatment methods, such as hot water treatment, chemical treatments, and biological seed treatments, and involve students in hands-on applications.	Class test focusing on definitions and short and long questions.
4	Students should be able to define and classify different types of plant pathogens, including bacteria, fungi, viruses, nematodes, and other microorganisms, and understand their biology and life cycles.	Traditional lectures can provide students with foundational knowledge about plant pathogens, their biology, and their impact on plants. Use multimedia presentations, case studies, and real-life examples to make the lectures more engaging.	Class test focusing on and short and long questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment tasks
5	Students should be able to identify and classify different types of plant pathogenic bacteria, including their characteristics, taxonomy, and modes of infection.	Begin with lectures on the basics of bacteriology, including bacterial structure, classification, and function. Introduce plant-specific topics such as plant-pathogenic bacteria, beneficial plant-microbe interactions, and the impact of bacteria on plant growth.	Class test focusing on and long questions.

MAJOR CORE COURS-I

3SPOC403: Chemistry-IV (Physical, Organic and Inorganic Chemistry)

(Credits: Theory-4, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SPOC403	Chemistry-IV (Physical, Organic and Inorganic Chemistry)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Understand phase compositions and eutectic systems.
- Grasp ideal and non-ideal liquid behavior.
- Learn electrical transport and concentration cells.
- Understand electronic structure and chemistry.
- Learn about aldehydes, ketones, and nitrogen compounds.

Course Learning Outcomes

- Identify phases and understand eutectic systems.
- Comprehend ideal and non-ideal behavior.
- Understand conductivity and concentration cells.
- Recognize electronic structures and chemistry.
- Learn synthesis and reactions of functional groups.

Syllabus

Credits :4-0-2

Physical Chemistry

UNIT – I

Phase Equilibrium

Statement and the meaning of the terms: Phase component and the degree of freedom, derivation of the Gibbs phase rule. Simple eutectic System: Bi-Cd, Pb-Ag system. Desiliverisation of lead. One component system: Water, CO_2 and S system. Two component system: Solid liquid equilibria.

Solid Solutions

Systems in which compound formation with congruent melting point (Mg-Zn) and incongruent melting point, (NaCl-H_2O) and ($CuSO_4$-H_2O) system. Freezing mixtures: Acetone-dry ice.

Liquid-Liquid Mixtures

Ideal liquid mixtures, Raoult's and Henry's law, non-ideal system. Azeotropes: HCl-H_2O and ethanol- Water systems.

Partial Miscible Liquids

Phenol-water, trimethylamine–water and nicotine-water systems. Lower and upper consulate temperature. Immiscible liquids, steam distillation. Nernst distribution law: Thermodynamic derivation, applications.

UNIT – II

Electrochemistry-I

Electrical transport, conduction in metals and in electrolyte solutions. Specific conductance and equivalent conductivity, Measurement of equivalent conductance, migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Theory of strong electrolytes, Transport number: Definition and determination by Hittorf method and moving boundary method.

Electrochemistry-II

Types of reversible electrodes: Gas-metal ion, metal-metal ion, metal- insoluble salt-anion and redox electrodes. Concentration cell with and without transport. Liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titration. Definition of pH and pK, determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods.

Inorganic Chemistry

UNIT – III

Chemistry of Lanthanides Elements

Electronic structure, oxidation states, ionic radii and lanthanide contraction, complex formation, occurrence and isolation of lanthanide compounds.

Chemistry of Actinides

General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between the later actinides and later lanthanides.

Organic Chemistry

UNIT – IV

Aldehydes and ketones

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 aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids, physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, Aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Use of acetals as protecting group, Oxidation of aldehydes, Baeyer-Villager oxidation of ketones, Cannizzaro reaction. Meer Wine-Pondrof -Verlay (MPV), Clemmensen, Wolf- Kischner, $LiAlH_4$ and $NaBH_4$ reductions, Halogenation of enolizable ketones. An introduction of alpha, beta unsaturated aldehydes and ketones.

UNIT – V

Organic Compounds of Nitrogen

Preparation of nitro alkanes and nitroarenes. Chemical reaction of nitro alkanes. Mechanism of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media.

Halo nitroarenes

Reactivity, structure and nomenclature of amines, physical properties, stereochemistry of amines, separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Amine salt as phase transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel-Phthalimide reaction, Hoffmann bromamide reaction. Reactions of amines. Electrophilic aromatic substitution in aryl amines, reaction of amines with nitrous acid. Synthetic transformation of aryl diazonium salts, Azo coupling.

Practical Content **Credits: 2**

Physical Chemistry

- To study the effect of solute (e.g., NaCl, succinic acid) on the critical solution temperature of two partially miscible liquid (e.g., phenol water system) and to determine the concentration of that soluble in phenol water system.
- To construct the phase diagram of two component (e.g., diphenyl amine benzophenone) by cooling curve method.
- To determine the enthalpy of neutralization of weak acid/weak base versus strong acid/ strong base and determine the enthalpy of ionization of the weak acid/ base.

Inorganic chemistry-

- Estimation of ferrous and ferric by dichromate method.
- Estimation of copper using thiosulphate.

Organic Chemistry

- Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

Text Books

- Unified Chemistry by Tandon, Rathore &Agarwal.
- Physical Chemistry by P. W. Atkins and Julio de Paula.
- Inorganic Chemistry by Gary L. Miessler and Paul J. Fischer.
- Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren.
- Electrochemistry by Philip N. Bartlett.
- Phase Equilibria in Chemical Engineering by Stanley M. Walas.

Reference Books

- Electrochemical Methods: Fundamentals and Applications by Allen J. Bard and Larry R. Faulkner.
- Principles of Phase Equilibria and Phase Diagrams by C. H. P. Lupis.
- Inorganic Chemistry by Catherine Housecraft and Alan G. Sharpe.
- Organic Synthesis by Michael B. Smith.
- Handbook of Lanthanide and Actinide Chemistry by Simon Cotton.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment tasks
1	Define and differentiate between phases, such as solid, liquid, and gas, and explain the fundamental principles governing phase transitions.	Provide foundational knowledge through lectures on topics like phase diagrams, phase transitions, Gibbs phase rule, chemical potential, and thermodynamic equilibrium.	Class test focusing and short questions.
2	The fundamental principles of electrochemistry, including the laws governing electrical transport, Faraday's laws, and the Nernst equation.	Conduct laboratory sessions where students perform electrochemical experiments, such as measuring cell potentials, conducting cyclic voltammetry, or investigating corrosion processes.	Class test focusing on definitions and short questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment tasks
3	The reactions specific to aldehydes and ketones, including nucleophilic addition reactions, reduction, oxidation, and formation of hemiacetals and acetals.	Conduct lectures to introduce key concepts related to aldehydes and ketones, including nomenclature, reactivity, and synthesis.	Class test focusing on and short and long questions.
4	Analyse and identify alkanes and nitroarenes. Synthetic transformation of aryl diazonium salts, Azo coupling.	Traditional lectures can introduce students to the fundamental concepts of alkanes and nitroarenes, including their structures, nomenclature, and basic properties.	Class test focusing on and long questions.
5	Identification and differentiate between lanthanide elements in the periodic table, recognizing their atomic numbers and electron configurations.	Encourage active participation through Q. and Ans sessions and open discussions on lanthanide properties and trends.	Class test focusing on definitions and short and long questions.

MAJOR CORE COURS-II

3SAMC403: Chemistry-IV Analytical Methods in Chemistry

(Credits: Theory-4, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SAMC403	Chemistry-IV Analytical Methods in Chemistry	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Learn sampling, data evaluation, and error analysis.
- Understand UV-Visible and Infrared Spectrometry basics.
- Grasp principles and techniques of atomic absorption and emission.
- Learn thermogravimetry theory and its application.
- Understand pH metric, potentiometric titrations, and chromatography principles.

Course Learning Outcomes

- Understand the fundamentals of analytical chemistry, including sampling and error analysis.
- Learn the principles and instrumentation of UV-Visible and Infrared Spectrometry.
- Grasp the techniques and applications of Flame Atomic Absorption and Emission Spectrometry.
- Master the theory and practice of thermogravimetry for quantitative analysis.
- Gain proficiency in electroanalytical methods such as pH metric and potentiometric titrations, as well as the basics of chromatography.

Syllabus

Credits :4-0-2

UNIT-I

Qualitative and Quantitative Aspects of Analysis

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of them expression, normal law of distribution if indeterminate errors.

UNIT-II

Optical Methods of Analysis

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; sampling techniques.

UNIT-III

Flame Atomic Absorption and Emission Spectrometry

Basic principles of instrumentation (Choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction.)

UNIT-IV

Thermal Methods of Analysis

Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

UNIT-V

Electroanalytical Methods

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition and ion exchange. Development of chromatograms: frontal, elution and displacement methods.

Practical Content — Credits :2

- Spectrophotometric determination of Fe in water sample using standard addition method.
- Determination of complex Lon composition by job's method of continuous variation.
- Determination of Fe in copper metal by flame atomic absorption spectrometry (FAAS).
- Determination of trace metals (Fe, Cu, Cr and in environmental water samples by atomic absorption spectrometry (FAAS).
- Determination of cadmium(cd) in biological reference material using graphite furnace atomic absorption spectrometry (GFAAS).
- Determination of Cu and Zn in soil by ICP-OES.

Text Book

- Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch.
- Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch.
- Instrumental Methods of Analysis by Hobart H. Willard, Lynne L. Merritt, John A. Dean, Jr., and Frederick A. Settle Jr.
- Quantitative Chemical Analysis by Daniel C. Harris.
- Introduction to Spectroscopy by Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan.

Reference Books

- Modern Spectroscopy by J. Michael Hollas.
- Atomic Absorption Spectrometry by Bernhard Welz and Michael Sperling.
- Introduction to Thermal Analysis: Techniques and Applications by Michael E. Brown.
- Electrochemical Methods: Fundamentals and Applications by Allen J. Bard and Larry R. Faulkner.
- Chromatographic Methods by A. Braithwaite and F. J. Smith.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Collecting qualitative data through surveys or feedback forms from students can provide insights into their experiences with the course. Open-ended questions can help identify strengths and weaknesses, as well as areas for improvement.	Qualitative content analysis involves examining course materials, assignments, and learning activities to ensure alignment with course objectives. It can also assess whether activities promote critical thinking, collaboration, and other desired skills.	Assignments on expressing accuracy and precision.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
2	Spectroscopic methods like UV-visible spectroscopy or infrared spectroscopy can be employed to qualitatively analyse the chemical composition of substances. Students can learn how to interpret spectra to identify functional groups or chemical compounds.	Provide students with microscopes and prepared slides of various specimens or materials. Instruct them to observe and identify different structures or components using optical microscopy.	Assignments on Beer-Lambert's law, and a project on the validity of spectroscopic laws.
3	Explain the fundamental principles of atomic absorption and emission spectroscopy, including absorption and emission processes, energy levels, and the role of flames in atomization.	Guide students through the process of instrument calibration. Provide samples of known concentrations and instruct them on how to create calibration curves and determine unknown concentrations.	Class test focusing on definitions, short and long questions.
4	Explain the fundamental principles underlying thermal analysis techniques, including thermogravimetry, differential scanning calorimetry, and thermal conductivity measurements.	Conduct lectures to introduce and explain the theoretical principles and concepts of thermal analysis methods. Engage students in discussions to ensure they understand the underlying physics and chemistry.	Assignments on TG instrument components, and a practical exam on TG analysis.
5	Understand the fundamental principles of electrochemistry, including electrode reactions, redox reactions, and Faraday's laws.	Organize laboratory sessions where students perform electroanalytical experiments. These may include cyclic voltammetry, spectroscopy.	Lab reports on electroanalytical techniques.

MINOR CORE COURS

3SAPM404: Zoology-IV (Animal Physiology)

(Credits: Theory-4, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SAPM404	Zoology-IV (Animal Physiology)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objective

- Develop a solid understanding of the fundamental principles of physiology, including cellular and molecular processes, homeostasis, and the organization of physiological systems.
- Gain knowledge of the structure and function of major physiological systems in animals, including the nervous system, muscular system, circulatory system, respiratory system, digestive system, and endocrine system.
- Describe and explain the cellular and molecular mechanisms that underlie key physiological processes, such as membrane transport, enzymatic reactions, and cell signaling.
- Understand how different physiological systems work together and integrate to maintain overall homeostasis within the body.

Course Learning Outcomes

- Students should have a solid understanding of the fundamental principles of physiology, including how various systems in animal's function.
- Mastery of the cellular and molecular mechanisms that underlie physiological processes, such as cell signaling, ion transport, and enzyme kinetics.
- The ability to integrate knowledge from different physiological systems, such as the nervous, muscular, circulatory, respiratory, digestive, and endocrine systems, to understand how they work together to maintain homeostasis.
- An understanding of how physiological processes differ across different species and how evolution has shaped these differences.
- Knowledge of how physiological processes are regulated and controlled, including feedback mechanisms, hormone signaling, and neural regulation.

Syllabus **Credits: 4-0-2**

UNIT-I

Nutrition, Metabolism

Physiology of digestion in mammals, Protein Metabolism; Deamination, decarboxylation, Transamination of amino acids, and Ornithine cycle, Carbohydrate metabolism; Glycogenesis, Glycogenolysis, glycolysis, The Citric acid cycle, Gluconeogenesis, Lipid Metabolism; Beta oxidation of fatty acids.

UNIT-II

Respiration

Organs of respiration in mammals, Mechanism of respiration in mammal's inspiration and expiration Physiology of respiration transport of gases, chloride shift, Properties and function of respiratory Pigments Hemoglobin, Myoglobin, Hemocyanin, Structure and function Lungs, Trachea, Bronchi and Bronchioles, Alveoli.

UNIT-III

Regulatory Mechanisms and Enzymes

Osmoregulation in vertebrae; fresh water fish marine, water fish terrestrial vertebrae, Physiology of Excretion; urea and urine formation in mammals, Thermoregulation concept and mechanism and temperature regulation, Definition and nomenclature of enzymes, classification of enzymes, Mechanism of enzyme action.

UNIT-IV

Neuromuscular Co-ordination

Structure and properties of nervous tissue. Physiology of nerve impulse conduction, Resting Membrane Potential, Action Potential, Synaptic Transmission, Types of muscles skeleton muscles, smooth muscles, cardiac muscles and their properties. Theory of muscle contraction and its biochemistry, Sliding Filament Theory; Concept, Key Components, Biochemical Basis; Role of ATP, Calcium Ion Involvement, Role of Motor Neurons.

UNIT-V:

Endocrine system

Structure and functions of Pituitary Gland, Structure and functions of Thyroid Gland, Structure and functions of Adrenal Gland, Structure and functions of Parathyroid, Thymus and Islets of Langerhans's, reproductive glands.

Practical Content **Credits :2**

- Detection of protein carbohydrate.
- Detection of nitrogenous waste products ammonia and urea.
- Estimation of hemoglobin in blood samples.
- Histological study of various endocrine glands T.S of thyroid T.S of pituitary gland T.S. of adrenal gland T.S of testis T.S of liver.
- Histological study of alimentary canal and various digestive organs T.S of stomach T.S of Intestine T.S of pancreas and of liver.
- Histological study of muscles striated untreated and cardiac muscle.

Text book

- Animal Physiology by Richard W. Hill, Gordon, A. Wyse, and Margaret Anderson.
- Principles of Animal Physiology by Christopher D. Moyes and Patricia M. Schulte.
- Comparative Animal Physiology by C. Ladd Prosser.
- Animal Physiology: From Genes to Organisms" by Lauralee Sherwood.
- Animal Physiology: Adaptation and Environment" by Knut Schmidt Nielsen.

Reference Book

- David McFarland, Animal Behavior, Pitman Publishing Limited, London, UK.
- Manning, A. and Dawkins, M. S, An Introduction to Animal Behavior, Cambridge, University Press, UK.
- John Alcock, Animal Behavior, Sinauer Associate Inc., US.
- Paul W. Sherman and John Alcock, Exploring Animal Behavior, Sinauer Associate Inc., Massachusetts, USA.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Understand the factors that influence individual variations in nutrient needs, including genetics and activity level.	Organize a practical session where students learn to perform nutritional assessments, including dietary recall interviews and anthropometric measurements.	Class test focusing and short and long questions.
2	Demonstrate an understanding of the structure and function of the respiratory system, including the roles of the lungs, diaphragm, bronchi, and alveoli.	Conduct experiments or demonstrations to illustrate respiration processes, such as demonstrating the role of enzymes in cellular respiration or using simple models to show	Class test focusing on long and short questions.
3	Understand and apply concepts of enzyme kinetics, including Michaelis-Menten kinetics, Lineweaver-Burk plots, and the effects of substrate concentration on enzyme activity.	Use physical models or computer simulations to demonstrate enzyme regulation mechanisms, such as allosteric modulation and feedback inhibition.	Class test focusing on definitions and short and long questions.
4	Understand how nerve impulses are generated, propagated, and transmitted to muscle Fibers, including the role of action potentials and neurotransmitters.	Organize practical sessions where students can conduct neuromuscular assessments, such as measuring muscle strength, reflexes, and reaction times.	Class test focusing on long and short questions.
5	Understand the processes involved in hormone synthesis, storage, and release, as well as the mechanisms of hormonal feedback regulation.	Conduct virtual or physical dissections of endocrine glands to help students understand their structure and location within the body.	Class test focusing on and long questions.

MINOR CORE COURS

3SSDM404: Botany-IV (Structure, Development and Reproduction in Flowering Plant)
(Credits: Theory-4, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SSDM404	Botany-IV (Structure, Development and Reproduction in Flowering Plant)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- The anatomy of a flower.
- The life cycle of flowering seed plants the anatomy of a seed.
- The role of pollination and seed dispersal in the angiosperm life cycle.
- Identify the characteristics of flowering plants.
- Describe the structure of a flower and the difference between perfect and imperfect flowers.
- Summarize the life cycle of a flowering plant, identifying the sporophyte, the gametophytes, and when mitosis and meiosis fertilization.

Course Learning Outcomes

- Understand the anatomical features of roots, stems, leaves, and flowers in flowering plants.
- Identify and describe the different reproductive structures in flowering plants, including flowers, fruits, and seeds.
- Comprehend the life cycle of flowering plants, focusing on stages from germination through flowering to seed development.
- Explore the cellular and molecular processes involved in plant growth, development, and reproduction.
- Explain the processes of fertilization in flowering plants, covering both self-pollination and cross-pollination.

Syllabus **Credits: 4-0-2**

UNIT – I

The Root System: Root apical meristems, differentiation of primary and secondary tissues and their roles. Anatomy of monocot and dicot roots. Morphological modification of root for storage. Respiration. Interaction of root with microbes.

UNIT – II

The Shoot System: Shoot apical meristem and histological organization. Anatomy of Monocot and Dicot Stem. Vascular cambium and its functions. Secondary growth in stem, characteristics of growth rings: sapwood and heart wood. Secondary Phloem, Cork Cambium and Periderm. Anatomy of C_3 and C_4 Plants Anomalous Secondary growth in *Nyctanthus*, *Boerhhavia*, *Achyranthus*, *Leptadenia*, *Salvadora*, *Bignonia* and *Dracaena.*

UNIT – III

The Leaf System: Origin and development of leaf. Diversity in size, shape and arrangement. Internal structure of Dicot and Monocot leaf. Adaptations to photosynthesis and water stress. Senescence and abscission.

UNIT – IV

The Flower System: Concept of flower as a modified shoot. Structure of anther, Microsporogenesis and Male Gametophyte. Structure of pistil, Ovules, Megasporogenesis and Development of Female Gametophyte (Embryo Sac) and its types. Pollination – Mechanism and agencies of pollination, Pollen pistil interactions and self-incompatibility.

UNIT – V

Embryology: Double fertilization and triple fusion. Development and types of endosperms and its morphological nature, Development of Embryo in Monocots and Dicot plants. Polyembryony and Apomixis, Application of Palynology Experimental Embryology including pollen storage and test tube fertilization. Fruit development and maturation, seed structure and dispersal, Vegetative propagation.

Practical Content **Credits :2**

- Study of anatomy of t. s. of dicot root *helianthus* annus.
- Study of anatomy of t. s. of dicot root *Cicer* and *ranunculus*.
- Study of anatomy of t. s. of monocot roots *asparagus*.
- Study of anatomy of t. s. of monocot roots *zea mays* and *orchid*.
- Study of anatomy of t. s. of dicot stem *Cucurbita* and *xanthium*.
- Study of anatomy of t. s. of monocot stem *Triticum aestivum* and *asparagus*.
- Study of v. s. of isobilateral monocot leaf *Zea mays* and *bambusa*.
- Study of prepared slide of l. s. of shoot apex.
- Study of prepared slide of l. s. of root apex.
- Study of different types of ovules.
- Study of pneumatophore or respiratory root.

