JAIPUR NATIONAL UNIVERSITY

A venture of The Seedling Group of Educational Institutions

Bachelor of Science

(BSC-CBZ)

Mode: Distance

PROGRAM PROJECT REPORT

Contents

1. Program Overview

1.1 Program's Vision and Objectives

The program's vision is to learn all basic concepts in biological and chemical sciences which are very much the need of the hour as there is a dearth of good students in the area of basic sciences by imparting the latest concepts and technology, and aligning them with industry demands in the country. The objectives of the program are as follows:

PSO1: Knowledge relating to the interrelationships of different plant and animal groups and their evolutionary tendencies.

PSO2: Differentiate between animals, plants and Microorganisms with their distinguishing characteristics.

PSO3: Capability of applying the knowledge in the areas of Agriculture, Plant Medicines, Horticulture and Tissue culture.

PSO4: Gain the Knowledge in electrical and thermal properties of d- block elements through Free Electron Theory, Valency Bond Theory and Band Theory.

PSO5: Learn the skills of Aquaculture, Vermiculture, Sericulture, Poultry Science and Fundamentals of Clinical Science and Immunology.

PSO6: Analyze the biomolecules and their chemical properties.

1.2 Relevance of the Program with JNU's Vision and Mission

Jaipur National University (JNU) was established in 2007. JNU provides a world-class learning experience, with a highly accomplished faculty, numerous extracurricular activities, and a wide range of academic pursuits. The university fosters holistic development of students.

JNU with its vision to transform the Education Landscape of India and contribute to the maximum to improve the GER of India has plans to launch affordable and flexible education programs. Distance programs are an excellent way to launch affordable and flexible education programs in sync with the vision and mission of the university stated below:

University Vision:

To be a leader in creating unique and exclusive learning opportunities in all disciplines of study that ultimately lead to the advancement of learning and creation of a sustainable society and environment.

University Mission:

- Provide global opportunities of learning through broad and balanced academic programmes.
- Explore and hone the potential of stakeholders, develop their human and intellectual capacities to the fullest.
- Create and maintain excellence with high standard driven activities, universal significance and acknowledgement.
- Inculcate and keep track of the current trends and finest practices in education for constant growing and evolving.
- Leverage diversity of thoughts, ideas, and perspectives to enrich the stake holders

1.3 Nature of Prospective Target Group of Students

The curriculum of B.Sc (Pass Course)-CBZ is designed in such a way that it helps the students to become not only more employable but also encourage them to become entrepreneurs. Primarily the target group of learners will be:

- Population of any age and those living in remote areas where higher education institutes are not easily accessible.
- Learners who could not get admission in the regular mode due to limited intake capacity.
- Learners who are working and who desire to pursue higher education as a means for movement up the ladder.
- Learners who are unable to pursue Higher education due to social, financial and economic compulsions as well as demographic reasons.

1.4 Appropriateness of programs to be conducted in Distance mode to acquire specific skills and competence

BSc (Pass course)-CBZ is tailored to make the students geared up for employment in the relevant industries, develop the culture of research and use these skills in ensuring food security of the nation. It also aims to create environmental awareness and sensitivity among students.

2. Procedure for Admission and Curriculum Transaction

The academic programs catered to candidates enrolled in the online mode of learning are facilitated by CDOE-JNU, with the backing of various faculties within the University. Eligibility criteria, course structure, detailed curriculum, program duration, and evaluation criteria are subject to approval by the Board of Studies and Academic Council, adhering to UGC guidelines for programs falling under the purview of online mode for degree conferment.

Below are the details of the admission procedure, eligibility criteria, fee structure, curriculum, and program delivery, information about the Learning Management System (LMS), and assessments and evaluations:

2.1 Procedure for Admission

Students who are seeking admission in programs offered by CDOE-JNU need to apply through https://online.jnujaipur.ac.in/ in the courses offered.

2.1.1 Minimum Eligibility Criteria for Admission

The minimum eligibility criteria for admission to the Online BSc-CBZ program require candidates to 10+2 (12th Standard) from a recognized Board, in accordance with UGC and AICTE norms. Additionally, candidates must have secured at least 40% marks in the qualifying examination.

Candidates must also fulfill all documentation requirements as specified on the program's website for admission purposes. Failure to submit proof of eligibility within the stipulated timeframe specified by CDOE-JNU will result in the cancellation of admission. Prospective candidates are encouraged to carefully review all instructions provided on the website before proceeding with the application process.

2.1.2 Admission Process and Instructions: Learner Communication

The admission process for the students is provided below:

Step	Process	Particulars
Step 1	**Counselling**	Prospective students will receive guidance and counseling for their chosen program from designated and authorized counselors.
Step 2	**Registration on admission portal to get access to My Account.**	To initiate the registration process, prospective students are required to complete the application form by providing all necessary details and uploading mandatory documents.

Step 3	**Details of Document upload**	Student Uploads document as follows- <u>Personal Documents</u> Passport-size Photograph Student's Signature Aadhar Card (Back & Front) <u>Academic Documents</u> *UG Student -* 10th Marksheet 12th Marksheet *PG Student -* 10th Marksheet 12th Marksheet UG Marksheet Other Certificates (detailed list of documents is provided in **Annexure II**)
Step 4	**Verification of documents by the Deputy Registrar**	The Deputy Registrar is responsible for verifying all documents uploaded by prospective students on the admission portal. Within a timeframe of 48 hours, the Deputy Registrar will review and either approve or disapprove the eligibility of the prospective student for the chosen program.
Step 5	**Undertaking**	Student will sign Undertaking after Approval in Application.

Step 6	**Payment of fees**	All eligible students, duly approved by the Deputy Registrar, will get fees payment link activated in their My Account for payment. The Fee is payable through any of the following means: (a) UPI (b) Credit/Debit Card (c) Net-banking Note: Cash, bank demand draft and Cheques are not accepted
Step 7	**Enrolment**	After the payment of program fee, the eligible student will get the Enrolment number and access to the LMS within 21 days.
Step 8	**Access to Learning Management System (LMS)**	

General Instructions:

1. Prior to applying for online programs, all students are advised to thoroughly read and comprehend the eligibility conditions provided in the student handbook document and outlined on the university website.
2. It is the responsibility of prospective learners to ensure that their educational or qualifying degree has been issued by a recognized university or board only. For learners from Indian higher education institutions, recognition by the regulatory authority of the Government of India is necessary. To verify degrees from recognized boards of education, refer to www.cobse.org.in/. For Polytechnic Diploma, check the respective State Board of Technical Education. Verification of degrees from recognized universities can be done at www.ugc.ac.in/.
3. Prospective learners must verify their eligibility on the date of admission and ensure that they have passed the qualifying exams before the commencement of the admission batch.

Upon enrolment, students must register with the Academic Bank of Credits (ABC), a central scheme for depositing credit formulated by the Ministry of Education, Government of India. Creation of an Academic Bank of Credits (ABC) ID is mandatory for all students. (Refer to Annexure V for details).

2.1.3 Program Fee for the Academic Session beginning July 2024

Program fees for students pursuing BSc-CBZ offered by CDOE-JNU is mentioned below:

Program	Academic Total Fees (INR)	Exam fees
B.Sc. (CBZ)	**54,000**	**1500 per semester**

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2.2 Curriculum Transactions

2.2.1 Program Delivery

The curriculum is delivered through Self Learning Materials (SLMs) in the form of e-Contents, supplemented by a variety of learning resources including audio-video aids via the Learning Management System (LMS). Furthermore, the program includes online contact hours featuring discussion forums and synchronous live interactive sessions conducted through the LMS, adhering to the current UGC norms for course delivery.

2.2.2 Learning Management System to support online mode of Course delivery

The Learning Management System (LMS) is available on URL https://lms.jnujaipur.ac.in/ is meticulously developed to offer students a truly global learning experience. With a user-friendly interface, the LMS simplifies the learning process and ensures it meets the highest global standards. Utilizing audio-visual teaching methods, self-learning materials, discussion forums, and evaluation patterns, the platform stands out as unique and aligns seamlessly with both industry requirements and the UGC Guidelines.

Students can engage in uninterrupted learning 24x7 via web and mobile devices, allowing them to progress at their preferred pace. The LMS boasts a simple and intuitive user interface, facilitating easy navigation through the e-learning modules. Designed in accordance with standard norms, all learning tools are easily accessible, ensuring a perfect learning experience for all users.

2.2.3 Course Design

The curriculum is designed by a committee comprising experts from the parent department of the University and Industry experts, keeping in view the needs of the diverse groups of learners.

2.2.4 Academic Calendar for Academic Session beginning July 2024

S. No.	Event	Session	Month (Tentative)
1.	Commencement of semester	January	January
		July	July
2.	Enrol learner to Learning	January	Within 21 working days from fee deposit and

	Management system	July	Eligibility confirmation
3.	Interactive Live Lectures for query resolution	January	February to May
		July	August to November
4.	Assignment Submission	January	By April
		July	By October
5	Project Report Submission (Wherever applicable during Final semester)	January	Last week of April
		July	Last week of November
6	Term End Examination	January	May onwards
		July	December onwards
7	Result Declaration of End Term Examination	January	By June
		July	By January

3. Instructional Design

3.1 Curriculum Design

BSc programme aims to develop scientific temper, observational skills and analytical ability in students. The programme leads the students to higher learning in biological, chemical and applied sciences and contributes to the welfare of the society. It is designed to help the students to understand the importance and judicious use of technology for the sustainable growth of mankind in synergy with nature. It has received approval from the Board of Studies, the Centre for Internal Quality Assurance (CIQA), and the University Academic Council.

3.2 Program Structure and detailed Syllabus

3.2.1 Program Structure

Semester I								
Course Name	**Course Category**	**Course Code**	**Credits**	**Contact Per Week**			**Evaluation**	
				L	**T**	**P**	**Internal**	**External**
Atomic Structure, bonding, General Organic chemistry & Aliphatic Hydrocarbons	CORE	DBSZCO101T24	3	2	1	0	30	70
Plant Diversity	CORE	DBSZCO102T24	3	2	1	0	30	70
Animal Diversity-I (Non-chordates)	CORE	DBSZCO103T24	3	2	1	0	30	70
Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab	CORE	DBSZCO101P24	1	0	0	2	30	70
Plant Diversity Lab	CORE	DBSZCO102P24	1	0	0	2	30	70
Animal Diversity-I (Non-chordates) Lab	CORE	DBSZCO103P24	1	0	0	2	30	70
Analytical Methods in Chemistry	DSE	DBSZDS101T24	3	2	1	0	30	70
Analytical Methods in Chemistry Lab	DSE	DBSZDS101P24	1	0	0	2	30	70
Mushroom Culture Technology	SEC-1	DBSZSE101T24	3	3	0	0	30	70
Environmental Science	AEC-1	DBSZAE101T24	2	2	0	0	30	70
Total Credits			**21**	13	4	8	1000	

SEMESTER-II								
Course Name	**Course Category**	**Course Code**	**Credits**	**Contact-Per Week**				**Evaluation**
				L	**T**	**P**	**Internal**	**External**
Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I	CORE	DBSZCO201T24	3	2	1	0	30	70
Plant Ecology and Taxonomy	CORE	DBSZCO202T24	3	2	1	0	30	70
Animal Diversity-II (Chordates)	CORE	DBSZCO203T24	3	2	1	0	30	70
Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I Lab	CORE	DBSZCO201P24	1	0	0	2	30	70
Plant Ecology and Taxonomy Lab	CORE	DBSZCO202P24	1	0	0	2	30	70
Animal Diversity-II (Chordates) Lab	CORE	DBSZCO203P24	1	0	0	2	30	70
Horticulture practices and post-harvest technology	DSE	DBSZDS201T24	**3**	2	1	0	30	70
Horticulture practices and post-harvest technology lab	DSE	DBSZDS201P24	1	0	0	2	30	70
English	AEC-2	DBSZAE201T24	2	2	0	0	30	70
Aquarium Fish Keeping	SEC-3	DBSZSE201T24	3	3	0	0	30	70
Total Credits			**21**	**13**	**4**	**8**	**1000**	

Exit option with UG certificate *Students will be awarded UG Certificate in Life Sciences provided they secure 4 credits in vocational courses /summer internship in addition to 6 credits from skill based courses earned during 1st and 2nd semester.

Semester – III								
Course Name	**Course Category**	**Course Code**	**Credits**	**Contact-Per Week**			**Evaluation**	
				L	**T**	**P**	**Internal**	**External**
Solutions, Phase equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II	CORE	DBSZCO301T24	3	2	1	0	30	70
Plant anatomy and embryology	CORE	DBSZCO302T24	3	2	1	0	30	70
Fundamentals of Biochemistry	CORE	DBSZCO303T24	3	2	1	0	30	70
Solutions, Phase equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II Lab	CORE	DBSZCO301P24	1	0	0	2	30	70
Plant anatomy and embryology (Botany) Lab	CORE	DBSZCO302P24	1	0	0	2	30	70
Fundamentals of Biochemistry Lab	CORE	DBSZCO303P24	1	0	0	2	30	70
Computational Biology	DSE	DBSZDS301T24	**3**	2	1	0	30	70
Computational Biology Lab	DSE	DBSZDS301P24	1	0	0	2	30	70
Professional Communication Skills	AEC-3	DBSZAE301T24	2	2	0	0	30	70
Green Methods in Chemistry	SEC-3	DBSZSE301T24	3	3	0	0	30	70
	Total Credit		**21**	**14**	**4**	**8**	**1000**	

Semester IV								
Course Name	**Course Category**	**Course Code**	**Credits**	**Contact-Per Week**			**Evaluation**	
				L	**T**	**P**	**Internal**	**External**
Transition Metal & Coordination Chemistry , State of Matter & Chemical Kinetics	CORE	DBSZCO401T24	3	2	1	0	30	70
Plant physiology and metabolism	CORE	DBSZCO402T24	3	2	1	0	30	70
Genetics and Evolutionary Biology	CORE	DBSZCO403T24	3	2	1	0	30	70
Transition Metal & Coordination Chemistry , State of Matter & Chemical Kinetics Lab	CORE	DBSZCO401P24	1	0	0	2	30	70
Plant physiology and metabolism Lab	CORE	DBSZCO402P24	1	0	0	2	30	70
Genetics and Evolutionary Biology Lab	CORE	DBSZCO403P24	1	0	0	2	30	70
Applications of Computers in Chemistry	DSE	DBSZDS401T24	3	2	1	0	30	70
Applications of Computers in Chemistry Lab	DSE	DBSZDS401P24	1	0	0	2	30	70
IPR	AEC-4	DBSZAE401T24	2	2	0	0	30	70
QUANTITATIVE APTITUDE	*VAC	DBSZVA401T24	2	2	0	0	30	70
Food Hygiene and Sanitation	*OE/GE-1	DBSZGE401T24	3	3	0	0	30	70
Fundamentals of Prescribing		DBSZGE401T24	3	3	0	0		
Human resourse management		DBSZGE401T24	3	3	0	0		
	Total Credits		**23**	**15**	**4**	**8**	**1100**	
Exit option with UG Diploma*Students will be awarded UG Diploma in Life Sciences provided they secure additional 4 credits in Skill based vocational courses /summer internship offered during 1st or 2nd year..								
* Open Elective credits could be replaced with options of MOOC and SWAYAM courses								

Semester V								
Course Name	**Course Category**	**Course Code**	**Credits**	**Contact-Per Week**			**Evaluation**	
				L	**T**	**P**	**Internal**	**External**
Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy	CORE	DBSZCO501T24	3	2	1	0	30	70
Cell and Molecular Biology	CORE	DBSZCO502T24	3	2	1	0	30	70
Ethology and Biostatistics	CORE	DBSZCO503T24	3	2	1	0	30	70
Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy Lab	CORE	DBSZCO501P24	1	0	0	2	30	70
Cell and Molecular Biology Lab	CORE	DBSZCO502P24	1	0	0	2	30	70
Ethology and Biostatistics Lab	CORE	DBSZCO503P24	1	0	0	2	30	70
Economic Botany	DSE	DBSZDS503T24	3	2	1	0	30	70
Economic Botany Lab	DSE	DBSZDS503P24	1	0	0	2	30	70
Web Designing	*VAC	DBSZVA501T24	2	2	0	0	30	70
Diet in Life Style disorders	*OE/GE-2	DBSZGE501T24	3	3	0	0	30	70
Essential Newborn Care (ENBC) & Facility based newborn care (FBNC)		DBSZGE501T24	3	3	0	0		
Marketing Management		DBSZGE501T24	3	3	0	0		
Total Credits			**21**	**13**	**4**	**8**	**1000**	
* Open Elective credits could be replaced with options of MOOC and SWAYAM courses								

Semester VI								
Course Name	**Course Category**	**Course Code**	**Credits**	**Contact-Per Week**			**Evaluation**	
				L	**T**	**P**	**Internal**	**External**
Quantum Chemistry, Spectroscopy & Photochemistry	CORE	DBSZCO601T24	3	2	1	0	30	70
Plant Pathology	CORE	DBSZCO602T24	3	2	1	0	30	70
Animal Physiology	CORE	DBSZCO603T24	3	2	1	0	30	70
Quantum Chemistry, Spectroscopy & Photochemistry Lab	CORE	DBSZCO601P24	1	0	0	2	30	70
Plant Pathology Lab	CORE	DBSZCO602P24	1	0	0	2	30	70
Animal Physiology Lab	CORE	DBSZCO603P24	1	0	0	2	30	70
Immunology	DSE	DBSZDS602T24	3	2	1	0	30	70
Immunology Lab	DSE	DBSZDS602P24	1	0	0	2	30	70
Fundamentals of Indian Constitution	*VAC	DBSZVC603T24	2	2	0	0	30	70
Techniques in Basic Life Support	*OE/GE-3	DBSZGE601T24	3	3	0	0	30	70
Integrated Management of Neonatal and Childhood Illness (IMNCI) & Pediatric Life Support (PLS)		DBSZGE601T24	3	3	0	0		
Leadership Skills and Change Management		DBSZGE601T24	3	3	0	0		
	Total Credits		**21**	**13**	**4**	**8**	**1000**	
* Open Elective credits could be replaced with options of MOOC and SWAYAM courses								

3.2.2 Detailed Syllabus of B.Sc.-CBZ

Detailed syllabus of BSC-CBZ is attached in Annexure-I.

