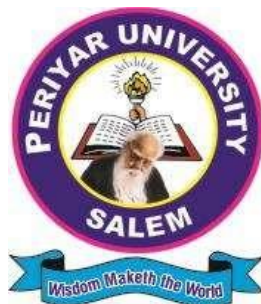


PERIYAR UNIVERSITY

Salem-636 011

(Reaccredited with 'A++' Grade by the NAAC)



DEPARTMENT OF ENVIRONMENTAL SCIENCE

FIVE YEAR
INTEGRATED M.Sc. ENVIRONMENTAL SCIENCE
[Choice Based Credit System (CBCS)]

OBE SYLLABUS

(Effective from the academic year 2026-2027 and thereafter)

**FIVE YEAR INTEGRATED M. Sc. ENVIRONMENTAL SCIENCE
OBE REGULATIONS AND SYLLABUS**

(with effect from the academic year 2026-2027 onwards)

1. Preamble

Growing population and high standards of living put increasing pressure on our environment. Since the beginning of industrialization and urbanization, we have been facing increasing number of environmental challenges such as air, water and soil contamination, energy crisis, land degradation, deforestation, loss of biodiversity, global warming and climate change, etc., Considering the above issues, addressing environmental problems from a scientific perspective is utmost important for today's world. Hence, there is a need to develop the next generation graduates as skilled professionals in the multidisciplinary field of Environmental Science through the integrated degree programme to solve the global environmental issues.

2. Vision

- Achieve academic excellence in environmental science through interdisciplinary teaching, innovative research, and community engagement, producing competent professionals for sustainable environmental management.

3. General Graduate Attributes

Graduates of the M.Sc. Environmental Science programme are expected to demonstrate the following attributes:

1. Advanced Scientific Knowledge

Possess strong conceptual understanding of environmental systems, ecological processes, pollution dynamics, and sustainability principles.

2. Research Competence

Design, conduct, and interpret scientific investigations using appropriate methodologies, instrumentation, and statistical tools.

3. Critical Thinking and Analysis

Evaluate environmental problems logically, interpret scientific evidence, and develop data-driven conclusions.

4. Technical Proficiency

Apply modern tools such as GIS, remote sensing, environmental modeling software, and laboratory analytical instruments.

5. Problem-Solving Skills

Develop practical and sustainable solutions for environmental challenges across industrial, urban, rural, and natural ecosystems.

6. Interdisciplinary Perspective

Integrate knowledge from life sciences, physical sciences, social sciences, and policy studies to address environmental issues holistically.

7. Environmental Ethics and Responsibility

Demonstrate commitment to environmental protection, professional integrity, and adherence to environmental laws and regulations.

8. Communication Skills

Effectively communicate scientific findings through technical reports, research publications, presentations, and public outreach.

9. Teamwork and Leadership

Work collaboratively in multidisciplinary teams and exhibit leadership in environmental projects and community initiatives.

10. Lifelong Learning and Adaptability

Stay updated with emerging environmental technologies, policies, and global sustainability trends, demonstrating readiness for continuous professional development.

4. Programme Objectives and Outcomes

Programme Educational Objectives (PEOs)

Graduates of Integrated M.Sc. Environmental Science program will be

PEO1	Utilizing domain knowledge to understand the environment and to provide solutions for the development of society.
PEO2	Applying research and acquired skills with a rich set of communication and leadership skills to sustain in the environment.
PEO3	Expressing constant development in their specialized career through life-long learning, appreciating human values and ethics.

Programme Outcomes (PO)

After successful completion of the Five years Integrated M.Sc. Environmental Science Programme, the students are expected to have

PO1	Advanced Environmental Knowledge Demonstrate in-depth understanding of ecological principles, environmental chemistry, pollution control, biodiversity, and climate science.
PO2	Analytical and Research Skills Apply scientific methods, statistical tools, and laboratory techniques to investigate environmental problems and interpret data.
PO3	Problem-Solving Ability Identify, analyze, and propose sustainable solutions to complex environmental issues at local, regional, and global levels.
PO4	Technical Competence Utilize modern environmental tools such as GIS, remote sensing, modeling software, and analytical instrumentation.
PO5	Sustainability Awareness Evaluate environmental challenges using sustainability principles and recommend eco-friendly technologies and management strategies.
PO6	Interdisciplinary Understanding Integrate concepts from biology, chemistry, geology, policy, and social sciences for holistic environmental assessment.
PO7	Professional and Ethical Responsibility Demonstrate environmental ethics, legal awareness, and professional responsibility in environmental management and research.
PO8	Communication and Leadership Skills Effectively communicate scientific information through reports, presentations, and teamwork while leading environmental projects.

Programme Specific Outcomes (PSOs)

After successful completion of the Five years Integrated M.Sc. Environmental Science Programme, the students will be equipped to

PSO1	Environmental Monitoring Skills: Apply advanced techniques for sampling, analysis, and interpretation of air, water, and soil quality parameters.
PSO2	Pollution Control Expertise: Design and evaluate treatment and remediation methods for environmental pollutants using physical, chemical, and biological approaches.
PSO3	Biodiversity Assessment: Conduct ecological surveys, biodiversity documentation, and conservation planning using standard scientific protocols.
PSO4	Environmental Impact Assessment (EIA): Prepare and critically evaluate EIA reports, risk assessments, and environmental management plans for developmental projects.
PSO5	Geospatial Analysis Proficiency: Utilize GIS, remote sensing, and spatial modeling tools for environmental mapping, monitoring, and decision-making.
PSO6	Climate Change Analysis: Assess climate variability, mitigation strategies, and adaptation measures based on scientific evidence and policy frameworks.
PSO7	Sustainable Resource Management: Develop strategies for sustainable utilization of natural resources, including water, forests, land, and energy systems.
PSO8	Research and Innovation Capability: Design independent research projects, publish scientific findings, and apply innovative technologies to solve environmental challenges.