Reference Book

- Plant Physiology by - Lincoln Taiz and Eduardo Zeiger.
- Plant Development and Evolution by- Quentin Cronk and Richard M. Bateman.
- Botany: An Introduction to Plant Biology by- J. D. Mauseth.
- Plant Reproduction by- Shashi. Kumar.
- Reproductive Biology of Plants by- K.R. Shivanna and V.K. Sawhney.

Text Book

- Structure Development and Reproduction in Flowering Plants - Arun. K. Pandey.
- A Text Book of Botany- Structure Development and Reproduction in Angiosperm –V. Singh.
- Anatomy of Flowering Plants- Paula. J. Rudall.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Students should be able to describe and differentiate between the various parts of a plant root, including the root cap, root hairs, primary and secondary roots, and the root apical meristem	Provide students with plant specimens and encourage them to carefully observe and describe the root systems. Have them draw or document their observations in a lab notebook.	Class test focusing and short questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
2	Upon completing this unit, students should be able to analyse and compare leaf morphology among different plant species, and understand the role of leaves in photosynthesis and transpiration.	Provide plant specimens with different types of stems (e.g., herbaceous, woody, rhizomes). Have students dissect and examine stem cross-sections under microscopes. Discuss how stem structure relates to its function (e.g., support, transport)	Class test focusing on definitions and short questions.
3	Students should be able to explain the primary functions of leaves, including photosynthesis, transpiration, and gas exchange, and understand how leaf structures support these functions.	Start the unit with a discussion on the structure of leaves, including the different parts such as the blade, petiole, veins, and specialized structures like stomata. Discuss the primary functions of leaves, including photosynthesis, transpiration, and gas exchange.	Class test focusing on definitions and short and long questions.
4	Interpret and explain the meaning of information. Summarize ideas or concepts in your own words. Compare and contrast different concepts or theories.	world biological case studies and have students analyse and explain the underlying principles and mechanisms involved. Organize group discussions where students collaboratively explain and interpret challenging scientific papers or research findings.	Class test focusing on and short and long questions.
5	Students should be able to differentiate between the two fertilization events that occur during double fertilization: one involving the fusion of a sperm cell with the egg cell to form a zygote, and the other involving the fusion of a sperm cell with two polar nuclei to form the triploid endosperm nucleus.	Start with an introductory lecture explaining the significance of double fertilization in angiosperms. Break down the process of double fertilization into distinct steps and discuss each step-in detail during separate lectures.	Class test focusing on and long questions.

MINOR CORE COURS

3SPOM404: Chemistry-IV (Physical, Organic and Inorganic Chemistry)

(Credits: Theory-4, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SPOM404	Chemistry-IV (Physical Organic and Inorganic Chemistry)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Understand phase compositions and eutectic systems.
- Grasp ideal and non-ideal liquid behavior.
- Learn electrical transport and concentration cells.
- Understand electronic structure and chemistry.
- Learn about aldehydes, ketones, and nitrogen compounds.

Course Learning Outcomes

- Identify phases and understand eutectic systems.
- Comprehend ideal and non-ideal behavior.
- Understand conductivity and concentration cells.
- Recognize electronic structures and chemistry.
- Learn synthesis and reactions of functional groups.

Syllabus Credits 4-0-2

Physical Chemistry

UNIT – I

Phase Equilibrium

Statement and the meaning of the terms: Phase component and the degree of freedom, derivation of the Gibbs phase rule. Simple eutectic System: Bi-Cd, Pb-Ag system. Desiliverisation of lead. One component system: Water, CO_2 and S system. Two component system: Solid liquid equilibria.

Solid Solutions

Systems in which compound formation with congruent melting point (Mg-Zn) and incongruent melting point, (NaCl-H_2O) and ($CuSO_4$-H_2O) system. Freezing mixtures: Acetone-dry ice.

UNIT – II

Electrochemistry

Electrical transport, conduction in metals and in electrolyte solutions. Specific conductance and equivalent conductivity, measurement of equivalent conductance, migration of ions and Kohlrausch law, Arrhenius theory of electrolyte

dissociation and its limitations. Weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Theory of strong electrolytes. Transport number: Definition and determination by Hittorf method and moving boundary method.

Inorganic Chemistry

UNIT – III

Chemistry of Lanthanides Elements

Electronic structure, oxidation states, ionic radii and lanthanide contraction, complex formation, occurrence and isolation of lanthanide compounds.

Chemistry of Actinides

General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between the later actinides and later lanthanides.

Organic Chemistry

UNIT – IV

Aldehydes and ketones

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 aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids, physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, Aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Use of acetals as protecting group, Oxidation of aldehydes, Baeyer-Villager oxidation of ketones, Cannizzaro reaction.

UNIT – V

Organic Compounds of Nitrogen

Preparation of nitro alkanes and nitroarenes. Chemical reaction of nitro alkanes. Mechanism of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media.

Halo nitroarenes

Reactivity, structure and nomenclature of amines, physical properties, stereochemistry of amines, separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Amine salt as phase transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel-Phthalimide reaction, Hoffmann bromamide reaction.

Practical Content **Credits: 2**

Physical Chemistry

- To study the effect of solute (e.g., NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g., phenol water system) and to determine the concentration of that soluble in phenol water system.
- To construct the phase diagram of two components (e.g., diphenyl amine benzophenone) by cooling curve method.
- To determine the enthalpy of neutralization of weak acid/weak base versus strong acid/ strong base and determine the enthalpy of ionization of the weak acid/ base.

Inorganic chemistry

- Estimation of ferrous and ferric by dichromate method.
- Estimation of copper using thiosulphate.

Organic Chemistry

- Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

Text Books

- Unified Chemistry by Tandon, Rathore & Agarwal.
- Physical Chemistry by P. W. Atkins and Julio de Paula.
- Inorganic Chemistry by Gary L. Miessler and Paul J. Fischer.
- Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren.
- Electrochemistry by Philip N. Bartlett.
- Phase Equilibria in Chemical Engineering by Stanley M. Walas.

Reference Books

- Electrochemical Methods: Fundamentals and Applications by Allen J. Bard and Larry R. Faulkner.
- Principles of Phase Equilibria and Phase Diagrams by C. H. P. Lupis.
- Inorganic Chemistry by Catherine Housecraft and Alan G. Sharpe.
- Organic Synthesis by Michael B. Smith.
- Handbook of Lanthanide and Actinide Chemistry by Simon Cotton.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Define and differentiate between phases, such as solid, liquid, and gas, and explain the fundamental principles governing phase transitions.	Provide foundational knowledge through lectures on topics like phase diagrams, phase transitions, Gibbs phase rule, chemical potential, and thermodynamic equilibrium.	Class test focusing on short questions.
2	The fundamental principles of electrochemistry, including the laws governing electrical transport, Faraday's laws, and the Nernst equation.	Conduct laboratory sessions where students perform electrochemical experiments, such as measuring cell potentials, conducting cyclic voltammetry, or investigating corrosion processes.	Class test focusing on definitions and short questions.
3	Analyse and identify alkanes and nitroarenes. Synthetic transformation of aryl diazonium salts, Azo coupling.	Traditional lectures can introduce students to the fundamental concepts of alkanes and nitroarenes, including their structures, nomenclature, and basic properties.	Class test focusing on long questions.
4	Identification and differentiate between lanthanide elements in the periodic table, recognizing their atomic numbers and electron configurations.	Encourage active participation through Qand A sessions and open discussions on lanthanide properties and trends.	Class test focusing on definitions and short and long questions.
5	The reactions specific to aldehydes and ketones, including nucleophilic addition reactions, reduction, oxidation, and formation of hemiacetals and acetals.	Conduct lectures to introduce key concepts related to aldehydes and ketones, including nomenclature, reactivity, and synthesis.	Class test focusing on and short and long questions.

ABILITY ENHANCEMENT COURSE (AEC)

3HCHA401: Cultural Heritage

(Credit: Theory -2 Tutorial - 0)

Scheme of Examination

Course Code	Course Name	Credit	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3HCHA401	Cultural Heritage	2(2-0-0)	60	20	20	-	-	100	2 hr	-

Course Objective

- The primary objective of this course is to explore the significance, evolution, and preservation of culture and heritage across different societies and time periods.
- Students will gain a deeper understanding of how culture and heritage shape identities, influence societies, and contribute to a sense of belonging.

Course Outcomes

- Upon completion of this course, students will have a comprehensive understanding of culture and heritage, their significance in society, and the various challenges and methods associated with their preservation.
- They will develop critical thinking skills to evaluate cultural issues and contribute to the sustainable management of cultural heritage.

Syllabus: **Duration 30 hrs (Credit – 2)**

Unit 1: Introduction to Culture and Heritage

- Definition of culture and heritage
- Importance of studying culture and heritage
- Overview of key concepts and terms (e.g., cultural diversity, cultural identity, intangible cultural heritage)

Unit 2: Cultural Expressions and Artifacts

- Exploration of various forms of cultural expressions (e.g., music, dance, visual arts, literature, traditional crafts)
- Analysis of the role of cultural expressions in preserving and transmitting heritage
- Case studies of significant cultural artifacts and their historical and cultural significance

Unit 3: UNESCO World Heritage Sites

- Introduction to UNESCO and its World Heritage program
- Study of selected UNESCO World Heritage Sites from different regions
- Analysis of the criteria for selection and the challenges faced in preserving and protecting these sites

Unit 4: Cultural Identity and Cultural Heritage

- Examination of the relationship between cultural identity and cultural heritage
- Discussion on the ways in which cultural heritage shapes individual and collective identities
- Impact of globalization and cultural assimilation on cultural identity and heritage preservation

Unit 5: UNESCO World Heritage Sites

- Introduction to UNESCO and its World Heritage program
- Study of selected UNESCO World Heritage Sites from different regions
- Analysis of the criteria for selection and the challenges faced in preserving and protecting these sites

Reference Books

- Bhartiya Kala avm Sanskriti - Nitin Singhania- ISBN -13:978-9354601842
- Bharti Sanskriti Kala avm virast – devdat patnayak –- ISBN. -13:978-935440095
- Madhukar Kumar Bhagat –II Adition, ISBN-13:9789389310382
- Bhartiya Kala avm Sanskriti awam virasat – ISBN-13:978-9388182577 Minakshi Kant
- Vishy vikhyat bhartiya kala or sanskriti virasat – ISBN- 9789381395462, Rama shyal

Facilitating the Achievement of Course Learning Objectives

Unit no.	Course Learning Objectives	Course Learning Outcomes	Teaching and Learning Activities	Assessment Tasks
Unit 1: Introduction to Culture and Heritage	● Define culture and heritage. ● Explain the importance of studying culture and heritage. ● Familiarize students with key concepts and terms related to culture and heritage (e.g., cultural diversity, cultural identity, intangible cultural heritage).	● Students will be able to define culture and heritage. ● Students will understand the significance of studying culture and heritage. ● Students will demonstrate knowledge of key concepts related to culture and heritage.	● Lectures and discussions on the definition and importance of culture and heritage. ● Reading assignments and case studies to explore key concepts. ● Group discussions and presentations on cultural diversity and identity.	● Class participation and engagement in discussions. ● Written assignments or quizzes on key concepts. ● Group presentations on cultural diversity and identity.
Unit 2: Cultural Expressions and Artifacts	● Explore various forms of cultural expressions such as music, dance, visual arts, literature, and literature, and traditional crafts. Analyze the role of cultural expressions in preserving and transmitting heritage	● Students will be able to identify different forms of cultural expressions. ● Students will understand the importance of cultural expressions in heritage preservation. Students will analyze the historical and cultural significance of selected artifacts.	● Practical sessions or workshops on various cultural expressions (e.g., music and dance workshops, art exhibitions). ● Case study analysis and group discussions on the role of cultural expressions in heritage preservation. ● Research assignments on selected cultural artifacts and their significance.	● Presentation or demonstration of a chosen cultural expression. ● Written analysis of the role of cultural expressions in heritage preservation. ● Research paper or presentation on a selected cultural artifact and its significance

Unit no.	Course Learning Objectives	Course Learning Outcomes	Teaching and Learning Activities	Assessment Tasks
Unit 3: UNESCO World Heritage Sites	● Introduce students to UNESCO and its World Heritage program. ● Study selected UNESCO World Heritage Sites from different regions. ● Analyze the criteria for selection and the challenges faced in preserving and protecting these sites.	● Students will understand the role of UNESCO in preserving cultural and natural heritage. ● Students will gain knowledge of specific UNESCO World Heritage Sites and their cultural importance ● Students will analyze the criteria used for selecting World Heritage Sites and the preservation challenges they face.	● Lectures and presentations on UNESCO and the World Heritage program. ● Virtual or physical tours of selected UNESCO World Heritage Sites. ● Discussions on the criteria for World Heritage Site selection and the preservation challenges they pose.	● Research project or presentation on a specific UNESCO World Heritage Site. ● Essay or report on the criteria for selecting World Heritage Sites and the challenges they face in preservation
Unit 4 Cultural Identity and Cultural Heritage	● Examination of the relationship between cultural identity and cultural heritage Discussion on the ways in which cultural heritage shapes individual and collective identities Impact of globalization and cultural assimilation on cultural identity and heritage preservation	● Students will be able to: Analyze the relationship between cultural identity and cultural heritage Evaluate the impact of cultural heritage on individual and collective identities Assess the impact of globalization and cultural assimilation on cultural identity and heritage preservation	● Lectures and presentations on cultural identity and cultural heritage Group discussions and debates on the impact of cultural heritage on individual and collective identities Case studies on the impact of globalization and cultural assimilation on cultural identity and heritage preservation	● Written assignments on the analysis of the relationship between cultural identity and cultural heritage Oral presentations on the impact of cultural heritage on individual and collective identities Case study analysis on the impact of globalization and cultural assimilation on cultural identity and heritage preservation
Unit 5 Cultural Identity and Cultural Heritage	● Introduction to UNESCO and its World Heritage program Study of selected UNESCO World Heritage Sites from different regions Analysis of the criteria for selection and the challenges faced in preserving and	● Students will be able to: Understand the importance of UNESCO World Heritage sites Analyze the criteria for selection of World Heritage sites Evaluate the challenges faced in preserving and	● Lectures and presentations on UNESCO and World Heritage sites Group discussions and debates on the criteria for selection and challenges faced in preserving and protecting World Heritage sites Field trips to	● Written assignments on the analysis of the criteria for selection and challenges faced in preserving and protecting World Heritage sites Oral presentations on the importance of UNESCO World Heritage sites Group projects on the preservation and

Unit no.	Course Learning Objectives	Course Learning Outcomes	Teaching and Learning Activities	Assessment Tasks
	protecting these sites	protecting World Heritage sites	selected World Heritage sites	protection of World Heritage site.

BACHLOR OF SCIENCE

(Chemistry, Biology, Zoology)

(B. Sc. (CBZ) – CKUG04B03)

V Semester

MAJOR CORE COURSE-I

3SAZC503: Zoology –V (Applied Zoology)

(Credits: Theory-4, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SAZC503	Zoology –V (Applied Zoology)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objective

- Identify and classify animals into major phyla, classes, and orders.
- Describe the key characteristics and evolutionary relationships of different animal groups.
- Understand fundamental ecological concepts such as population dynamics, community interactions, and ecosystem functioning.
- Apply ecological theories to real-world scenarios and case studies.

Course Learning Outcome

- Gain a comprehensive understanding of fundamental zoological concepts, including taxonomy, anatomy, physiology, and behavior of animals.
- Develop knowledge of the diversity of animal life, including major animal phyla, classes, and orders, and the ability to classify and identify animals.
- Understand ecological principles and how they apply to the study of animals, including.
- Develop practical fieldwork skills, including animal observation, specimen collection, and data recording techniques, essential for research and conservation efforts.
- Gain proficiency in laboratory techniques such as microscopy, dissection, DNA analysis, and histology for the study of animal morphology and genetics.

Syllabus Credits 4-0-2

UNIT-I

Aquaculture

Definition and scope of aquaculture, Prawn culture; Culture of fresh water prawn, Methods of prawn fishing, preservation and processing of prawns, Pearl culture and Pearl Industry, By products of fishing industry, Frog culture, Breeding and selection.

UNIT-II

Pisciculture

General account of Edible fresh water fishes, Carp culture; Management of ponds, Preservation and processing of fishes, Maintenance of Aquarium, Plankton and their role in Fisheries, Elementary knowledge of polyculture.

UNIT-III

Economic Entomology

Sericulture; Species of silkworm, life history of Bombyx mori, Sericulture Industry in India, Apiculture; life cycle and species Methods of bee keeping, Products of bees, enemies of bees, Lac culture; Lifecycle, Host Plant cultivation, Common Pest; Stored Grains *Sitophilus oryzae* and *Tribolium Castanaeum*, Vegetable pest *Piers brassicae* and *Dacuscucurbitae*, Biological control of insect pests.

UNIT-IV

Toxicology

Toxicology; Basic concepts, definition, Heavy metal toxicity; Pb, Cd, Hg, Toxicity testing, LC 50, LD 50, acute and chronic toxicity, Pesticide and their toxicological effect; Organophosphates Pyrethroids Occupational health hazards, chemical, physical, biological hazard and their control.

UNIT-V

Lab Techniques

pH- Definition, Study of pH- meter, determination of pH. Chromatography; Principles and Types of chromatography; Paper Chromatography. Types of microtomes and their uses, General ideas of some common fixatives, stains and reagents, Museum keeping, preservation and skeleton preparation, taxidermy (Bird).

Practical Content **Credits :2**

- Study of museum specimen of fresh water edible fishes.
- Study of pH of Water and soil.
- Study of Chromatography (Paper Chromatography).
- Study of different techniques for Museum Keeping.
- Maintenance of aquarium.

Study of pests:

- Stored grain pests- Sitophilus Oryzae and *Tribolium Castanaeum.*
- Vegetable pests- *Pieris brassicae* and *Dacus cucurbitae.*
- Study of Plankton – *Euglena, Paramecium, Cyclops, Mysis, Daphnia*.

Text book

- Applied Zoology, Dr. B.S. Tomar, Meerut Publication.
- Applied Zoology, Banerjee Tarit Kumar, London, New Central book agency.
- Economic Zoology, Chaudhari Sangarika, New Delhi, New Central Book Agency.
- Aquaculture Science, Rick Parker, 3rd edition.
- Aquaculture farming aquatic animal and plants, 3rd Edition, John S. Lucas, Paul C. Southgate and craig, Wiley Blackwell.
- A textbook of Modern Toxicology, 4th edition Eenest Hodgson.

Reference Book

- Biological Systematics by Minelli Chapman and Hall, London, 387 pp.
- An introduction to Taxonomy, Zoological Survey of India by Narendran, Kolkata.
- Biological Systematics by Addison-Wesley Publishing Company, Inc.
- Conservation of biodiversity for sustainable development by Sandiurd, O. T., A.H.D. (1982). Scandinavian University Press, Columbia.
- Principles of Animal Taxonomy by Hindar, K. and Brown, Oxford IBH.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching And Learning Activities	Assessment Tasks
1	Understand the principles of designing, constructing, and managing aquaculture facilities, including ponds, tanks, recirculating systems, and net pens.	Facilitate discussions to encourage critical thinking and provide opportunities for students to ask questions and clarify concepts.	Class test focusing and short questions.
2	Study fish reproduction and breeding techniques, including the manipulation of spawning and selective breeding for desirable traits.	Arrange visits to commercial fish farms or aquaculture research centres to expose students to real-world pisciculture practices.	Class test focusing on definitions and short questions.
3	Develop a comprehensive understanding of insect biology, including anatomy, physiology, and life cycles. Gain knowledge of insect taxonomy and the ability to identify major insect orders and families.	Facilitate discussions to encourage critical thinking and provide opportunities for students to ask questions and clarify concepts. Field Trips and educational visit like Zoo, sanctuaries, national park.	Class test focusing on definitions and short and long questions.
4	Understand the processes of toxic kinetics (absorption, distribution, metabolism, and excretion) and toxic dynamics (mechanisms of toxicity) of toxic substances.	Conduct experiments or simulations to illustrate dose-response relationships and toxicological concepts such as LD50 (lethal dose) and NOAEL (no observed adverse effect level).	Class test focusing on and short and long questions.
5	Understand and adhere to laboratory safety protocols, including proper attire, chemical handling, equipment uses, and emergency procedures.	Organize regular laboratory sessions where students perform experiments and practice techniques under the guidance of instructors.	Class test focusing on and long questions.