3.3 Duration of the Program

Program	Level	Duration	Maximum duration for completion	Credits
BSc-CBZ	Bachelor's Degree	3 years (6 Semesters)	6 Years	128

3.4 Faculty and Support staff requirements (Refer Regulation Document for all Staff Details)

Academic Staff	Number available to meet the norms
Program Coordinator	1 Member
Course Coordinator	61
Course Mentor	1 Member per batch of 250 students

3.5 Instructional delivery mechanisms

JNU boasts a fully dedicated team of faculty members and staff proficient in delivering online lectures through CDOE – JNU. At the commencement of each session, students will receive the academic calendar *via* the Learning Management System (LMS). The distribution of self-learning material, audio, and video content to students will be facilitated through the LMS via the following delivery channels:

- Self-Learning Material
- E-Books
- Study Guide
- Question Bank in Learning Management system - For Practice Test through LMS
- Audio / Video Component in Learning Management System
- Assignments (Submitted through Assignment Response Sheet)
- Personal Contact Program would be conducted at University Campus.

3.6 Identification of media-print, audio, or video, online, computer aided

The Learning Management System (LMS) serves as a comprehensive digital platform, offering a multitude of features including recorded faculty video lectures, real-time discussion forums, live sessions, e-content comprising study material, open source materials, and graded assessments.

For each module within a course, there will be one live session conducted by the respective faculty member, focusing on a specific topic. CDOE-JNU has curated study material that is clear and easily comprehensible, complete with concise summaries, self-assessment questions, and case studies.

Access to these course materials is facilitated through:

- Login credentials provided in the welcome email sent by the university
- Students can also log in on the University website at https://online.jnujaipur.ac.in/

Online Courseware

Through the Learning Management System (LMS), students will have access to a comprehensive array of course materials mentioned in above clause.

The Dashboard feature of the LMS serves to track and monitor students' learning progress. It includes functionalities such as:

- Monitoring progress in learning
- Comparing progress with peers
- Receiving regular notifications about upcoming webinars, virtual classes, assignments, discussion forum participations, and examinations

3.7 Student Support Services

Students will have access to support services provided by CDOE-JNU through the Student Relationship Management (SRM) system for queries related to administration and general technical issues. A ticketing system integrated into the LMS will enable learners to connect with the CDOE-JNU technical team for support services, with resolutions haned by the appropriate authority. Notifications will also be sent to the Deputy Registrar to ensure queries are addressed within 24 hours or sooner.

For academic course-related queries, students can raise queries directly through an open discussion forum, which will notify the Course Coordinator, Program Coordinator, and Deputy Director. Queries should be resolved within 48 hours of being raised, with the Program Coordinator responsible for managing and resolving any unresolved matters. The Deputy Director will ensure the timely resolution of academic queries.

In addition to academic excellence, CDOE-JNU prioritizes the holistic development of its students. The department supports various initiatives to broaden students' opportunities and shape them into future leaders.

4. Assessment and Evaluation

4.1 Overview

The evaluation of students' learning will encompass internal assignments, quizzes, learner response sheets, and end-of-term examinations. CDOE-JNU follows a rigorous process in the development of question papers, creation of question and quiz banks, preparation and moderation of assignments, administration of examinations, analysis of answer scripts by qualified academics, and declaration of results. Question papers are meticulously framed to ensure comprehensive coverage of the syllabus.

The evaluation process will include two types of assessments:

Examination Name	Marks Division
Continuous internal assessment	30%
Summative assessment in the form of end-term examination. End-term examination will be held with proctored examination tool technology (follow **Annexure VI** for guidelines and pre-requisites for Proctored Examination)	70%

The examinations are designed to evaluate the knowledge acquired during the study period.

For theory courses, internal evaluation will be conducted through Continuous Internal Assessment (CIA), which includes assignments and quizzes in form of MCQ type of questions. The internal assessment will contribute a maximum of 30 marks for each course.

At the end of each semester, an end-of-semester online examination will be held for each course, lasting two hours.

Guidelines issued by the Regulatory Bodies from time-to-time about conduct of examinations shall be considered and new guidelines if any will be implemented.

4.2 Question Paper Pattern

Online Exam Time: 2 Hours

Max. Marks: 70

Exam will be comprising of 70 Multiple-Choice Questions (1 Mark Each) – 70 Marks

4.3 Distribution of Marks in Continuous Internal Assessments

The following procedure shall be followed for internal marks for theory courses. Weightage for Assignment is provided below:

Particular	A1 (MCQ Type)	A2 (MCQ Type)
Marks	15	15

Note: Refer to **Annexure VI** and **VII** for reference to the question paper pattern and formats of documents accepted.

Students may re-appear for CIA up to next two semesters and has to follow the same procedure. For the last semester the academic rules shall apply.

4.4 Statistical Method for the Award of Relative Grades

Letter Grade	Grade point	Range of Marks(%)
O (Outstanding)	10	90-100
A+ (Excellent)	9	80-89
A (Very good)	8	70-79
B+ (Good)	7	60-69
B (Above average)	6	50-59
C (Average)	5	40-49
p (Pass)	4	35-39
F (Fail)	0	0-34
Ab (Absent)	0	Absent

Abbreviations:

CO	Core Course	MM	Maximum Marks
DS	Discipline Specific Course	MO	Marks Obtained
GE	Generic Elective Course		

4.4.1 Cumulative Grade Point Average (CGPA) and Semester Grade Point Average

Semester Grade Point Average (SGPA):

It is the summation of product of Credit Points and Grade Points divided by the summation of Credits of all Courses taught in a semester.

SGPA = $\Sigma C_i G_i / \Sigma C_i$

Where, G is grade and C. is credit for a Course.

Cumulative Grade Point Average (CGPA): $CGPA = \Sigma(C_i \times Si)/\sum c$.

Where, Si is the SGPA of the semester and Ci is the total number of credits in that semester.

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Note:

- In case of any mistake being detected in the preparation of the Grade Statement at any stage or when it is brought to the notice of the concerned authority the University shall have the right to make necessary corrections.

4.4.2 Cumulative Grade Point Average (CGPA)

CGPA will be used to describe the overall performance of a student in all courses in which letter grades are awarded since his entry into the University or transferred from other University upto the latest semester as per the procedure provided in JNU Academic Regulations. It is the weighted average of the grade points of all the letter grades received by the student from his entry into the University or transferred from other University. Since multiple performance in a course in which the student has already received a grade is possible, whenever through such a process a new grade is obtained, it will replace the earlier one in the calculation of CGPA. On the other hand, if through this process merely a report emerges, this event by itself will not alter the CGPA.

A student's grades, reports, CGPA, etc. at the end of every semester/term will be recorded on a grade card, a copy of which will be issued to him. The grade card will be withheld if a student has not paid his dues or when there is a pending case of breach of discipline or a case of unfair means against him.

The faculty members also responsible for maintaining the complete records of each student's attendance, performance in different components of evaluation. If a scrutiny or statistical analysis becomes necessary, the above records and any other pertinent information should be made available by the faculty member of the course.

4.4.3 Conversion Factor

Formula for Conversion of CGPA to Percentage:

Percentage of marks = CGPA ^{x} 10

4.5 Grade card

All grades and reports and other pertinent information for a semester are given in a grade card which is a complete record of the outcome of what was intended in the original registration. The various grades and reports would be appropriately used to tally the grade card with the original registration.

Chronologically organized information from the grade cards of a student with the necessary explanation constitutes

is transcript which is issued at the time the student leaves the University or at an intermediate point on request.

4.5.1 Grade cards and Certification – Student Communication

- The student can get soft copy of grade cards through the University website, the hard copy grade card would be provided only after successfully completion of full program along with degree certificate.
- Once the student completes all the mandated assignments, examinations and projects (if applicable) the final mark sheet/grade card and certificate would be dispatched by the University to the student registered address.
- All pending payments/dues need to be cleared by the student, before the final certification.
- If required, the University may request the mandatory documents from student as submitted during admission time, the students may have to re-submit the same if required during final degree certification.
- Students need to apply for degree by filling the degree application form and submit all the required documents and the applicable degree processing application fees as mentioned in this document.

4.5.2Results, grade card and Degree Logistics–Internal Process

- After verification of all data by the Controller of Examination, the results would be published on the CDOE-JNU website.
- Students need to download and save the copy of semester / year wise results.

CDOE-JNU would provide hard copy grade cards and degree certificate at the end of the program to students who have successfully completed the program. Students who successfully completed the program will receive hard copy mark sheet/grade cards and a degree certificate from the University at the end of the program. A provision for On Demand Mark Sheets can be provided wherein student would have to fill the requisition and pay postal charges enabling university to dispatch the hard copy marksheets as requested by the student; prior to completion of the overall program.

5. Requirement of the Laboratory Support and Library Resources

5.1 Laboratory Support

Jaipur National University offers access to state-of-the-art laboratories equipped with the latest tools and resources necessary for research and analytical work. The laboratory support at JNU aims to foster a robust research environment, encouraging students to develop essential skills required for their academic and professional growth.

*5.*2 Library Resources

The Central Library at CDOE-JNU offers a comprehensive range of sections, including reference, circulation, audio-

visual, periodical, book-bank, digital library, and reprographic sections. With a collection exceeding 1,00,000 books, the library also provides access to e-journals, online databases such as Scopus and Web of Science, and institutional repositories featuring rare book collections. University has 449 subscriptions of online and offline Journals. Equipped with modern facilities like reading rooms, computer labs, and quiet study areas, the library fosters a conducive environment for learning and intellectual growth. Additionally, the library frequently organizes workshops, seminars, and exhibitions to enhance academic engagement and promote a culture of continuous learning.

All electronic resources can be accessed seamlessly through the Local Area Network (LAN) on campus, as well as remotely via login credentials. This ensures convenient access to resources for students, faculty, and researchers both on-site and off-site.

6. Cost Estimate of the Program and the Provisions

The Estimate of Cost & Budget could be as follows (all figures on Annual basis) :

Sl. No.	Expenditure Heads	Approx. Amount
1	Program Development (Single Time Investment)	43,00,000 INR
2	Program Delivery (Per Year)	8,00,000 INR
3	Program Maintenance (Per Year)	27,00,000 INR

7. Quality Assurance Mechanism

The quality of a program hinges upon the course curriculum, syllabus, and academic delivery, all of which are meticulously designed to bridge the gap between industry standards and academia. To uphold this standard, the Centre for Internal Quality Assurance (CIQA) and the Academic Council play crucial roles.

The Academic Council is entrusted with ratifying the curriculum and any proposed changes recommended by CIQA to ensure the continual enhancement and maintenance of quality in education at CDOE-JNU.

The Centre for Internal Quality Assurance (CIQA) is tasked with several responsibilities:

(i) Conducting periodic assessments of online learning course materials and audio-video tutorials to maintain the quality of learning.

(ii) Soliciting stakeholder feedback and implementing recommended changes to meet the evolving needs of course delivery and industry requirements.

(iii) Evaluating the quality of assignments, quizzes, and end-term assessments and providing suggestions for enhancements to sustain the learning program's standards.

(iv) Ensuring that the learning experience is truly global, aligning with program outcomes and reflecting the vision and mission of JNU.

The Chief Operating Officer (CoE) of the University oversees examinations and the evaluation system to ensure fairness and integrity in the assessment process.

CDOE-JNU is committed to continual improvement, striving to enhance processes, assessments, teaching methodologies, and e-learning materials in line with the regulatory norms. The University is dedicated to delivering exceptional education across all learning modes while adhering to NEP, UGC, and other regulatory guidelines, fostering a truly global educational environment.

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Program Outcomes

PO1. **Scientific Knowledge**: Acquire fundamental scientific knowledge to address scientific challenges.

PO2. **Problem Analysis**: Identify, formulate and analyze scientific problems reaching substantiated conclusions.

PO3. **Design/development of solutions**: Devise resolutions for issues or procedures that fulfill the designated requirements.

PO4. **Moral and Ethical Awareness**: Apply ethical principles and commit to professional ethics and responsibilities in scientific field.

PO5**.** **Analytical and Research skills**: Comprehend the knowledge and role of biological products in Industry in Eco- friendly manner.

PO6. **Environment and Sustainability**: Understand the impact of the Professional solutions in societal and environmental contexts, and demonstrate the knowledge for sustainable development.

PO7. **Individual and Team work**: Work competently as an individual or in a team in one or more core areas of Sciences.

PO8. **Communication:** Communicate effectively on latest research activities to understand, write and present reports.

PO9. **Life-Long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of change in scientific methods.

PO10. **Modern Tool Usage**: Apply modern tools and techniques for prediction and modelling of complex activities of Life and Basic Sciences.

The detailed syllabus for the Program is as follows

SEMESTER –I

Course Nomenclature	**Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons**	
Course Credit	3	
Course Outcomes	After studying this course, a student will able to – **CO 1:**Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration,	

	radial and angular distribution. **CO 2:**Draw the plausible structures and geometries of molecules using radius ratio rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules). **CO 3:**Understand and explain the differential behavior of organic compounds based on fundamental concepts learnt. **CO 4:**Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved. **CO 5:**Learn and identify many organic reaction mechanisms including free radical substitution, electrophilic addition and electrophilic aromatic substitution. **CO 6**: Create the mechanism of reaction of hydrocarbons.	
Unit I	Atomic Structure	**11 Hours**
	Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle.Hydrogen atom spectra. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it.Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial andangular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals.Significance of quantum numbers, orbital angular momentum and quantum numbers m, *l* and m *s*. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy.Relative energies of atomic orbitals, Anomalous electronic configurations.	
Unit II	Chemical Bonding and Molecular Structure	**11 Hours**
	Ionic Bonding*:* General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds.Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.Covalentbonding:VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonalbipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.	
Unit III	Fundamentals of Organic Chemistry	**10 Hours**
	Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule. Stereochemistry Conformations with respect to ethane, butane and cyclohexane.InterconversionofWedge Formula, Newmann, Sawhorse and Fischer	

	representations. Concept of chirality (upto two carbon atoms).Configuration: Geometrical and Optical isomerism;Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D andL; *cis- trans*nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E /Z Nomenclature (for upto two C=C systems).	
Unit IV	Aliphatic Hydrocarbons	**10 Hours**
	Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation. Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration ofalkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes(Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cisaddition(alk. $KMnO_4$) and trans-addition (bromine), Addition of HX(Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis,oxymecuration-demercuration, Hydroboration-oxidation. Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.	
➢	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books	1. Lee, J.D. Concise Inorganic ChemistrySloman& Mark Sutcliffe "Economics for Business", Pearson Education, 2000 2. Huheey, J.E., Keiter, E.A., Keiter, R.L. &Medhi, O.K. Inorganic Chemistry:Principles of Structure and Reactivity, Pearson Education India 3. Stereochemistry by P.SKalsiMcMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. CengageLearningIndiaEdition*Jhingan M. L.*, Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.SMorrison, R.T. & Boyd, R.N. Organic Chemistry, PearsonBahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand,
➢	Online resources	https://www.khanacademy.org/

Course Nomenclature	**Plant diversity**	
Course Credit	3	
Course Outcomes	After studying this course, a student will able to – CO1: Enumerate the structure, pigmentation, food reserves and methods of reproduction of Algae. CO2. Summarized about the structure, pigmentation, food reserves and methods of reproduction of Fungi. CO3.Explain about the Economic importance of algae, Fungi and lichen. CO4. Differentiate some plant diseases with special reference to the causative agents, symptoms, etiology and control measures. CO5. Interpret the general characters and classification by K.R. Sporne, stelar evolution in Pteridophytes, heterospory and origin of seed habit. CO6.Determine the structure, life history and Economic importance of Gymnosperms.	