5. Programme Specific Qualification Attributes

- **Knowledge and understanding level (K1 and K2)**
Students will be able to understand the basic components of ecology and environment, chemistry of pollutants and their toxic effects, biodiversity and natural resources and their process for sustainable development.
- **Application level (K3)**
Students will be capable of applying microbes, plants and animals for potential environmental cleanup and green energy production, and to generate value-added products through waste recycling.
- **Analytical level (K4)**
Students will be able to analyze the environmental quality parameters and to address the issues of different environmental compartments.
- **Evaluation capability level (K5)**
Students can acquire the capability of evaluating the responsible factors for environmental related issues and can be able to apply the acquired knowledge in providing solutions.
- **Scientific or synthesis level (K6)**
Students will be able to synthesize or develop new processes, products and to formulate new scientific tools related to sustainable environmental management

6. Candidate's eligibility for admission

Candidate who has passed in Higher Secondary Examinations with science subjects (Physics, Chemistry, Mathematics/ Biology/ Botany/ Zoology/ Agriculture/ Microbiology/ Computer Science or any other Life Science subjects or any other Examination as equivalent thereto under the Board of Higher Secondary Education, Government of Tamil Nadu / CBSE / ICSE or any other boards equivalent thereto shall be eligible for admission to Five years Integrated M.Sc. Degree Programme in Environmental Science.

7. Duration of the programme

The duration of the Integrated M.Sc. Environmental Science shall be over a period of Five Years from the commencement of the course. Undergraduate degree shall be awarded after successful completion of three years (up to VI Semester).

8. CBCS- Structure of the Programme

The programme structure comprises of two parts

Course Component	No. of Courses	Credit/ Course	Hours of Learning	Marks	Total Credits
Part A (Credit Courses)					
Language Courses	8	4	4 h/ Week / Course	800	32
Core Courses (UG Level)	20	5	5 h/ Week / Course	2000	100
Elective Courses (UG Level)	2	4	4 h/ Week / Course	200	08
Elective Courses (PG Level- Optional)	3/6	4	4 h/ Week / Course	300	12
Allied Courses	4	4	5 h/ Week / Course	400	16
Skill Based Elective Courses (UG Level)	5	2	2 h/ Week / Course	500	10
Non-Major Elective Courses	1	2	3 h/ Week	400	02
Practical Courses - Major (UG Level)	6	2/3	4-6 h/ Week / Course	600	14
Practical Courses - Major (PG Level)	3	3	6 h/ Week / Course	300	09
Practical Courses - Allied	4	2	3 h/ Week / Course	400	08
Research Projects (UG Level)	1	5	10 h / week	200	05
Research Projects (PG Level)	1	10	30 h / week	200	10
Summer Internship	2	1	-	150	02
Industrial Visits/Study Tour	1	1	2 to 5 visits/tours	50	01
Extension Activity	2	1	2 h / week	100	02
Disaster management(UGC mandatory course)	1	1	2 h / week	100	01
Environmental Studies (UGC mandatory course)	1	1	1 h / week	100	01
Sub Total	65	-	-	6700	233
Part B (Self-Learning Credit Courses)					
Online Courses (MOOC /SWAYAM)	2	1/2	-	200	03
Human Rights (UGC mandatory course)	1	1	-	100	01
Peace Education (UGC mandatory course)	1	1	-	100	01
Sub Total	4	4		400	05
Grand Total	69	-	-	7100	238

9. Curriculum structure for each semester as per course alignment (Refer Table at the end of this section)

Main syllabus (Attached as Annexure I)

9.1. Semesters

An academic year consists of two semesters namely, Odd Semester (I/III/V/VII/IX): July to November; and Even Semester (II/IV/VI/VIII/X): December to April. A semester normally extends over a period of 15 weeks. Each week has 30 hours instruction spread over a 5 day week. The duration of each semester shall be 90 working days for all PG Programme inclusive of examinations.

9.2. Credits

Credit defines the quantum of contents/syllabus prescribed for a course and determines the number of hours of instruction required per week. Thus, normally in each of the courses, credits will be assigned on the basis of the number of lectures/tutorial/ laboratory work and other forms of learning required to complete the course contents in a 15-week schedule:

1 Credit=Minimum 1 hour of lecture per week
(1 Credit course= Minimum 15 hours of lectures per semester)

3 Credits = Minimum 3 hours of lecture per week
(3 Credit course = Minimum 45 hours of lectures per semester)

The total minimum credits required for awarding a three year UG degree is 140 and a two year PG degree is 90.

9.3. Project

Each student shall be required to take up an Individual Student Project Work at UG and PG level and submit it at the end of the VI Semester and Final Semester of their respective programs. Students shall be allotted to all the faculty members for project guidance in a departmental committee meeting with the concurrence of all the members. A copy of the Project Report shall be submitted to the Department on or before the last date fixed by the Department/University. The Project shall be evaluated by the guide and an external examiner nominated by the University and viva-voce examination be conducted to award the marks as per norms.

9.4. Non Major Elective (Supportive) Course:

Non Major Elective (Supportive) Course should be offered only in second and third semesters of the PG Level. Students are expected to opt Non Major Elective (Supportive) Course offered by other departments.

9.5. Swayam Course:

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy namely access, equity and quality. SWAYAM. The courses hosted on SWAYAM are in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-

assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology. In order to ensure best quality content are produced and delivered, nine National Coordinators (AICTE, NPTEL, UGC, CEC, NCERT, NIOS, IGNOU, IIMB and NITTR) have been appointed

Courses delivered through SWAYAM are available free of cost to the learners, however, students wanting certifications shall be registered, shall be offered a certificate on successful completion of the course, with a little fee. At the end of each course, there will be an assessment of the student through proctored examination and the marks/grades secured in this exam could be transferred to the academic record of the students.

Integrated MSc Environmental Science (5 Year Programme)
CBCS CURRICULUM (SEMESTER WISE STRUCTURE)