MAJOR CORE COURSE-II

3SWLC503: Zoology-V (Wild Life Conservation)

(Credits: Theory-2, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SWLC503	Zoology-V (Wild Life Conservation)	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objective

- This paper is aimed to introduce wildlife conservation, endangered species, sentries, biosphere reserve Project Tiger and Gir Lion.
- To provide students with comprehensive knowledge of the wildlife, conservation efforts, and biodiversity in India.
- To understand the factors influencing biodiversity, conservation strategies, and the role of local communities.
- To study the management measures for maintaining wildlife habitats, protection, and addressing biotic interference.

Course Learning Outcome

- The student has a knowledge of different biosphere reserve, sanctuaries, wildlife conservation Skill to develop employment in Zoo.
- Skill development in various forensic sciences needed for investigation on illegal animal hunting, poaching etc.
- Developed Employ ability in Forest Services, wild life institutes and NGO Sectors.
- Students will be able to analyze and appraise wildlife threats and will have a basic understanding of wildlife in India, which can be used to pursue a career in a wildlife conservation group or further research and the complexity.

Syllabus

Credits :2-0-2

UNIT – I

Wild life

Wild Life of India; Types of Wild Life, Value of Wild Life, Positive negative of Wild Life. Biodiversity in India; In situ conservation, Ex-situ conservation, Botanical and Zoological Gardens, Gene Banks, Tissue Culture and DNA banks, Butterfly gardening.

UNIT – II

Conservation in India

Wild Life protection act, International and National Organizations in Wildlife Conservation, Government Organizations; CITES, Global Tiger Forum, Conservation of wild Life in India, Endangered and dangerous species in India.

UNIT – III

National Park and Sanctuaries

Wild Life conservation, National Parks and Sanctuaries, Management measures; Wildlife habitats, Protection, Biotic interference, Forestry operation, use of fire, National Park in India, Sanctuaries in M.P.

UNIT – IV

Conservation Project

Project Tiger; Initiation, Finance, Objective, Management, Status, Threats, Gir Lion Sanctuary Project; Threats, Management, Work plan and achievements, Crocodile Breeding Project; Causes of depletion, Work Plan, achievement, Project Elephant, Conservation of Sea Turtle, National animal and their conservation.

UNIT – V

Biosphere Reserves

Biosphere reserve concept and components, Wild Life in M.P with references to mammals, Biosphere reserves, Bird sanctuaries in India.

Practical Content **Credits :2**

- Wild life; Endangered and threatened species.
- National animal and their conservation.
- Project Tiger.
- Zoo Visit Kannan Pendari.
- Crocodile Project, National Park in India.
- Bird sanctuaries in India.
- Butterfly identification, Sanctuaries, Biosphere Reserve.

Text book

- Wildlife Ecology, Conservation, and Management by Anthony R. E. Sinclair, John M. Fryxell, and Graeme Caughley.
- Conservation Biology; Foundations, Concepts, Applications by Fred Van Dyke.
- Essentials of Conservation Biology by Richard B. Primack.

Reference Book

- Introduction to Wildlife Management, by P.R. Krausman, Prentice Hall Pearson Educ. Inc. New Jersey.
- Genetics; A Conceptual Approach by Benjamin A. Pierce.
- Wildlife Management. by R.H. Giles.
- Wildlife Ecology and Management, by W.L. Robinson and E.G. Bolen. Mc. Millan Publications Comp. New York.
- Environmental Impact Assessment and Management, Ed. B.B. Hosetti and A. Kumar, Daya Publishing House, Delhi.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Develop the ability to identify common Indian wildlife species, including mammals, birds, reptiles, and amphibians.	Organize field trips to national parks, wildlife sanctuaries, and reserves in India to observe wildlife in their natural habitats.	Class test focusing and short questions.
2	Dvelop a comprehensive understanding of the wildlife protection laws and regulations in the specific region or country of study.	Conduct class discussions to encourage critical thinking and debate about the act's effectiveness and challenges.	Class test focusing on definitions and short questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
	Familiarize oneself with the historical context and evolution of wildlife protection laws.		
3	Develop a fundamental understanding of wildlife conservation principles, theories, and concepts. Familiarize oneself with the importance of biodiversity and its role in ecosystem stability.	Organize field trips to natural habitats, wildlife reserves, or conservation areas. Conduct wildlife surveys, focusing on species identification, population assessment, and habitat evaluation.	Class test focusing on definitions and short and long questions.
4	Understand the legal frameworks and policies related to the protection and conservation of the national animal. Evaluate the effectiveness of these legal measures.	Conduct a field trip or visit a local wildlife sanctuary or zoo to observe the national animal in its natural or simulated habitat. Encourage students to make observations and take notes on the specie's behaviour, appearance, and interactions.	Class test focusing on and short and long questions.
5	Learn to assess different habitats, including forests, grasslands, and wetlands, in M.P. and C.G. for their suitability for mammalian species. Understand the impact of habitat loss and fragmentation on mammal populations.	Organize wildlife tours and field trips to national parks, wildlife sanctuaries, and protected areas in M.P. and C.G. Observe and document mammal species in their natural habitats.	Class test focusing on and long questions.

MAJOR CORE COURSE-III

3SABC503: Zoology-V (Aquatic Biology)

(Credits: Theory-2, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SABC503	Zoology-V (Aquatic Biology)	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Provide students with a fundamental understanding of the various types of aquatic ecosystems, including freshwater lakes, rivers, estuaries, oceans, and wetlands.
- Explore the diversity of aquatic organisms, including microorganisms, plants, invertebrates, and vertebrates, and their adaptations to aquatic environments.
- Examine the physical and chemical properties of aquatic environments, including water quality, nutrient cycling, and the impact of human activities on aquatic chemistry.
- Study the structure and dynamics of aquatic food webs, including trophic interactions among organisms and energy flow through ecosystems.

Course Learning Outcome

- The student has a knowledge of aquatic organisms, ecosystem understanding, water quality assessment, conservation and management, research skill etc.
- To inculcate basic knowledge on marine ecosystem and its importance.
- Create awareness on the ecology, biology and biodiversity of various marine organisms.
- Prepare a biologist to specialize on marine biology.

Syllabus Credits: 2-0-2

UNIT I:

Aquatic Biomes

Aquatic Biomes Brief introduction of the aquatic biomes, Freshwater ecosystem; lakes, wetlands, streams and rivers, estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT II:

Fresh Water Biota

Freshwater Biology Lake; Origin and classification, Lake Ecosystem, Lake morphometry, Physio–chemical Characteristics; Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases, Oxygen, Carbon dioxide.

UNIT III:

Lotic and Lectic Biota

Nutrient Cycles in Lakes; Nitrogen, Sulphur and Phosphorous, Streams; Different stages of stream development, physio-chemical environment, Adaptation of hill-stream fishes.

UNIT IV:

Marine Water Biota

Marine Biology Salinity and density of Sea water, Continental shelf, Adaptations of deep-sea organisms, Coral reefs, Biodiversity; Discuss the high biodiversity found in coral reefs and the importance of this ecosystem, Coral Bleaching, Conservation Efforts Sea weeds.

UNIT V:

Aquatic Pollution

Management of Aquatic Resources Causes of pollution; Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation, legislations, Sewage treatment Water quality assessment; BOD and COD.

Practical Content **Credits: 2**

- Study of museum specimen of fresh water edible fishes.
- Study of pH of water and soil.
- Study of paper chromatography.
- Study of working instrument microtome.
- Maintenance of aquarium.
- Aquatic pollution and fisheries.
- Aquatic pollution and toxicology.

Text Book

- Aquaculture Science, Rick Parker,3rd edition.
- Aquaculture farming aquatic animal and plants, 3rd Edition by John S. Lucas, Paul C. Southgate and craig, Wiley Blackwell.
- Anathakrishnan; Bioresources Ecology 3rd Edition.
- Goldman; Limnology, 2nd Edition.
- Odum and Barrett; Fundamentals of Ecology, 5th Edition.
- Trivedi and Goyal; Chemical and biological methods for water pollution studies.

Reference Book

- Introduction to Wildlife Management, by P.R. Krausman, Prentice Hall Pearson Educ. Inc. New Jersey.
- Genetics: A Conceptual Approach by Benjamin A. Pierce.
- Wildlife Management, by R.H. Giles.
- Wildlife Ecology and Management, by W.L. Robinson and E.G. Bolen. McMillan Publications Comp. New York.
- Managing Protected Areas in Tropics, by J.K. Mackinnon, Natraj Publications Dehradun.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Start with your high school biology curriculum. It will introduce you to the basics of ecosystems, which are fundamental to understanding aquatic biomes.	Setup a classroom aquarium with a small ecosystem of aquatic plants and animals found in your local aquatic biome (e.g., freshwater or marine). Students can observe and learn about interactions among organisms and the environment.	Class test focusing and short questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
2	Students should be able to identify and classify common organisms found in lake ecosystems, including fish, invertebrates, phytoplankton, and zooplankton.	Organize fish identification sessions using preserved specimens or images. Additionally, conduct fish dissections to study their anatomy and adaptations.	Class test focusing on definitions and short questions.
3	Understand the major nutrients involved in lake ecosystems, including carbon, nitrogen, phosphorus, and sulphur.	Organize a field trip to a local lake or pond. Provide students with water sampling kits to collect water and sediment samples. Back in the classroom, they can analyse these samples for nutrient content and water quality parameters.	Class test focusing on definitions and short and long questions.
4	Understand the anatomical and physiological adaptations of marine organisms for life in the ocean, such as gills, buoyancy mechanisms, and osmoregulation.	Organize a field trip to a local aquarium or marine research canter. Students can observe marine organisms up close and learn about their adaptations and behaviours.	Class test focusing on and short and long questions.
5	Understand the methods and techniques used to assess the quality and quantity of aquatic resources, including water bodies, fisheries, and aquatic ecosystems.	Conduct water quality assessments in a local water body. Students can measure parameters like pH, turbidity, dissolved oxygen, and nutrient levels. Discuss the implications for resource management.	Class test focusing on and long questions.

MAJOR CORE COURSE-I

3SPPC503: Botany-V (Plant Physiology and Biochemistry)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SPPC503	Botany-V (Plant Physiology and Biochemistry)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objective

- Understand the basic principles related to various physiological functions in plant life.
- Familiarize with the basic skills and techniques related to plant physiology.
- Understand the role, structure and importance of the bio molecules associated with plant life.
- Familiarize with applied aspects of plant physiology in other fields like agriculture.
- To get an idea of environmental issues and its conservation.
- To have an understanding of environmental legislation and laws.

Course Learning Outcome

- The study of functions of plant cell incorporates knowledge at molecular level.
- This gives an idea of the cell functions and by alteration of the functioning of enzymes and bimolecular.
- The student can find out more ideas of improving productivity.
- The physiological knowledge help to develop newer ideas in developing newer techniques in agriculture.
- Environmental awareness makes the students respect mother earth by protecting and conserving the plants and animals and keep up the balance on the earth.

Syllabus **Credits: 4-0-2**

UNIT – I

Plant Water Relations: Properties of water, Importance of water in plant life, Diffusion, Osmosis and osmotic relation to plant cell. Water absorption, Ascent of sap. Transpiration: Structure and physiology of stomata, Mechanism of transpiration, Factors affecting the rate of transpiration.

UNIT – II

Plant Nutrition, Biomolecules & Metabolism: Mineral Nutrition. Essential Macro and Micronutrients and their role. Absorption of mineral nutrients and hydroponics, Translocation of organic solutes

Biomolecules: Structure classification and functions of Carbohydrates. Amino acids, Proteins and Lipids. Nitrogen fixation and Lipid Metabolism.

UNIT – III

Photosynthesis: Chloroplast, Photosynthetic pigments, Concept of two photosystems, Light reaction, red drop, Emerson's effect, Dark reaction - Calvin cycle, Hatch-Slack cycle, CAM cycle, Factors affecting rate of photosynthesis and Photo respiration.

UNIT – IV

Respiration: Mitochondria, aerobic and anaerobic respiration, fermentation, Respiratory coefficient, Mechanism of respiration - Glycolysis, Krab's cycle, Pentose phosphate pathway, Electron transport system, Factors affecting rate of respiration, Redox potential and theories of ATP synthesis.

UNIT – V

Enzymes and plant Hormones: Classification nomenclature and characteristics of Enzymes, Concept of holoenzyme, apoenzyme, co-enzyme and co-factors. Mode and mechanism of enzyme action, Factors affecting enzyme activity.

Plant Hormones: Discovery, Structure Mode of action and role of auxins, Gibberellins, Cytokinin, abscisic acid and Ethylene.

Practical Content **Credits: 2**

1. Experiment to demonstrate transpiration in plants by bell jar method.
2. To demonstrate that there is loss in weight of plant due to transpiration. Demonstrate that oxygen (O_2) gas is released during photosynthesis.
3. Experiment to show that carbon dioxide (CO_2) is necessary for photosynthesis.
4. General test for carbohydrates in plant tissue.
5. To test the presence of monosaccharide in plant tissue.
6. To perform starch test in leaves.
7. To test the presence of lipids in plant tissues.
8. Demonstration of micro propagation (seed culture, stem culture).
9. Perform starch test in leaves.
10. Demonstration of micro propagation.

Reference Book

- Plant Physiology by- Lincoln Taiz and Eduardo Zeiger.
- Plant Biochemistry by- Hans-Walter Heldt and Fiona Heldt.
- Introduction to Plant Physiology by- William. G. Hopkins and Norman P. A. Huner.
- Principles of Plant Physiology by- Frank B. Salisbury and Cleon W. Ross.

Text Book

- Plant Biochemistry by- Hans Walter Heldt and Fiona Heldt.
- Biochemistry and Molecular Biology of Plants by- Buchanan Gruissem and Jones.
- Text Book of Plant Physiology and Biochemistry – A.K. Singh and Shalini Singh.
- Text Book of Plant Physiology – C.P. Malik and A.K. Srivastava.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Students should be able to explain how plants take up water from the soil through roots, including the role of root structures and mechanisms such as osmosis and active transport.	Begin with an overview of the topic, including the importance of water for plants and its role in various physiological processes. Explain the mechanisms of water uptake by roots, including diffusion, osmosis, and active transport.	Class test focusing and long questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
2	Explain the overall process of photosynthesis, including the role of chloroplasts, pigments, and the conversion of light energy into chemical energy.	Provide comprehensive lectures on the theory and principles of photosynthesis, covering topics such as the photosynthetic equation, pigments, and the two stages (light-dependent and light-independent reactions).	Class test focusing on long and short questions.
3	Students should be able to explain the process of cellular respiration, including glycolysis, the Krebs cycle, and the electron transport chain. They should understand how cells generate ATP (adenosine triphosphate) through these processes.	Provide comprehensive lectures covering the theory and principles of cellular respiration, including glycolysis, the citric acid cycle, and oxidative phosphorylation.	Class test focusing short and long questions.
4	Students should have a solid understanding of the structure and function of enzymes. They should be able to explain how enzymes catalyse biochemical reactions and the key features of enzyme structure, including the active site.	Begin with a comprehensive lecture on the basics of enzymes, including their structure, function, and classification. Engage students in a group discussion on real-life applications of enzymes, such as in medicine, industry, and biotechnology.	Class test focusing on and short and long questions.
5	Students should demonstrate the ability to design and execute genetic modification experiments, including the insertion, deletion, or modification of genes in different organisms.	Begin with foundational lectures on genetics, molecular biology, and the principles of genetic engineering.	Class test focusing on and long questions.

MAJOR CORE COURSE-II

3SEEC503: Botany- V (Evolutionary and Economic Botany)

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SEEC503	Botany- V (Evolutionary and Economic Botany)	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Construct a phylogenetic tree.
- Explain the mechanisms which underlie evolution at the molecular level.
- To identify the following crops: Sorghum, *Maize*, *Rice*, and *Wheat.*
- To know the origin, distribution, spread and taxonomy of the above listed crops.
- To be able to describe morphological feature.
- To know the economic importance of the listed crops.

Course Learning Outcomes

- Acknowledge the economic uses of plants in modern society.
- Acquire an increased awareness and appreciation of plants and plant products encountered in everyday life.
- Appreciate the diversity of plants and the plant products in human use.
- Understand the conditions and consequences of natural selection and describe different modes of speciation.
- Search the library for literature review and choosing a valuable research topic.

Syllabus Credits 2-0-2

UNIT – I

Evolutionary Biology: Origin of life (including aspects of prebiotic environment and molecular evolution). Concept of evolution: Theories of organic evolution, Origin and evolution of economically important microbes and plants.

UNIT – II

Origin of Agriculture: World centers of primary diversity of domesticated plants, Plant introduction: Plant as a source of renewable energy.

UNIT - III

Botany Cultivation and Uses: Food, forage and fodder crops (cereals, pulses, vegetables and fruits) Fiber's classification based on the origin of fiber's cotton and jute (morphology, extraction and uses) Botany, cultivation and uses of medicinal plants (*Amlaki, Arjuna, Ashoka, Neem*) oil yielding plants (groundnut coconut linseed and *Brassica spp.*)

UNIT – IV

Timber Yielding Plant: Timber yielding trees of India and their products (*Shisham*, *Sal*, Teak, *Deodar Babool*) Important fire-wood, plants and non-wood forest products such as- Bamboo and Cane Industry, raw materials for paper-making, gums, tannins.

UNIT – V

Forming of Medicinal Plant: Cryopreservation, seed bank and drug yielding plants - Therapeutic and habit-forming drugs with special reference of *Cinchona digitalis (Linn), Papaver* and *Cannabis.*

Practical Content **Credits: 2**

- Study of cultivation and uses of medicinal plants.
- Study of Food, forage and fodder crops. (cereals, pulses vegetables and fruits)
- Study of timber Yielding plants *Shisham* and *Deodar.*
- Study of oil yielding plants Groundnut and Coconut.
- Study of Drug yielding plants *Papaver* and *Cannabis.*

Reference Book

- The Diversity of Life by- Edward O. Wilson.
- Plant Evolution: An Introduction to The History of Life by- Karl. J. Nikel.
- Kochhar. S.L. (2012) Economic Botany in Tropics. Mac. Millan New Delhi, India.

Text Book

- Text Book of Economic Botany – V. Verma.
- Text Book of Economic Botany – Afroz. Alam and Vinay. Sharma.
- A Text Book of Economic Botany And Ethnobotany- John Gonsalves.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Explain the basic principles of evolution by natural selection. Describe the historical development of evolutionary thought	Traditional lectures can provide a structured introduction to key concepts in evolutionary biology. Instructors can use multimedia presentations and real-world examples to illustrate principles.	Class test focusing and short questions.
2	Demonstrate a comprehensive understanding of the history of agriculture, including its origins and development in different regions of the world.	Understand the significance of the Neolithic Revolution. Identify key developments that led to the rise of agriculture. Analyse the impact of agriculture on human societies.	Class test focusing on long and short questions.
3	Analyse the principles of sustainable agriculture and their impact on the environment.	Study common plant diseases and pests, guest speakers from plant pathologists and entomologists, and pest control demonstrations.	Class test focusing short and questions.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
	Design and implement sustainable cultivation practices for different types of crops.		
4	Students will comprehend the ecological importance of firewood and timber-yielding plants in various ecosystems, including their roles in habitat creation, soil stabilization, and carbon sequestration.	Traditional lectures can provide students with foundational knowledge about firewood and timber-yielding plants. These lectures can cover topics like plant identification, ecological roles, and basic wood properties.	Class test focusing on and short questions.
5	Describe the importance of medicinal plants in healthcare and traditional medicine systems. Identify and classify common medicinal plants based on their botanical characteristics and therapeutic properties.	Instructor-led lectures on the theory and principles of medicinal plant farming. Class discussions to explore concepts, challenges, and emerging trends in the field.	Class test focusing on and long questions.

MAJOR CORE COURSE-III

3SIBC503: Botany-V (Industrial Botany)

(Credits: Theory-2, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SIBC503	Botany-V (Industrial Botany)	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- This course will provide knowledge on plants and their parts used in various industries.
- Students will get an idea to establish plants based natural product industry.
- This course will make the students self-reliant.
- Understand the historical development and significances of industrial botany in modern agriculture and industries.