Unit I	Viruses, Bacteria & Algae	11Hours
	Viruses – Discovery, general structure, replication (general account), viroids and prions structure and general properties and their importance. DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); economic importance; Bacteria Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance Algae General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Fucus*, *Polysiphonia*. Economic importance of algae.	
Unit II	Fungi	11 Hours
	Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition , nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, *Alternaria* (Ascomycota), *Puccinia*,*Agaricus* (Basidiomycota); Symbiotic Associations-Lichens General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance..	
Unit III	Introduction to Archegoniate, Bryophytes	10 Hours
	Introduction to ArchegoniateUnifying features of archegoniates, Transition to land habit, Alternation of generations. BryophytesGeneral characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.	
Unit IV	Pteridophytes, Gymnosperms	10 Hours
	Pteridophytes General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up tofamily), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes. Gymnosperms General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum*. (Developmental details not to be included). Ecological and economical importance.	
➢	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

➢	Text books	• Tortora, G.J., Funke, B.R., Case, C.L. (2010). *Microbiology: An Introduction*, Pearson BKumar, H.D. (1999). *Introductory Phycology*. Affiliated East-West. Press Pvt. enjamin Cummings, U.S.A. 10th edition. • Sethi, I.K. and Walia, S.K. (2011). *Text book of Fungi & Their Allies*, MacMillan Publishers Pvt. Ltd., Delhi. • Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). *Introductory Mycology*, John Wiley and Sons (Asia), Singapore. 4th edition. • Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). *Biology*. Tata McGraw Hill, Delhi, India. • Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). *Pteridophyta*, S. Chand. Delhi, India. • Bhatnagar, S.P. and Moitra, A. (1996). *Gymnosperms*. New Age International (P) Ltd Publishers, New Delhi, India.
➢	Online resources	https://www.omicsonline.org>open access JSTOR Plant Science

Course Nomenclature	**Animal Diversity-I (Non-chordates)**	
Course Credit		
3		
Course Outcomes	After studying this course, a student will able to – CO1: Identify the animals according to their taxonomic classification and recall the characteristics of each phylum. CO2: Compare the body organization from phylum porifera to echinodermata. CO3: Determine the connecting links between phylums. CO4: Sketch the life cycle of animals from non-chordates to chordates. CO5: Support the ecological importance of various animals including coral reefs. CO6: Assemble the animals according to hierarchy and to be able to construct flow-chart for the same.	
Unit I	Protista, Porifera & Cnidaria& Ctenophora	11Hours
	General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa, Canal System in *Sycon*, Polymorphism in Hydrozoa, Corals and coral reefs,Ctenophora General characteristics and Evolutionary significance	
Unit II	Platyhelminthes, Nemathelminthes &Annelida	11 Hours
	General characteristics and Classification up to classes .Life cycle and pathogenicity of Taenia solium & Ascaris lumbricoides. Parasitic adaptations in helminthes,Metamerism in Annelida	
Unit III	Arthropoda, Onychophora, Mollusca	10 Hours
	General characteristics and Classification up to classes ;Vision in Arthropoda, Metamorphosis in Insects ,Social life in bees and termites Onychophora : General characteristics and Evolutionary significance Pearl formation in bivalves .	
Unit IV	Echinodermata and Hemichordata	10 Hours

	General characteristics and Classification up to classes Water-vascular system in Asteroidea Affinities with Chordates , General characteristics and classification of Hemichordata	
➢	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	**Text books**	• Ruppert and Barnes, R.D(2006).*Invertebrate Zoology*,VIII Edition .Holt Saunders International Edition. • Barnes , R.S.K.,Calow ,P.,Olive ,P.J.W.,Golding,D.W and Spicer,J.I (2002).*The Invertebrates :A New Synthesis* ,III Edition ,Blackwell Science. • Young ,J.Z.(2004).*The Life of Vertebrates*.III Edition.Oxford University press. • The Invertebrates: A Synthesis by R. S. K. Barnes 7th edition
➢	**Online resources**	W1 https://cec.nic.in/cec/curriculum_class#quadrantab (Classification of protozoa) W2 https://cec.nic.in/cec/curriculum_class#quadrantab (Polymorphism in hydrozoa) W3 https://cec.nic.in/cec/curriculum_class#quadrantab (Coral and Coral reefs) W4 https://cec.nic.in/cec/curriculum_class#quadrantab (Ctenophora Affinities) W5 https://cec.nic.in/cec/curriculum_class#quadrantab (Metamerism) W6 https://cec.nic.in/cec/curriculum_class#quadrantab (Arthropoda) W7 https://cec.nic.in/cec/curriculum_class#quadrantab (Vision in arthropoda) W8 https://cec.nic.in/cec/curriculum_class#quadrantab (Social life in insects part-1) W9 https://cec.nic.in/cec/curriculum_class#quadrantab (Social life in insects part-2

Course Nomenclature	**Analytical Methods in Chemistry**	
Course Credit	3	
Course Outcomes	On satisfying the requirements of this course, students will have the knowledge and skills to: CO 1: Perform experiment with accuracy and precision. CO 2: Develop methods of analysis for different samples independently. CO 3: Test contaminated water samples. CO 4: Understand basic principle of instrument like Flame Photometer, UV-vis spectrophotometer. CO 5: Learn separation of analytes by chromatography. CO 6: Apply knowledge of geometrical isomers and keto-enol tautomers to analysis.	
Unit I		**11 Hours**
	Optical methods of analysis-I **Infrared Spectrometry**: Basic principles of instrumentation (choice of source, monochromator &detector) for single and double beam instrument; sampling	

	techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution. **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; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.	
Unit II		**11 Hours**
	Optical methods of analysis-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; Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.	
Unit III		10 Hours
	Thermal methods of analysis **Thermal methods of analysis**: Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture. Electroanalytical methods: Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values	
Unit IV		10 Hours
	Separation techniques **Separation techniques**: **Solvent extraction**: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. **Chromatography**: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition &ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC. Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1.Willard, H.H.(1988),Instrumental Methods of Analysis, 7th Edition, Wardsworth Publishing Company. 2. Christian, G.D.(2004),Analytical Chemistry, 6th Edition, John Wiley &Sons, New York. 3. Harris, D. C.(2007),Quantitative Chemical Analysis,6th Edition, Freeman. 4. Khopkar, S.M. (2008), Basic Concepts of Analytical

		Chemistry, New Age International Publisher. 5. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005), Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Jeffery, G.H., Bassett, J., Mendham, J. &Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley &Sons, 6. Christian, G.D; Analytical Chemistry, 6th Ed. John Wiley &Sons, New York, 2004. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001. 7. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009. 8. Skoog, D.A. Holler F.J. &Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	**Mushroom Culture Technology**	
Course Credit	3	
Course Outcomes	After studying this course, student will be able to: CO1: Recall various types and categories of mushrooms. CO2: Compare the various types of mushroom cultivating technologies. CO3: Use the various types of food technologies associated with mushroom industry. CO4: Classify the economic factors associated with mushroom cultivation CO5: Justify the new methods and strategies to contribute to mushroom production. CO6: Design the types of foods prepared by mushroom.	
Unit I		11 Hours
	Introduction, history,Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea,Pleurotus citrinopileatus, Agaricus bisporus*.	
Unit II		11 Hours
	Cultivation Technology: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.	
Unit III		10 Hours

	Storage and nutrition: Short-term storage (Refrigeration - upto 24 hours) Long termStorage (canning, pickels, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.	
Unit IV		10 Hours
	Food Preparation: Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) 2. Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore. 3. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018. 4. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi. 5. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I &Vol. II. 94
	Online resources	https://www.stopfakes.gov>online-intellectual oxforde.com>view>acrefore

Course Nomenclature	Environmental Sciences	
Course Credits	2	
Course Outcomes	CO 1: Define the intellectual flexibility necessary to view environmental questions from multiple perspectives CO 2: Prepared to alter their understanding as they learn new ways of understanding. CO 3: Learn about Renewable and non renewable recourses CO 4: Able to discuss Social issues and the Environment. CO5: Differentiate Renewable and nonrenewable recourses. CO6: Develop Social issues and Environment issue.	
Unit I	Ecosystems and Biodiversity and its conservation	
	Ecosystems: Concept of ecosystem; Structure and function of an ecosystem; Producers, consumers and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic structure and function of the following ecosystems: Forest ecosystems, Grassland ecosystems, Desert ecosystems, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) Biodiversity and its conservation Introduction: definition: genetic, species and ecosystem diversity; Biogeographical classification of India; Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, national and local levels; India as a mega –diversity nation; Hotspots of biodiversity ; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity	
Unit II	Environmental Pollution	
	Environmental Pollution: Definition; Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear pollution Solid waste management: Causes, effects and control measures of urban and industrial wastes Disaster management: floods, earthquakes, cyclones and landslides Human Population and the Environment Population growth, variation among nations; Population explosion – Family welfare Programme Environment and human health; Human Rights; Intellectual Property Rights(IPR);Value Education; HIV/AIDS; Women and child welfare Role of Information Technology in Environment and human health; Case Studies	
Unit III	Natural Resources:	

	Renewable and non renewable recourses Natural resources and associated problems Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources, case studies. Land resources: Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification Role of individual in conservation of natural resource
Unit IV	Social issues and the Environment
	From unsustainable to sustainable development; Urban problems related to energy Water conservation, rain water harvesting, watershed management Environmental ethics: Issues and possible solutions Climate change, global warming, acid rain, ozone layer depletion and nuclear accidents. Environment protection Act; Air (Prevention and Control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act Issues involved in enforcement of environmental legislation; Public awareness
Learner support Material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc

Course Nomenclature	**Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Lab CO Practical-I**
Course Credit	1
Course Outcomes	On satisfying the requirements of this course, students will have the knowledge and skills to: CO 1: Student can follow the concepts of Volumetric analysis CO 2: To organize a sequence to Identify hetero atoms in organic compounds. CO 3: To demonstrate the protocol for Separation of mixtures by Chromatography CO 4: To create a complete sequence pathway to identify the organic compounds. CO 5: To estimate the amount of inorganic ion in different samples analytically**.**
Practical List 1.	.. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2.	. Estimation of oxalic acid by titrating it with $KMnO_4$.
3.	. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4.	. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5.	Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

6.	Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing uptotwo extra elements)	
7.	Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)	
8.	Identify and separate the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography	
9	Identify and separate the sugars present in the given mixture by paper chromatography. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing uptotwo extra elements)	
10	Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing uptotwo extra elements)	
11	. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)	
➢	Learner support Material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books	*Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012*
➢	Online resources	

Course Nomenclature	**Plant Diversity Lab**	**CO Practical-II**
Course Credit	**1**	
Course Outcomes	CO1: Students will gain skill about slide preparation, staining and mounting. CO2: Follow and perform slide preparation to identify fresh and preserved plant specimens of Algae & Fungi. CO3: Assemble fresh and preserved plant specimens of Bryophytes according to their morphological and anatomical basis. CO4: Calibrate fresh and preserved plant specimens of Sellaginella, Cycas, Pinus & Ephedra on the basis of their morphological and anatomical criteria. CO5: Identifications of various plant specimens (fresh and preserved) along with sections.	
Practical List **1.**	EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.	
2.	Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.	
3.	Gram staining	
4.	EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.	
5.	Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.	
6.	Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), *Oedogonium, Vaucheria, Fucus* and Polysiphonia* through temporary preparations and permanent slides. (* *Fucus* - Specimen and permanent slides)	
7.	*Rhizopus and Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.	
8	*Alternaria:* Specimens/photographs and tease mounts	
9.	*Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.	
10.	*Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.	
11.	*Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.	
12.	*Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.	
13.	Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)	
➢	Learner support Material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books	Practical botany rastogi publication, Practical botany CBH
➢	Online resources	Environmental Science Journals Guides.library.plu.edu>biol 462

Course Nomenclature	**Animal Diversity lab**	**CO Practical-III**
Course Credit	1	
Course Outcomes	On completion of this course, students will be able to: CO1: Sketch the specimens neatly and clearly. CO2: Perform the given dissections. CO3: Master the dissection and display skills. CO4: Revise the distinct characteristics of each and every given Specimen. CO5: Design a photo album according to the given syllabus.	
Practical List 1	Study of the following specimens: *Amoeba*, *Euglena*, *Plasmodium*, *Paramecium*, *Sycon*, *Hyalonema*, and *Euplectella*, *Obelia*, *Physalia*, *Aurelia*, *Tubipora*, *Metridium*, *Taenia solium*, Male and female *Ascaris lumbricoides*, *Aphrodite*, *Nereis*, *Pheretima*, *Hirudinaria*, *Palaemon*, *Cancer*, *Limulus*, *Palamnaeus*, *Scolopendra*, *Julus*, *Periplaneta*, *Apis*, *Chiton*, *Dentalium*, *Pila*, *Unio*, *Loligo*, *Sepia*, *Octopus*, *Pentaceros*, *Ophiura*, *Echinus*, *Cucumaria* and *Antedon*.	
2.	Study of the following permanent slides: T.S. and L.S. of *Sycon*, Study of life history stages of *Taenia*, T.S. of Male and female *Ascaris* .	
3.	Dissection -Alimentary Canal of Earthworm	
4.	Dissection -Digestive System of Cockroach.	
5.	Nervous System of Pila.	
6.	Mounting - Mouth parts of Cockroach, Gill Lamella, Osphradium and Radula of Pila	
7.	Mounting of Gill lamella, Ospharadium and Radula of Pila	
8.	An "**animal album**" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose .	
➢	Learner support Material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc
➢	Text books	1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition. 2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *TheInvertebrates: A New Synthesis*, III Edition, Blackwell Science 3. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press. 4. Pough H. *Vertebrate life*, VIII Edition, Pearson International. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
➢	Online resources	Guides.library.plu.edu>biol 462

Course Nomenclature	**Analytical Methods in Chemistry lab**	
Course Credit	1	
Course Outcomes	On satisfying the requirements of this course, students will have the knowledge and skills to: CO 1: Handling of chromatographic Methods CO 2: Understand about different extraction methods CO 3: Known about the principle of spectrophotometer CO 4: Analysis of water sample	
Practical List	I. Separation Techniques Chromatography: (a) Separation of mixtures (i) Paper chromatographic separation of Fe3+, Al3+, and Cr3+. (ii) Separation and identification of the monosaccharides present in the given mixture (glucose &fructose) by paper chromatography. Reporting the Rf values. (b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values. (c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC	
	Solvent Extractions: (i) To separate a mixture of Ni2+ &Fe2+ by complexation with DMG and extracting the Ni2+- DMG complex in chloroform, and determine its concentration by spectrophotometry. (ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.	
	Spectrophotometry 1. Determination of pKa values of indicator using spectrophotometry. 2 Structural characterization of compounds by infrared spectroscopy.	
	Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.	
	Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.	
	Analysis of soil: (i) Determination of pH of soil. (ii) Total soluble salt (iii) Estimation of calcium, magnesium, phosphate, nitrate	
	Ion exchange: (i) Determination of exchange capacity of cation exchange resins and anion exchange resins. (ii) Separation of metal ions from their binary mixture. (iii) Separation of amino acids from organic acids by ion exchange chromatography.	
	Determination of dissolved oxygen in water.	
	Determination of chemical oxygen demand (COD).	
	Determination of Biological oxygen demand (BOD).	
	Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method	
•	Learner support	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.