S. No.	Part	Course Code	Course Title	Weekly Contact Hours	Credits	Internal Marks	External Marks	Total Marks
Semester -I								
1	I	26UPEVS2T01	Tamil- I	5	4	25	75	100
2	II	26UPEVS2E01	English- I	5	4	25	75	100
3	III	26UPEVS2C01	Core -I- Ecology	5	5	25	75	100
4	III	26UPEVS2A01	Allied-I Basics of Chemistry	5	4	25	75	100
5	III	26UPEVS2SC1	SBEC I- Communication Skills	2	2	25	75	100
6	III	26UPEVS2CL1	Core Practical - I	4	2	40	60	100
7	III	26UPEVS2AL1	Allied Practical- I	3	2	40	60	100
-	IV	26UPEVS2DM1	Disaster Management (NIDM Mandatory Course)	1	-	-	-	-
Sub Total				30	23	205	495	700
Semester -II								
8	I	26UPEVS2T02	Tamil- II	5	4	25	75	100
9	II	26UPEVS2E02	English- II	5	4	25	75	100
10	III	26UPEVS2C02	Core -II- Cell Biology	5	5	25	75	100
11	III	26UPEVS2A02	Allied-II Applied Chemistry	5	4	25	75	100
12	III	26UPEVS2SC2	SBEC II- Computational Skills	2	2	25	75	100
13	III	26UPEVS2CL2	Core Practical - II	4	2	40	60	100
14	III	26UPEVS2AL2	Allied Practical- II	3	2	40	60	100
15	IV	26UPEVS2DM1	Disaster Management (NIDM Mandatory Course)	1	1	25	75	100
Sub Total				30	24	230	570	800
Semester -III								
15	I	26UPEVS2T03	Tamil- III	5	4	25	75	100
16	II	26UPEVS2E03	English- III	5	4	25	75	100
17	III	26UPEVS2C03	Core -III- Environmental Biochemistry	5	5	25	75	100
18	III	26UPEVS2A03	Allied-III – Botany	5	4	25	75	100
19	III	26UPEVS2SC3	SBEC III- Employability Skills	2	2	25	75	100
20	III	26UPEVS2CL3	Core Practical - III	4	2	40	60	100
21	III	26UPEVS2AL3	Allied Practical- III	3	2	40	60	100
			Library	1	-	-	-	-
Sub Total				30	23	205	495	700

S. No.	Part	Course Code	Course Title	Weekly Contact Hours	Credits	Internal Marks	External Marks	Total Marks
			Semester -IV					
22	I	26UPEVS2T04	Tamil- IV	5	4	25	75	100
23	II	26UPEVS2E04	English- IV	5	4	25	75	100
24	III	26UPEVS2C04	Core -IV- Basics of Microbiology and Biotechnology	5	5	25	75	100
25	III	26UPEVS2A04	Allied-IV -Zoology	5	4	25	75	100
26	III	26UPEVS2SC4	SBEC IV- Entrepreneurial Skills	2	2	25	75	100
27	III	26UPEVS2CL4	Core Practical - IV	4	2	40	60	100
28	III	26UPEVS2AL4	Allied Practical- IV	3	2	40	60	100
29	IV	26UPEVS2ES1	Environmental Studies (UGC Mandatory Course)	1	1	25	75	100
			Sub Total	30	24	230	570	800
			Semester -V					
30	III	26UPEVS2C05	Core -V – Environmental Pollution	5	5	25	75	100
31	III	26UPEVS2C06	Core-VI – Natural Resources Management	5	5	25	75	100
32	III	26UPEVS2C07	Core-VII - Biostatistics	5	5	25	75	100
33	III	26UPEVS2EL1	Core Elective – I -Ecotourism	4	4	25	75	100
34	III	26UPEVS2SC5	SBEC V- Industrial Skills	2	2	25	75	100
35	III	26UPEVS2CL5	Core Practical - V	6	3	40	60	100
36	IV	26UPEVS2EX1	Extension Activity	2	1	50	-	50
37	IV	26UPEVS2MO1	MOOC- I (Mandatory Course -Self Study)	-	1	-	100	100
			Library	1		-	-	-
			Sub Total	30	26	215	535	750
			Semester -VI					
38	III	26UPEVS2C08	Core-VIII – Environmental Geosciences	5	5	25	75	100
39	III	26UPEVS2C09	Core-IX – Environmental Analytical Techniques	5	5	25	75	100
40	III	26UPEVS2EL2	Core Elective – II -Global Environmental Issues	4	4	25	75	100
41	III	26UPEVS2CL6	Core Practical - VI	6	3	40	60	100
42	III	26UPEVS2PR1	Core Project I	10	5	50	150	200
43	IV	26UPEVS2IN1	Summer Internship I	-	1	-	50	50
			Sub Total	30	23	165	485	650
			UNDER GRADUATION LEVEL - TOTAL	-	143	1250	3150	4400

S. No.	Part	Course Code	Course Title	Weekly Contact Hours	Credits	Internal Marks	External Marks	Total Marks
			Semester -VII					
44	III	26UPEVS2C10	Core-X – Biodiversity and Conservation	5	5	25	75	100
45	III	26UPEVS2C11	Core-XI – Environmental Chemistry	5	5	25	75	100
46	III	26UPEVS2C12	Core-XII- Environmental Geoinformatics	5	5	25	75	100
47	III	26UPEVS2C13	Core-XIII- Industrial Health and Safety	5	5	25	75	100
48	III	26UPEVS2 EL3 26UPEVS2 EL4	Core Elective – III – Wildlife Management/ Energy and Environment	4	4	25	75	100
49	III	26UPEVS2CL7	Core Practical - VII	6	3	40	60	100
50	IV	26UPEVS2MO2	MOOC- II-(Mandatory Course-Self Study)	-	2	-	100	100
			Sub Total	30	29	165	535	700
			Semester -VIII					
51	III	26UPEVS2C14	Core-XIV- Environmental Microbiology & Biotechnology	5	5	25	75	100
52	III	26UPEVS2C15	Core-XV – Pollution Control Strategies	5	5	25	75	100
53	III	26UPEVS2C16	Core-XVI – Environmental Impact Assessment	5	5	25	75	100
54	III	26UPEVS2C17	Core-XVII – Environmental Toxicology	5	5	25	75	100
55	III	26UPEVS2 EL5 26UPEVS2 EL6	Core Elective – IV- Disaster Management/ Environmental Management Systems	4	4	25	75	100
56	III	26UPEVS2CL8	Core Practical - VIII	6	3	40	60	100
57	IV	26UPPGC1H01	Human Rights (UGC Mandatory Course -Self Study)	-	1	25	75	100
			Sub Total	30	28	190	510	700
			Semester -IX					
58	III	26UPEVS2C18	Core-XVIII – Waste Management	5	5	25	75	100
59	III	26UPEVS2C19	Core-XIX – Climate Change and Current Issues	5	5	25	75	100
60	III	26UPEVS2C20	Core-XX - Research Methodology and Instrumentation	5	5	25	75	100
61	III	26UPEVS2 EL7 26UPEVS2 EL8	Core Elective – V – Environmental Nanotechnology / Environmental Law and Policies	4	4	25	75	100
62	III	26UPEVS2CL9	Core Practical - IX	6	3	40	60	100
63	IV	26UPEVS2NM1	Non-Major Elective (Supportive)Course	3	2	25	75	100
64	IV	26UPGEN1V01	Peace Education (UGC Mandatory Course -Self Study)	-	1	25	75	100
65	IV	26UPEVS2EX2	Extension Activity	2	1	50	-	50
			Sub Total	30	26	240	510	750
			Semester -X					
66	III	26UPEVS2PR2	Core Project II	30	10	50	150	200
67	IV	26UPEVS2IN2	Summer Internship II	-	1	-	100	100
68	IV	26UPEVS2IV1	Industrial Visit/Study Tour		1	-	50	50
			Sub Total	30	12	50	300	350
			POST GRADUATION LEVEL - TOTAL	-	95	645	1855	2500
			GRAND - TOTAL	-	238	1895	5005	6900

10. Examinations

There shall be examinations at the end of each semester: for odd semesters in October/ November; and for even semesters in April/May.