Course Learning Outcomes

- Students will know about concept of diseases, knowledge and awareness of diseases, causal agents of plant diseases, identification methods and management of crop diseases.
- Students will understand the historical development and significance of industrial botany in agriculture and various industries.
- Ability to articulate and apply fundamental terminology and concepts in industrial botany.
- Demonstrate a comprehensive understanding of plant physiological processes and their practical applications in industrial crop production.
- Apply knowledge to analyze and solve problems related to plant physiology in an industrial context.

Syllabus **Credits: 2-0-2**

UNIT-I

Plant in Timber Industry: Timber yielding trees of India, - Importance of timber or products of timber structure of wood porous and non-porous of wood, Physical Properties of wood preservation, Types of wood and their products. (*Shisham*, *Sal*, *Teak*, *Deodar*, *Babool*) Bamboo and cane industry-Bamboos in India properties of bamboo cultivation, Utilization of bamboo.

Kattha Industry- Industry profile and market opportunities manufacturing process raw material availability advantages and disadvantages of *Kattha*.

UNIT-II

Leaf Based Industries: Utility products of leaf- Botanical characters and use (*Palash*, Banana).

Tea Industry-Origin, distribution botanical characters, cultivation processing of tea production, others types of tea, special types of Indian tea.

Leaf oil Industry- Essential or volaille oils (Mint, Camphor, *Neem*, *Tulsi*, Eucalyptus and Lemon grass).

Leaves used as spices-Cultivation of different types of leaves (*Kasoori Methi*, *Pudina, curry patta*, onion, *tejpatta*).

UNIT-III

Flower Based Industries: Perfume products of flowers – Perfume industry of India rose- Characters importance of rose extraction of rose oil and uses Jasmine. - Characters, Cultivation, Extraction of jasmine oil. Heena - Characters, Cultivation, making of henna oil, and uses.

Colour Industry- Aims of food coloring history and types of food colours side effects of artificial food colours food colour industry of India. Holi colours - preparation of natural colours of holi, Holi colour industry of India.

Raw material for fermentation- Fermentation types of fermentation types of fermentation *Mahua- mahua* as a raw material for fermentation, fermentation process of *mahua* flowers and uses of *mahua*.

UNIT-IV

Fruits and Seed Based Industries: Preparation and methods - Jams, Jellies, Juice, Souce and Pickles and scope of business of fruit and vegetable.

Poha and *Daal* Industries- *Poha* industry production technique of *poha*, Processing methods of flaked rice. health benefits of *poha*: *Poha* industry in MP. *Dal* Industry- Production process of *Dal*.

Edible oil industry- Types of oil commonly used in India process of manufacturing edible oil Groundnut, and *Soyabean,* Starch, Glucose, and Dextrose Industry- Starch industry – getting starch from *maize* importance of starch Indian starch industry Glucose- Production of glucose, applications of glucose Indian glucose industry Dextrose – uses of dextrose production and Indian dextrose industry.

UNIT- V

Other part of plants-based Industries: Sugar and Jaggery Industries- Sugar industry, bio- ethanol sugar production of India, manufacturing process of sugar in India types of sugar. Jaggery industry- types of jaggery, processing of jaggery benefit of jaggery.

Jute and *Agarbatti* stick making Industry. - *Jute* industry, history of *jute* industry in India used of *jute Agarbatti*- *Agarbatti* making business in India, manufacturing process of *Agarbatti* production of *Agarbatti*, future of *Agarbatti* industry in India Project proposal preparation for Establishment of an Industry. Grants and Funding provider organizations of India – India grants PMMY (*Pradhan Mantri Mudra yojana*) RKVY (*Rastriya Krishi Vikash yojana*) SIDBI Fund and scheme.

Practical Content **Credits: 2**

- Preparation of *Holi* colours from locally available flowers.
- Perfume extraction process by distillation method.
- Preparation and preservation techniques of jams, jellies and prickles.
- Extraction and preservation of juices. (lemon and orange etc.)
- Preparation of different types of teas. (*Tulsi* tea, lemon tea etc.)
- Identification, collection and extraction of oil yielding leaves.
- Hands on training for preparation of *Douna* and *Pattal* using *Palash* and Banana leaves.

Reference Book

- Gerald E Wickens (Auth.)- Economic Botany Principles and Practice Kliver academic publishers 2001.
- Kocchar S.L.- Economic Botany Cambridge University Press U.K. 2016.
- Industrial Botany – Prof. Dr. Khan Mahfouz Raza and Prof. Dr. R.D. Joseph and Dr. Smita Krishnarao Kadwe.

Text Book

- Industrial and Commodity Uses of Tropical Plants by- R.H.M.J. Lemmens.
- Industrial Plant Biology by- Randhir. Singh. and Sudhir. P. Singh. and Bhavna Kaushik.
- Industrial Crop Production by- Sant. S. Virmani. and A. A. Sie.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Understand the environmental impact of timber harvesting and processing and explore sustainable forestry practices.	Instructor-led lectures to provide theoretical knowledge about the timber industry, tree identification, and forest management principles. Engage students in discussions to explore key concepts and stimulate critical thinking.	Class test focusing and short questions.
2	Students should develop a comprehensive understanding of industries that rely on leaves as a primary resource. This includes industries like tea, tobacco, herbal medicine, and natural products.	Traditional lectures can provide a foundational understanding of the subject matter. Instructors can use multimedia presentations, guest speakers from the industry, and case studies to make the lectures engaging.	Class test focusing on long and short questions.
3	Understand the processes involved in handling and preserving flowers, including techniques to extend shelf life and maintain product quality.	Organize hands-on floral design workshops where students can learn and practice various floral arranging techniques. This can include creating bouquets, centrepieces, wreaths, and other floral arrangements.	Class test focusing short and questions.
4	Develop a comprehensive understanding of industries that rely on fruits and seeds as key resources, including agriculture, food processing, beverage production, seed production, and nut processing.	organize visits to fruit orchards, seed farms, and agricultural fields to give students firsthand exposure to cultivation practices and production processes.	Class test focusing on and short questions.
5	Students will develop a comprehensive understanding of the various parts of plants, including roots, stems, leaves, flowers, and non-food parts like fibres, extracts, and resins, and their potential industrial applications.	Analyse real-world case studies of companies and industries that utilize plant-based resources. This helps students apply theoretical knowledge to practical scenarios and understand the challenges and opportunities in these sectors.	Class test focusing on and long questions.

CORE COURSE-I

3SPOC503: Chemistry-V (Physical, Organic and Inorganic Chemistry)
(Credits: Theory-4, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SPOC503	Chemistry-V (Physical Organic and Inorganic Chemistry)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Understand spectroscopy's principles and applications.
- Learn about carbohydrates, fats, oils, detergents, and synthetic dyes.
- Explore the role of essential elements in biological processes.
- Grasp the concepts of hard and soft acids and bases.

Course Learning Outcomes

- Interpret various spectra to determine molecular structures.
- Differentiate and analyze carbohydrates.
- Apply lipid chemistry knowledge to understand industrial applications.
- Evaluate the biological significance of metal ions.
- Apply HSAB concept to predict reactivity.

Syllabus

Credits 4-0-2

Physical Chemistry

UNIT- I

Spectroscopy: An Introduction

Introduction, electromagnetic radiation, regions of electromagnetic spectrum, basic features of different spectrometers, Born-Oppenheimer approximation, degrees of freedom.

Spectroscopy: Rotational spectrum

Introduction; Rotational spectrum of diatomic molecules. energy levels of a rigid rotator (Semi Classical Principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann Distribution), determination of bond length, qualitative description of non-rigid rotator, isotope effect.

Organic Chemistry

UNIT – II

Carbohydrates

Introduction, classification of carbohydrates; Monosaccharides- general properties, mutual transformations (interconversion), stereoisomerism and configuration of monosaccharides; Threo and erythro diasterioisomers, epimerization, determination of ring size in monosaccharides. Glucose- physical and chemical properties, uses, tests and

constitution. Fructose- properties, uses, test; Structure of ribose and deoxyribose. Disaccharides: Glycoside linkage, reducing and non-reducing sugars. Maltose-properties, uses and structure. Sucrose preparation, properties, uses, tests. Polysaccharides: Starch- manufacture, properties, uses and structure. Cellulose-preparation, properties, industrial applications of cellulose, structure, Exercises.

UNIT – III

Fats, Oils and Detergents

Introduction; Edible and industrial oil of vegetable origin, glycerides occurrence and extraction, properties. Hydrogenation of unsaturated oils, analysis of oils and fats: Soaps manufacture of soap. Kinds of soluble soap, cleansing action of soap: Synthetic detergents, additive of detergents, comparison between soap and synthetic detergents, Alkyl and aryl sulphonates, cleansing action of alkyl-aryl benzene sulphonates.

Inorganic Chemistry

UNIT – IV

Bioinorganic Chemistry

Introduction, Essential and trace elements in biological processes, biological function of the bio elements, availability of bio-metals and bio-son-metals; Metalloporphyrin's Hemoglobin, structure of hemoglobin, biological functions of hemoglobin in animals; Myoglobin, mechanism of oxygen transfer through hemoglobin and myoglobin, relation between chlorophyll and hemoglobin, chemical reactions of hemoglobin and myoglobin, biological role of alkali and alkaline earth metal ion, biochemistry of potassium and sodium. Biochemistry of magnesium and calcium; Nitrogen fixation, mechanism of nitrogenase, iron-Sulphur protein and nitrogen fixation, Exercises.

UNIT – V

Hard and Soft Acids and Bases (HSAB)

Introduction, Lewis's concept of acids and bases, classification of Lewis acids and bases, utility and limitations, classification of hard and soft acid-base-soft acid, hard acids, soft base, and hard base; Hard-soft acid-base concept of Pearson, applications of hard and soft acid-base theory. Symbiosis; Acid-base strength and hardness and softness; Theoretical basis of hardness and softness: Electronic theory, pi-bonding theory, Drago-Wayland theory, Electronegativity and hardness and softness, limitation of hard and soft acid-base concept; Exercises.

Practical Content — Credits 2

Physical Chemistry

- Effluent Analysis: Identification of cations and anions in different water samples.
- Water Analysis: To determine the amount of dissolved oxygen in water samples in ppm units.

Organic Chemistry

Preparation:

- Acetylation
- Benzoylation
- meta-Dinitrobenzene
- Picric acid

Inorganic Chemistry

- Analysis of inorganic mixture containing five radicals with at least one interfering radical (phosphate, borate, oxalate or fluoride).

Text Book

- Spectroscopy: An Introduction by Donald L. Pavia, Gary M. Lampman, George S. Kriz, and James A. Vyvyan.
- Organic Chemistry by Robert T. Morrison and Robert N. Boyd.
- Fats and Oils by Clyde E. Stauffer.

- Bioinorganic Chemistry by Rosette M. Roat-Malone.
- Hard and Soft Acids and Bases (HSAB) by Ralph G. Pearson.

Reference Book

- Introduction to Spectroscopy by Donald L. Pavia.
- Advanced Organic Chemistry by Francis A. Carey and Richard J. Sundberg.
- Fats and Oils Handbook by Michael Bockisch.
- Bioinorganic Chemistry: A Short Course by Rosette M. Roat-Malone.
- Theoretical Principles of Inorganic Chemistry by James E. House.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	The fundamental principles underlying spectroscopic techniques, including the interaction of electromagnetic radiation with matter and the concept of energy levels.	Teach students how to prepare samples for spectroscopic analysis, including proper techniques for dilution, dissolution, or extraction.	Assignments on the electromagnetic spectrum.
2	The principles of metal ion coordination chemistry, including coordination number, ligands, and bonding modes.	Teach students how to analyse metal concentrations in biological samples using techniques like atomic absorption spectroscopy or inductively coupled plasma mass spectrometry.	Presentation on carbohydrate uses and tests.
3	The basic structure of an atom, including the nucleus, electrons, protons, and neutrons, and how they contribute to the overall properties of elements.	Introduce students to different types of matter (solids, liquids, gases) and have them observe and classify common objects and substances in their environment. Use simple sorting activities to help students differentiate between various materials based on properties like colour, texture, and state.	Class test focusing on long questions.
4	Classify carbohydrates into various categories, including monosaccharides, disaccharides, and polysaccharides, and differentiate between aldoses and ketoses.	Begin with informative lectures that introduce the basic concepts of carbohydrates, their classification, and their importance in chemistry and biology.	assignments on metalloporphyrin structure and function
5	The hard and soft acid-base theory, including the concept of hard and soft acids and bases and their interactions.	Provide students with a set of chemical species and ask them to classify each as hard or soft acids and bases based on HSAB principles. Discuss their reasoning and findings as a class.	Class test focusing on long questions.

MAJOR CORE COURSE-II

3SRMC503: Chemistry-V (Research Methodology for Chemistry)

(Credits: Theory-2, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SRMC503	Chemistry-V (Research Methodology for Chemistry)	4(2-0-2)	60	20	20	60	40	200	3hr	2hr

Course Objectives

The objective of this paper is to formulate the research problems and connect the research outcomes to the society. Student should be able to assess the local resources and opportunities in public domains. It further helps in gaining the knowledge of safety and ethical handlings of chemicals in lab and households.

Course Learning Outcomes

By the end of the course, the students will be able to

- Learn how to identify research problems.
- Evaluate local resources and need for addressing the research problem
- Find out local solution.
- Know how to communicate the research findings.

Syllabus Credits: 2-0-2

UNIT-I

Literature Survey

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, Chem. Industry, Wiki- Databases, Chem. Spider, Science Direct, Scopus.

Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information. Open-source Lead lectures. Open-source chemistry designing sources, Essentials of Problem formulation and communication with society.

UNIT-II

Methods of Scientific Research and Writing Scientific Papers

Reporting practical and project work. Idea about public funding agencies of research, Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific

contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism. Assessment of locally available resources.

UNIT-III

Chemical Safety and Ethical Handling of Chemicals

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric level. Safe storage and disposal of waste chemicals. Recovery, recycling and reuse of laboratory chemicals. Procedure for laboratory disposal of explosives. Identification, verification and segregation of laboratory waste. Disposal of chemicals in the sanitary sewer system. Incineration and transportation of hazardous chemicals.

UNIT-IV

Data Analysis

The Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, r and its abuse. Basic aspects of multiple linear regression analysis.

Biostatistics: brief introduction and data handling

UNIT-V

Electronics

Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

Practical Credits :2

- Ethical handlings of chemicals in the lab and households.
- Methods of Scientific Research and Writing Scientific Papers: Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display.
- Chemical Safety and Ethical Handling of Chemicals: Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation.
- Data Analysis the Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.

Reference Books

- Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. and Jones, A. (2011) Practical skills in chemistry. 2nd Ed. Prentice-Hall, Harlow.
- Hibbert, D. B. and Gooding, J. J. (2006) Data analysis for chemistry. Oxford University Press.
- Topping, J. (1984) Errors of observation and their treatment. Fourth Ed., Chapman Hall, London.
- Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, how to use Excel in analytical chemistry and in general scientific data analysis. Cambridge Univ. Press (2001) 487 pages.
- Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.

Text Book

- Research Methodology in Chemical Sciences: Experimental and Theoretical Approaches by Tanmoy Chakraborty and Shounak Roy.
- Chemical Research: A Practical Guide for Undergraduates by Robert J. Ouellette and J. David Rawn.
- Research Methodology in Chemistry and Chemical Engineering by H. Panda.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1.	The distinctions between primary, secondary, and tertiary sources of information in the context of scientific research.	Theory class on Navigate and utilize digital resources including e-journals, databases, search engines, and academic websites.	Compile a comprehensive report summarizing the findings, including references from various sources such as databases, and textbooks.
2.	Importance of ethical considerations in scientific writing and avoid plagiarism.	Teaching will be done through lectures and discussion mode. Demonstrate the ability to justify the scientific contributions of their work and follow appropriate publication styles.	Write a scientific paper on a laboratory experiment or research project.
3.	Laboratory ventilation and storage requirements for hazardous substances. Apply procedures for working with gases at varying pressures and dispose of waste chemicals properly.	Implement safe working procedures and maintain a protective environment in a laboratory setting.	Class test focusing short and questions.
4.	Recognize the importance of data analysis in drawing meaningful conclusions from experiments.	Teaching will do through lectures and discussion mode. Make accurate measurements and record data effectively.	Analyse a set of experimental data using appropriate statistical methods.
5.	Identify and analyse typical circuits involving operational amplifiers used in electrochemical instruments.	Teaching will do through lectures and discussion mode. Apply electronic principles to enhance their understanding of scientific instrumentation	Document the circuit design, components used, and testing procedures.

MAJOR CORE COURSE-III

3SGCC503: Chemistry-V (Green Chemistry)

(Credits: Theory-2, Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SGCC503	Chemistry-V Green Chemistry	(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives: With the environmental concern and shrinking resources acquiring enormous proportions, it has become imperative to devise safer alternative materials and technology that would ensure the human sustenance. This course intends to take the students through the newer, environment friendly products and procedures and incite them to take a more holistic view of different chemical processes.

Course Learning Outcomes

- Explain the field of green chemistry.
- Acquire knowledge of the 12 principles of green chemistry.
- Develop an understanding of cleaner production and green synthesis methods.
- Acquire the knowledge catalysis, and microwave theory.
- Appreciate the Principle of Photochemical.

Syllabus Credits 2-0-2

Unit l

Definition and concepts: green chemistry; sustainable consumption of resources; individual and community level participation such as small-scale composting pits for biodegradable waste.

Unit II

Principles of Green Chemistry and Designing a Chemical synthesis. Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy).

Unit III

The Cleaner Production Concept, Difference with End of Pipe Concept, Cleaner Production and Sustainable Development, Implementation of Cleaner Production, Change of Raw Material, Technology Change, Good Operating Practice, Product Change, On Site Reuse and Recycling, Who Is Responsible for Cleaner Production, Government Rules, Green Synthesis of Nano Particles.

Unit IV

Green Chemical Strategies for Sustainable Development Areas of green chemistry, Reaction mass Balance-Atom Economy, Evaluation for Chemical Reaction Efficiency, Green Solvents/ reaction Media, Catalysis and Bio catalysis. Microwave oven as a reactor, Theory of Microwave Heating.

Unit V

Photochemical Degradation: An Eco-friendly Approach of Waste Treatment Photochemical Principles, Heterogeneous Photo-catalysis, Homogeneous Photo-degradation, photo oxidation, Direct Photo-degradation, Gas phase Detoxification, Equipments and applications.

Practical Credits 2

- Preparation of biodiesel from vegetable oil.
- Use of enzymes as catalysts Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide Alternative Green solvents
- Diels Alder reaction in water Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux.
- Extraction of D-limonene from orange peel using liquid CO2 prepared form drive.
- Mechanochemical solvent free synthesis of azomethines
- Co-crystal controlled solid state synthesis (C2S3) of N-organ phthalimide using phthalic anhydride and 3-aminobenzoic acid. Alternative sources of energy
- Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
- Photo reduction of benzophenone to benzo pinacol in the presence of sunlight.

Reference Books

- Anastas, P. T., Warner, J. Green Chemistry: Theory and Practice; Oxford University Press: London, 1998.
- Mukesh Doble, Anil Kumar Kruthiventi, in Green Chemistry and Engineering, 2007
- V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
- P.T. Anastes & J.K. Warmer: Oxford Green Chemistry- Theory and Practical, University Press (1998).
- A.S. Matlack: Introduction to Green Chemistry, Marcel Deckkar (2001).

Text Book

- Green Chemistry: Theory and Practice by Paul T. Anastas and John C. Warner.
- Introduction to Green Chemistry by Albert Matlack.
- Green Chemistry: An Introductory Text by Mike Lancaster.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Understand the foundational concepts of green chemistry, sustainable resource consumption, and the importance of individual and community participation.	Lectures introducing the concepts of green chemistry and sustainable resource consumption.	Quizzes or short answer questions to assess understanding of key concepts.
2	Demonstrate knowledge of the twelve principles of green chemistry and their application in designing environmentally friendly chemical synthesis.	In-depth lectures on each principle of green chemistry, with real-world examples.	Design projects or case studies where students apply green chemistry principles to develop environmentally friendly synthesis pathways.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
3	Understand the concepts of cleaner production, its relationship with sustainable development, and implementation strategies.	Interactive discussions on the differences between cleaner production and end-of-pipe approaches.	Research projects or presentations exploring cleaner production implementation in specific industries or contexts.
4	Gain knowledge of green chemical strategies and their role in sustainable development.	Hands-on laboratory experiments or simulations demonstrating green chemistry principles.	Written assignments or presentations on the role of green chemistry in specific sustainability challenges.
5	Understand the principles and applications of photochemical degradation in eco-friendly waste treatment	Lectures on photochemical degradation principles and various approaches to waste treatment.	Class test focusing on and long questions.