	Material	
•	Text books	1.Jeffery, G.H., Bassett, J., Mendham, J. &Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley &Sons, 1989. 2. Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988. 3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley &Sons, New York, 2004. 4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001. 5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009. 6. Skoog, D.A. Holler F.J. &Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed. 7. Mikes, O. Laboratory Hand Book of Chromatographic &Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley &Sons, 1979. 8. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.
•	Online resources	https://nptel.ac.in/ https://www.edx.org

SEMESTER II

Course Nomenclature	**Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I**	
Course Credit	3	
Course Outcomes	On satisfying the requirements of this course, students will have the knowledge and skills to: CO 1: Understand the laws of thermodynamics, thermo chemistry and equilibria. CO 2: Understand concept of pH and its effect on the various physical and chemical properties of the compounds. CO 3: Predict the pH of buffer salts. CO 4: Apply the concepts learnt to predict feasibility of chemical reactions and to study the behavior of reactions in equilibrium. CO 5: Understand the fundamentals of functional group chemistry through the study of methods of preparation, properties. CO 6: Create mechanism for chemical reactions with underlying mechanism.	
Unit I	**Chemical Energetics**	11 Hours
	Chemical Energetics Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances	
Unit II	**Chemical Equilibrium**	**11 Hours**
	. **Chemical Equilibrium:** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle. Relationships between K_p, K_c and K_xf or reactions involving ideal gases. **Ionic Equilibria:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.	
Unit III	**Aromatic hydrocarbons**	**10 Hours**
	Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. **Aromatic hydrocarbons** Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene).Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene). **Alkyl and Aryl Halides** **Alkyl Halides** (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and	

	SNi) reactions. Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution. **Aryl Halides** Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 or $NaNH_2/NH_3$. Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.	
Unit IV	**Alcohols, Phenols and Ethers**	10 Hours
	. **Alcohols, Phenols and Ethers** (Upto 5 Carbons) **Alcohols:** Preparation: Preparation of 1º, 2º and 3º alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3).Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement. **Phenols:** (Phenol case) Preparation: Cumenehydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction. **Ethers (aliphatic and aromatic):** Cleavage of ethers with HI. **Aldehydes and ketones (aliphatic and aromatic):** (Formaldehye, acetaldehyde, acetone and benzaldehyde) Preparation: from acid chlorides and from nitriles. Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoformtest. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishnerreduction. Meerwein-PondorffVerleyreduction.	
➢	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books	1. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry,John Wiley & Sons (2014). 2. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. CengageLearningIndia Edition, 2013. 3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman,New Delhi (1988). 4. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S. 5. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010. 6. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010. 7. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007). Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
➢	Online resources	The Journal of Organic Chemistry •The Journal of Chemical Education •ScienceDirect • Journal of Physical Chemistry & Biophysics •Asian Journal of Organic Chemistry

Course Nomenclature	**Plant Ecology and Taxonomy**

Course Credit	3	
Course Outcomes	CO1: Define the types of classifications- artificial, Natural and phylogenetic. CO2: Explain the knowledge about ICBN. CO3: Determine the herbarium techniques. CO4: Compare the taxonomic evidences from molecular, numerical and chemicals. CO5: Conclude the approaches to the study of Ecology (Autecology, Synecology and Genecology). CO6: Develop the population & Community Ecology - concept of metapopulation.	
Unit I	**Ecological factors**	10 Hours
	Ecological factors Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes	
Unit II	**Plant communities**	**10 Hours**
	Plant communities Characters; Ecotone and edge effect; Succession; Processes and types. **Ecosystem**Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous. **Phytogeography** Principle biogeographical zones; Endemism	
Unit III	**Introduction to plant taxonomy**	11 Hours
	Introduction to plant taxonomy: Identification, Classification, Nomenclature. **Identification**Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access. Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. Ranks, categories and taxonomic groups **Botanical nomenclature** Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations	
Unit IV	**Classification**:	**11 Hours**
	Classification: Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series). **Biometrics, numerical taxonomy and cladistics**Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).	
➢	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books	1. Kormondy, E.J. (1996). *Concepts of Ecology*. Prentice Hall, U.S.A. 4th edition. 1. Sharma, P.D. (2010) *Ecology and Environment*. Rastogi Publications, Meerut, India. 8th edition. 2. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA, U.S.A. 3. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
➢	Online resources	https://www.khanacademy.org/

Course Nomenclature	**Animal Diversity-II (Chordates)**

Course Credit	**3**	
Course Outcomes	After studying this course, a student will able to – CO1: Identify the animals according to their taxonomic classification and recall the characteristics of each phylum. CO2: Compare the body organization from phylum hemichordate to mammalia. CO3: Determine the connecting links between phylums. CO4: Sketch the general characters of each phylum. CO5: Support the conservation of endangered animals. CO6: Assemble the animals according to hierarchy and to be able to construct flow-chart for the same.	
Unit I	Introduction to Chordates	11 Hours
	Introduction to Chordates, General characteristics and outline classification: Protochordata , General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata	
Unit II	Agnatha,Pisces &Amphibia	**11 Hours**
	Agnatha : General characteristics and classification of cyclostomes up to class. Pisces : General characteristics of Chondrichthyes and Osteichthyes, Classification up to order Migration, Osmoregulation and Parental care in fishes Amphibia ; General characteristics and classification up to order; Parental care in Amphibians	
Unit III	Reptilia,Aves	**10 Hours**
	: Reptilia General characteristics and classification up to classes; Poison apparatus and Biting mechanism in snakes: Aves General characteristics and classification up to Class .Archaeopteryx-- a connecting link; Flight adaptations and Migration in birds	
Unit IV	Mammals & Zoogeography	10 Hours
	Mammals General characters and classification up to classesr; Adaptive radiation with reference to locomotory appendages: Zoogeography Zoogeographical realms and Continental drift theory,	
➢	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books	Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press. Pough H. Vertebrate life, VIII Edition, Pearson International. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub. Co. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
➢	Online resources	https://www.khanacademy.org/ https://cec.nic.in/cec/curriculum_class (Animal Diversity II- Theory)

Course Nomenclature	**Horticulture practices and post-harvest technology**

Course Credit	3	
Course Outcomes	On completion of this course the students will be able to: CO1: Recall the basics of horticultural and horticultural practices. CO2: Summarize the growth & development of horticultural crops. CO3: Familiarize on basic gardening techniques. CO4: Acquaintance on special practices, harvesting and post harvest handling.	
Unit I	Introduction -Scope and importance	11 Hours
	Introduction -Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism. Horticultural crops - conservation and management Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.	
Unit II	Ornamental plants, Fruit and vegetable crops	**11 Hours**
	Ornamental plants, Fruit and vegetable crops -Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (Opuntia, Agave and Spurges)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, Coral tree). Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).	
Unit III	Horticultural technique	**10 Hours**
	Horticultural techniques Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations. Landscaping and garden design (6 lectures) Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices. Floriculture Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.	
Unit IV	Horticultural techniques	10 Hours
	Horticultural techniques Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations. Landscaping and garden design (6 lectures) Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.	

	Floriculture Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India. 2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India. 3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi. 4.Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications,USA. 5. Capon B. (2010) Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon
	Online resources	https://www.springer.com>journal www.e-journals.org>botany

Course Nomenclature	English	
Course Credit	2	
Course Outcomes	After studying this course, a student will able to – CO1: Recall the abilities to express their feelings with proper vocabulary and pronunciation as well as write clearly, grammatically and syntactically correct sentences. CO2: Illustrate the texts closely and explicate texts written in a wide variety of forms, styles, structures, and modes. CO3: Determine students in achieving their career and lifelong goals by exhibiting balanced professional attitude in every walk of life. CO4: Compare and contrast primary and secondary documents, and advance their reading comprehension. CO5: Conclude the Persuade and convince. CO6: Develop the English language with propriety and effectiveness to develop an argument in a positive manner as well as develop acquaintance to various aspects to the fullest.	
Unit I	Grammatical Focus	
	Grammatical Focus : Grammatical & Structural aspects covering Parts of Speech, Tense, Voice, Clause, Preposition, Degrees of Comparison, Synonyms & Antonyms, etc; Identifying & Analyzing Grammatical Errors including errors in Spelling & Punctuation..	

Unit II	Reading	
	Reading : Vocabulary Building; Comprehension; Interpretation; Summarizing	
Unit III	Writing	
	Writing : Letter Writing – Formal, Informal; Accepting & Declining Invitations; Paragraph Writing, Precise Writing, Essay Writin	
Unit IV	Speaking	
	Speaking : Interactive Communication like Introducing Self, Greetings, Conversations, etc; Pronunciation : appropriate stress, intonation, clarity .Listening : Understanding – Spoken English, Formal English; Exercises	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	

Course Nomenclature	**Aquarium Fish Keeping(Zoology)**	
Course Credit	3	
Course Outcomes	After studying this course, student will be able to: CO1: Identify the Various aquarium Fishes. CO2: Compare the feeding habits of various aquarium fishes. CO3: Operate a self made aquarium. CO4: Choose and formulate fish feed. CO5: Support conservation of fresh water resources. CO6: Set up a functional aquarium in the lab.	
Unit I	**Introduction to Aquarium Fish Keeping**	11 Hours
	Introduction to Aquarium Fish Keeping The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes	
Unit II	**Biology of Aquarium Fishes**	**11 Hours**
	Biology of Aquarium Fishes Common characters and sexual dimorphism of Fresh water and Marine Aquariumfishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish	
Unit III	**Food and feeding of Aquarium fishes**	**10 Hours**
	Food and feeding of Aquarium fishes Use of live fish feed organisms. Preparation and composition of formulated fish feeds	
Unit IV	**Fish Transportation**	10 Hours
	Fish Transportation: Live fish transport - Fish handling, packing and forwarding techniques. **Maintenance of Aquarium:** General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text book	• Fish & Fisheries Rastogi publications 2020 4th edition.

		• Handbook of Fish Biology and Fisheries: Fish Biology, Volume 1 Paul J.B. Hart, John D. ReynoldsFirst published:3 October 2002:Willey
	Online resources	https://www.accessscience.com>content

Course Nomenclature	**Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I Lab**	**Practical-I**
Course Credit	1	
Course Outcomes	On satisfying the requirements of this course, students will have the knowledge and skills to: CO 1: Measure the heat capacity of calorimeter, enthalpy of neutralization, enthalpy of ionization, integral enthalpy of solution, enthalpy of hydration and solubility of benzoic acid in water and determination of ΔH. CO 2: Perform titration for Measurement of pH of different solutions. CO 3: Demonstrate Different Process for Purification of organic compounds like crystallization and recrystallization and determination of melting and boiling points. CO 4: Create the Preparations of various reactions involved Bromination, Benzoylation, Oxime and 2,4-dinitrophenylhydrazone**.** **CO5:** Perform the synthesis of different buffer solution.	
Practical List **1.**	Section A: Physical Chemistry Thermochemistry Determination of heat capacity of calorimeter for different volumes.	
2.	Determination of enthalpy of ionization of acetic acid.	
3.	Determination of integral enthalpy of solution of salts (KNO3, NH4Cl).	
4.	Determination of enthalpy of hydration of copper sulphate.	
5.	Study of the solubility of benzoic acid in water and determination of Δ*H*.	
6.	pH measurements Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.	
7.	Preparation of buffer solutions: a. Sodium acetate-acetic acid b. Ammonium chloride-ammonium hydroxide	
8.	Measurement of the pH of buffer solutions and comparison of the values with theoretical values.	
9.	Section B: Organic Chemistry 1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.	
10.	2. Criteria of Purity: Determination of melting and boiling points.	
11.	3. Preparations: Mechanism of various reactions involved to be discussed.	
12.	4. Recrystallisation, determination of melting point and calculation ofquantitative yields to be done. a. Bromination of Phenol/Aniline b. Benzoylation of amines/phenols oxime and 2,4-	

	dinitrophenylhydrazone of aldehyde/ketone	
13.	Section B: Organic Chemistry 2. Purification of organic compounds by crystallization (from water and alcohol) and distillation.	
➢	Learner support Material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc
➢	Text books	*Khosla, B. D.; Garg, V. C. &Gulati, A. Senior Practical Physical Chemistry,R. Chand & Co.: New Delhi (2011).* 2. Mahan, B. H.(2013),University Chemistry, Narosa. 3. Barrow, G.M. (2006). Physical Chemistry, 5th Edition,McGraw Hill.
➢	Online resources	https://www.khanacademy.org/

Course Nomenclature	**Plant Ecology and Taxonomy Lab** **CO Practical-II**
Course Credit	1
Course Outcomes	After studying this course, a student will able to – CO1: Follow the distribution of flora in different realms interaction and learn interaction of biota and abiota. CO2: Perform quantitative analysis of herbaceous vegetation. CO3: Comparison of bulk density, porosity and rate of infiltration of water in soil. CO4: Revise the general taxonomic rules on plant classification. CO5: Develop the knowledge of vegetative and floral characters of the monocot and dicot families.
Practical List 1.	Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2.	Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3.	Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4.	Study of morphological adaptations of hydrophytes and xerophytes (four each).
5.	Study of biotic interactions of the following: Stem parasite (*Cuscuta)*, Root parasite (Orobanche), Epiphytes, Predation (Insectivorous plants)
6.	Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
7.	Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
8.	Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):Brassicaceae -*Brassica, Alyssum / Iberis;* Asteraceae -*Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax;* Solanaceae -*Solanum nigrum, Withania;* Lamiaceae -*Salvia, Ocimum*; Liliaceae -*Asphodelus / Lilium / Allium.*
9.	Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

➢	Learner support Material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books	1. Kormondy, E.J. (1996). *Concepts of Ecology*. Prentice Hall, U.S.A. 4th edition. 2. Sharma, P.D. (2010) *Ecology and Environment*. Rastogi Publications, Meerut, India. 8th edition.
➢	Online resources	Environmental Science Journals Guides library.plu.edu

Course Nomenclature	**Animal Diversity-II (Chordates) Lab CO Practical-III**	
Course Credit	1	
Course Outcomes	After studying this course, a student will able to – CO1: Sketch the specimens neatly and clearly. CO2: Perform the given dissections. CO3: Master the dissection and display skills. CO4: Revise the distinct characteristics of each and every given specimen. CO5: Design a photo album according to the given syllabus.	
Practical List 1.	Protochordata :Balanoglossus, Herdmania, Branchiostoma, Colonial Urochordata, Sections of Balanoglossus through proboscis and branchiogenital regions, Sections of Amphioxus through pharyngeal, intestinal and caudal regions. Permanent slide of Herdmania spicules	
2.	Agnatha Petromyzon, Myxine	
3.	Fishes Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas, Flat fish	
4.	Amphibia Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra	
5.	Reptilia Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus Key for Identification of poisonous and non-poisonous snakes	
6.	Aves Study of six common birds from different orders. Types of beaks and claw	
7.	Mammalia Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes, Erinaceous.	
8.	Mount of Placoid Scales of Scoliodon ,	
9.	Dissection of Scoliodon :Afferent &Efferent Branchial arteries of Scoliodon	
➢	Learner support Material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books	Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press. Pough H. Vertebrate life, VIII Edition, Pearson International.□ Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub.□ Co. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition.□ Jones and Bartlett Publishers Inc.
➢	Online resources	https://cec.nic.in/cec/curriculum_class (Animal Diversity - Practical)

Course Nomenclature	**Horticulture practices and post-harvest technology (Botany) Lab**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
1	**2 Hours**	**28 Hours**
Course Outcomes	After studying this course, a student will able to – CO1: Students can learn apply concepts of horticulture science, manage and improve plants and their products. CO2: Develop innovative agro- techniques to enhance the production and productivity of horticultural crops. CO3: Study of post harvest loss and their control.	
Practical List:	1. Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at Agri-Horticultural Society/ Agricultural Research stations/ State/Central Agricultural Universities/ IARI or other suitable locations. 2. Identification only (not work out) of ornamental and horticultural plants based on theoretical syllabus.	
	Learner support material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). *Embryology of Angiosperms*. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition. 2. Mauseth, J.D. (1988). *Plant Anatomy*. The Benjamin/Cummings Publisher, USA.
	Online resources	https://www.amazon.in>practical-manual

SEMESTER III

Course Nomenclature	**Solutions, Phase equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II**	
Course Credit	3	
Course Outcomes	***On satisfying the requirements of this course, students will have the knowledge and skills to:*** CO 1: Explain the concepts of different types of binary solutions-miscible, partially miscible and immiscible along with their applications. CO 2: Explain the thermodynamic aspects of equilibria between phases and draw phase diagrams of simple one component and two component systems. CO 3: Explain the factors that affect conductance, migration of ions and application of conductance measurement. CO 4: Understand different types of galvanic cells, their Nernst equations, measurement of emf, calculations of thermodynamic properties and other parameters from the emf measurements. CO 5: Understand and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses. CO 6: Design newer synthetic routes for various organic compounds	
Unit I		11 Hours
	Solutions Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperaturecompositioncurves of ideal and non-ideal solutions. Distillation of solutions.Leverrule.Azeotropes.Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation.Nernst distribution law and its applications, solvent extraction. **Phase Equilibrium** Phases, components and degrees of freedom of a system, criteria of phaseequilibrium.Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).	
Unit II		**11 Hours**
	Conductance Conductivity, equivalent and molar conductivity and their variation with dilution for	

	weak and strong electrolytes.Kohlrausch law of independent migration of ions.Transference number and its experimental determination using Hittorf and Moving boundary methods.Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base). **Electrochemistry** Reversible and irreversible cells.Concept of EMF of a cell.Measurement of EMF of a cell.Nernst equation and its importance.Types of electrodes.Standardelectrodepotential.Electrochemical series. Thermodynamics of a reversible cell, calculation ofthermodynamic properties: ΔG, ΔH and ΔS from EMF data. Calculation of equilibrium constant from EMF data.Concentration cells withtransference and without transference.Liquid junction potential and salt bridge.pH determination using hydrogen electrode and quinhydroneelectrode.Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).	
Unit III		**10 Hours**
	Carboxylic acids and their derivatives Carboxylic acids (aliphatic and aromatic) Preparation: Acidic and Alkaline hydrolysis of esters. Reactions: Hell – Vohlard - Zelinsky Reaction. **Carboxylic acid derivatives (aliphatic):** (Upto 5 carbons) Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion. Reactions: Comparative study of nucleophilicity of acyl derivatives. ReformatskyReaction, Perkin condensation. **Amines and Diazonium Salts** Amines (Aliphatic and Aromatic): (Upto 5 carbons) Preparation: from alkyl halides, Gabriel'sPhthalimide synthesis, Hofmann Bromamide reaction. Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation. **Diazonium salts**: Preparation: from aromatic amines. Reactions: conversion to benzene, phenol, dyes.	
Unit IV		10 Hours
	Amino Acids, Peptides and Proteins: Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis.Reactions of Amino	

	acids: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrintest. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme).Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonylandphthaloyl) & C-activating groups and Merrifield solid-phase synthesis. **Carbohydrates**: Classification, and General Properties, Glucose and Fructose (openchain and cyclic structure), Determination of configuration of monosaccharides,absolute configuration of Glucose and Fructose, Mutarotation, ascending anddescending in monosaccharides. Structure of disacharrides (sucrose, cellobiose,maltose, lactose) and polysacharrides (starch and cellulose) excluding their structureelucidation.	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. *Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).* 2. *Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).* 3. *Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry, CengageLearning India Pvt. Ltd.: New Delhi (2009).* 4. *Mahan, B.H. University Chemistry, 3rd Ed. Narosa (1998).* 5. *Petrucci, R.H. General Chemistry, 5th Ed., Macmillan Publishing Co.: NewYork (1985).* 6. *Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley* 7. *(India) Pvt. Ltd. (Pearson Education).* 8. *Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt.Ltd. (Pearson Education).*
	Online resources	•The Journal of Organic Chemistry •The Journal of Chemical Education •ScienceDirect •Journal of Physical Chemistry & Biophysics •Asian Journal of Organic Chemistry