10.1. Evaluation

The performance of a student in each course is evaluated in terms of percentage of marks with a provision for conversion to grade points. Evaluation for each course shall be done by a Continuous Internal Assessment (CIA) by the course teacher concerned as well as by an end semester examination and will be consolidated at the end of the semester.

10.2. Theory examination

Evaluation of Continuous Internal Assessment

Test	:	5 Marks (Best one out of Two Tests)
Model Examination	:	5 Marks
Seminar	:	5 Marks
Assignment	:	5 Marks
Attendance	:	5 Marks
Total	:	25 Marks

There is no Minimum pass in the internal Assessment.

10.3. End Semester Examination Question Paper Pattern

Time duration: 3 Hours

Max.Marks:75

PART- A: 20 x1 = 20

Answer all the questions

(Four Objective type questions from each unit)

PART- B: 3 x5 = 15

Answer any three questions out of five questions

(One question should be taken from each unit) (Questions must be analytical type)

PART- C: 5 x8 = 40

Answer all the questions

(Either or type one pair from each unit)

The Passing minimum shall be 50% (i.e. 38 marks) out of 75 marks.

10.4. Practical/ Mini Project Examination

Evaluation of Internal Assessment

Test	:	20 Marks (Best one out of Two Tests)
Model Practical	:	20 Marks
Total	:	40 Marks

There is no Minimum pass mark in the Internal Assessment for Practical examinations.

10.5. Grading System

Passing Minimum

A candidate shall be declared to have passed in each course if he/she secures not less than 50% marks in the University Examinations and not less than 50% in the aggregate, including CIA and University Examinations marks.

Marks and Grades

Conversion of Marks to Grade Point and Letter Grade (Performance in a subject) as follows.

Range of Marks	Grade Points	Letter Grade	Description
90 - 100	9.0 – 10.0	O	Outstanding
80 - 89	8.0 – 8.9	D+	Excellent
75 - 79	7.5 – 7.9	D	Distinction
70 - 74	7.0 – 7.4	A+	Very Good
60 - 69	6.0 – 6.9	A	Good
50 - 59	5.0 – 5.9	B	Average
00 - 49	0.0	U	Re-Appeal
ABSENT	0.0	AAA	Absent

C_i = Credits earned for course i in any semester

G_i = Grade Point obtained for course i in any semester

n = The semester in which such courses were credited.

For a Semester:

$$\text{GRADE POINT AVERAGE [GPA]} = \sum_i C_i G_i / \sum_i C_i$$

GPA = Sum of the multiplication of grade points by the credits of the courses /
Sum of the Credits of the courses in a semester

For the Entire Programme:

$$\text{CUMULATIVE GRADE POINT AVERAGE [CGPA]} = \sum_n \sum_i C_i G_{ni} / \sum_n \sum_i C_{ni}$$

CGPA = Sum of the multiplication of grade points by the credits of the entire
Programme / Sum of the Credits of the courses of the entire Programme

Classification of Final Result

CGPA	Grade	Classification of Final Result
9.5 – 10.0	O+	First Class with Exemplary*
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First Class with Distinction*
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0 and above but below 6.5	A	
5.5 and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	
0.0 and above but below 5.0	U	Re-Appear

* The candidates who have passed in the first appearance and within the prescribed semester of the PG Program are eligible.

Condonation

Students must have 75% of attendance in each semester to appear for the examination. Students who have attendance between 65% and 74% shall apply for condonation in the prescribed form with the prescribed fee to write the examination in the same semester. Students who have attendance between 50% and 64% shall apply for condonation in prescribed form with the prescribed fee along with the Medical Certificate in the current semester but they can write their examinations only in the next semester. Students who have attendance below 50% are not eligible to appear for the examination. But the student can continue the programme to complete the duration. To complete the programme they shall re- do the semester(s) after completion of the programme duration to acquire required attendance for appearing missed semester examinations.

However, the candidates have to clear all the subjects prescribed for programme within N+3 Years to acquire degree, where N denotes the duration of the programme.

Course Teacher

A teacher offering a course will also be responsible for maintaining attendance and evaluate the performance of all the students registered for the course.

Break of Study

A student intends to temporarily discontinue the programme in the middle of the semester for valid reasons and to rejoin the programme in the next academic year, for which he / she shall apply in advance with applicable Re-admission fees to the Registrar, Periyar University through the Principal/HOD of the respective colleges/University Department.

Student Advisor and Course Registration

Every student will have a member of faculty of the department as his/her student advisor. All teachers of the department shall function as Student Advisors and will have more or less equal number of students. The Student Advisor will advise the students in choosing Elective courses and offer all possible student support services. The student will then register for the course he/she plans to take for the semester before the commencement of the classes.

COURSE REGISTRATION

Name of the Student :

Department :

Registration Number :

Programme :

Semester :

Elective Course Option :

Signature of the Student Advisor/Mentor

Signature of the Student

Approved by Head of the Department

The entire Program, Curriculum Structure, Teaching Learning Methods, Examination Pattern, Evaluation Methods and Grading Systems given above is governed by the CBCS Regulations of Periyar University.