MINOR CORE COURSE

3SABM504: Zoology- V Aquatic Biology

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SABM504	Zoology- V Aquatic Biology	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Provide students with a fundamental understanding of the various types of aquatic ecosystems, including freshwater lakes, rivers, estuaries, oceans, and wetlands.
- Explore the diversity of aquatic organisms, including microorganisms, plants, invertebrates, and vertebrates, and their adaptations to aquatic environments.
- Examine the physical and chemical properties of aquatic environments, including water quality, nutrient cycling, and the impact of human activities on aquatic chemistry.
- Study the structure and dynamics of aquatic food webs, including trophic interactions among organisms and energy flow through ecosystems.

Course Learning Outcome

- The student has a knowledge of aquatic organisms, ecosystem understanding, water quality assessment, conservation and management, research skill etc.
- To inculcate basic knowledge on marine ecosystem and its importance.
- Create awareness on the ecology, biology and biodiversity of various marine organisms.
- Prepare a biologist to specialize on marine biology.

Syllabus Credits: 2-0-2

UNIT I:

Aquatic Biomes

Aquatic Biomes Brief introduction of the aquatic biomes, Freshwater ecosystem; lakes, wetlands, streams and rivers, estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT II:

Fresh Water Biota

Freshwater Biology Lake; Origin and classification, Lake Ecosystem, Lake morphometry, Physio–chemical Characteristics; Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases, Oxygen, Carbon dioxide.

UNIT III:

Lotic and Lectic Biota

Nutrient Cycles in Lakes; Nitrogen, Sulphur and Phosphorous, Streams; Different stages of stream development, physio-chemical environment, Adaptation of hill-stream fishes.

UNIT IV:

Marine Water Biota

Marine Biology Salinity and density of Sea water, Continental shelf, Adaptations of deep-sea organisms, Coral reefs; Biodiversity, Discuss the high biodiversity found in coral reefs and the importance of this ecosystem, Coral Bleaching, Conservation Efforts Sea weeds.

UNIT V:

Aquatic Pollution

Management of Aquatic Resources Causes of pollution; Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation legislations, Sewage treatment Water quality assessment; BOD and COD.

Practical Content **Credits: 2**

- Study of museum specimen of fresh water edible fishes.
- Study of pH of water and soil.
- Study of paper chromatography.
- Study of working instrument microtome.
- Maintenance of aquarium.
- Aquatic pollution and fisheries.
- Aquatic pollution and toxicology.

Text Book

- Aquaculture Science by Rick Parker,3rd edition.
- Aquaculture farming aquatic animal and plants ,3rd Edition by John S. Lucas, Paul C. Southgate and craig, Wiley Blackwell.
- Bioresources Ecology by Anathakrishnan 3rd Edition.
- Limnology by Goldman 2nd Edition.
- Fundamentals of Ecology by Odum and Barrett 5th Edition.

Reference book:

- Introduction to Wildlife Management, by P.R. Krausman, Prentice Hall Pearson Educ. Inc. New Jersey.
- Genetics: A Conceptual Approach by Benjamin A. Pierce.
- Wildlife Management by R.H. Giles.
- Wildlife Ecology and Management by W.L. Robinson and E.G. Bolen. Mc. Millan Publications Comp. New York.
- Managing Protected Areas in Tropics by J.K. Mackinnon, Natraj Publications Dehradun.
- Environmental Impact Assessment and Management, Ed. B.B. Hosetti and A. Kumar, Daya Publishing House, Delhi.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Start with your high school biology curriculum. It will introduce you to the basics of ecosystems, which are fundamental to understanding aquatic biomes.	Setup a classroom aquarium with a small ecosystem of aquatic plants and animals found in your local aquatic biome (e.g., freshwater or marine). Students can observe and learn about interactions among organisms and the environment.	Class test focusing and short questions.

2	Students should be able to identify and classify common organisms found in lake ecosystems, including fish, invertebrates, phytoplankton, and zooplankton.	Organize fish identification sessions using preserved specimens or images. Additionally, conduct fish dissections to study their anatomy and adaptations.	Class test focusing on definitions and short questions.
3	Understand the major nutrients involved in lake ecosystems, including carbon, nitrogen, phosphorus, and sulphur.	Organize a field trip to a local lake or pond. Provide students with water sampling kits to collect water and sediment samples. Back in the classroom, they can analyse these samples for nutrient content and water quality parameters.	Class test focusing on definitions and short and long questions.
4	Understand the anatomical and physiological adaptations of marine organisms for life in the ocean, such as gills, buoyancy mechanisms, and osmoregulation.	Organize a field trip to a local aquarium or marine research centre. Students can observe marine organisms up close and learn about their adaptations and behaviours.	Class test focusing on and short and long questions.
5	Understand the methods and techniques used to assess the quality and quantity of aquatic resources, including water bodies, fisheries, and aquatic ecosystems.	Conduct water quality assessments in a local water body. Students can measure parameters like pH, turbidity, dissolved oxygen, and nutrient levels. Discuss the implications for resource management.	Class test focusing on and long questions.

MINOR CORE COURSE

3SIBM504: Botany-V (Industrial Botany)

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SIBM504	Botany-V (Industrial Botany)	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- This course will provide knowledge on plants and their parts used in various industries.
- Students will get an idea to establish plants based natural product industry.
- This course will make the students self-reliant.
- Understand the historical development and significances of industrial botany in modern agriculture and industries.

Course Learning Outcomes

- Students will know about concept of diseases, knowledge and awareness of diseases, causal agents of plant diseases, identification methods and management of crop diseases.
- Students will understand the historical development and significance of industrial botany in agriculture and various industries
- Ability to articulate and apply fundamental terminology and concepts in industrial botany.
- Demonstrate a comprehensive understanding of plant physiological processes and their practical applications in industrial crop production.
- Apply knowledge to analyze and solve problems related to plant physiology in an industrial context.

Syllabus **Credits: 2:0:2**

UNIT-I

Plant in Timber Industry: Timber yielding trees of India, - Importance of timber or products of timber structure of wood porous and non-porous of wood, Physical Properties of wood preservation, Types of wood and their products. (*Shisham*, *Sal*, *Teak*, *Deodar*, *Babool*) Bamboo and cane industry-Bamboos in India properties of bamboo cultivation, Utilization of bamboo.

Kattha Industry- Industry profile and market opportunities manufacturing process raw material availability advantages and disadvantages of *Kattha*.

UNIT-II

Leaf Based Industries: Utility products of leaf- Botanical characters and use (*Palash*, Banana).

Tea Industry-Origin, distribution botanical characters, cultivation processing of tea production, others types of tea, special types of Indian tea.

Leaf oil Industry- Essential or volaille oils (Mint, Camphor, *Neem*, *Tulsi*, Eucalyptus and Lemon grass).

Leaves used as spices-Cultivation of different types of leaves (*Kasoori Methi*, *Pudina, curry patta*, onion, *tejpatta*).

UNIT-III

Flower Based Industries: Perfume products of flowers – Perfume industry of India rose- Characters importance of rose extraction of rose oil and uses Jasmine. - Characters, Cultivation, Extraction of jasmine oil. Heena - Characters, Cultivation, making of henna oil, and uses.

Colour Industry- Aims of food coloring history and types of food colours side effects of artificial food colours food colour industry of India. Holi colours – preparation of natural colours of holi, Holi colour industry of India.

Raw material for fermentation- Fermentation types of fermentation types of fermentation *Mahua- mahua* as a raw material for fermentation, fermentation process of *mahua* flowers and uses of *mahua*.

UNIT-IV

Fruits and Seed Based Industries: Preparation and methods - Jams, Jellies, Juice, Souce and Pickles and scope of business of fruit and vegetable.

Poha and *Daal* Industries- *Poha* industry production technique of *poha*, Processing methods of flaked rice. health benefits of *poha*: *Poha* industry in MP. *Dal* Industry- Production process of *Dal*.

Edible oil industry- Types of oil commonly used in India process of manufacturing edible oil Groundnut, and *Soyabean,* Starch, Glucose, and Dextrose Industry- Starch industry – getting starch from *maize* importance of starch Indian starch industry Glucose- Production of glucose, applications of glucose Indian glucose industry Dextrose – uses of dextrose production and Indian dextrose industry.

UNIT- V

Other part of plants-based Industries: Sugar and Jaggery Industries- Sugar industry, bio- ethanol sugar production of India, manufacturing process of sugar in India types of sugar. Jaggery industry- types of jaggery, processing of jaggery benefit of jaggery.

Jute and *Agarbatti* stick making Industry. - *Jute* industry, history of *jute* industry in India used of *jute Agarbatti*- *Agarbatti* making business in India, manufacturing process of *Agarbatti* production of *Agarbatti*, future of *Agarbatti* industry in India Project proposal preparation for Establishment of an Industry. Grants and Funding provider organizations of India – India grants PMMY (*Pradhan Mantri Mudra yojana*) RKVY (*Rastriya Krishi Vikash yojana*) SIDBI Fund and scheme.

Practical Content **Credits: 2**

- Preparation of *Holi* colours from locally available flowers.
- Perfume extraction process by distillation method.
- Preparation and preservation techniques of jams, jellies and prickles.
- Extraction and preservation of juices. (lemon and orange etc.)
- Preparation of different types of teas. (*Tulsi* tea, lemon tea etc.)
- Identification, collection and extraction of oil yielding leaves.
- Hands on training for preparation of *Douna* and *Pattal* using *Palash* and Banana leaves.

Reference Book

- Gerald E Wickens (Auth.)- Economic Botany Principles and Practice Kliver academic publishers 2001.
- Kocchar S.L.- Economic Botany Cambridge University Press U.K. 2016.
- Industrial Botany – Prof. Dr. Khan Mahfouz Raza and Prof. Dr. R.D. Joseph and Dr. Smita Krishnarao Kadwe.

Text Book

- Industrial and Commodity Uses of Tropical Plants by- R.H.M.J. Lemmens.
- Industrial Plant Biology by- Randhir. Singh. and Sudhir. P. Singh. and Bhavna Kaushik.
- Industrial Crop Production by- Sant. S. Virmani. and A. A. Sie.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Understand the environmental impact of timber harvesting and processing and explore sustainable forestry practices.	Instructor-led lectures to provide theoretical knowledge about the timber industry, tree identification, and forest management principles. Engage students in discussions to explore key concepts and stimulate critical thinking.	Class test focusing and short questions.
2	Students should develop a comprehensive understanding of industries that rely on leaves as a primary resource. This includes industries like tea, tobacco, herbal medicine, and natural products.	Traditional lectures can provide a foundational understanding of the subject matter. Instructors can use multimedia presentations, guest speakers from the industry, and case studies to make the lectures engaging.	Class test focusing on long and short questions.
3	Understand the processes involved in handling and preserving flowers, including techniques to extend shelf life and maintain product quality.	Organize hands-on floral design workshops where students can learn and practice various floral arranging techniques. This can include creating bouquets, centrepieces, wreaths, and other floral arrangements.	Class test focusing short and questions.
4	Develop a comprehensive understanding of industries that rely on fruits and seeds as key resources, including agriculture, food processing, beverage production, seed production, and nut processing.	organize visits to fruit orchards, seed farms, and agricultural fields to give students firsthand exposure to cultivation practices and production processes.	Class test focusing on and short questions.
5	Students will develop a comprehensive understanding of the various parts of plants, including roots, stems, leaves, flowers, and non-food parts like fibres, extracts, and resins, and their potential industrial applications.	Analyse real-world case studies of companies and industries that utilize plant-based resources. This helps students apply theoretical knowledge to practical scenarios and understand the challenges and opportunities in these sectors.	Class test focusing on and long questions.

MINOR CORE COURSE

3SRMM504: Chemistry-V (Research Methodology for Chemistry)

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SRMM504	Chemistry-V (Research Methodology for Chemistry)	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

The objective of this paper is to formulate the research problems and connect the research outcomes to the society. Student should be able to assess the local resources and opportunities in public domains. It further helps in gaining the knowledge of safety and ethical handlings of chemicals in lab and households.

Course Learning Outcomes

By the end of the course, the students will be able to

- Learn how to identify research problems.
- Evaluate local resources and need for addressing the research problem
- Find out local solution.
- Know how to communicate the research findings.

Syllabus

Credits: 2-0-2

UNIT-I

Literature Survey

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, Chem. Industry, Wiki- Databases, ChemSpider, Science Direct, Scopus.

Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information. Open-source Lead lectures. Open-source chemistry designing sources, Essentials of Problem formulation and communication with society.

UNIT-II

Methods of Scientific Research and Writing Scientific Papers

Reporting practical and project work. Idea about public funding agencies of research, Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific

contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism. Assessment of locally available resources.

UNIT-III

Chemical Safety and Ethical Handling of Chemicals

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric level. Safe storage and disposal of waste chemicals. Recovery, recycling and reuse of laboratory chemicals. Procedure for laboratory disposal of explosives. Identification, verification and segregation of laboratory waste. Disposal of chemicals in the sanitary sewer system. Incineration and transportation of hazardous chemicals.

UNIT-IV

Data Analysis

The Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, r and its abuse. Basic aspects of multiple linear regression analysis.

Biostatistics: brief introduction and data handling

UNIT-V

Electronics

Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

Practical Credits :2

- Ethical handlings of chemicals in the lab and households.
- Methods of Scientific Research and Writing Scientific Papers: Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display.
- Chemical Safety and Ethical Handling of Chemicals: Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation.
- Data Analysis the Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.

Reference Books

- Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. and Jones, A. (2011) Practical skills in chemistry. 2nd Ed. Prentice-Hall, Harlow.
- Hibbert, D. B. and Gooding, J. J. (2006) Data analysis for chemistry. Oxford University Press.
- Topping, J. (1984) Errors of observation and their treatment. Fourth Ed., Chapman Hall, London.
- Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, how to use Excel in analytical chemistry and in general scientific data analysis. Cambridge Univ. Press (2001) 487 pages.
- Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.

Text Book

- Research Methodology in Chemical Sciences: Experimental and Theoretical Approaches by Tanmoy Chakraborty and Shounak Roy.
- Chemical Research: A Practical Guide for Undergraduates by Robert J. Ouellette and J. David Rawn.
- Research Methodology in Chemistry and Chemical Engineering by H. Panda.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1.	The distinctions between primary, secondary, and tertiary sources of information in the context of scientific research.	Theory class on Navigate and utilize digital resources including e-journals, databases, search engines, and academic websites.	Compile a comprehensive report summarizing the findings, including references from various sources such as databases, and textbooks.
2.	Importance of ethical considerations in scientific writing and avoid plagiarism.	Teaching will be done through lectures and discussion mode. Demonstrate the ability to justify the scientific contributions of their work and follow appropriate publication styles.	Write a scientific paper on a laboratory experiment or research project.
3.	Laboratory ventilation and storage requirements for hazardous substances. Apply procedures for working with gases at varying pressures and dispose of waste chemicals properly.	Implement safe working procedures and maintain a protective environment in a laboratory setting.	Class test focusing short and questions.
4.	Recognize the importance of data analysis in drawing meaningful conclusions from experiments.	Teaching will do through lectures and discussion mode. Make accurate measurements and record data effectively.	Analyse a set of experimental data using appropriate statistical methods.
5.	Identify and analyse typical circuits involving operational amplifiers used in electrochemical instruments.	Teaching will do through lectures and discussion mode. Apply electronic principles to enhance their understanding of scientific instrumentation	Document the circuit design, components used, and testing procedures.

Skill Enhancement Course

3SAFS505: Aquarium Fish Keeping

(Credits: Theory- 0, Tutorial-1, Practical- 1)

Scheme of Examination

Course Code	Course Name	Credits	Maximum marks Allotted						Duration of Exam.	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign.	End Sem	Term work			
3SAFS505	Aquarium Fish Keeping	1(0-1-1)	-	-	-	60	40	100	-	2 hr

Course Objective

- Understand the basics of aquarium fish keeping as a hobby and its historical significance.
- Explore the diverse range of aquatic life that can be kept in aquariums.
- Learn about different types of aquariums, including freshwater, saltwater, and planted tanks.
- Understand the essential components of an aquarium setup, such as tanks, filters, lighting, and heating systems.
- Gain knowledge of water chemistry and its importance in maintaining a healthy aquarium ecosystem.
- Learn how to test and regulate parameters like pH, ammonia, nitrite, nitrate, and hardness.

Course Learning Outcomes

- Identify different types of aquariums, including freshwater, saltwater, and planted tanks.
- List the essential components required for setting up an aquarium.
- Define the key concepts and terminology related to aquarium fish keeping.
- Explain the historical significance and modern-day relevance of the hobby.

Syllabus: **(Credits 2)**

Unit: 1

Introduction of Aquarium Fish Keeping, The potential scope of Aquarium Fish, Industry; Cottage Industry, Exotic and Endemic species of Aquarium Fishes.

Unit: 2

Biology of Aquarium Fishes, Common characters and sexual dimorphism of Fresh water and Marine water, Aquarium fishes; Guppy, Molly, Sword tail, Gold fish, Angel fish, blue morph, Anemone fish and Butterfly fish.

Unit: 3

Food and feeding of Aquarium fishes, Use of live fish feed organisms, Preparation and composition of formulated fish feeds, ornamental fishes and plants.

Unit: 4

Fish Transportation, Live fish transport, Fish handling, packing and forwarding techniques, ornamental equipment.

Unit: 5

Maintenance of Aquarium, Marketing, General Aquarium maintenance; budget for setting aquarium, Aquarium Fish Farm; Cottage Industry.

Practical: **Credit: 1**

- Introduction to Aquarium accessories and equipment's.
- Identification of ornamental fishes.
- Acclimatization of fish.
- Preparation of formulated fish feed.
- Identification of ornamental fish diseases and prophylactic measures.
- Identification of common Aquarium fishes.
- Identification of live feed organisms.
- Study of different types of formulated feeds.
- Preparation of formulated feed.
- Study of slides of parasites and diseases.
- Setting up of an aquarium.

Text Book

- The Complete Manual of Tropical Fish by Peter W. Scott.
- The New Marine Aquarium by Michael S. Paletta.
- Aquarium Plants by Christel Kasselmann.
- The Simple Guide to Freshwater Aquariums by David E. Boruchowitz.

Reference Books

- The New Marine Aquarium by Michael S. Paletta.
- The Conscientious Marine Aquarist by Robert M. Fenner.
- The Marine Aquarium Handbook: Beginner to Breeder by Martin A. Moe.

Facilitating the achievement of course learning objectives

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
1	• Explain the concept of a cottage industry and its relevance to aquarium fish keeping. • Assess the potential scope and economic opportunities of the aquarium fish industry at the cottage level.	• Start the course with a discussion on the history and cultural significance of aquarium fish keeping. Encourage students to share their experiences and interests in the hobby. Use this discussion to set the context for the course.	• Class text and short and long questions.
2	• Identify and describe the common anatomical and physiological characteristics shared by freshwater aquarium fishes. • Explain how these characteristics adapt them to life in freshwater ecosystems.	• Begin with a classroom lecture highlighting the key differences between freshwater and marine fish in terms of anatomy, physiology, and adaptations. Use images and diagrams to illustrate these differences. Discuss how these adaptations relate to their respective environments.	• Class text and short and long questions.

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
3	• Identify common live fish feed organisms, including daphnia, brine shrimp, and microworks. • Understand the nutritional value and benefits of using live feed organisms in aquariums.	• Assign students to conduct feeding observations of aquarium fish over a period of time. Have them record feeding behaviors, feeding frequencies, and any changes in fish health or behavior? Use the data collected to discuss optimal feeding practices.	• Class text and short questions and definitions.
4	• Explain the importance of safe and efficient live fish transportation in the aquaculture and aquarium industries. • Understand the unique requirements and challenges associated with transporting live fish.	• Begin with a demonstration on proper fish handling techniques. Show students how to approach, catch, and handle fish with minimal stress. Discuss the importance of gentle handling to prevent injuries and reduce stress during transportation.	• Class text and short and long questions.
5	• Understand the basic principles of aquarium maintenance, including water quality, filtration, and temperature control. • Learn the importance of regular maintenance routines in sustaining a healthy aquarium ecosystem.	• Set up a laboratory session where students learn to use water testing kits to measure parameters like pH, ammonia, nitrites, and nitrates. Analyze water samples from different aquarium setups and discuss how to interpret the results.	• Class text and short and long questions.