Course Nomenclature	**Plant anatomy and embryology**	
Course Credit	3	
Course Outcomes	**After studying this course, student will be able to:** CO1: Describe plant cells, tissues and their functions. CO2: Explain plant anatomy and the other major disciplines of biology. CO3: Determine the function and morphology of pollen grains. CO4: Differentiate the structure and development of monocot and dicot embryo. CO5: Conclude the function and morphology of pollen grains. CO6: Develop and illustrate modern and fossil spores and pollen grains.	
Unit I		11 Hours
	Meristematic and permanent tissues Root and shoot apical meristems; Simple and complex tissues. Structure of dicot and monocot root stem and leaf.	
Unit II		**11 Hours**
	Secondary Growth Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood). **Adaptive and protective systems** Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.	
Unit III		**10 Hours**
	Structural organization of flower Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac. **Pollination and fertilization** Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.	
Unit IV		10 Hours
	Embryo and endosperm Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm relationship. **Apomixis and polyembryony** Definition, types and practical applications.	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). *Embryology of Angiosperms*. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition. 1. Mauseth, J.D. (1988). *Plant Anatomy*. The Benjamin/Cummings Publisher, USA
	Online resources	https://www.amazon.in>plant-anatomy https://www.sapnaonline.com>books

Course Nomenclature	**Fundamentals of Biochemistry**	
Course Credit	3	
Course Outcomes	After studying this course, student will be able to: CO1: To identify the requirement of mineral nutrition for plant growth CO2: To differentiate between the process of Photosynthesis, Respiration and Nitrogen metabolism. CO3: To examine Sensory photobiology CO4: To utilize the knowledge about Plant Growth hormones (Auxins, Gibberellins. Cytokinins, Ethylene).	
Unit I	**Carbohydrates**	11 Hours
	Carbohydrates Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates **Lipids** Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids	
Unit II	**Proteins**	**11 Hours**
	Proteins **Amino acids:** Structure, Classification and General properties of α-aminoacids; Physiological importance of essential and non-essential α-amino acids, **Proteins:** Bonds stabilizing protein structure; Levels of organization in proteins; Denaturation; Introduction to simple and conjugate proteins **Immunoglobulins:** Basic Structure, Classes and Function, Antigenic Determinants	
Unit III	**Nucleic Acids**	**10 Hours**
	Nucleic Acids Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids Cot Curves: Base pairing, Denaturation and Renaturation of DNA Types of DNA and RNA, Complementarity of DNA, Hpyo-Hyperchromaticity of DNA	
Unit IV	**Enzymes**	10 Hours
	Enzymes Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme Action	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.

		□□Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc. □□Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K. □□Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*, VI Edition, Cold Spring Harbor Lab.Press, Pearson Pub.
	Online resources	https://www.accessscience.com>content https://www.scitechnol.com>plant-physiology

Course Nomenclature	**Computational Biology**	
Course Credit	3	
Course Outcomes	**After studying this course, a student will able to –** CO1: List out different biological database and information they provide. CO2: Explain the different OMICS fields and their utility. CO3: Apply the importance of various concepts and tools for biological data. CO4: Analyze biological data using various softwares and tools for biological data analysis. CO5: Assess the biological data based on various concepts and tools. CO6: Assemble the result and identify the relationship between the biological data.	
Unit I	**Introduction to Bioinformatics**	11 Hours
	Introduction to Bioinformatics 5 Importance, Goal, Scope; Genomics, Transcriptomics, Systems Biology, Functional Genomics, Metabolomics, Molecular Phylogeny; Applications and Limitations of Bioinformatics	
Unit II	Biological Databases	11 Hours
	Biological Databases 10 Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISSPROT, TrEMBL, PDB); Metabolic pathway database (KEGG, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD)	
Unit III	Data Generation and Data Retrieval	**10 Hours**
	Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)	
Unit IV	**Basic Concepts of Sequence Alignment & Applications of Bioinformatics**	**10 Hours**
	Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences. Structural Bioinformatics (3-D protein, PDB), Functional genomics	

	(genome-wide and high throughput approaches to gene and protein function), Drug discovery method (Basic concepts)	
➢	**Learner support Material**	**NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.**
➢	**Text books**	• **Ghosh Z and Mallick B. (2008). Bioinformatics: Principles and Applications, Oxford University Press. .Pevsner J. (2009).** • **Bioinformatics and Functional Genomics, II Edition, Wiley Blackwell. Zvelebil, Marketa and Baum O. Jeremy (2008). Understanding Bioinformatics, Garland Science, Taylor and Francis Group, USA. Zar, Jerrold H. (1999).** • **Biostatistical Analysis, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc. USA Antonisamy, B., Christopher S. and Samuel, P. P. (2010).** • **Biostatistics: Principles and Practice. Tata McGraw Hill Education Private Limited, India. Pagana, M. and Gavreau, K. (2000). Principles of**
➢	**Online**	

Course Nomenclature	**Professional Communication Skills**

Course Credit	2	
Course Outcomes	After studying this course, a student will able to – CO1: Recall the abilities to express their feelings with proper vocabulary and pronunciation as well as write clearly, grammatically and syntactically correct sentences. CO2: Illustrate the texts closely and explicate texts written in a wide variety of forms, styles, structures, and modes. CO3: Determine students in achieving their career and lifelong goals by exhibiting balanced professional attitude in every walk of life. CO4: Compare and contrast primary and secondary documents, and advance their reading comprehension. CO5: Conclude the Persuade and convince. CO6: Develop the English language with propriety and effectiveness to develop an argument in a positive manner as well as develop acquaintance to various aspects to the fullest.	
Unit I	**Communication**	**7 Hours**
	Communication: Definition, barriers in communications, implication of communication, purpose of communication. Elements: Preparation, structure and personal interaction.	
Unit II	**Oral Communication**	**7 Hours**
	Oral Communication; Skill and techniques of Speaking, preparation of Speaking, Development of speaking skills, barriers to speaking, speaking structure, bridging points, time limitation/length of speech, Use of Humor. Visual Communication: Nature and scope of visual aids, Bolds, slides, overhead projector, cutouts	
Unit III	**Technical letter writing**	**7 Hours**
	Technical letter writing: Purpose of writing, space/layout, economy of words, use of verb/passive voice, type face (italics, bold, underline) and use of indentation. Report writing: Preparation, report structure (purpose of report, scope, shape, presentation of report, introduction of report, bridging of report, style of report, and index of report.	
Unit IV	**Public communication**	**7 Hours**
	Public communication: meetings, planning and discussion, opening procedure, timing, degree of formality, behavior, repetitive, Interviews (complexity of situation, preparation of thinking, preparation of setting, preparing the interview, style of interview).Group discussion. (to enhance oral communication and debates, speeches; addresses may be introduced for Public).	
➢	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books	1. Abelow, Daniel, Hilpert Edusin J. 1986 Communications in the Modern Corporate Environment, Prentice Hall , Englewood Cleffs. 2. Colay Jay, Communication Skills, PBS Publishers and Distributors, Bhopal. 3.Rao N. and Das R. P. ,2007 Himalaya Publication
➢	Online resources	https://www.illumine.co.uk>resources

Course Nomenclature	**APPLICATIONS OF GREEN CHEMISTRY**	
Course Credit	2	
Course Outcomes	By the end of the course, a student will be able to do the following – CO1: Explain the need and scope of green chemistry. CO-2: Understand and apply knowledge of the common metrics used in Green Chemistry applications. CO-3: apply knowledge of introductory green chemical synthetic methods, choice of solvents, atom economy, and sustainable raw materials. CO 4: Solve the problems by numerical methods. CO5: Analyze how to use solvent selection for pollution prevention CO 6: Develop and demonstrate knowledge pertaining to the background and development of Green Chemistry.	
Unit I	**INTRODUCTION**	**5 Hours**
	Introduction to Green Chemistry What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Tools of Green chemistry .Limitations/ Obstacles in the pursuit of the goals of Green Chemistry **Principles of Green Chemistry and Designing a Chemical synthesis :** Twelve principles of Green Chemistry with their explanations and examples	
Unit II	**Green chemistry in real world cases**	**10 Hours**
	The following Real world Cases in Green Chemistry should be discussed: Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis) 2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction 3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine) 4. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments. 5. Designing of Environmentally safe marine antifoulant. 6. Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments. 7. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn. 8. Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils 9. Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting	
Unit III	Pollution prevention	**10 Hours**
	Pollution Prevention (7 lectures) New Green and sustainable synthetic methods. An entry level overview to green synthetic methods, including waste reduction processes explained through use of	

	synthetic reactions commonly performed in industrial settings; amide bond formation, alkene reduction and deoxychlorination. Solvent use and alternatives to toxic solvents; mechanochemistry, ionic liquids, water, supercritical carbon dioxide (scCO2) and biorenewable solvents – applications to industrial settings. Solvent selection guides. Society reliant chemicals – commodity and fine chemicals. Reliance on their production from fossil fuels and possible alternative sources such as biorenewable lignocellulosic biomass Use of biorenewable platform chemicals in chemical synthesis, with case studies. Lignin and its potential.	
Unit IV	Future trends	**5 Hours**
	Future Trends in Green Chemistry (8L) Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.	
➢	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books	**Reference Books:** **Reference Books:** 1. Manahan S.E. (2005) Environmental Chemistry, CRC Press 2. Miller, G.T. (2006) Environmental Science 11th edition. Brooks/Cole 3. Mishra, A. (2005) Environmental Studies. Selective and Scientific Books, New Ryan, M.A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical Society, Washington DC (2002). ► Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore CISBN 978-93-81141-55-7 (2013).

Course Nomenclature	**Solutions, Phase equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II Lab**	
Course Credit	1	
Course Outcomes	**On satisfying the requirements of this course, students will have the knowledge and skills to:** **CO 1: Construction of phase diagram of different component system.** **CO 2: Perform of conductometric and pH metric titrations.**	

	CO 3: Demonstrate systematic Qualitative organic analysis. **CO 4: Manage the handling of different types of chromatography for separation and identification.** **CO5 : Organize the instrumentation for quantitative and qualitative determination.**
Practical List:	**Section A: Physical Chemistry** **Distribution** Study of the equilibrium of one of the following reactions by the distribution method: $I_2(aq) + I^-(aq) \rightarrow I_3^-(aq)$ $Cu^{2+}(aq) + xNH_2(aq) \rightarrow [Cu(NH_3)x]^{2+}$
	Phase equilibria a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves. b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it. c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.
	Conductance I. Determination of cell constant II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid. III. Perform the following conductometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base
	Potentiometry Perform the following potentiometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Potassium dichromate vs. Mohr's salt ***Section B: Organic Chemistry*** **I** Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic,ketonic, amide, nitro, amines) and preparation of one derivative. **II** 1. Separation of amino acids by paper chromatography 2. Determination of the concentration of glycine solution by formylation method. 3. Titration curve of glycine

	4. Action of salivary amylase on starch 5. Effect of temperature on the action of salivary amylase on starch. 6. Differentiation between a reducing and a non-reducing sugar.	
	Learner support material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	*Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G.,Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.* *a) Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman,1960.* *b) Khosla, B. D.; Garg, V. C. &Gulati, A. Senior Practical Physical Chemistry,R. Chand & Co.: New Delhi (2011).* *c) Ahluwalia, V.K. &Aggarwal, R. Comprehensive Practical Organic* *d) Chemistry, Universities Press.*
	Online resources	Science Direct •Journal of Physical Chemistry & Biophysics

Course Nomenclature	**Plant anatomy and embryology Lab**	
Course Credit	1	
Course Outcomes	CO1: Follow the conceptual knowledge of anatomy of plants, their adaptations and associations in relation to their environment. CO2: Organize the basic concepts of reproductive botany. CO3: Illustrate about double fertilization and their significance. CO4: Differentiate between the Structure and development of dicot and monocot embryos. CO5: Assess about the production of Synthetic seeds & significance.	
Practical List:	1. Study of meristems through permanent slides and photographs. 2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs) 3. Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides). 4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides). 5. Leaf: Dicot and Monocot leaf (only Permanent slides). 6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem). 7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides). 8. Types of ovules: anatropous, orthotropous, circinotropous,	

	amphitropous/ campylotropous. 9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs). 10. Ultrastructure of mature egg apparatus cells through electron micrographs. 11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens). 12. Dissection of embryo/endosperm from developing seeds. 13. Calculation of percentage of germinated pollen in a given medium.	
	Learner support material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	*e)* 1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). *Embryology of Angiosperms*. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition. *f)* 2. Mauseth, J.D. (1988). *Plant Anatomy*. The Benjamin/Cummings Publisher, USA. 5. S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House
	Online resources	https://www.amazon.in>practical-manual

Course Nomenclature	**Fundamentals of Biochemistry Lab**	
Course Credit	1	
Course Outcomes	After studying this course, a student will able to – CO1: Identify the economic products related to cereals, legumes, sugar and starch, spices, beverages, oil and fats, drug yielding plants and fibres, wood producing plants and write Botanical name, family and uses.	
Practical List:	1. Qualitative tests of functional groups in carbohydrates, proteins and lipids. 2. Paper chromatography of amino acids.	

	3. Action of salivary amylase under optimum conditions. 4. Effect of pH, temperature and inhibitors on the action of salivary amylase. 5. Demonstration of proteins separation by SDS-PAGE.	
	Learner Support Material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc. Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.
	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	**Computational Biology Lab** DSE Practical-III	
Course Credit	1	
Course Outcomes	**After studying this course, a student will able to –** CO1: Trace the information for various biological databases. CO2: Execute and understand the various formats of biological data CO3: Demonstrate the tools of data interpretation and format conversion. CO4: Formulate the sequence information stored within. CO5: Design and develop various types of biological data.	
Practical List 1	To perform pair-wise alignment of sequences (BLAST) and interpret the output	
2	To perform a ―two-sample t- test‖ for a given set of data	

3	To learn graphical representations of statistical data with the help of computers (e.g. MS Excel	
4	Retrieval of nucleotide and protein sequences from the databases	
5	Predict the structure of protein from its amino acid sequence.	
6	To perform pair-wise alignment of sequences (BLAST) and interpret the output	
7	Translate a nucleotide sequence and select the correct reading frame of the polypeptide from the output sequences	
➢	**Learner support Material**	**NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.**
➢	**Text books**	• **Ghosh Z and Mallick B. (2008). Bioinformatics: Principles and Applications, Oxford University Press. .Pevsner J. (2009).** • **Bioinformatics and Functional Genomics, II Edition, Wiley Blackwell. Zvelebil, Marketa and Baum O. Jeremy (2008). Understanding Bioinformatics, Garland Science, Taylor and Francis Group, USA. Zar, Jerrold H. (1999).** • **Biostatistical Analysis, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc. USA Antonisamy, B., Christopher S. and Samuel, P. P. (2010).** • **Biostatistics: Principles and Practice. Tata McGraw Hill Education Private Limited, India. Pagana, M. and Gavreau, K. (2000).**
➢	**Online**	**Guides.library.plu.edu>biol 462**

SEMESTER IV

Course Nomenclature	**Transition Metal & Coordination chemistry, States of Matter & Chemical Kinetics**	
Course Credit	3	
Course Outcomes	***On satisfying the requirements of this course, students will have the knowledge and skills to:*** CO 1: Understand the general characteristics of the d block elements and the bonding in coordination compounds. CO 2: Explain the chemistry of organ metallic compounds, metal carbonyls and metal clusters.	