Semester - I

ECOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	26UPEVS2C01	100	5	4	1	-	5

Course Objectives

The course focuses on the concepts of ecology from individual level to environmentally complex habitats, aiming towards environmental management

Course Outcomes

On the successful completion of the course, students will be able to

- CO1** Understand the basic concepts of ecology
- CO2** Learn the types, structure and function of ecosystem
- CO3** Understand the principle and concepts of autecology
- CO4** Perceive the knowledge of population ecology and its concepts
- CO5** Explore the knowledge of community ecology and ecological succession

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	L	M	L	S	M	L	L
CO2	S	M	S	L	S	S	L	L
CO3	S	M	M	L	M	S	L	L
CO4	S	M	S	L	S	S	M	L
CO5	S	S	S	M	S	S	M	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – I**ECOLOGY**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	26UPEVS2C01	100	5	4	1	-	5

Unit I Introduction**Contact Hours: 10**

Basic concepts and definitions: Ecology - Ecosystems - Habitat - Ecological niche - Biome and Biosphere - *Branches of Ecology:* Introduction to autecology - Synecology - Population ecology - Community ecology - Ecosystem ecology - Landscape ecology - Behavioral ecology and Applied ecology - Ecosystem stability - Resistance and Resilience - Concept of the ecological footprint (K1, K2, K3, K4, K5 & K6)

Unit II Ecosystems**Contact Hours: 12**

Ecosystem: Definition and classification - *Structure of an Ecosystem:* Biotic and abiotic components - Range of existence - Regulation - *Function of an Ecosystem:* Food chain - Food web - Ecological pyramids - Primary and Secondary productivity - Energy flow - *Types of Ecosystems:* Forests (Tropical, temperate and evergreen) - Grassland (Chaparral and savannah) - Desert (Hot and cold) - Riverine - Marine - Wetlands - Estuarine (mangroves) - Ecosystem services (K1, K2, K3, K4, K5 & K6)

Unit III Ecosystem of Individuals**Contact Hours: 14**

Concept of ecosystem of individuals (Autecology): Abiotic and biotic factors interaction, *Ecological niche:* Fundamental niche, Realized niche - *Niche differentiation (Resource partitioning):* Temporal, Spatial and Morphological - Significance of ecological niche - Tolerance limits - *Laws of limiting factors:* Liebig's law of the minimum - Shelford's law of tolerance - *Strategies of adaptation in plants and animals:* Structural - Behavioral - Physiological (K1, K2, K3, K4, K5 & K6)

Unit IV Population Ecology**Contact Hours: 12**

Concept of population and meta-population - 'r' (Rate of increase) and 'K' selection (Carrying capacity) - Keystone species - *Characteristics of population:* Density - Natality-Mortality - Age distribution - Sex ratio - Survivorship curves - *Population growth:* Geometric - Exponential and Logistic - Factors limiting population growth - Population fluctuations - Population dispersion (K1, K2, K3, K4, K5 & K6)

Unit V Community Ecology**Contact Hours: 12**

Species interactions: Mutualism – Commensalism - Amensalism - Competition - Predation - Parasitism - Mimicry and Herbivory - Photocooperation - *Ecological succession:* Causes of succession (Climatic, Topographic and Biotic) - Primary succession and Secondary succession with examples - Stages of succession (Nudation, Invasion, Competition and Co-action, Reaction and Stabilization or Climax) - Ecotone and Edge effect (K1, K2, K3, K4, K5 & K6)

CORE COURSE – I**ECOLOGY**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	26UPEVS2C01	100	5	4	1	-	5

References:**Text Books & Reference Books:**

1. Begon, M., Howarth, R. W., & Townsend, C. R. (2016). *Essentials of ecology* (4th ed.). John Wiley & Sons.
2. Cunningham, W. P., Cunningham, M. A., O'Reilly, C. M., & Winsett, K. E. (2024). *Environmental science: A global concern* (16th ed.). McGraw Hill.
3. DK. (2019). *The ecology book*. DK Publishing.
4. Miller, G. T., & Spoolman, S. E. (2023). *Living in the environment* (20th ed.). Cengage Learning.
5. Misra, S. P., & Pandey, S. N. (2023). *Essential environmental studies* (4th ed.). Ane Books.
6. Rana, S. V. S. (2013). *Essentials of ecology and environmental science* (5th ed.). Prentice Hall.
7. Singh, J. S., Singh, S. P., Gupta, S. R., & Singh, R. (2025). *Ecology, environmental science and conservation* (2nd ed.). S. Chand and Company.

Web References:

1. [http://archive.mu.ac.in/myweb_test/M.A.Part%20-%20II%20-%20Paper%20VII .pdf](http://archive.mu.ac.in/myweb_test/M.A.Part%20-%20II%20-%20Paper%20VII.pdf)
2. <http://dspace.vpmthane.org:8080/jspui/bitstream/123456789/4202/1/FC%20Sem%202%20THE%20CONCEPT%20OF%20ECOLOGY%20AND%20ENVIRONMENT.pdf>
3. https://shodhganga.inflibnet.ac.in/bitstream/10603/68238/6/06_chapter%201.pdf
4. http://rvskvv.net/images/Environmental-Science_23.04.2020.pdf
5. <https://www.environmentalscience.org/ecology>
6. <http://environment-ecology.com/what-is-environment/669-environment.html>
7. https://www.nationalgeographic.org/topics/resource-library-human-impacts-environment/?q=&page=1&per_page=25

ALLIED COURSE – I
BASICS OF CHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	26UPEVS2A01	100	5	4	1	-	4

Course Objectives

The course focus on the basic concept of organic, inorganic, physical chemistry acid-base chemistry, electrochemistry and photochemistry

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| CO1 | Learn the properties of organic compounds and its organic reactions. |
| CO2 | Know the basic concepts of inorganic compounds of its properties. |
| CO3 | Understand the fundamental theories of coordination chemistry and thermodynamics. |
| CO4 | Learn the stoichiometry calculations, acid-base theories and solutions. |
| CO5 | Acquire the knowledge about electrodes, photochemical theories and nuclear particles. |

Mappings of course outcomes with programme outcomes

[illegible]

ALLIED COURSE – I
BASICS OF CHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	26UPEVS2A01	100	5	4	1	-	4

Unit I Fundamentals of Organic Chemistry

Contact Hours: 14

Organic chemistry: Classification of organic compounds, Functional groups and homologous series - *IUPAC nomenclature:* Rules for naming simple aliphatic and alicyclic hydrocarbons - *Chirality:* Concept of symmetry elements and chiral centers - *Aromaticity:* Hückel's rule ($4n+2$ rule), Benzenoid and non-Benzenoid aromatic compounds, Types of organic reactions, Electrophilic aromatic substitution mechanism in benzene (Nitration and Halogenation) (K1, K2 & K3).