RAMANUJAN SCHOOL OF SCIENCE

BACHLOR OF SCIENCE

(Chemistry, Biology, Zoology)

(B. Sc. (CBZ) – CKUG04B03)

VI Semester

MAJOR CORE COURSE-I

3SEBC603: Zoology – VI (Environmental Biology and Evolution)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SEBC603	Zoology – VI (Environmental Biology and Evolution)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- This paper is aimed to introduce Ecology, Origin of life and evolution, Paleontology and distribution.
- To create and disseminate knowledge to the students about environmental problems at local, regional and global scale.
- To provide practical training on modern instrumentation and analytical techniques for environmental analyses.
- To sensitize students towards environmental concerns, issues, and impacts of climate change and related mitigation strategies.
- To make the students to apply their knowledge for efficient environmental decision-making, management and sustainable development.

Course Learning Outcomes

- Students have knowledge about environmental awareness, conservation knowledge, sustainable practice, environmental ethics etc.
- Students will be able to understand the Environmental Impact Assessment (EIA) process and stages, as well as how it is applied to specific areas such as landscape and visual impact assessment, ecology, soils, and climate change, among others.
- Student will understand they will have gained an awareness of the function of Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) in development project decision making, as well as the ability to assess and appraise the EIA process.

Syllabus Credits 4-0-2

UNIT–I:

Concept of Ecology

Abiotic and Biotic Factors, Energy flow in ecosystem, Food chain and Food web, Biogeochemical cycle; CO_2, N and P, Population Concept; Characteristics of population, Factors affecting population growth, Community Concept; Succession, Periodicity, Indicators.

UNIT–II:

Habitat Ecology

Fresh water habitat; Factors and classification, Marine habitat; Factors and classification, Terrestrial habitat; Factors and classification, Ecological divisions of India, Natural resources and their Conservation with forests.

UNIT–III:

Man, and Environment

Wild life conservation; Laws, National Parks and Sanctuaries of MP, Environmental degradation and pollution, Thermal and Noise pollution, Radiation Ecology, Global Warming and Green House Effect, Urbanization and effect of human population on environment.

UNIT–IV

Origin of life and evolution

Origin of life; modern concept, Lamarckism, Darwinism Modern Synthetic theory, Variations, Mutations, Isolation and Speciation, Adaptations and Mimicry, Micro, macro and Meta-evolution.

UNIT–V

Paleontology and distribution

Fossils, Methods of fossilization, Determination of age of Fossils, Study of Extinct forms; Dinosaurs and Archaeopteryx, Zoogeographical distribution of animals, Evolution of man.

Practical Content — Credits 2

- Study the impact of environmental pollution on the evolution of a specific species.
- Investigate how pollution affect their behavior reproductive success and genetic change our time.
- Exploring the adaptive traits of organisms in the response to climate change analyzing how certain species have evolved to survive and thrive in changing environment.
- Water analysis; Comparative water quality analysis of lentic and lotic water bodies, Ground water quality analysis.
- Study of quantitative and qualitative analysis of aquatic vegetation.
- Productivity of water bodies.

Text book

- A textbook of Cell biology, Genetics, Molecular biology, evolution and Ecology, P. S. Verma and V.K. Agarwal, S. Chand. Publication.
- Fundamental of Ecology, Dr. Sat guru Prasad., Emkey Publications.
- The annotated origin, Charles Darwin, annotated by James T. COSTA.
- Evolution What the fossils Say and Why it matters, Donald R. Rrothero, 2nd Edi.

Reference Book

- IPCC (Intergovernmental panel on Climate Change). 1990.
- Climate change: The IPCC Assessment. Cambridge University Press, Cambridge.
- IPCC (Intergovernmental panel on Climate Change). 1995.
- Climate change: The science of climate change. Houghton, J.T., Maria Filho, L.G., Callender, B.A.

- IPCC (Intergovernmental panel in Climate change). 2001. Climate change: the scientific basis. Third Assessment Report. Cambridge University Press, Cambridge.
- Conservation and evolution; O.H. Frankel and E.S. Michaele, Camb. University Press.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Define ecology and its significance in the field of zoology. Explain the levels of ecological organization, from individuals to ecosystems. Describe the key ecological concepts, such as populations, communities, and habitats.	Start with introductory lectures to provide a foundation for ecological concepts. Encourage class discussions to explore topics in-depth, allowing students to ask questions and share their perspectives.	Class test focusing and short questions.
2	Define the concept of a habitat and distinguish between different types of habitats (e.g. terrestrial, aquatic, forest, desert, and urban habitats). Identify key characteristics that define specific habitats.	Teach students how to create habitat maps using GIS (Geographic Information Systems) or simple hand-drawn maps. Ask them to classify and label different habitat types and their boundaries.	Class test focusing on and short questions.
3	Describe the various ways in which human activities affect the environment, including habitat destruction, pollution, climate change, and overexploitation of natural resources.	Initiate class discussions on topics such as habitat destruction, pollution, climate change, and wildlife conservation. Encourage students to express their opinions and engage in debates.	Class test focusing short and questions.
4	Understand the concept of abiogenesis (the emergence of life from non-living matter) and its historical significance.	Students have created a timeline depicting key milestones in the history of life on Earth, including the emergence of life from non-living matter.	Class test focusing on and short questions.
5	Define the field of palaeontology and its significance in understanding Earth's history. Explain how fossils provide insights into past life forms and environments.	Organize a field trip to a fossil-rich area where students can collect and document fossils. Instruct them on proper fossil collection techniques and safety measures.	Class test focusing on and long questions.

MAJOR CORE COURSE-II

3SAQC603: Zoology - VI (Aquaculture)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SAQC603	Zoology - VI (Aquaculture)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objective

- This paper is aimed to introduce fresh water Prawn, Fish Pearl Culture and some other culture method.
- This paper aimed to understand the concepts of Aquatic Ecosystems.
- This paper aimed to understand the Characteristics of water and dynamics of Aquatic ecosystem.
- This paper aimed to understand the Aquatic vegetation.
- Energy transfer in the ecosystem.

Course Learning Outcome

- The student has a knowledge of different culture skill to develop own Business, marketing and self-employment.
- Apply knowledge in Aquatic Ecology and ecosystem to understand the physical and chemical characteristics of water constituents their physio chemical and functional properties.
- To assess organic matter and recognize various biogeochemical cycles. Determine the dynamics of aquatic ecosystem and productivity.
- Identify and understand different types of fishes and fin fish anatomy related to classification of commercially important crustaceans and mollusks up to sub class level and their salient features and distribution.
- Apply knowledge on shell fish anatomy and examine identification and morphology of cultivable organisms.
- Design supplementary feeds applying the principles of food and feeding habits and nutrition to meet the challenges of nutritional problems.
- Describe fertilization and liming in aquaculture ponds, dynamics of dissolved oxygen, aeration and miscellaneous treatments to increase the production. Determination and estimation of total proteins, carbohydrates and 8 lipids in aquatic feeds.

Syllabus **Credits :4-0-2**

UNIT – I

Aquaculture

Aquaculture; 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, cage culture, raft culture, race way culture, culture in circulatory systems. Warm water and cold-water aquaculture, sewage – fed fish culture, integrated fish farming. Abiotic and biotic factors of water necessary for fish life.

UNIT – II

Aquaculture Design and Construction

Aquaculture engineering; Design and construction of pond, layout and design of aquaculture farm, construction, water intake system, drainage system; Aeration and Aerators, Recent advances in aquaculture engineering; tips for better aquaculture practices, design and construction of hatcheries, Hydrology of pond; Types of ponds, sources of water precipitation, direct run off, stream inflow, ground water inflow, regulated inflow. losses of water– evaporation, seepage, outflow, consumptive use, water budgets of embankment ponds, water budget of an excavated pond, water exchange.

UNIT – III

Management and Stock

Selection of species biological characteristics of aquaculture species, economic and market considerations; seed resources, collection and transportation, 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. Fish breeding in natural conditions. Transport of live fish and seed.

UNIT – IV

Fresh Water Preservation

Fresh water fish farm; different types of fish ponds preservation and processing by products of fish Industry. Fish; Induced breeding, hypo-physation of Indian, Major carps; types of hatcheries Hapa, Jar hatchery, circular hatchery, Modern Indian hatchery system, Fresh water prawn; Identification of post larval stages, brood stock management, breeding, Hatchery management, larval rearing, Fresh water pearl culture; Definition and scope, origin of pearls, pearl producing, freshwater pearl culture in the World and in India, Types of pearls; mantle cavity insertion, mantle tissue insertion, gonadal insertion.

UNIT – V

Aquatic Pollution

Water pollution and its effects on fisheries and their control, Common fish diseases and their control, Biochemical composition and nutritional value of fish, Cultivable species of fishes in India, Water quality management.

Practical Content — Credits 2

- Study of Fresh water, Marine and Terrestrial Fauna.
- Water analysis – Oxygen, Chloride.
- Pond ecosystem.
- Study of specimen of fresh water fishes.
- Study of slide preparation from fish scale.

Text Book

- Aquaculture Farming Aquatic Animals and Plants by John S. Lucas and Paul C. Southgate.
- Aquaculture Principles and Practices by T. V. R. Pillay and M. N. Kutty.
- Aquaculture An Introductory Text by Robert R. Stickney.
- Aquaculture and Fisheries Biotechnology Genetic Approaches by Rex A. Dunham.

Reference Book

- Aquaculture Principles and Practices. The Fishing News Books by Pillay.
- Freshwater Aquaculture. Scientific Publishers (India) Jodhpur. Rath, R. K. 2000.
- Fisheries and Aquaculture. Lahari Publications. Hyderabad. Piska, R. S. 1999.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Define aquaculture and explain its importance in global food production. Describe the history and evolution of aquaculture practices. Differentiate between various aquaculture systems, such as pond, cage, and recirculating systems.	Traditional lectures can introduce key concepts and theories in aquaculture. Follow-up discussions allow students to ask questions and clarify their understanding.	Class test focusing on and short questions.
2	Understand the nutritional requirements of various fish species at different life stages. Demonstrate knowledge of fish feed formulation, preparation, and feeding strategies.	Organize hands-on laboratory experiments related to water quality analysis, fish health assessment, and feed formulation. Provide opportunities for students to gain practical skills.	Class test focusing on and short questions.
3	Understand the critical role of parental care or natural conditions in larval and juvenile fish survival. Describe the transition from yolk sac dependence to independent feeding.	Conduct hands-on sessions where students learn to identify local fish species and observe their breeding behaviours. Use underwater cameras or snorkelling to document fish behaviour.	Class test focusing on short and questions.
4	Define freshwater fish farming and its significance in food production and aquaculture. Explain the history and evolution of freshwater fish farming practices.	Conduct feeding trials with various fish species. Assign students to formulate fish feeds and calculate feed conversion ratios.	Class test focusing on and short questions.
5	Define water pollution and its various sources, including point and non-point sources. Describe the environmental and ecological implications of water pollution.	Analyse case studies of notable water pollution incidents (e.g., oil spills, industrial discharges) and their impacts on aquatic life. Encourage students to discuss and propose solutions based on the cases.	Class test focusing on and long questions.

MAJOR CORE COURSE-III

3SEZC603: Zoology-VI Economic Zoology

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SEZC603	Zoology-VI Economic Zoology	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objective

- This paper is aimed to introduce Pearl Culture, Lac Culture, Sericulture and Poultry keeping. Protozoa, rats, mites, insect diseases and control.
- Provide students with an overview of the field of economic zoology, its historical development, and its importance in contemporary society.
- Explore the role of animals in agriculture, including livestock production, animal husbandry practices, and their impact on food security.
- Study economically important insects, their biology, behavior, and their effects on crops, stored products, and public health.
- Examine beekeeping and silkworm culture, including the economic value of honey, beeswax, and silk production.

Course Learning Outcome

- The student has a knowledge of different culture Skill and diseases and their control to develop own Business, marketing and self-employment.
- Recognize animals that have significant economic value in various sectors, including agriculture, aquaculture, and industry.
- Evaluate the economic impact of animals on human society, agriculture, and public health.
- Analyze and propose strategies for managing economically important pests, including insect pests and disease vectors.
- Assess the sustainability of practices related to animal agriculture, fisheries, and wildlife conservation.

Syllabus Credits 2-0-2

UNIT – I:

Diseases and Control

Protozoa and human diseases, House hold insect, Mites and their control, Insect traps and biological control agents.

UNIT – II

Toxicity

Toxicology; Basic concepts and definition, Heavy metal toxicity; Pb, Cd, Hg, Toxicity testing; LC 50, LD 50, acute and chronic toxicity, Pesticide and their toxicological effect.

UNIT – III:

Pesticides

Chemical control of pest, Natural control of pest, Physical control of pest, biological control of insect pests, Insecticides and insect resistance, biological control of insect pests, Insect pests of some crops of economic importance.

UNIT – IV:

Economical Keeping

Economic importance of mammals, Poultry keeping, Rats and their control, Economic importance of Mammals; Piggery, Dairy industry, Leather, wool and Fur industry.

UNIT – V:

Culture

Pearl culture
Sericulture
Lac culture
Apiculture.

Practical Content **Credits: 2**

- Study of Life cycle of Silk worm.
- Study of Bee culture.
- Study of pests-Stored grain pests- *Sitophilus Oryza* and *Tribolium Castanaeum.*
- Study of Vegetable pests- *Pieris brassicae* and *Dacuscucurbitae*
- Study of Plankton – *Euglena, Paramecium, Cyclops, Mysis, Daphnia*.
- Study of Protozoa and diseases.

Text Book

- Economic Zoology by Shukla and Upadhyay.
- Economic Zoology by Dr. P.C. Kotpal.
- Economic Zoology a Systematic Study of Animals and Their Importance by R.L. Kotpal.
- Insects and Human Society by Brian Morris.
- Aquaculture: Principles and Practices by T. V. R. Pilla.

Reference Book

- The science of climate change by Houghton, J.T., Maria Filho, L.G., Callender.
- Economic environmental change by Harris, N., Katten berg and Maskell, UK.
- Global environmental factors by McCarthy, J.J., Brewer, P.G. and Feldman. Global Ocean Flux.
- Conservation and evolution by Frankel and E.S. Michaele, Camb. University Press.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching And Learning Activities	Assessment Tasks
1	Students should be able to identify different types of protozoa, both pathogenic and non-pathogenic, and classify them into relevant groups based on characteristics like morphology, locomotion, and life cycle.	Analyse real-life case studies of protozoan diseases, such as malaria outbreaks in different regions. Discuss the epidemiology, symptoms, and treatment strategies.	Class test focusing on and short questions.
2	Understand and recognize common sources of toxins, including natural toxins (e.g., plant toxins, venom), environmental pollutants (e.g., heavy metals, pesticides), and synthetic chemicals (e.g., drugs, industrial chemicals).	Start with a lecture that provides an overview of toxicology and its relevance in zoology. Discuss key concepts such as toxicity, dose-response relationships, and different types of toxins. Engage students with case studies and real-world examples of toxins affecting animals.	Class test focusing on and short questions.
3	Explain the principles of chemical pest control, including the modes of action of common pesticides. Describe the concept of natural pest control and identify various natural predators, parasites, and pathogens of pests. Analyse case studies and real-world examples of successful biological pest control programs.	Start with a lecture explaining the principles of chemical pest control, types of pesticides, and their modes of action. conduct field trips to study natural predator-prey interactions. Students can observe and document beneficial organisms in action.	Class test focusing on short and questions.
4	Understand the key functions of mammalian organ systems, including circulatory, respiratory, digestive, and reproductive systems.	Provide an introductory lecture on mammalian diversity, and encourage class discussions about the vast range of mammalian species.	Class test focusing on and short questions.
5	Explain the biological processes involved in pearl formation in molluscs, with a focus on the role of pearls in the animals defines mechanism. Understand the life cycle and biology of silk producing insects, primarily the silkworm *(Bombyx mori).*	Organize a field trip to a pearl farm where students can witness pearl cultivation techniques first-hand. They can observe pearl *oysters* or mussels, nucleus insertion, and pearl harvesting. Assign students the task of rearing silkworms from egg to cocoon, providing insights into the life cycle and biology of silk-producing insects.	Class test focusing on and long questions.

MAJOR CORE COURSE-I

3SPEC603: Botany-VI (Plant Ecology, Biodiversity and Phytogeography)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SPEC603	Botany-VI (Plant Ecology, Biodiversity and Phytogeography)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- To examine the role that biotic and abiotic factors play in ecological biogeography.
- To gain an appreciation of Earth's geological history and understand the role of historical biogeography in interpreting plant distributions.
- To investigate the relationship between systematics and biogeography. (phyllo geography)
- To review major features of contemporary plant distributions with emphasis on hot- spots, endemics, and islands.
- To understand the role that glaciation has played in plant distributions.
- To examine pattern and process in bent hic marine algal distributions with a focus on kelp.

Course Learning Outcomes

- Distinguish between ecological versus historical biogeography.
- Recognize patterns and hypothesize underlying process.
- Summarize the five areas that have resulted in a renaissance in biogeography.
- Describe the 3 major biogeographic patterns and illustrate them with significant plant genera.
- Compare long-distance dispersal vs vicariance as mechanisms for disjunct distributions.

Syllabus Credits: 4-0-2

UNIT – I

Ecosystems: Structure and types, Biotic and Abiotic components, Trophic levels, Food chain, Food Web. Ecological pyramids. Energy flow, Concept of Biogeochemical cycles: Gaseous liquid and Sedimentary cycles: Carbon, Nitrogen, Water, Phosphorus and Sulfur cycle.

UNIT – II

Ecological Adaptations: Morphological, Anatomical and Physiological responses water adaptation (Hydrophytes, Xerophytes and Mesophytes) Temperature adaptation (Thermoperiodism and Vernalization), Light adaptation (Heliophytes and Sciophytes), Photoperiodism. Plant Succession: Causes, Trends and processes, Types of succession - Hydrosere and Xerosere.

UNIT – III

Biodiversity & Population Ecology: Distribution patterns, Density, Natality, Mortality, Growth curves, Ecotypes and Ecads: Community Ecology; Frequency, Density, Abundance, Cover and life forms. Biodiversity: Basic concept, Definition, Importance, Biodiversity of India, Hotspots, in situ and ex situ conservation, Biosphere Reserves. Sanctuaries and National Parks of Madhya Pradesh. Endangered and threatened species, red data book.

UNIT – IV

Soil and pollution: Physical and chemical properties, Soil formation, Development of soil profile, Soil classification, Soil composition, Soil factors, Pollution: Definition, Types and Causes; Global warming, Acid Rain, Climate Change and ozone layer & Ozone Hole. Plant Indicators. Environmental Protection Act, Farmer's Rights and Intellectual Property Rights.

UNIT – V

Phytogeography: Phytogeographical Regions of India, Vegetation Types of Madhya Pradesh, Natural resources – Definition and classification. Conservation and Management of Natural Resources, Land Resources Management, Water and Wet Land Resources Management.

Practical Content **Credits: 2**

- To determine the minimum size of the quadrat by species area curve.
- To determine the frequency of various species occurring in a given area.
- Determination of percentage frequency of plant species by quadrat method.
- Determination of density of plant species by quadrat methods.
- Study the soil texture of field soil.
- To study the composition of field soil.
- To study out the water holding capacity of the soil.
- To test the presence of nitrate in the soil.
- To study the. Morphological adaptation in hydrophytes.
- To classify hydrophytes, xerophytes plant.
- To study the morphological adaptation in hydrophytes.
- To study the hydrophytic adaptation in the T.S. of hydrilla stems.
- To study the morphological and anatomical adaptation in xerophytes.

Reference Book

- Plant Ecology by- Michael. G. Barbour, Jack. H. Burk and Frank S. Gilliam.
- Principles of Terrestrial Ecosystem Ecology by- F. Stuart Chapin III and Pamela. A. Matson. and Peter. Vitousek.
- Plant Ecology and Conservation by- Robert. K. Peet. and David J. Allard.
- Biodiversity by- John. Spicer.

Text Book

- Text Book of Plant Ecology – R.S. Ambasht and N. K. Ambasht.
- An Advanced Text Book on Biodiversity – K.V. Krishnamurthy.
- Plant Ecology and Phytogeography – V. Kumaresan. and N. Arumugam.