	CO 3: Apply the concept of rate laws e.g., order, molecularity, half-life and their determination on chemical reaction To have an idea about the different types of catalysis and their mechanisms. CO 4: Classify ideal and real gases on the basis of gas law and critical phenomenon. CO 5: Evaluate the properties of liquids especially surface tension and viscosity. CO 6: Set up symmetry elements,	
Unit I		11 Hours
	Transition Elements and Lanthanoids and Actinoids: Transition Elements (3d series): General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. **Lanthanoids and actinoids**: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).	
Unit II		**11 Hours**
	Coordination Chemistry and Crystal Field Theory: **Coordination Chemistry, Valence Bond Theory (VBT)**: Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT.IUPAC system of nomenclature. **Crystal Field Theory**: Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry.Factors affecting the magnitude of D. Spectrochemical Series.Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry.Jahn-Teller distortion, Square planar coordination.	
Unit III		10 Hours
	State of Matter: **Kinetic Theory of Gases**: Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals Equation.Andrews isotherms of CO2 Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions.Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only). **Liquids**: Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer.Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only). **Solids**: Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of	

	constancy of interfacial angles, Law of rational indices. Miller indices.X–Ray diffraction by crystals, Bragg's law.Structures of NaCl, KCl and CsCl (qualitative treatment only).Defects in crystals.Glasses and liquid crystals.	
Unit IV		**10 Hours**
	Chemical Kinetics: The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants).Half–life of a reaction.General methods for determination of order of a reaction.Concept of activation energy and its calculation from Arrhenius equation. **Theories of Reaction Rates**: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).	
•	Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF
•	Text books	• Lee., J. D. A new Concise Inorganic Chemistry, Pearson Education. Page 20 of 96 B.Sc. Physical Science • Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010),Shriver and Atkin's Inorganic Chemistry, Oxford. • Miessler, G. L.; Tarr, D.A.(2014), Inorganic Chemistry, Pearson. • Castellan, G. W.(2004),Physical Chemistry, Narosa. 5. Kapoor, K.L. (2015),A Textbook of Physical Chemistry, Vol.1, 6th Edition, McGraw Hill Education. • Kapoor, K.L. (2015),A Textbook of Physical Chemistry, Vol.5, 3rd Edition, McGraw Hill Education. • B.R.Puri, L.R.Sharma, M.S.Pathania, (2017),Principles of Physical Chemistry, Vishal Publishing Co.*Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).* • *Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).* • *Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).* • *Cotton, F.A. &Wilkinson, G. BasicInorganic Chemistry, Wiley.* • *Shriver, D.F. &Atkins, P.W. Inorganic Chemistry, Oxford University Press.* • *Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd. Rodgers, G.E. Inorganic &Solid State Chemistry, Cengage Learning India Ltd., 2008.*
•	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	**Plant physiology and metabolism**	
Course Credit	3	
Course	After studying this course, student will be able to:	

Outcomes	CO1: Define plant-water relations, water potential and its components, water absorption by roots and aquaporins. CO2: Explain antitranspirants and mechanism of stomatal movement. CO3: Determine the Criteria for essentiality and mineral deficiency symptoms. CO4: Characterize about the transport of ions across cell membrane, passive absorption, electrochemical gradient. CO5: Conclude between the process of Photosynthesis, Respiration and Nitrogen metabolism. CO6: Develop knowledge about Plant Growth hormones (Auxins, Gibberellins. Cytokinins, Ethylene).	
Unit I		11 Hours
	Plant-water relations Importance of water, water potential and its components; Mechanism of water absorption. Transpiration and its significance; Mechanism of stomatal opening and closing. Factors affecting transpiration, ascent of sap. Root pressure and guttation. **Mineral nutrition** Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps. Hydroponics and its significance. **Translocation in phloem** Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading	
Unit II		**11 Hours**
	Photosynthesis Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbonfixation; Photorespiration. **Respiration** Glycolysis, anaerobic respiration, Respiratory quotient TCA cycle; Oxidative phosphorylation, Glyoxylate,Oxidative Pentose Phosphate Pathway	
Unit III		**10 Hours**
	Enzymes Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition. **Nitrogen metabolism** Biological nitrogen fixation; Nitrate and ammonia assimilation. **Plant growth regulators** Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene, salicylic acid, brassinolide, jasmonic acid and strigolactone. Industrial application of plant metabolic pathway.	
Unit IV		10 Hours
	Plant response to light and temperature Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization. Seed germination and dormancya. Fruit ripening, senescence and abscission.	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. Taiz, L., Zeiger, E., (2010). *Plant Physiology*. Sinauer Associates Inc., U.S.A. 5thEdition. 2.Hopkins, W.G., Huner, N.P., (2009). *Introduction to Plant Physiology*. John Wiley &Sons, U.S.A. 4thEdition*Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.* 3.Bajracharya, D., (1999). *Experimentsin Plant Physiology- A*

		Laboratory Manual. Narosa Publishing House, New Delhi
	Online resources	https://www.accessscience.com>content https://www.scitechnol.com>plant-physiology

Course Nomenclature	**Genetics and Evolutionary Biology**	
Course Credit	3	
Course Outcomes	After studying this course, student will be able to: CO1: Recall the gene theory and Mendelian principles of inheritance. CO2: Explain the concept of multiple alleles and incomplete inheritance.X CO3: Calculate the recombination frequency and other related terms. CO4: Subdivide the evolutionary theories on the basis of evidences. CO5: Predict the type of cross in given questions. CO6: Design various types of one-factor and two-factor cross and solve the same.	
Unit I		**11 Hours**
	Introduction to Genetics Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information **Mendelian Genetics and its Extension**	

	Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance	
Unit II		**11 Hours**
	Linkage, Crossing Over and Chromosomal Mapping Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics - an alternative approach to gene mapping	
Unit III		10 Hours
	History of Life and Introduction to Evolutionary Theories Major Events in History of Life, Lamarckism, Darwinism, Neo-Darwinism **Direct Evidences of Evolution** Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse	
Unit IV		10 Hours
	Processes of Evolutionary Change Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection **Species Concept, Macro-evolution, Extinction** Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric), Macro-evolutionary Principles (example: Darwin's Finches), Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	• Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India. • Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc. • Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings. • Russell, P. J. (2009). *Genetics- A Molecular Approach.*III Edition. Benjamin Cummings. • Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction toGenetic Analysis*. IX Edition. W. H.Freeman and Co. • Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing • Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press. • Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and

		Bartlett Publishers • Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings. • Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.
	Online resources	https://www.genome.gov/10000464/online-genetics-educationresources http://faculty.virginia.edu/evolutionlabs/online-Resources.html https://cec.nic.in/cec/curriculum_class (Genetica and Evolution)

Course Nomenclature	**APPLICATIONS OF COMPUTERS IN CHEMISTRY**	
Course Credit	3	
Course Outcomes	By the end of the course, a student will be able to do the following – CO1: Understand about the basics of computer programming , creating and application of spreadsheet software (MS Excel) CO-2: Explain the concept of molecular modeling. CO-3: Select a computational tool that is capable of solving a particular chemistry problem. Such tools include MATLAB, MS Excel CO 4: Solve the problems by numerical methods. CO5: Implement key numerical routines for: – solutions of differential calculus, integral and simultaneous equation. CO 6: Can perform statistical analysis of data.	
Unit I	**Basics**	**11 Hours**
	Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.	
Unit II	**Numerical methods**	**11 Hours**
	Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi. *Differential calculus:* Numerical differentiation. *Integral calculus:* Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values.	

	Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss-Siedal method. *Interpolation, extrapolation and curve fitting:* Handling of experimental data. *Conceptual background of molecular modelling:* Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods.	
Unit III	Fundamentals of Organic Chemistry	**10 Hours**
	Molecular Mechanics and Minimization of Multi-Dimensional Functions We will begin with molecular mechanics and the methods used to find the minimum-energy structure of a molecule. **Initial Value Problems and Molecular Dynamics** The basic aspects of the integration of differential equations will be covered. We will then use Cerius2 to run molecular trajectories and predict thermodynamic functions. The problems associated with finding the global minimum of a large molecule will then be discussed and the simulated annealing minimization procedure will be introduced.	
Unit IV	Aliphatic Hydrocarbons	**10Hours**
	Modeling of Data The fundamentals of numerical mathematics will be introduced by fitting experimental data to both linear and nonlinear models. The linear least squares problem will allow us to review the basics of matrix manipulations and the computer solution of linear equations. We will then discuss approaches to the fitting of nonlinear models, focussing on the Levenberg-Marquadt algorithm, error estimation and statistical estimates of the robustness of the models.	
➢	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books	**Reference Books:** • 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. • Noggle, J. H. *Physical chemistry on a Microcomputer.* Little Brown & Co. (1985). • Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).
➢	Online resources	

Course Nomenclature	**Transition Metal & Coordination Chemistry, State of Matter & Chemical Kinetics lab Practical-II**	
Course Credit	1	
Course Outcomes	***On satisfying the requirements of this course, students will have the knowledge and skills to:*** **CO 1: Follow the process Semi-micro qualitative analysis of mixtures of ionic species.** **CO 2: Perform Estimate the amount of nickel, (i) Mg^{2+} or (ii) Zn^{2+} and total hardness .** **CO 3: Calibrate the viscometer and Surface tension.** **CO 4: Determination of the relative and absolute viscosity and Chemical Kinetics** **CO5 : Develop method to determination of rate of reaction.**	
Practical List	Section A: Inorganic Chemistry: 1.Semi-micro qualitative analysis (using H_2S or other methods) of mixtures - not more than four ionic species (two anions and two cations, excluding insoluble salts) out of the following:	
	2. Cations : NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+},Ca^{2+}, K^+	
	3. Anions : CO_3^{2-}, S^{2-}, SO^{2-}, $S_2O_3^{2-}$, NO^{3-}, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}, PO_4^{3-},BO_3^{3-}, $C_2O_4^{2-}$, F^-	
	4. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.	
	5. Estimation of (i) Mg^{2+}or (ii) $Zn^{2+}$by complexometric titrations using EDTA.	
	6. Estimation of total hardness of a given sample of water by complexometric titration.	
	Section B: Physical Chemistry: 7. Surface tension measurement (use of organic solvents excluded).	
	8. Determination of the surface tension of a liquid or a dilute solution using an stalagmometer.	
	9. Study of the variation of surface tension of a detergent solution with concentration.	
	10. Viscosity measurement (use of organic solvents excluded).	
	11. Determination of the relative and absolute viscosity of a liquid or dilutesolution using an Ostwald's viscometer.	
	12. Study of the variation of viscosity of an aqueous solution with concentration of solute.	
	13. Chemical Kinetics : Study the kinetics of the following reactions. Initial rate method: Iodide-persulphate reaction	
	14. Acid hydrolysis of methyl acetate with hydrochloric acid.	
	15. Saponification of ethyl acetate.	
	16. Compare the strengths of HCl and $H_2SO_4$by studying kinetics ofhydrolysis of methyl acetate	
	Learner support Material	Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	• Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.

		• Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009. • Khosla, B. D.; Garg, V. C. &Gulati, A. Senior Practical Physical Chemistry,R. Chand &Co.: New Delhi (2011).
	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	**Plant physiology and metabolism Lab**	
Course Credit	1	
Course Outcomes	After studying this course, a student will able to – CO1: Understand Water relation of plants with respect to various physiological processes. CO2: Explain chemical properties and deficiency symptoms in plants CO3: Classify aerobic and anaerobic respiration CO4: Explain the significance of Photosynthesis and respiration CO5: Assess dormancy and germination in plants	
Practical List:	1. Determination of osmotic potential of plant cell sap by plasmolytic method.	
	2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.	
	3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.	
	4. Demonstration of Hill reaction.	
	5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.	
	6. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.	
	7. Comparison of the rate of respiration in any two parts of a plant.	
	8. Separation of amino acids by paper chromatography.	
	9. Demonstration experiments (any four): a) Bolting b) Effectof auxins on rooting c) Suction due to transpiration d) R.Q. e) Respiration in roots	
	Learner support material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1.Taiz, L., Zeiger, E., (2010). *Plant Physiology*. Sinauer Associates Inc., U.S.A. 5thEdition. 2.Hopkins, W.G., Huner, N.P., (2009). *Introduction to Plant Physiology*. John Wiley &Sons, U.S.A. 4thEdition*Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.* • 3.Bajracharya, D., (1999). *Experimentsin Plant Physiology- A*

		Laboratory Manual. Narosa Publishing House, New Delhi
	Online resources	https://www.accessscience.com>content https://www.scitechnol.com>plant-physiology

Course Nomenclature	**Genetics & Evolutionary Biology Lab**	
Course Credit	1	
Course Outcomes	After studying this course, a student will able to – CO1: Measure the linkage and recombination frequencies using the data. CO2: Assemble limbs of rabbit and horse. CO3: Master the skill of differentiating between normal and abnormal human karyotypes. CO4: Revise the phylogeny of horse with diagrams. CO5: Create a data set of various types of anomalies in human karyotypes.	
Practical List:	1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.	
	2. Study of Linkage, recombination, gene mapping using the data.	
	3. Study of Human Karyotypes (normal and abnormal).	
	4. Study of fossil evidences from plaster cast models and pictures.	
	5. Study of homology and analogy from suitable specimens/ pictures.	
	6. Charts:Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors.Darwin's Finches with diagrams/ cut outs of beaks of different species.	
	7. Visit to Natural History Museum and submission of report.	
	Learner support material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. Hall, B. K. and Hallgrimsson, B. (2008). *Evolution.* IV Edition. Jones and Bartlett Publishers 2. Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings. 3. Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.
	Online resources	https://www.genome.gov/10000464/online-genetics-educationresources http://faculty.virginia.edu/evolutionlabs/online-Resources.html

Course Nomenclature	**APPLICATIONS OF COMPUTERS IN CHEMISTRY Lab**	
Course Credit	1	
Course Outcomes	By the end of the course, a student will be able to do the following – CO1: To follow the concept to Creating mailing labels Using Label Wizard, generating labels in MS WORD CO-2: to organize a sequence for solving roots of equation. CO-3: To demonstrate numerical integration for many chemistry equations. CO 4: To create and retrieve the information of a drug and its adverse effects using online tools CO5: To perform Matrix operations by Gauss-Siedel method in colourimetry.	
Unit I	**Basics**	
	Computer programs based on numerical methods for: 1. Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid). 2. Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations). 3. Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values. 4. Matrix operations. Application of Gauss-Siedel method in colourimetry. 5. Simple exercises using molecular visualization software. 6. Create an HTML web page to show personal information. 7. Retrieve the information of a drug and its adverse effects using online tools 8. Creating mailing labels Using Label Wizard, generating labels in MS WORD 9. Creating invoice table using MS Access	
➢	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books	• McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008). • Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005). • Steiner, E. The Chemical Maths Book Oxford University Press (1996). • Yates, P. Chemical Calculations. 2nd Ed. CRC Press (2007). • Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman

		(2007) Chapters 3-5. • Noggle, J. H. *Physical Chemistry on a Microcomputer.* Little Brown & Co. (1985). • Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).
➢	Online resources	

Course Nomenclature	**Intellectual Property Rights**	
Course Credit	2	
Course Outcomes	After studying this course, student will be able to: CO1: Explain the basics of intellectual property rights with special reference to Indian laws and its practices CO2: Summarize the different forms of intellectual property protection in terms of their key differences and similarities CO3: Determine the overview of the statutory, procedural and case law underlining these processes and their interplay with litigation. CO4: Encourage and protect innovation in the form of intellectual property rights. CO5: Assess the Information Technology Related Intellectual Property Rights. CO6: Develop the Biotechnology and Intellectual Property Rights.	
Unit I		**7 Hours**
	Introduction to intellectual property right (IPR) Concept and kinds. Economic importance.IPR in India and world: Genesis and scope, some important examples. IPR and WTO(TRIPS,WIPO). **Patents**Objectives,Rights,PatentAct1970 and its amendments. Procedureofobtainingpatents, Workingofpatents.Infringement **Copyrights** Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.	
Unit II		**7 Hours**
	Trademarks Objectives, Types, Rights, Protection of goodwill, Infringemnt, Pas sing off, Defences, Domain name. **Geographical Indications** Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position. **Protection of Traditional Knowledge** Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generisregime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library	
Unit III		**7 Hours**
	Industrial Designs Objectives, Rights, Assignments, Infringements, Defences of Design Infringement **Protection of Plant Varieties** Plant Varieties Protection-Objectives, Justification,	

	International Position, Plant varieties protection in India. Rights off armers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers Rights Act, 2001.	
Unit IV		**7 Hours**
	Information Technology Related Intellectual Property Rights Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection **Biotechnology and Intellectual Property Rights.** Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. N.K.Acharya:*Textbook on intellectual property rights,* Asia Law House (2001). 2. Manjula Guru &M.B.Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003). 3. P.Ganguli, *Intellectual Property Rights: Unleashing the Knowledge Economy*, Tata McGraw-Hill (2001). 4. Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell*, West Group Publishers (2000). 5. JayashreeWatal,*Intellectual property rights in the WTO and developing countries*, Oxford University Press, Oxford.
	Online resources	https://www.stopfakes.gov>online-intellectual oxforde.com>view>acrefore

Course Nomenclature	Quantities Aptitude	
Course Credit	2	
Course Outcomes	After studying this course, a student will able to – CO1: Describe formation of Equation related to number and ages problem. CO2: Explain Time and work ,Profit and loss related problem. CO3: Apply the Concept of a Number series , and calendar related problem CO4: Characterizations of various types of probability. CO5: Know about Bays theorem and its application. CO6 Develop the Structure of pie chart, bar graph etc.	
Unit I	Arithmetic Ability	
	Percentage, Problems on Numbers and Ages, Ratio, Average, Fraction, Square and Cube. Time & Work, Time & Distance, Profit & Loss , Simple and Compound Interest	
Unit II	Series Completion	

	Number series, Alphabet series and Alpha-Numeric series, Calendar, Syllogism, Cube, Mirror image, Blood relation.	
Unit III	Probability-	
	Sample space , PMF, PDF, Conditional probability, Bays theorem	
Unit IV	Data Interpretation	
	Tabulation, Pie chart, Line Graph,Ogive	
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.	