Unit II Fundamentals of Inorganic Chemistry

Contact Hours: 14

Inorganic chemistry: Atomic structure, Quantum numbers, Pauli Exclusion Principle, Hund's rule, Aufbau's principle and Electronic configurations of Sodium and Chlorine elements - *Classification of elements:* s, p, d and f-block elements - *Periodicity of properties and Trends:* Definition of Atomic and ionic radii, Ionization energy, Electron affinity and Electronegativity - Molecular Orbital Theory - Bonding and Anti-bonding molecular orbitals - MO diagrams for H_2 and N_2 (K1, K2, K3 & K4)

Unit III Coordination chemistry and Thermodynamics

Contact Hours: 11

IUPAC nomenclature of coordination compounds - Werner's theory - Coordination number - Sidgwick's theory - Types of ligands - *Valence Bond Theory:* Inner and outer orbital complexes and magnetic properties - *Thermodynamics:* System and surroundings - Enthalpy (H) - Entropy (S) - Gibbs free energy - Hess's Law - *Laws of thermodynamics:* Zeroth, First, Second and Third laws (K1, K2, K3 & K4)

Unit IV Solutions, Acid-Base Equilibria and Stoichiometry

Contact Hours: 10

Definitions and calculation: Molarity, Normality, Molality and Mole Fraction - Primary and secondary standards - *Acid-base theories:* Arrhenius - Brønsted - Lowry - Lewis concepts - HSAB principle (Pearson's theory) and Applications - Stoichiometry - *Types of solutions:* Buffer solutions - Henderson-Hasselbalch equation (K1, K2, K3, K4 & K5)

Unit V Electrochemistry, Photochemistry and Nuclear Chemistry

Contact Hours: 11

Galvanic cells - EMF - Standard electrode potential - Reference electrodes - Corrosion and its prevention - *Photochemistry:* Grothus Draper Law - Stark Einstein's Law - Quantum yield - Photosynthesis - Jablonski diagram - *Nuclear particles and nuclear isomers:* Isotopes - Isobars - Isotones - *Nuclear reactions:* Fusion and fission - *Applications of radioisotopes:* Carbon dating - Rock dating - Medicinal (K1, K2, K3, K4 & K5)

References:

Text Books & Reference Books:

1. Clayden, J., Greeves, N., & Warren, S. (2001). *Organic chemistry* (2nd ed.). Oxford University Press.
2. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (2006). *Inorganic chemistry: Principles of structure and reactivity* (4th ed.). Pearson Education.
3. Puri, B. R., Sharma, L. R., & Pathania, M. S. (2017). *Principles of physical chemistry* (48th/49th rev. ed.). Vishal Publishing Co.
4. Singh, J. K. (2018). *Photochemistry and pericyclic reactions* (3rd ed.). New Age International Publishers.
5. Singh, J. K. (2022). *Nuclear chemistry and pericyclic reactions* (2nd ed.). Pragati Prakashan.

ALLIED COURSE – I
BASICS OF CHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	26UPEVS2A01	100	5	4	1	-	4

Web References:

1. https://chem.libretexts.org/Bookshelves/Organic_Chemistry
2. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry
3. <https://edu.rsc.org/resources>
4. <https://www.khanacademy.org/science/chemistry>
5. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps
6. <https://www.iaea.org/resources>

SKILL BASED ENHANCEMENT COURSE I

COMMUNICATION SKILLS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	26UPEVS2SC1	100	2	2	-	-	2

Course Objectives

The course provides knowledge to improve communication skills by integrating listening, speaking, reading, writing, grammar and composition techniques

Course Outcomes

On the successful completion of the course, students will be able to

- C01** Apply fundamental communication concepts, types, elements and ethical language practices in academic and professional contexts.
- C02** Demonstrate effective listening and speaking skills in formal and informal interactions, meetings and presentations.
- C03** Analyse written texts and produce clear, coherent academic and professional documents using appropriate reading and writing strategies.
- C04** Use standard grammatical structures accurately in spoken and written communication.
- C05** Compose well-structured paragraphs, essays, and professional documents with logical organization and correct mechanics.

Mappings of course outcomes with programme outcomes

	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
	C01	L	S	L	L	S	M	S	S
	C02	M	M	L	M	M	M	M	M
	C03	L	L	M	L	L	M	M	M
	C04	M	S	S	M	M	L	M	M
	C05	L	M	L	S	L	M	M	M
Alignment: S - Strong, M - Moderate, L – Low									

SKILL BASED ENHANCEMENT COURSE I
COMMUNICATION SKILLS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	26UPEVS2SC1	100	2	2	-	-	2

Unit I Introduction

Contact Hours: 06

Communication - Types of Communication (Verbal, Non-Verbal, Written, Visual, Horizontal, Vertical, Interpersonal, Grapevine), Importance of Communication, Role of Communication in personal, academic, and professional life, Intercultural Communication, Elements of Communication (Sender, Message, Encoding and Decoding, Channel, Receiver, Feedback, Context) - Importance of Non-Verbal Communication (Body Language, Facial Expressions, Gestures and Postures, Eye Contact, Proxemics) Learning to understand the usages of officialese, sexism, jargon, racism (K1, K2, K3, K4 & K5).

Unit II Listening and Speaking

Contact Hours: 06

Listening - Passive and active, Empathetic Listening, Critical Listening, Gist listening, Biased Listening and its benefits, Denotation and Connotation. Listening and responding to complaints (formal situation), Listening to problems and offering solutions (informal) Listening with courtesy, adding ideas, giving opinions during the meeting and making concluding remarks, Speaking effective (intelligibility and clarity), Making Short presentation – Formal Presentation with PPT. Face to Face meeting and online meeting. (K1, K2, K3, K4 & K5).

Unit III Reading and Writing

Contact Hours: 06

Methods and techniques of reading such as skimming, scanning and searching for information; Reading to understand the literal, morphological and suggested meaning of a passage. Identifying the writer's tone (admiring, accusatory, ironical, sympathetic, evasive, indecisive, ambiguous and neutral) and view-points, Cohesive and Coherent Writing, Precis Writing, Note taking skills, writing letters of application for jobs; writing CV and writing leave letters (K1, K2, K3, K4 & K5).

Unit IV Grammatical Skills

Contact Hours: 06

Simple tenses (Past, Present, Future) and its usage, Continuous tenses (Past, Present, Future) and its usage, Active Voice, Passive Voice, Phrasal Verbs, Phrasal Verbs with Objects, Short forms (he's/I'd/don't etc.) and Question Tags (K1, K2, K3, K4 & K5).