Unit No.	Course Learning Outcome	Teaching And Learning Activities	Assessment Tasks
1	Students should gain a solid understanding of fundamental ecosystem concepts, including biotic and abiotic components, energy flow, and nutrient cycling.	Present real-world case studies of ecosystems, their challenges, and conservation efforts. Ask students to analyse and discuss these cases in groups or as individuals.	Class test focusing definition and short questions.
2	Students should develop a solid understanding of fundamental ecological principles, including concepts such as competition, predation, mutualism, and niche theory.	Assign case studies where students analyse specific ecological adaptations in various organisms or ecosystems. This can help them apply theoretical knowledge to practical situations.	Class test focusing on long and short questions.
3	Students should understand the dynamics of populations, including factors like birth rates, death rates, immigration, and emigration, and how these factors affect population size and structure.	Start with lectures to provide foundational knowledge on population ecology. Encourage class discussions to promote critical thinking and deeper understanding of concepts.	Class test focusing short and questions.
4	Students should comprehend the processes of soil erosion and the environmental and agricultural consequences. They should be familiar with soil conservation techniques and their importance in sustainable land use.	Organize field trips or laboratory sessions where students collect soil samples from different locations and perform basic soil tests. This can include measuring pH, texture, and moisture content.	Class test focusing on definition and short questions.
5	Students should gain knowledge of key ecological concepts such as ecosystems, biodiversity, ecological services, and the interactions between human societies and natural environments.	Analyse case studies of biosphere reserves from around the world, focusing on their unique challenges, successes, and approaches to conservation and sustainable development.	Class test focusing on and long questions.

MAJOR CORE COURSE-II

3SEBC603: Botany-VI (Ethnobotany)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical		Total	Theory	Practical
			End Sem	Mid Sem	Assign	End Sem	Term Sem			
3SEBC603	Botany-VI (Ethnobotany)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- To proper documentation and presentation of traditional knowledge about plants.
- To use important plants by the tribal communities for various purposes.
- Conservation natural growing plants and socioeconomic impacts.
- Ethnobotany solves human problem of nutrition health care and life support system.

Course Learning Outcomes

- To express the historical development of ethnobotany. Recognize and identify important plant species.
- Explain ethno botanically uses of plants. Detail their native habitats and cultivated land.
- Identify and classify plants relevant to ethnobotanical studies.
- Learn plant anatomy, morphology, and taxonomy.
- Explore the cultural significance of plants in different societies.

Syllabus Credits: 4-0-2

UNIT-I

Ethnobotany introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or tribals of India and their life styles. Plants used by the tribals: a) Food plants. b) Intoxicants and beverages. c) Resins and oils and miscellaneous uses.

UNIT-II

Role of ethnobotany in modern medicine: Medico-ethnobotanical sources in India. Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadirachta indica.* b) *Ocimum sanctum.* c) *Vitex negundo*. d) *Gloriosa superba.* e) *Tribulus terrestris.* f) *Pongamia pinnata.* g) *Cassia auriculata.* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauwolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania.*

UNIT-III

Ethno-botany and Legal aspect Ethnobotany as an interdisciplinary. Aims and object of legal aspect. Application of natural habitat and propagation of ethno-botanical species. Propagation through cutting, layering, grafting, and budding.

UNIT-IV

Ethnobotany and legal aspects ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

UNIT-V

Economic ethno-botany active principals and method of screening, Drug adulteration- types, biological testing of herbal medicines. Tribal economic realization through different sources for their livelihood.

Practical Content **Credits: 2**

- Study of ethno medicinal plant.
- Study of plants used in various systems of medicines.
- Study of plant used in Ayurveda, Unani and Homoeopathic system.
- Plants used by villagers and tribal people.
- Study of biological testing of herbal medicines.

Reference Book

- S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
- S.K. Jain (ed.) Glimpses of Indian. Ethnobotany, Oxford and I.B.H. New Delhi – 1981.
- S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.

Text Book

- Plants, People, and Culture: The Science of Ethnobotany by- Michael. J. Balick. and Paul. Alan. Cox.
- Ethnobotany: Principles and Applications by- Cunliffe, Henry, and Teixidor-Toneu.
- Ethnobotany: A Methods Manual by- Gary. J. Martin.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching And Learning Activities	Assessment Tasks
1	The aims and objectives of Ethnobotany are as follows: Proper documentation of indigenous knowledge about medicinal plants. Preservation of unwritten traditional knowledge about herbal plants.	Ethnobotany draws from disciplines like botany, anthropology, ecology, and pharmacology. It combines the strengths of these fields to provide a holistic understanding of the relationships between people and plants.	Class test focusing and short questions.
2	Ethnobotany emphasizes the importance of biodiversity in traditional medicine, promoting awareness of diverse plant species and their potential medicinal properties.	Inviting experts in ethnobotany to deliver guest lectures exposes students to diverse perspectives and experiences, enhancing their understanding of the subject.	Class test focusing on and short questions.
3	Understand the fundamental concepts and principles of ethnobotany, including the relationships between plants and human cultures, traditional knowledge, and the ecological importance of plant species.	Teach students how to identify and classify plants, emphasizing the interdisciplinary nature of botanical taxonomy. Discuss how indigenous and scientific plant naming systems differ.	Class test focusing short and questions.
4	Students will comprehend international and national legal frameworks related to biodiversity conservation, traditional knowledge, and benefit-sharing.	Discuss the ethical considerations when a corporation patents a traditional remedy without proper	Class test focusing on definition and short questions.

Unit No.	Course Learning Outcome	Teaching And Learning Activities	Assessment Tasks
		consent, exploring potential legal repercussions.	
5	Understand the chemical compounds and pharmacological properties of economically important plants, including their roles in medicine, nutrition, and industry.	Organize field trips to local botanical gardens, farms, or natural areas where students can learn to identify and collect economically important plants. Discuss their traditional and modern uses.	Class test focusing on and long questions.

MAJOR CORE COURSE-III

3SPRC603: Botany –VI (Plant Reproduction)

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SPRC603	Botany –VI (Plant Reproduction)	4(2-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Describe the anatomy and morphology of plant reproductive organs, including flowers, seeds, and fruits.
- Articulate the mechanisms and processes involved in plant reproduction, covering both sexual and asexual modes of reproduction.
- Differentiate between various plant life cycles, including alternation of generations, and comprehend the significance of each stage in the context of reproduction.
- Analyze the processes of pollination and fertilization, detailing the role of different agents (wind, insects, etc.) and their impact on plant diversity.

Course Learning Outcomes

- Identify and describe the various reproductive structures in plants, including flowers, fruits, and seeds.
- Explore different pollination methods, such as wind, insects, and animals, and analyze their significance in plant reproduction.
- Define and compare the life cycles of different plants, including alternation of generations, and understand the role of meiosis and mitosis.
- Investigate the processes of fertilization in plants, emphasizing the union of male and female gametes and the formation of zygotes.

Syllabus **Credits: 2-0-2**

UNIT-I

Flower: Calyx, corolla, androecium, gynoecium, microsporangium: Anther wall, endothecium middle layers, tapetum, sporogenous tissue; Male gametophyte: Formation of vegetative and generative cells, formation of sperms, megasporangium: Types of ovules, integuments, nucellus, megasporogenesis, female gametophyte: Types of female gametophytes, mature embryo sac, haustorial behavior of embryo sac.

UNIT-II

Pollination: Pollination anther dehiscence, pollen transfer, self-pollination, cross pollination, Fertilization: Double fertilization, syngamy, endosperm: Types of endosperms, functions of endosperm.

UNIT-III

Embryogeny: Embryo zygote, Proembryo, Embryogeny and Embryogenesis in monocot and dicots: Polyembryony and parthenocarpy, Suspenser, Nutrition of embryo.

UNIT-IV

Embryology: Embryology in relation to taxonomy importance of embryological characters in taxonomic considerations, examples of the value of embryology in taxonomy.

UNIT-V

Dynamic of Fruit Growth: Dynamic of fruit growth biochemistry and biology of fruit maturation, apomixes, significance of apomixes. Vegetative reproduction. Experimental embryology, parthenocarpy.

Practical Content **Credits: 2**

- To study the parts of flower.
- To cut the T.S. of anther, pollen and ovule.
- To cut the T.S. of Dicot and monocot embryo.
- To study of different types of ovules.
- To study of polyembryony and Parthenocarpy.

Reference Book

- Plant Reproduction by- Andrew. V. Roberts and Betty. Smocovitis.
- Plant Reproductive Ecology: Patterns and Strategies by- Jon. Lovett-Doust.
- Plant Reproductive Biology by- Kingsley. R. Stern. and Richard J. Geber.
- Plant Reproductive Systematics: Taxonomy and Evolution of Angiosperms by- Kurt. M. Neubig. and W. Mark. Whitten, and Norris H. William.

Text Book

- Plant Reproductive Development and Function by- D. L. Mulcahy and E. Ottaviano.
- Plant Reproduction: Molecular, Developmental, and Environmental Contexts by- S. C. H. Barrett. and R. J. D. Knight.
- Reproductive Biology of Plants by- K. R. Shivanna. and V. P. Singh.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching And Learning Activities	Assessment Tasks
1	Understand the anatomy of a flower, including the parts such as petals, sepals, stamens, and pistils, and describe their functions in the reproductive process.	Take students on a field trip to a botanical garden or a local park to observe and identify various flowers in their natural habitat. Provide field guides and encourage students to make observations and take notes.	Class test focusing and short questions.
2	Understand the diversity of pollinators, including insects (e.g., bees, butterflies, beetles), birds (e.g., hummingbirds), bats, and wind, and their unique roles in pollination.	Take students on a field trip to a local garden or natural area where they can observe various pollinators in action. Provide binoculars and magnifying glasses for close-up observations.	Class test focusing on and short questions.
3	Understand the relevance of embryology in the medical field, including its role in understanding congenital defects and genetic disorders.	Provide students with preserved embryos or access to online resources with embryo images and videos. Have	Class test focusing short and questions.

Unit No.	Course Learning Outcome	Teaching And Learning Activities	Assessment Tasks
		them observe and compare embryonic development at different stages.	
4	Develop a comprehensive understanding of the process of embryonic development from fertilization through birth or hatching, including key stages and milestones.	Provide students with preserved embryos (e.g. chicken embryos) and dissecting kits, and guide them through the process of observing and identifying key embryonic structures at various developmental stages.	Class test focusing on and short questions.
5	Describe the different mechanisms of apomixis, such as apospory, diplospory, and parthenogenesis, and understand how they function at the cellular and genetic levels.	Start with a class discussion or lecture introducing the concept of apomixis, its historical background, and its significance in plant biology and agriculture.	Class test focusing on and long questions.

MAJOR CORE COURSE-I

3SPOC603: Chemistry-VI (Physical Organic and Inorganic Chemistry)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SPOC603	Chemistry-VI (Physical Organic and Inorganic Chemistry)	6(4-0-2)	60	20	20	60	40	200	3 hr	2 hr

Course Objectives

- Understand photochemical processes, including radiation-matter interaction and laws such as Grotthus-Draper and Stark-Einstein.
- Analyze quantum efficiency and deviations from Stark-Einstein law using Jablonski diagrams.
- Explore molecular properties like optical activity, polarization, and magnetic behavior, relating them to structure.
- Study organometallic compounds, their preparation, properties, and synthetic applications.
- Examine organosulphur compounds, including preparation methods, properties, and industrial uses.

Course Learning Outcome

- Understand the principles of photochemistry and its laws, including Grotthus-Draper and Stark-Einstein.
- Analyze quantum efficiency and deviations from Stark-Einstein law using Jablonski diagrams.
- Apply knowledge of molecular properties to predict optical activity, polarization, and magnetic behavior.
- Demonstrate proficiency in preparing and utilizing organometallic compounds in synthetic applications.
- Evaluate the properties and uses of Organosulphur compounds in industrial contexts.

Syllabus Credits 4-0-2

Physical Chemistry

UNIT – I

Photochemistry

Introduction, interaction of radiation with matter, thermal and photochemical processes and difference between thermal and photo- chemical processes, Laws of photochemistry: Grotthus-Draper law. Stark-Einstein law of photochemical equivalence, quantum efficiency or yield, deviation from law of photochemical equivalence and its explanation, experimental verification of Stark-Einstein law or determination of quantum efficiency, Jablonski diagram depicting various processes occurring in the excited state. Non-radiative process, radiative process, photosensitized reactions energy transfers processes, photosensitization in solution, Exercise.

UNIT – II

Physical Properties and Molecular Structures

Introduction, optical activity, measurement of optical activity, optical activity and molecular structure. Polarization: polarization of molecules in an electrical field, Mossotti-Clausius equation, permanent dipole, dipole moment and orientation of dipole in an electric field, determination of dipole moment, dipole moment and molecular structure; Magnetic properties- diamagnetism, Paramagnetism, and ferromagnetism; Exercises.

Organic Chemistry

UNIT – III

Organometallic Compounds

Introduction; Organomagnesium compound (Grignard reagent)- preparation, structure of Grignard reagent, properties, synthetic applications, technical applications. Organozinc compound (zinc alkyls) - preparation, properties, chemical reactions. Organolithium compounds- preparation, properties, chemical reactions, differentiating reactions from Grignard reagent, uses, Exercises.

Organosulphur Compounds

Introduction; Structural features; Thioalcohols or Mercaptans or alkyl hydrogen sulphides - nomenclature, general methods of preparation, physical properties, chemical properties, important members; Thioethers (dialkyl sulphides)-general method of preparation, physical properties, chemical properties, individual members. Sulphonic acids- methods of preparation, physical properties, chemical reactions and uses; Sulphonamides, sulphaguanidine; Exercises.

Inorganic Chemistry

UNIT – IV

Inorganic Polymers

Introduction and scope of inorganic polymers, special characteristics, classification, homo and hetero atomic polymers and their applications. Silicones and phosphorene's as examples of inorganic polymers, nature of bonding in triphosphazenes.

UNIT – V

Organometallic Chemistry

Definition, nomenclature and classification of organometallic compounds, preparation, properties, bonding and applications of alkyls and aryls 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. Transition metal organometallic compounds with bonds to hydrogen and boron.

Practical Content — Credits: 2

Physical Chemistry

Physical Instrumentation

- Job's method
- Mole-ratio method

Organic Chemistry

- Binary mixture analysis containing two solids: Separation, identification and preparation of derivatives.

Inorganic Chemistry

Complex Compound Preparation:

- Diaquabis (methyl acetoacetate) nickel (II)

- Diaquabis (ethyl acetoacetate) cobalt (II)
- Bis (methyl acetoacetate) copper (II) monohydrate
- Potassium chlorochromate (IV)
- Tetra ammine copper (II) sulphate monohydrate
- Mercury (II) tetra thio cyanate cobaltate (II)
- Hexamine nickel (II) chloride

Textbooks

- Physical Chemistry by P. W. Atkins and J. de Paula.
- Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren.
- Inorganic Chemistry by Catherine and Alan G. Sharpe.
- Organometallic Chemistry by Gary O. Spessard and Gary L. Miessler.
- Photochemistry by V. Ramamurthy and Kirk S. Schanze.

Reference Books

- Physical Chemistry: A Molecular Approach by Donald A. McQuarrie and John D. Simon.
- Organometallics by Christoph Elschenbroich.
- Inorganic Chemistry by James E. Huheey, Ellen A. Keiter, and Richard L. Keiter.
- Photochemistry and Photo physics: Concepts, Research, Applications" by Virender K. Sharma.
- Organic Chemistry by Paula Y. Bruice.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Define photochemistry and its importance in chemistry. Explain how photochemical reactions differ from thermal reactions.	Conduct lectures to introduce the fundamental concepts of photochemistry. Use discussions to encourage students to ask questions and clarify doubts.	Assignments on the laws of photochemistry,
2	Understand optical activity and its correlation with molecular structure, and analyse magnetic properties in materials.	Hands-on laboratory experiments to measure optical activity and investigate magnetic properties, followed by discussions to reinforce understanding.	Lab reports on measuring optical activity and dipole moments.
3	Understand the basic principles of organ magnesium compounds, including the nature of the metal-carbon bond in Grignard reagents.	Conduct lectures to introduce the fundamental concepts and theories related to organ magnesium compounds. Use classroom discussions to engage students, encourage questions, and clarify doubts.	Presentation on the uses of organosulphur compounds.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
4	Basic concepts and definitions related to inorganic polymers, including the differences between inorganic and organic polymers.	Conduct lectures to introduce key concepts related to inorganic polymers, their classification, and properties. Engage students in discussions to explore the differences between inorganic and organic polymers.	Assignments on bonding in silicones and phosphorene's.
5	Principles and definitions related to organometallic chemistry, including the nature of metal-carbon bonds.	Conduct lectures to introduce key concepts, principles, and reactions in organometallic chemistry. Use classroom discussions to engage students, encourage questions, and explore practical applications.	Assignments on the preparation and properties of organometallic compounds.

MAJOR CORE COURSE-II

3SNCC603: Chemistry-VI (Nano Chemistry)

(Credits: Theory-4 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SNCC603	Chemistry-VI (Nano Chemistry)	6(4-0-2)	60	20	20	60	40	200	3hr	2hr

Course Objective

- Understand nanoscale science's interdisciplinary implications and its applications in various fields.
- Explore synthesis methods for nanostructured materials and their unique properties.
- Investigate diverse nano porous materials and their applications.
- Examine organic nanoparticles and their roles in drug delivery systems.
- Assess nanotechnology's potential in environmental protection and energy efficiency.

Course Learning Outcome

- Explain the interdisciplinary significance of nanoscale science and its applications.
- Identify nanostructured materials and understand their synthesis methods and properties.
- Analyze the applications of Nano porous materials in different fields.
- Evaluate the properties and applications of organic nanoparticles, particularly in drug delivery.
- Assess nanotechnology's contributions to environmental protection and energy efficiency.

Syllabus Credits 4-0-2

UNIT - I

Introduction; Nanoscale Science and Technology-Implications for Physics, Chemistry, Biology and Engineering; Classifications of Nanostructured Materials, Nano Particles; Nanowires, Ultra-Thin Films-Multi-Layered Materials.

UNIT – II

Methods Bottom-up Synthesis-Top-down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy.

UNIT – III

Nano porous materials Zeolites, mesoporous materials, Nano membranes. Carbon Nanotubes and Graphene - Core shell and hybrid Nano composites.

UNIT – IV

Organic Nanoparticles: Introduction, Definition, Structure, Analytical Methods (Extraction and isolation, Separation, Characterization and Imaging), General Method of Preparation, Properties, Detection, and Characterization of Organic Nanoparticles: Hydrophobic Drugs, Protein, Peptide, Lipid, Cyclodextrine, Polysaccharides. Nano Cochleates, Prospects and Future Challenges.

UNIT - V

Nanomaterials for Environmental Protection: Nano technology processes – Nano Engineering materials for Pollution Prevention, Green Chemistry, Energy Efficient Resources and Materials, Nano Technology Products- Nanomaterials (Nanostructures) Nano devices and Nano systems.

Practical Content — Credits 2

- Synthesize nanoparticles using various methods.
- Characterize nanoparticles using techniques like TEM, SEM, DLS, and XRD.
- Functionalize nanoparticles for specific applications.
- Investigate the stability of nanoparticles in different environments.
- Design and evaluate nanoparticle-based drug delivery systems.
- Assess the toxicity and biocompatibility of nanoparticles.
- Explore environmental applications of nanoparticles.
- Fabricate nanostructures through self-assembly or template-assisted methods.

Reference Book

- Introduction to Nanoscience and Nanotechnology by Chris Binns, Edward L. Wolf, and Simon B. Walker.
- Principles of Nanotechnology: Molecular-Based Study of Condensed Matter in Small Systems by G. Ali Mansoori.
- Nanomaterials: Synthesis, Properties and Applications by A. S. Edelstein and R. C. Cammarata.
- Nanotechnology: Basic Science and Emerging Technologies by Mick Wilson, Geoff Smith.

Text Book

- Nano chemistry: A Chemical Approach to Nanomaterials by Geoffrey A. O zin and André C. Arsenault.
- Nano chemistry: Synthesis and Applications by Kenneth J. Klabunde.
- Nano chemistry: A Chemical Approach to Nanomaterials by Kenneth J. Shea and Akira Suzuki.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Describe the unique properties and behaviours of nanomaterials, including size-dependent properties such as quantum confinement, surface Plasmon resonance, and increased reactivity.	Conduct lectures to introduce key concepts, theories, and principles related to nanoscale science and technology.	Assignments on the classification of nanostructured materials.
2	Analyse chemical reactions and mechanisms involved in bottom-up synthesis, including nucleophilic and electrophilic reactions, coordination chemistry, and catalysis.	Organize laboratory sessions where students perform bottom-up synthesis reactions.	Presentation on recent advancements in nanomaterial synthesis.