SEMESTER V		

Course Nomenclature	**Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy**	
Course Credit	3	
Course Outcomes	CO1.To get a deep insight into the various spectroscopic methods used for the characterization of organic compounds. · CO2. Enable the students to elucidate the structure of compounds by analyzing the spectral data CO3.To know the basics principle of different techniques employed in molecular spectroscopy · CO4.To study the origin, instrumentation and important applications of Microwave, IR, Raman, UV, techniques CO5.To understand the functions and applications of bioorganic compounds · CO6.To have a basic idea about nuclear Chemistry and its applications·	
Unit I	**Chemistry of 3d metals**	11 Hours
	Chemistry of 3d metals Oxidation states displayed by Cr, Fe, Co, Ni and Co.A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$. **Organometallic Compounds** Definition and Classification with appropriate examples based on nature of metalcarbonbond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals.p-acceptorbehaviour of carbon monoxide. Synergic effects (VB approach), (MO diagram of CO can be referred to for synergic effect to IR frequencies).	
Unit II	**Bio-Inorganic Chemistry**	**11 Hours**
	Bio-Inorganic Chemistry A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones). **Section B: Organic Chemistry-4**	
Unit III	**Polynuclear and heteronuclear aromatic compounds**	**10 Hours**

	Polynuclear and heteronuclear aromatic compounds: Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene , Furan, Pyrrole, Thiophene, and Pyridine. **Active methylene compounds:** Preparation: Claisen ester condensation. Keto-enoltautomerism.Reactions: Synthetic uses of ethylacetoacetate (preparation of non-heteromolecules havingupto 6 carbon)..	
Unit IV	**Application of Spectroscopy to Simple Organic Molecules**	10 Hours
	Application of Spectroscopy to Simple Organic Molecules Application of visible, ultraviolet and infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, λmax&εmax, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and woodward rules for calculating l max of conjugated dienes and α,β– unsaturated compounds. **Infrared radiation and types of molecular vibrations, functional group and fingerprintregion. Ir spectra of alkanes, alkenes and simple alcohols (inter and intramolecularhydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >c=o stretching absorptions.**	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. *James E. Huheey, Ellen Keiter& Richard Keiter: Inorganic Chemistry:Principles of Structure and Reactivity, Pearson Publication.* 2. *G.L. Miessler& Donald A. Tarr: Inorganic Chemistry, Pearson Publication.* 3. *J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.* 4. *F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley & Sons.* 5. *I.L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S.* 6. *John R. Dyer: Applications of Absorption Spectroscopy of OrganicCompounds, Prentice Hall.* 7. *R.M. Silverstein, G.C. Bassler& T.C. Morrill: Spectroscopic Identification ofOrganic Compounds, John Wiley & Sons.* 8. *R.T. Morrison & R.N. Boyd: Organic Chemistry, Prentice Hall.* 9. *Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, OrientLongman.* 10. *ArunBahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.*
	Online resources	•The Journal of Organic Chemistry •The Journal of Chemical Education •ScienceDirect •Journal of Physical Chemistry & Biophysics •Asian Journal of Organic Chemistry

Course Nomenclature	**Cell and Molecular Biology**	
Course Credit	3	
Course Outcomes	On completion of this course, the students will be able to; CO1: Summarize knowledge about "Cell Science. CO2: Explain Cell wall Plasma membrane, Cell organelles and cell division. CO3: Discuss the scope and importance of molecular biology. CO4: Analyse the structures and chemical properties of DNA and RNA through various historic experiments CO5: Evaluate the main types of prokaryotes through their grouping abilities and their characteristic CO6: Formulate the experiments establishing central dogma and genetic code.	
Unit I		11 Hours
	Techniques in Biology: Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis.	
Unit II		**11 Hours**
	Cell as a unit of Life The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components. **Cell Organelles:** Mitochondria: Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA.Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA.ER, Golgi body & Lysosomes: Structures and roles.Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis.Nucleus: Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).	
Unit III		**10 Hours**
	Cell Membrane and Cell Wall The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall. **Cell Cycle** Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.	
Unit IV		10 Hours
	Genetic materialDNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material.DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi–conservative, semi discontinuous RNA priming, Ǿ (theta) mode of replication, replication of linear, ds-	

	DNA, replicating the 5′ end of linear chromosome including replication enzymes. **Transcription (Prokaryotes and Eukaryotes)**Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code. **Regulation of gene expression:** Prokaryotes:Lac operon and Tryptophan operon ; and in Eukaryotes.	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	Karp, G. 2010. *Cell and Molecular Biology*: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc. **2.** De Robertis, E.D.P. and De Robertis, E.M.F. 2006. *Cell and Molecular Biology*. 8th edition. Lippincott Williams and Wilkins, Philadelphia. **4.** Cooper, G.M. and Hausman, R.E. 2009. The *Cell: A Molecular Approach*. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. *The World of the Cell.* 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
	Online resources	https://www.stopfakes.gov>online-intellectual oxforde.com>view>acrefore

Course Nomenclature	**Ethology and Biostatistics**	
Course Credit	3	
Course Outcomes	After studying this course, student will be able to: CO1: Apprentice the concept of ethology and brain behavior. CO2: Understand the animal behavior and its historical perception. CO3: collection, interpretation and presentation of statistical data. CO4: Understand the concept of Probability and Correlation	
Unit I	**Introduction &Concepts of Ethology**	11 Hours
	• Introduction and history of Ethology • Concepts of Ethology: Fixed action pattern, sign stimulus, innate releasing mechanism, action specific energy, motivation imprinting and learning. • Methods of studying brain behavior: Neuroanatomical, neurophysiological and neurochemical techniques. • Pheromones and their role in alarm spreading,	
Unit II	**Acquired behavior &Social behaviour**	**11 Hours**
	• Acquired behaviour (Learnt behaviour): Imprinting, Habituation, Trial and Error learning. **Social behavior:** • Social behaviour in Insects – Honey Bees and Termites • **Biological rhythms:** Definition, Circadian rhythm and Biological clock. • **Communication in Animals:** Dances of Honey Bees	
Unit III	**Measures of central tendency**	10 Hours
	Measures of central tendency, Measures of dispersion; skewness, kurtosis;	
Unit IV	**Probability and Correlation**	**10 Hours**
	Elementary Probability andbasic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences;	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	• □ Ahsan J. and Sinha S.P. (1983). A handbook on economic zoology, 9th edition S. chand& co. Ltd. • Breed M.D. and Moore J. (2015). Animal behaviour, Academic Press.

		• Manning A., Dawkins M.S. (2012). An introduction to animal behaviour, Cambridge University press. • Mathur R. (2010). Animal behaviour, Rastogi publications. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc
	Online resources	https://www.accessscience.com>content

Course Nomenclature	**Economic Botany**	
Course Credit	3	
Course Outcomes	After studying this course, student will be able to: CO1: Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems CO2: Develop critical understanding on the evolution of concept of organization of apex new crops/varieties, importance of germplasm diversity, issues related to access and ownership CO3: Develop a basic knowledge of taxonomic diversity and important families of useful plants CO4: Increase the awareness and appreciation of plants &plant products encountered in everyday life CO5: Appreciate the diversity of plants and the plant products in human use. CO6: Build the knowledge about cultivation of economic important crops.	
Unit I		**11 Hours**
	Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity. **Cereals**: Wheat and Rice (origin, morphology, processing &uses); Brief account of millets.	
Unit II		**11 Hours**
	Legumes: Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem. **Sources of sugars and starches**: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation &uses.	
Unit III		**10 Hours**
	Spices: Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper **Beverages**: Tea, Coffee (morphology, processing &uses) **Sources of oils and fats**: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family &uses).	

	Essential Oils: General account, extraction methods, comparison with fatty oils &their uses.	
Unit IV		**10 Hours**
	Natural Rubber: Para-rubber: tapping, processing and uses. **Drug-yielding plants**: Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis; Tobacco (Morphology, processing, uses and health hazards). Timber plants; General account with special reference to teak and pine. **Fibers**: Classification based on the origin of fibers; Cotton and Jute (morphology, extraction and uses)	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan &Co. New Delhi, India. 2. Wickens, G.E. (2001). Economic Botany: Principles &Practices. Kluwer Academic Publishers, The Netherlands. 3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones &Bartlett Publishers.
	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	**Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy Lab**	
Course Credit	1	
Course Outcomes	On completion of this lab course: CO 1: Follow the procedure of chromatography techniques. CO2: Correlate various parameters of theory with practical applications. CO 3: Perform Gravimetric analysis CO 4: Demostrate of new inorganic complexes. CO5: Develop the identification of organic compounds.	
Practical List:	**Section A: Inorganic Chemistry**	
	Paper chromatographic separation of Fe^{3+}, $A1^{3+}$ and Cr^{3+} or	
	Paper chromatographic separation of Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+}	
	2. Preparation of any two of the following complexes and measurement of their	
	conductivity:	
	(i) tetraamminecarbonatocobalt (III) nitrate	
	(ii) tetraamminecopper (II) sulphate	
	(iii) potassiumtrioxalatoferrate (III) trihydrate	
	Compare the conductance of the complexes with that of M/1000 solution of NaCl, $MgCl_2$ and $LiCl_3$.	
	Section B: Organic Chemistry	
	Systematic Qualitative Organic Analysis of Organic Compounds possessing	
	monofunctional groups (-COOH, phenolic, aldehydic,ketonic, amide, nitro preparation of one derivative.	
	Learner support material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. *A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.* 2. *A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.* 3. *Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G.,Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.* *4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman,1960.*
	Online resources	•The Journal of Physical Chemistry •The Journal of Organic Chemistry •The Journal of Chemical Education •ScienceDirect •Asian Journal of Organic Chemistry •Bioinorganic Chemistry and Applications

Course Nomenclature	**Cell and Molecular Biology Lab**	
Course Credit	1	
Course Outcomes	CO1: Follow the cell and molecular techniques. CO2: Build the tools and techniques employed in the study of cell. CO3: Demonstrate the plasmolysis and deplasmolysis on *Rhoeo* leaf. CO4: Formulate the cell size (either length or breadth/diameter) by micrometry CO5: Design temporary mounts and permanent slides of satges of cell cycle.	
Practical List:	1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs. 2. Study of the photomicrographs of cell organelles 3. To study the structure of plant cell through temporary mounts. 4. To study the structure of animal cells by temporary mounts- squamous epithelial cell and nerve cell. 5. Preparation of temporary mounts of striated muscle fiber 6. To prepare temporary stained preparation of mitochondria from striated muscle cells /cheek epithelial cells using vital stain Janus green. 7. Study of mitosis and meiosis (temporary mounts and permanent slides). 8. Study the effect of temperature, organic solvent on semi permeable membrane. 9. Demonstration of dialysis of starch and simple sugar. 10. Study of plasmolysis and deplasmolysis on Rhoeo leaf. 11. Measure the cell size (either length or breadth/diameter) by micrometry. 12. Study the structure of nuclear pore complex by photograph (from Gerald Karp)Study of special chromosomes (polytene & lampbrush) either by slides or photographs. 13. Study DNA packaging by micrographs. 14. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.	
	Learner support material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India. 2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	**Ethology and Biostatistics Lab**	
Course Credit	1	
Course Outcomes	After studying this course, a student will able to – CO1: Understand the animal behavior and its historical perception. CO2: collection, interpretation and presentation of statistical data	
Practical List:	1 Life history of silkworm, honeybee and lac insect. 2. Food preference study in Tribolium 3. Geotaxis behaviour in Earthworm. 4.Phototaxis behaviour in insect larvae 5.Graphical representation of data 6.Correlation &Regression 7. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.	
	Learner support material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	• Ahsan J. and Sinha S.P. (1983). A handbook on economic zoology, 9th edition S. chand& co. Ltd. • Breed M.D. and Moore J. (2015). Animal behaviour, Academic Press. • Manning A., Dawkins M.S. (2012). An introduction to animal behaviour, Cambridge University press. • Mathur R. (2010). Animal behaviour, Rastogi publications. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc
	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	**Economic Botany Lab**	
Course Credit	1	
Course	After studying this course, a student will able to –	

Outcomes	CO1: Identify the economic products related to cereals, legumes, sugar and starch, spices, beverages, oil and fats, drug yielding plants and fibres, wood producing plants and write Botanical name, family and uses.	
Practical List:	1. Cereals: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests)Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).	
	2. Legumes: Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).	
	3. Sources of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).	
	4. Spices: Black pepper, Fennel and Clove (habit and sections).	
	5. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).	
	6. Sources of oils and fats: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.	
	7. Essential oil-yielding plants: Habit sketch of Rosa, Santalum and Eucalyptus (specimens/photographs).	
	8. Rubber: specimen, photograph/model of tapping, samples of rubber products.	
	9. Drug-yielding plants: Specimens of Digitalis, Papaver and Cannabis.	
	10. Tobacco: specimen and products of Tobacco.	
	11. Woods: Tectona, Pinus: Specimen, Section of young stem.	
	12. Fiber-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).	
	Learner support material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan &Co. New Delhi, India. 2. Wickens, G.E. (2001). Economic Botany: Principles &Practices. Kluwer Academic Publishers, The Netherlands
	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	Web Designing
Course Credits	2

Course Outcomes	After studying this course, a student will able to – CO1: Describe Electronic publishing using list ; table.Working with HTML element and attribute. CO2:Discuss Web-Page Pseudo element and style sheet. CO3. Show the CSS Working with block element and tables. CO4: Classify page layout with advanced CSS properties.s CO5: Appraise the HTML page meet the requirement and properly positioned. CO6: Develop a Website using HTML & CSS.
Unit I	Electronic publishing
	Electronic publishing - lists and their types - nested lists - table handling- Working with Hyperlinks, Images and Multimedia- Frames: Frameset definition – frame definition – nested framesets...
Unit II	Pseudo-elements
	Pseudo-elements – defining Styles – elements of styles – linking a style sheet to a HTML document – inline styles – External style sheets – internal Style sheets – Multiple Styles – Web page Designing..
Unit III	Concept of CSS
	Concept of CSS -Creating Style Sheet - CSS Properties - CSS Styling(Background-Text Format Controlling Fonts) - Working with block elements and objects -Working with Lists and Tables. CSS Advanced(Grouping, Dimension, Display, Positioning, Floating, Align, Pseudo class, Navigation Bar, Image Sprites, Attribute sector) -CSS Color -Creating page Layout and Site Designs.
Unit IV	Forms and form elements
	Forms and form elements- Creating the Web Site -Saving the site -Working on the web site - Creating web site structure -Creating Titles for web pages -Themes—Div- SPAN-table-farames
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

SEMESTER VI

Course Nomenclature	**Quantum Chemistry, Spectroscopy & Photochemistry**	
Course Credit	3	
Course Outcomes	CO1: Define the classical quantum chemistry concepts. CO2: Explain the concepts of the fundamentals of quantum mechanics and its applications in the study of structure of atoms, bonding in molecules and molecular spectroscopy. CO3: Apply the concept of valence bond and molecular orbital theory. CO4: To impart a thorough knowledge of the fundamentals of microwave, infra red, Raman, electronic and magnetic resonance spectroscopy, mass spectrometry and photochemistry CO5: Justify the energy levels of diatomic molecules. CO6: Develop the knowledge of different spectroscopy techniques.	
Unit I		**11 Hours**
	Quantum Chemistry: Postulates of quantum mechanics, quantum mechanical operators, Schrödingerequation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and HeisenbergUncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.Rigid rotator model of rotation of diatomic molecule.Schrödingerequation,transformation to spherical polar coordinates.Separation of variables.Spherical Harmonics.Discussion of solution.Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up ofSchrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom	
Unit II		**11 Hours**
	Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibondingorbitals.Qualitative extension to H2. Comparison of LCAO-MO and VB treatments of H2 (only wavefunctions, detailed solution not required) and their limitations.Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB).Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH).Localised and non-localized molecular orbitals treatment of triatomic (BeH2, H2O) molecules. Qualitative MO theory and its application to AH2 type molecules	
Unit III		**10 Hours**
	Molecular Spectroscopy:	

	Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches. Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spinspincoupling and high resolution spectra, interpretation of PMR spectra of organic molecules. Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.	
Unit IV		**10 Hours**
	Photochemistry: Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations,physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.	
•	Learner support Material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc
•	Text books	• Banwell, C. N. &McCash, E. M. Fundamentals of Molecular Spectroscopy4th Ed. Tata McGraw-Hill: New Delhi (2006). • Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001). • House, J. E. Fundamentals of Quantum Chemistry 2ndEd. Elsevier: USA(2004). • Lowe, J. P. &Peterson, K. Quantum Chemistry, Academic Press (2005). • Kakkar, R. Atomic &Molecular Spectroscopy: Concepts&Applications,Cambridge University Press (2015).
•	Online resources	https://www.khanacademy.org/

Course Nomenclature	**Plant Pathology**	
Course Credit	3	
Course Outcomes	After studying this course, student will be able to: CO1: Define the understanding about general introduction of plant pathology. CO2: Summarize the general symptoms of plant diseases. CO3: Determine the living, non-living and environmental causes of plant diseases. CO4: Compare the relationship of fungi with other organism. CO5: Assess the different plant management strategies. CO6: Develop an understanding about growth, reproduction and role of environment in plant diseases	
Unit I		**11 Hours**
	Introduction to plant pathology: Historical background of plant pathology, general accounts of plant diseases and their pathogen, mode of transmission of disease, pathogenesis, pathogenicity, plant pathogen interaction and environmental relation, disease cycle, plant pathogen defense mechanisms, physical, physiological, biochemical and molecular levels.	
Unit II		**11 Hours**
	Diseases, symptoms, causal organism and prophylaxis (i) Brief account on Tobacco mosaic, Yellow mosaic disease, Potato tuber disease, Citrus canker, Tundu disease of wheat, Bacterial blight of cotton, Little leaf of brinjal and Spike disease of sandalwood.	
Unit III		**10 Hours**
	Diseases, symptoms, causal organism and prophylaxis (ii) Brief account on Black rust of wheat, Late blight of potato, Smut of wheat, Tikka disease of groundnut, downy and powdery mildew of grapevines, Rice blast , ergot of bajra, red rot of sugarcane and root-knot disease.	
Unit IV		**10 Hours**
	Plant disease protection and management strategies: Traditional knowledge based, Chemical management, Biological management, IPM system, development of gene assisted plants, legal policy, biopesticides, microbial toxin, health issue, post harvest management, plant disease clinics, application of plant breeding and biotechnology in phytopathology	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York. 2. Mehrotra RS & Aggarwal A. 2003. Plant Pathology. 2nd Ed. Oxford & IBH, New Delhi. 3. Singh RS. 2002. Introduction to Principles of Plant Pathology. Oxford & IBH, New Delhi. 4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd. 5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication,

		Meerut, India.
	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	**Animal Physiology**	
Course Credit	3	
Course Outcomes	After studying this course, student will be able to: CO1 Identify structure of a neuron and its propogation in myelinated and non-myelinated nerve fibres. CO2: Understand the structural and functional organization of different organ systems in humans. CO3: Compare the functioning of all endocrine glands. CO4: Explain transport of oxygen and carbon dioxide in human blood. CO5: Examine carbohydrate, protein, and lipid metabolism. CO6 Build an understanding about the structure and function of endocrine glands.	
Unit I		**11 Hours**
	Physiology of Digestion: Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of secretion of enzymes in Gastrointestinal tract. **Nervous System:** Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc; Physiology of hearing and vision.	
Unit II		**11 Hours**
	Physiology of Respiration: Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Carbon monoxide poisoning; Control of respiration **Reproductive System:** Histology of testis and ovary; Physiology of male and female reproduction; Puberty, Methods of contraception in male and female	
Unit III		**10 Hours**
	Renal Physiology: Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance **Endocrine System:** Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones; Regulation of their secretion; Mode of hormone action, Signal transduction pathways for steroidal and non-steroidal hormones; Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; Placental hormones	
Unit IV		**10 Hours**
	Blood: Components of blood and their functions; Structure and functions of haemoglobin, Blood clotting system **Physiology of Heart**: Structure of mammalian heart; Coronary circulation; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac	

	impulses Cardiac cycle; Cardiac output and its regulation, Frank-Starling Law of the heart, nervous and chemical regulation of heart rate. Electrocardiogram, Blood pressure and its regulation	
	Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. Guyton, A.C. &Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company. 2. Tortora, G.J. &Grabowski, S. (2006). Principles of Anatomy &Physiology. XI Edition John Wiley &sons, 3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. &Wilkins. 4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
	Online resources	https://nptel.ac.in/ https://www.edx.org https://cec.nic.in/cec/curriculum_class (Animal Physiology)

Course Nomenclature	**Immunology (Zoology)**	
Course Credit	3	
Course	On completion of this course the students will be able to:	

<table>
<tr><td>Outcomes</td><td colspan="2">CO1: Identify various immune responses in organisms.
CO2: Compare innate and adaptive immune system.
CO3: Determine structure, class and function of antibodies.
CO4: Sketch the structure of MHC and antigen processing pathway.
CO5: Justify the importance of immune system in humans.
CO6: Prepare list of vaccines to be given for immunodeficient person.</td></tr>
<tr><td rowspan="2">Unit I</td><td>Overview of the Immune System</td><td>11 Hours</td></tr>
<tr><td colspan="2">Overview of the Immune System
Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system.
Cells and Organs of the Immune System
Haematopoeisis, Cells of immune system and organs (primary and secondary lymphoid organs) of the immune system.</td></tr>
<tr><td rowspan="2">Unit II</td><td>Antigens & Antibodies</td><td>11 Hours</td></tr>
<tr><td colspan="2">Antigens
Basic properties of antigens, B and T cell epitopes, haptens and adjuvants
Antibodies
Structure, classes and function of antibodies, monoclonal antibodies, antigen antibody interactions as tools for research and diagnosis. Life history and pathogenicity of Ancylostoma duodenale and W</td></tr>
<tr><td rowspan="2">Unit III</td><td>Working of the immune system</td><td>10 Hours</td></tr>
<tr><td colspan="2">Working of the immune system
Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing.
Immune Effector Mechanism
Basic properties and functions of cytokines, Complement system: Components and pathways.</td></tr>
<tr><td rowspan="2">Unit IV</td><td>Immune system in health and disease</td><td>10 Hours</td></tr>
<tr><td colspan="2">Immune system in health and disease
Gell and Coombs' 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,AIDS and other immuno deficiency.</td></tr>
<tr><td></td><td>Learner support Material</td><td>NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td></td><td>Text books</td><td>Kindt, T. J., Goldsby, R.A., Osborne, B.A. and Kuby, J (2006). Immunology,VI Edition. W.H. Freeman and Company.
David, M., Jonathan, B., David, R. B. and Ivan R. (2006). Immunology, VII Edition, Mosby, Elsevier Publication.
Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and MolecularImmunology. V Edition. Saunders Publication.</td></tr>
</table>

	Online resources	www.immunologylink.com https://www.immunology.org/public-information/immunology https://www.researchgate.net

Course Nomenclature	**Quantum Chemistry, Spectroscopy & Photochemistry lab**	
Course Credit	1	
Course Outcomes	On completion of this lab course, CO 1: Follow the fundamental principles of different instruments. CO 2: Perform work on UV Spectrometer and calorimeter. CO3:Demostrate analysis on calourimeter. CO4: Perform UV analysis. CO5: Develop separation of component by UV and calorimeter.	
Practical List	1. UV/Visible spectroscopy Study the 200-500 nm absorbance spectra of KMnO4 and K2Cr2O7 (in 0.1 M H2SO4) and determine the λmax values. Calculate the energies of the two transitions in different units (J molecule-1, kJ mol-1, cm-1, eV).	
	2. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K2Cr2O7.	
	3. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.	
	Colourimetry 4. Verify Lambert-Beer's law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration	
	5. Determine the concentrations of KMnO4 and K2Cr2O7 in a mixture.	
	6. Study the kinetics of iodination of propanone in acidic medium.	
	7. Determine the amount of iron present in a sample using 1,10-phenathroline.	
	8. Determine the dissociation constant of an indicator (phenolphthalein).	
	9. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.	
	10. Analyse the given vibration-rotation spectrum of HCl(g)	
	Learner support Material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009. Khosla, B. D.; Garg, V. C. &Gulati, A., Senior Practical Physical Chemistry, R. Chand &Co.: New Delhi (2011). Garland, C. W.; Nibler, J. W. &Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003). Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman &Co.: New York (2003).
	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	**Plant Pathology Lab**	
Course Credit	1	
Course Outcomes	After studying this course, a student will able to – CO1: Follow the introduce plant pathology (definitions,objective,concept, scope and importance) CO2: Assemble the roles of microorganism to cause disease in plant, pathogenesis and epidemiology. CO3: Perform the staining and identification of plant pathogenic bacteria. CO4: Revise the disease based on symptoms and applied the management strategies for the control of plant disease. CO5: Develop the laboratory equipment and their uses in plant pathology.	
Practical List:	1. Staining of fungi & bacteria.	
	2. Study of sterilization procedure of seeds.	
	3. Observation of fungal spores using permanent slide.	
	4. Observation of bacterial and viral disease symptoms using specimen as given in theory.	
	5. Demonstration of fungal disease in given spot as given in theory.	
	6. Study of Phytonematodes by making temporary slide and using permanent slide.	
	7. Isolation of DNA from fungi.	
	8. Field visit for demonstration of plant disease.	
	9. Prepare a report on history of Plant disease and Indian agriculture.	
	10. To study post harvest management using review articles and traditional knowledge with suitable reference.	
	Learner support material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition. 2. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd. 3. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.
	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	**Animal Physiology Lab**	
Course Credit	1	
Course Outcomes	After studying this course, a student will able to – CO1: Examine various mammalian tissue samples. CO2: Prepare the temporary mounts.	

	CO3: Record blood pressure in humans. CO4: Develop basic hematological parameters and laboratory skills. CO5: Prepare haemin and haemochromogen crystals.	
Practical List:	• Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid	
	• Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells	
	• Determination of ABO Blood group	
	• Enumeration of red blood cells and white blood cells using haemocytometer	
	• Estimation of haemoglobin using Sahli's haemoglobinometer	
	• Preparation of haemin and haemochromogen crystals	
	• Recording of frog's heart beat under in situ and perfused conditions*	
	• Recording of blood pressure using a sphygmomanometer	
	• Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney	
	Learner support material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1.Guyton, A.C. &Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company. 2. Tortora, G.J. &Grabowski, S. (2006). Principles of Anatomy &Physiology. XI Edition John Wiley &sons 3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. &Wilkins.
	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	**Immunology (Zoology) Lab**	
Course Credit	1	
Course Outcomes	To identify various immune responses. Co1: Measure blood cell count. CO2: Perform Ouchterlony's double immuno-diffusion method. CO3: Demonstrate ELISA and immunoelectrophoresis. CO4: Revise ABO blood group determination. CO5: Resign human blood profile.	
Practical List:	1. Demonstration of lymphoid organs. 2. Histological study of spleen, thymus and lymph nodes through slides/ photographs. 3. Preparation of stained blood film to study various types of blood cells. 4. Ouchterlony's double immuno-diffusion method. 5. ABO blood group determination. 6. Cell counting and viability test from splenocytes of farm bred animals/cell lines. 7. Demonstration of a) ELISA b) Immunoelectrophoresis	
	Learner support material	Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books	1. *A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.* 5. *A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.* 6. *Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G.,Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.* *Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman,1960*
	Online resources	https://nptel.ac.in/ https://www.edx.org

Course Nomenclature	Fundamental of Indian Constitution
Course Credits	2

Course Outcomes	After studying this course, a student will able to – CO1: Understand the key aspects of the Indian Constitution.. CO2: Comprehend the structure and philosophy of the Constitution CO3. Understand the power and functions of various constitutional offices and institutions. CO4: Realise the significance of the constitution and appreciate the role of constitution and citizen oriented measures in a democracy.
Unit I	Indian Constitution: Making and basic premise
	Meaning and Significance of Constitution. Constituent Assembly- Composition, Objectives Preamble and Salient features of the Indian Constitution. Fundamental Rights, Fundamental Duties. Directive Principle ..
Unit II	Union and State Government
	President of India- Election, Powers and functions Prime Minister and Cabinet – Structure and functions Governor- Powers and functions Chief Minister and Council of Ministers – Functions.
Unit III	Legislature and Judiciary
	Parliament – Lok Sabha and Rajya Sabha – Composition and powers ,State Legislative Assembly and Legislative Council – Composition and powers .Judicial System in India – Structure and features . Supreme Court and High Court: Composition, Jurisdiction.
Unit IV	Governance and Constitution
	Federalism in India - Features Local Government -Panchayats –Powers and functions; 73rd and 74th amendments .Election Commission – Composition, Powers and Functions; Electoral Reforms . Citizen oriented measures – RTI and PIL – Provisions and significance.
Learner support Material	NPTEL, Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc. Lectures/ Tutorials/ Interactive Sessions/ Self-guided Learning Materials/ Open Educational Resources (as reference materials)/ Practical Exercises/ Assignments/ Seminars/ Group Discussions and Week-end Counselling.

Annexure II- Mandatory Documents for Admission

To be uploaded on the Online Admission Portal by the Prospective students

Admission Documents	Format (Jpeg/PNG/PDF)	Documents Size
Duly filled online application form with student signature	Digital signature/Student signature JPEG/PNG	20 KB
Colour scan copy of all year/semester mark sheet/grade cards (for PG programs only) or consolidated mark sheet/grade cards also accepted.	PDF/JPEG	500 KB
Colour scan copy of 10th std. Mark sheet/grade card	PDF/JPEG	
Colour scan copy of 12th std./ Three-Year Polytechnic Diploma Mark sheet/grade card	PDF/JPEG	
Colour scan copy of passport size photograph	JPEG or PNG Format	50 KB
Colour scan copy of Govt. Photo id proof, Aadhar card is mandatory. (Other options: Voter's id, Driving License, Passport etc.)	PDF/JPEG	100 KB
In case of name change, Gazette notification documents for name changes For married women – marriage certificate would be accepted – provided previous maiden name is clearly mentioned in the same. In case of deferred Father name or mother name in such cases without a Gazette notification document.	PDF	500 KB
If foreign student: colour scan copy of passport	PDF/JPEG	500 KB

Fees submission transaction details or receipt as per University policy for respective online programs	PDF/JPEG	500 KB
Digitally Signed undertaking as per the process; where applicable	PDF	500 KB

Students can also visit the University website for the said information.

Annexure III- Academic Bank of Credit Id Creation Process

All enrolled students, particularly those of Indian nationality, are required to register with ABC (Academic Bank of Credits), a central scheme established by the Ministry of Education, Government of India, for depositing credit. ABC ID creation is mandatory for all students, ensuring their participation in this scheme.

Process	• Students can register by logging in at www.abc.digilocker.gov.in • Click on My Account → Login as Student • Click on "Sign up with DigiLocker" → Enter valid mobile number → An OTP is sent at the phone number via SMS → Enter the OTP and click on "Continue" button → Enter Security PIN set created during Sign Up and click "Submit" Button • You will be prompted with ABC student account creation window
Documents and proofs required	• Aadhaar Card is mandatory for ABC Id creation • Learners Name • Date of Birth • Gender • Enrolment Number • Requirements by Academic Institution: • Mobile Number

The ABC Id can be created by students themselves using Digi-locker, UMANG application, ABC portal or Academic Institution Portal. The process for which is provided below.

The University will extend support to the students to create ABC ID. The documents required will remain the same as stated above.

Annexure IV – Continuous Internal Assessment Pattern

Particular	A1 (Objective Type)	A2 (Objective Type)
Marks	15	15

Question Pattern for the CIA Components
A-1 1.There will be 15 Objective type Multiple Choice Questions (MCQs), each carrying mark 1 mark 2. The time for the A-1 assignment will be 30 mins 3. All questions are compulsory 4. There will be NO NEGATIVE MARKING for the wrong answers. **A-2** 1. There will be 15 Objective type Multiple Choice Questions (MCQs), each carrying mark 1 mark 2. The time for the A-1 assignment will be 30 mins 3. All questions are compulsory 4. There will be NO NEGATIVE MARKING for the wrong answers.

Annexure V – End-term Examination Pattern

JNU

Centre for Distance and Online Education

End Term Examination

[PROGRAM NAME]

[COURSE NAME][COURSE CODE]

Time : 2 Hours	Max. Marks : 70
Note for students: The paper will comprises of 70 compulsory objective questions of 1 mark each.	
Answer all the questions. Each question carries one mark.	
Q. No. 1 to Q. No. 70 - Objective questions with four multiple choices.	