Unit V Composition Skills

Contact Hours: 06

Logical Connectors between sentences, Methods of developing a paragraph, Structure of an essay, Types of an essay and methods of developing an essay, Minutes of Meeting, Punctuation (period, question mark, exclamation point, comma, semicolon, colon, dash, hyphen, parentheses, brackets, braces, apostrophe, quotation marks, and ellipsis) and Capitalization and its uses (K1, K2, K3, K4 & K5).

References

Text Books & Reference Books

1. M. Ansell, Free English Grammar by, Second Edition
2. Communicative English II by TANSCHÉ
3. R. Murphy, Essential English Grammar
4. N. Rao & R. P. Das, Communication Skills, Himalaya Publishing House, 2009.

SKILL BASED ENHANCEMENT COURSE I
COMMUNICATION SKILLS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	26UPEVS2SC1	100	2	2	-	-	2

Web References

1. <https://www.scribd.com/document/794781961/Communication-Skills>
2. <https://writingcenter.fas.harvard.edu/pages/strategies-essay-writing>
3. <https://www.osou.ac.in/eresources/Understanding%20the%20Structure%20of%20a%20Paragraph.pdf>
4. Communicative English II - share.google/wgYpR9yh485Wl2rBq

CORE PRACTICAL – I**ECOLOGY**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	26UPEVS2CL1	100	4	-	-	4	2

Experiments:

1. Study of Abiotic Factors in Different Habitats
2. Determination of Soil Characteristics
3. Study of Food Chains and Food Webs in Local Ecosystems
4. Quadrat Method for Estimation of Plant Population Density
5. Study of Ecological Adaptations in Plants
6. Assessment of Species Diversity in a Local Community
7. Field Visit to a Natural Ecosystem

ALLIED PRACTICAL - I**CHEMISTRY - I**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	26UPEVS2AL1	100	3	-	-	3	2

Experiments:**Volumetric Analysis**

1. Estimation of Sodium hydroxide using standard Sodium Carbonate.
2. Estimation of Hydrochloric acid using standard Oxalic acid.
3. Estimation of Ferrous sulphate using standard Mohr's salt.
4. Estimation oxalic acid using standard Ferrous Sulphate.
5. Estimation of Potassium permanganate using standard NaOH

Semester - II

CELL BIOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	26UPEVS2C02	100	5	4	1	-	5

Course Objectives

The course aims to help the students to learn and understand the evolution theories of cell biology, structure and functions of cell, cellular cycle, its transport and metabolism processes

Course Outcomes

On the successful completion of the course, students will be able to

- C01** Learn the evolution theories of cell biology
- C02** Study the structure and function of cellular organelles
- C03** Understand the stages of cell cycle
- C04** Acquire knowledge on cellular transport mechanisms
- C05** Understand the cellular metabolism processes

Mappings of course outcomes with programme outcomes

[illegible]

CORE COURSE – II

CELL BIOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	26UPEVS2C02	100	5	4	1	-	5

Unit I Introduction

Contact Hours: 10

Evolution of cell biology - Cell theory and protoplasm theory - Cell as the basic unit of life - Types of cells - Similarities and differences among cells - Prokaryotic cells (Bacteria and Archaea) and Eukaryotic cells (Plant and animal cells) (K1, K2, K3, K4, K5 & K6)

Unit II Cell Organelles

Contact Hours: 11

Structure and functions of cell wall (Bacteria and plant) - Plasma membrane - Nucleus - Chloroplast - Mitochondria - Endoplasmic reticulum - Golgi bodies - Ribosomes - Vacuoles - *Cytoskeleton structure*: Microfilaments - Microtubules - Centrioles (K1, K2, K3, K4, K5 & K6)

Unit III Cell Cycle

Contact Hours: 14

Stages of cell cycle: G1, S, G2, M and G0 phases - *Cell division*: Mitosis and Meiosis - *Cell differentiation*: Mechanism and potency levels - *Cell death*: Apoptosis and Necrosis (K1, K2, K3, K4, K5 & K6)

Unit IV Cell Transport Mechanism

Contact Hours: 13

Types of cellular transport: Passive (Diffusion, osmosis and facilitated diffusion) - Active (Primary and secondary) - *Cell signalling*: Pathways - Messengers - Receptor responses (K1, K2, K3, K4, K5 & K6)

Unit V Cell Metabolism

Contact Hours: 12

Photosynthesis: Light and Dark reactions - Significance - *Respiration*: Glycolysis - Krebs cycle - Oxidative phosphorylation - *Transpiration*: Types and Mechanism - *Lysosome*: Intracellular digestion and Autophagy - Cellular response to environmental stress (K1, K2, K3, K4, K5 & K6)

References

Text Books& Reference Books:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). *Molecular biology of the cell* (4th ed.). Garland Science.
2. Islam, A. (2011). *A text book of cell biology* (1st ed.). Books and Allied.
3. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., & Darnell, J. (2000). *Molecular cell biology* (4th ed.). W. H. Freeman and Company.
4. Paul, A. (2011). *Text book of cell and molecular biology* (3rd ed.). Books and Allied.
5. Rastogi, V. B. (2019). *Cell biology*. New Age International.

Web References

1. https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/
2. <https://teachmephysiology.com/biochemistry/cell-growth-death/cell-cycle/>
3. <https://opentextbc.ca/biology/chapter/3-3-eukaryotic-cells/>
4. <https://microbenotes.com/cell-organelles/>
5. <https://le.ac.uk/vgec/topics/cell-cycle/the-cell-cycle-higher-education>

ALLIED COURSE – II
APPLIED CHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	26UPEVS2A02	100	5	4	1	-	4

Course Objectives

The course aims to provide comprehensive knowledge about applied field of chemistry relevant to environmental science

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| C01 | Learn the basic concept and preparations of dyes and pigments |
| C02 | Learn the raw materials and steel Manufacturing process |
| C03 | Understand the polymer classification, preparation and processing methods |
| C04 | Know the importance of fertilizers and to enhance the crop yield |
| C05 | Acquire the preparation and processing methods of dairy products |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
C01	S	M	M	L	M	M	L	L
C02	S	M	M	M	M	M	L	L
C03	S	M	M	M	M	M	L	L
C04	S	M	S	L	S	S	M	L
C05	S	M	M	L	M	M	M	M
Alignment: S - Strong, M - Moderate, L - Low								

ALLIED COURSE – II
APPLIED CHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	26UPEVS2A02	100	5	4	1	-	4

Unit I Dyes and Pigments Contact Hours: 14

Basics and Preparation: Introduction to dyes and pigments - Classification of dyes (Azo, Anthraquinone, Vat) - Preparation of fabrics (singeing, scouring, bleaching and mercerizing) - *Processing Methods:* Batch processing (exhaust dyeing) - continuous/semi-continuous processing and printing techniques - Specialized leather dyeing (drum, spray, dip, hand dyeing) - *Applications:* Textile industry, food coloring, cosmetics, printing inks and paints (K1, K2 & K3).