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
3	Fundamental understanding of nanomaterials, their unique properties, and the principles that govern their behaviour at the nanoscale.	Traditional lectures can be used to introduce key concepts, theories, and principles related to nanomaterials.	Quizzes on carbon nanotubes and graphene.
4	Solid understanding of nanoparticles, their unique properties at the nanoscale, and the differences between bulk materials and nanoparticles.	Use lectures to introduce key concepts, theories, and principles related to organic nanoparticles chemistry.	Class test focusing on long and short questions.
5	Develop a solid understanding of nanomaterials, their unique properties, and how these properties can be harnessed for environmental protection.	Use lectures to introduce key concepts, principles, and case studies related to nanomaterials in environmental protection.	Project on the design of nanomaterials for environmental applications.

MAJOR CORE COURSE-III

3SBIC603: Chemistry-VI (Biochemistry)

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SBIC603	Chemistry-VI (Biochemistry)	4(2-0-2)	60	20	20	60	40	200	3hr	2hr

Course Objective

- Understand biochemistry fundamentals, focusing on vitamins and their roles in health and disease prevention.
- Explore water's unique properties and its significance in biological systems.
- Study carbohydrates, lipids, amino acids, and nucleic acids, emphasizing their structures and functions.

Course Learning Outcomes

- Identify key vitamins, deficiency diseases, and their preventive measures.
- Explain water's role as a solvent, reactant, and pH regulator in biological processes.
- Recognize the structural diversity and biological functions of carbohydrates, lipids, amino acids, and nucleic acids.
- To study the biological phenomenon at cellular and molecular level is studied to gain knowledge about the principle that govern complex biological systems.

Course Learning Outcomes

- It is helpful to get knowledge of preparation of some complex compound.
- Separation and identification of binary organic mixture, prepare derivatives and know about physical instrumentation techniques

Syllabus Credits 2-0-2

UNIT- I

The foundations of biochemistry and Vitamins Cellular and chemical foundations of life. Structure and active forms of water soluble and fat-soluble vitamins, deficiency diseases and symptoms, hypervitaminosis.

UNIT- II

Water Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.

UNIT-III

Carbohydrates and Glycobiology Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and non-reducing disaccharides. Polysaccharides –

homo and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lip polysaccharides). Carbohydrates as informational molecules, working with carbohydrates.

UNIT-IV

Lipids Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids -triacylglycerol and waxes. Structural lipids in membranes –glycerophospholipids, galactolipids and sulpolipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids. Lipids as signals, cofactors and pigments.

UNIT-V

Amino acids structure and classification, physical, chemical and optical properties of amino acids nucleic acids. Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA – m RNA, t RNA and r RNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.

Practical **Credits 2**

- Buffer solution preparation and pH measurement.
- Test of amino acids.
- Separation of amino acids by TLC.
- Estimation of DNA by diphenylamine method.
- Identification of lipids by TLC.
- Separation of sugar by paper Chromatography.

Reference Book

- Harper's Illustrated Biochemistry by Victor W. Rodwell, David A. Bender, and Kathleen M. Botham.
- Water: A Matrix of Life by Felix Franks.
- Principles of Carbohydrate Chemistry by R. W. Harding and T. J. L. Simeons.
- Lipidomics: Comprehensive Mass Spectrometry of Lipids edited by Xianlin Han.
- Amino Acids, Peptides and Proteins in Organic Chemistry by Andrew B. Hughes.

Text book

- Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox.
- Biochemistry by Lubert Stryer, Jeremy M. Berg, and John L. Tymoczko.
- Water: A Comprehensive Guide for Brewers by John Palmer and Colin Kaminski.
- Carbohydrates: The Essential Molecules of Life by Robert V. Stick
- Lipid Biochemistry: An Introduction by Michael I. Gurr, John L. Harwood, and Keith N. Frayn.

Facilitating the achievement of course learning objectives

Unit No.	Course Learning Outcome	Teaching and Learning Activities	Assessment Tasks
1	Grasp fundamental chemical concepts and principles, such as bonding, chemical reactions, and thermodynamics, as they apply to biochemistry.	Traditional lectures are often used to deliver essential content and introduce key biochemical concepts. Instructors may use multimedia presentations, slides, and diagrams to aid in understanding.	Class test focusing on short questions.

2	Describe the molecular structure of water, including its bent shape, covalent bonds, and polar nature. Explain how hydrogen bonding contributes to water's unique properties.	Use molecular model kits or interactive software to allow students to construct water molecules and explore the polarity of water and hydrogen bonding.	Laboratory report on the unique properties of water and its significance in biological systems.
3	Students should categorize monosaccharides based on the number of carbon atoms they contain (e.g., triose, pentose, hexose) and distinguish between aldoses and ketoses.	Provide students with samples of different monosaccharides and have them use chemical tests (e.g., Benedict's test, Fehling's test) to identify and differentiate between reducing and non-reducing sugars.	Presentation on the structure, properties, and biological significance of carbohydrates.
4	Define what lipids are and explain their role as essential biomolecules in living organisms.	Provide students with various fatty acids and ask them to identify and classify them based on chain length, degree of saturation, and the presence of functional groups.	Case study on the role of lipids in cellular structure and function.
5	Define what nucleic acids are and explain their role as essential biomolecules that store and transmit genetic information.	Provide students with molecular model kits to build physical models of DNA molecules. This hands-on activity helps students understand the double helix structure and complementary base pairing.	Essay on the structure, classification, and properties of amino acids and nucleic acids.

MINOR CORE COURSE

3SEZM604: Zoology-VI Economic Zoology

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SEZM604	Zoology-VI Economic Zoology	4(2-0-2)	60	20	20	60	40	200	3hr	2hr

Course Objective

- This paper is aimed to introduce Pearl Culture, Lac Culture, Sericulture and Poultry keeping. Protozoa, rats, mites, insect diseases and control.
- Provide students with an overview of the field of economic zoology, its historical development, and its importance in contemporary society.
- Explore the role of animals in agriculture, including livestock production, animal husbandry practices, and their impact on food security.
- Study economically important insects, their biology, behavior, and their effects on crops, stored products, and public health.
- Examine beekeeping and silkworm culture, including the economic value of honey, beeswax, and silk production.

Course Learning Outcome

- The student has a knowledge of different culture Skill and diseases and their control to develop own Business, marketing and self-employment.
- Recognize animals that have significant economic value in various sectors, including agriculture, aquaculture, and industry.
- Evaluate the economic impact of animals on human society, agriculture, and public health.
- Analyze and propose strategies for managing economically important pests, including insect pests and disease vectors.
- Assess the sustainability of practices related to animal agriculture, fisheries, and wildlife conservation.

Syllabus Credits 2-0-2

UNIT – 1

Diseases and Control

Protozoa and human diseases, House hold insect, Mites and their control, Insect traps and biological control agents.

UNIT – II

Toxicity

Toxicology; Basic concepts and definition, Heavy metal toxicity; Pb, Cd, Hg, Toxicity testing; LC 50, LD 50, acute and chronic toxicity, Pesticide and their toxicological effect.

UNIT – III:

Pesticides

Chemical control of pest, Natural control of pest, Physical control of pest, biological control of insect pests. Insecticides and insect resistance, biological control of insect pests, Insect pests of some crops of economic importance.

UNIT – IV

Economical Keeping

Economic importance of mammals, Poultry keeping, Rats and their control, Economic importance of Mammals; Piggery, Dairy industry, Leather, wool and Fur industry.

UNIT – V:

Culture

Pearl culture
Sericulture
Lac culture
Apiculture.

Practical Content **Credits: 2**

- Study of Life cycle of Silk worm.
- Study of Bee culture.
- Study of pests-Stored grain pests- *Sitophilus Oryza* and *Tribolium Castanaeum.*
- Study of Vegetable pests- *Pieris brassicae* and *Dacuscucurbitae.*
- Study of Plankton – *Euglena, Paramecium, Cyclops, Mysis, Daphnia*.
- Study of Protozoa and diseases.

Text Book

- Economic Zoology by Shukla and Upadhyay.
- Economic Zoology by Dr. P.C. Kotpal.
- Economic Zoology A Systematic Study of Animals and Their Importance by R.L. Kotpal.
- Insects and Human Society" by Brian Morris.
- Aquaculture: Principles and Practices" by T. V. R. Pilla.

Reference Book

- The science of climate change. Houghton, J.T., Meria Filho, L.G., Callender.
- Economical environmental changes by Harris, N., Kattenberg, A. and Maskell, K. (eds.) Cambridge, UK.
- Global Environmental factors by McCarthy, J.J., Brewer, P.G. and Feldman, Global Ocean
- Conservation and evolution; O.H. Frankel and E.S. Micheaele, Camb. University Press.
- Conservation and evolution; O.H. Frankel and E.S. Micheaele, Camb. University Press.

Facilitating the achievement of course learning objectives

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
1	Students should be able to identify different types of protozoa, both pathogenic and non-pathogenic, and classify them into relevant groups based on characteristics like morphology, locomotion, and life cycle.	Analyse real-life case studies of protozoan diseases, such as malaria outbreaks in different regions. Discuss the epidemiology, symptoms, and treatment strategies.	Class test focusing on and short questions.
2	Understand and recognize common sources of toxins, including natural toxins (e.g., plant toxins, venom), environmental pollutants (e.g., heavy metals, pesticides), and synthetic chemicals (e.g., drugs, industrial chemicals).	Start with a lecture that provides an overview of toxicology and its relevance in zoology. Discuss key concepts such as toxicity, dose-response relationships, and different types of toxins. Engage students with case studies and real-world examples of toxins affecting animals.	Class test focusing on and short questions.
3	Explain the principles of chemical pest control, including the modes of action of common pesticides. Describe the concept of natural pest control and identify various natural predators, parasites, and pathogens of pests. Analyse case studies and real-world examples of successful biological pest control programs.	Start with a lecture explaining the principles of chemical pest control, types of pesticides, and their modes of action. conduct field trips to study natural predator-prey interactions. Students can observe and document beneficial organisms in action.	Class test focusing on short and questions.
4	Understand the key functions of mammalian organ systems, including circulatory, respiratory, digestive, and reproductive systems.	Provide an introductory lecture on mammalian diversity, and encourage class discussions about the vast range of mammalian species.	Class test focusing on and short questions.
5	Explain the biological processes involved in pearl formation in molluscs, with a focus on the role of pearls in the animals defines mechanism. Understand the life cycle and biology of silk-producing insects, primarily the silkworm (*Bombyx mori*).	Organize a field trip to a pearl farm where students can witness pearl cultivation techniques first-hand. They can observe pearl *oysters* or mussels, nucleus insertion, and pearl harvesting. Assign students the task of rearing silkworms from egg to cocoon, providing insights into the life cycle and biology of silk-producing insects.	Class test focusing on and long questions.

MINOR CORE COURSE

3SPRM604: Botany-VI (Plant Reproduction)

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SPRM604	Botany-VI (Plant Reproduction)	4(2-0-2)	60	20	20	60	40	200	3hr	2hr

Course Objectives

- Describe the anatomy and morphology of plant reproductive organs, including flowers, seeds, and fruits.
- Articulate the mechanisms and processes involved in plant reproduction, covering both sexual and asexual modes of reproduction.
- Differentiate between various plant life cycles, including alternation of generations, and comprehend the significance of each stage in the context of reproduction.
- Analyze the processes of pollination and fertilization, detailing the role of different agents (wind, insects, etc.) and their impact on plant diversity.

Course Learning Outcomes

- Identify and describe the various reproductive structures in plants, including flowers, fruits, and seeds.
- Explore different pollination methods, such as wind, insects, and animals, and analyze their significance in plant reproduction.
- Define and compare the life cycles of different plants, including alternation of generations, and understand the role of meiosis and mitosis.
- Investigate the processes of fertilization in plants, emphasizing the union of male and female gametes and the formation of zygotes.

Syllabus Credits :2-0-2

UNIT - I

Flower: Calyx, corolla, androecium, gynoecium, microsporangium: Anther wall, endothecium middle layers, tapetum, sporogenous tissue; Male gametophyte: Formation of vegetative and generative cells, formation of sperms, megasporangium: Types of ovules, integuments, nucellus, megasporogenesis, female gametophyte: Types of female gametophytes, mature embryo sac, haustorial behavior of embryo sac.

UNIT-II

Pollination: Pollination anther dehiscence, pollen transfer, self-pollination, cross pollination, Fertilization: Double fertilization, syngamy, endosperm: Types of endosperms, functions of endosperm.

UNIT-III

Embryogeny: Embryo zygote, Proembryo, Embryogeny and Embryogenesis in monocot and dicots: Polyembryony and parthenocarpy, Suspenser, Nutrition of embryo.

UNIT-IV

Embryology: Embryology in relation to taxonomy importance of embryological characters in taxonomic considerations, examples of the value of embryology in taxonomy.

UNIT-V

Dynamic of Fruit Growth: Dynamic of fruit growth biochemistry and biology of fruit maturation, apomixes, significance of apomixes. Vegetative reproduction. Experimental embryology, parthenocarpy.

Practical Content **Credits: 2**

- To study the parts of flower.
- To cut the T.S. of anther, pollen and ovule.
- To cut the T.S. of Dicot and monocot embryo.
- To study of different types of ovules.
- To study of polyembryony and Parthenocarpy.

Reference Book

- Plant Reproduction by- Andrew. V. Roberts and Betty. Smocovitis.
- Plant Reproductive Ecology: Patterns and Strategies by- Jon. Lovett-Doust.
- Plant Reproductive Biology by- Kingsley. R. Stern. and Richard J. Geber.
- Plant Reproductive Systematics: Taxonomy and Evolution of Angiosperms by- Kurt. M. Neubig. and W. Mark. Whitten, and Norris H. William.

Text Book

- Plant Reproductive Development and Function by- D. L. Mulcahy and E. Ottaviano.
- Plant Reproduction: Molecular, Developmental, and Environmental Contexts by- S. C. H. Barrett. and R. J. D. Knight.
- Reproductive Biology of Plants by- K. R. Shivanna. and V. P. Singh.

Facilitating the achievement of course learning objectives

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
1	Understand the anatomy of a flower, including the parts such as petals, sepals, stamens, and pistils, and describe their functions in the reproductive process.	Take students on a field trip to a botanical garden or a local park to observe and identify various flowers in their natural habitat. Provide field guides and encourage students to make observations and take notes.	Class test focusing and short questions.
2	Understand the diversity of pollinators, including insects (e.g., bees, butterflies, beetles), birds (e.g., hummingbirds), bats, and wind, and their unique roles in pollination.	Take students on a field trip to a local garden or natural area where they can observe various pollinators in action. Provide binoculars and magnifying glasses for close-up observations.	Class test focusing on and short questions.
3	Understand the relevance of embryology in the medical field, including its role in understanding congenital defects and genetic disorders.	Provide students with preserved embryos or access to online resources with embryo images and videos. Have them observe and compare embryonic development at different stages.	Class test focusing short and questions.

4	Develop a comprehensive understanding of the process of embryonic development from fertilization through birth or hatching, including key stages and milestones.	Provide students with preserved embryos (e.g., chicken embryos) and dissecting kits, and guide them through the process of observing and identifying key embryonic structures at various developmental stages.	Class test focusing on and short questions.
5	Describe the different mechanisms of apomixis, such as apospory, diplospory, and parthenogenesis, and understand how they function at the cellular and genetic levels.	Start with a class discussion or lecture introducing the concept of apomixis, its historical background, and its significance in plant biology and agriculture.	Class test focusing on and long questions.

MINOR CORE COURSE

3SBIM604: Chemistry-VI (Biochemistry)

(Credits: Theory-2 Practical-2)

Scheme of Examination

Course Code	Course Name	Credits	Maximum Marks Allotted						Duration of exam	
			Theory			Practical				
			End Sem	Mid Sem	Assign	End Sem	Term Sem	Total	Theory	Practical
3SBIM604	Chemistry-VI (Biochemistry)	4(2-0-2)	60	20	20	60	40	200	3hr	2hr

Course Objective

- Understand biochemistry fundamentals, focusing on vitamins and their roles in health and disease prevention.
- Explore water's unique properties and its significance in biological systems.
- Study carbohydrates, lipids, amino acids, and nucleic acids, emphasizing their structures and functions.

Course Learning Outcomes

- Identify key vitamins, deficiency diseases, and their preventive measures.
- Explain water's role as a solvent, reactant, and pH regulator in biological processes.
- Recognize the structural diversity and biological functions of carbohydrates, lipids, amino acids, and nucleic acids.
- To study the biological phenomenon at cellular and molecular level is studied to gain knowledge about the principle that govern complex biological systems.

Course Learning Outcomes

- It is helpful to get knowledge of preparation of some complex compound.
- Separation and identification of binary organic mixture, prepare derivatives and know about physical instrumentation techniques

Syllabus Credits 2-0-2

UNIT- I

The foundations of biochemistry and Vitamins Cellular and chemical foundations of life. Structure and active forms of water soluble and fat-soluble vitamins, deficiency diseases and symptoms, hypervitaminosis.

UNIT- II

Water Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.

UNIT-III

Carbohydrates and Glycobiology Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and non-reducing disaccharides. Polysaccharides –

homo and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lip polysaccharides). Carbohydrates as informational molecules, working with carbohydrates.

UNIT-IV

Lipids Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids -triacylglycerol and waxes. Structural lipids in membranes –glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids. Lipids as signals, cofactors and pigments.

UNIT-V

Amino acids structure and classification, physical, chemical and optical properties of amino acids nucleic acids. Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA – m RNA, t RNA and r RNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.

Practical **Credits 2**

- Buffer solution preparation and pH measurement.
- Test of amino acids.
- Separation of amino acids by TLC.
- Estimation of DNA by diphenylamine method.
- Identification of lipids by TLC.
- Separation of sugar by paper Chromatography.

Reference Book

- Harper's Illustrated Biochemistry by Victor W. Rodwell, David A. Bender, and Kathleen M. Botham.
- Water: A Matrix of Life by Felix Franks.
- Principles of Carbohydrate Chemistry by R. W. Harding and T. J. L. Simeons
- Lipidomics: Comprehensive Mass Spectrometry of Lipids edited by Xianlin Han.
- Amino Acids, Peptides and Proteins in Organic Chemistry by Andrew B. Hughes.

Text book

- Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox
- Biochemistry by Lubert Stryer, Jeremy M. Berg, and John L. Tymoczko.
- Water: A Comprehensive Guide for Brewers by John Palmer and Colin Kaminski.
- Carbohydrates: The Essential Molecules of Life by Robert V. Stick
- Lipid Biochemistry: An Introduction by Michael I. Gurr, John L. Harwood, and Keith N. Frayn.

Facilitating the achievement of course learning objectives

Unit no.	Course learning outcome	Teaching and learning activities	Assessment tasks
1	Grasp fundamental chemical concepts and principles, such as bonding, chemical reactions, and thermodynamics, as they apply to biochemistry.	Traditional lectures are often used to deliver essential content and introduce key biochemical concepts. Instructors may use multimedia presentations, slides, and diagrams to aid in understanding.	Class test focusing on short questions.

2	Describe the molecular structure of water, including its bent shape, covalent bonds, and polar nature. Explain how hydrogen bonding contributes to water's unique properties.	Use molecular model kits or interactive software to allow students to construct water molecules and explore the polarity of water and hydrogen bonding.	Laboratory report on the unique properties of water and its significance in biological systems.
3	Students should categorize monosaccharides based on the number of carbon atoms they contain (e.g., triose, pentose, hexose) and distinguish between aldoses and ketoses.	Provide students with samples of different monosaccharides and have them use chemical tests (e.g., Benedict's test, Fehling's test) to identify and differentiate between reducing and non-reducing sugars.	Presentation on the structure, properties, and biological significance of carbohydrates.
4	Define what lipids are and explain their role as essential biomolecules in living organisms.	Provide students with various fatty acids and ask them to identify and classify them based on chain length, degree of saturation, and the presence of functional groups.	Case study on the role of lipids in cellular structure and function.
5	Define what nucleic acids are and explain their role as essential biomolecules that store and transmit genetic information.	Provide students with molecular model kits to build physical models of DNA molecules. This hands-on activity helps students understand the double helix structure and complementary base pairing.	Essay on the structure, classification, and properties of amino acids and nucleic acids.