Unit II Steel (Metallurgy) Contact Hours: 14

Metals and Alloys: Iron ore - Coking coal - Limestone and other additives - *Preparation/Manufacturing:* Primary Steelmaking - Secondary Steelmaking and Ladle Metallurgy - *Processing and Shaping:* Casting - Forming and Heat Treatment - *Applications:* Construction - Machinery - Vehicles - Infrastructure - Household appliances (K1, K2 & K3).

Unit III Polymers Contact Hours: 11

Monomers and polymers - Polymerization processes - Classification of polymers - *Preparation of Methods:* Polymerization techniques (bulk, solution, suspension and emulsion polymerization) - *Processing methods:* Extrusion - Injection molding - Blow molding and Compression molding - *Applications:* Automotive - Medical and Construction industries (K1, K2, K3 & K4).

Unit IV Fertilizers Contact Hours: 10

Introduction: Importance of fertilizers (N, P, and K types) - *Preparation Methods:* Industrial manufacturing processes for common fertilizers (Haber process for ammonia/urea and production of NPK fertilizers) - *Applications:* Essential for modern agriculture to enhance soil nutrient levels and improve crop yields (K1, K2, K3 & K4).

Unit V Dairy Products Contact Hours: 11

Introduction: Composition of milk and dairy industry overview - *Preparation Methods:* Processing of milk - Pasteurization - Homogenization - Separation and production (cheese, yogurt and butter) - *Applications:* Key food source, providing essential nutrients like calcium and protein (K1, K2, K3, K4 & K5).

References:

Text Books & Reference Books:

1. Gupta, C. K. (2003). *Chemical metallurgy: Principles and practice*. WILEY-VCH Verlag GmbH & Co. KGaA.
2. Kumar, A., & Gupta, R. K. (2018). *Fundamentals of polymer engineering* (2nd ed.). CRC Press.
3. Walling, E., & Vaneeckhaute, C. (2022). Nitrogen fertilizers and the environment. In *Nitrate handbook*. CRC Press.
4. Walstra, P., Wouters, J. T. M., & Geurts, T. J. (2005). *Dairy science and technology* (2nd ed.). CRC Press.
5. Zollinger, H. (2003). *Color chemistry: Syntheses, properties, and applications of organic dyes and pigments* (3rd ed.). WILEY-VCH Verlag GmbH & Co. KGaA.

ALLIED COURSE – II
APPLIED CHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	26UPEVS2A02	100	5	4	1	-	4

Web References:

1. <https://www.sdc.org.uk>
2. <https://chem.libretexts.org>
3. <https://worldsteel.org>
4. <https://www.iim-india.net>
5. https://chem.libretexts.org/Bookshelves/Polymer_Chemistry
6. <https://www.fertilizer.org>
7. <https://fil-idf.org>

SKILL BASED ELECTIVE COURSE – II
COMPUTATIONAL SKILLS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	26UPEVS2SC2	100	2	2	-	-	2

Course Objectives

The course provides the fundamental computer knowledge and practical digital skills

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| C01 | Identify basic computer components and their applications |
| C02 | Operate computers using operating system functions and file management |
| C03 | Create scientific documents, spreadsheets, and presentations |
| C04 | Use the internet and digital tools effectively for data and literature access |
| C05 | Apply basic computer skills in laboratory work, field surveys and projects. |

Mappings of course outcomes with programme outcomes

[illegible]

SKILL BASED ELECTIVE COURSE – II
COMPUTATIONAL SKILLS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	26UPEVS2SC2	100	2	2	-	-	2

Unit I Introduction to Computers and Applications Contact Hours: 06

Definition and components of computers: Hardware, software, input, output and storage devices – Types of computers – Applications of computers in environmental science – Introduction to Artificial Intelligence (AI) and Internet of Things (IoT) – AI applications in environmental monitoring and management – Mobile applications for environmental data collection. (K1, K2, K3, K4 & K5).

Unit II Operating System and File Management Contact Hours: 06

Concept and functions of operating systems – Introduction to Windows/Linux environment – File and folder organization – Data storage and backup – Cloud storage systems – IoT device connectivity basics – Data security and privacy in digital environmental monitoring systems – Basic troubleshooting (K1, K2, K3, K4 & K5).

Unit III Word Processing and Presentations Contact Hours: 06

Creating and formatting scientific documents: Tables, charts and images – Page layout and referencing basics – AI-assisted writing and editing tools – Preparing presentations for seminars using conventional and AI-powered presentation software – Good presentation practices. (K1, K2, K3, K4 & K5).

Unit IV Spreadsheets and Data Handling Contact Hours: 06

Introduction to spreadsheets – Data entry and formatting – Basic formulas and functions – Charts and simple data interpretation – Environmental data examples – Introduction to AI-assisted data analysis – Handling environmental datasets obtained from IoT sensors – Basic data visualization dashboards. (K1, K2, K3, K4 & K5).

Unit V Internet, Digital Tools and Cyber Awareness Contact Hours: 06

Internet basics and search strategies – Accessing environmental databases and journals – AI-powered search tools and literature discovery – Environmental mobile applications and citizen science platforms – Email and cloud storage – Digital collaboration tools – Cyber safety, digital ethics, and ethical issues related to AI and IoT technologies. (K1, K2, K3, K4 & K5)

References

Text Books & Reference Books

1. P. K. Sinha & Priti Sinha, Computer Fundamentals, BPB Publications.
2. V. Rajaraman, Fundamentals of Computers, Prentice Hall of India.
3. Peter Norton, Introduction to Computers, Tata McGraw-Hill

Web References

1. <https://www.gcfglobal.org>
2. <https://www.tutorialspoint.com>
3. <https://www.microsoft.com/en-in/education>

CORE PRACTICAL – II**CELL BIOLOGY**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	26UPEVS2CL2	100	4	-	-	4	2

Experiments:

1. Measurement of cell- epidermal cell (Onion/Animal)
2. Study of divisional stages in Mitosis
3. Study of divisional stages in Meiosis
4. Buccal smear – Identification of Barr Body
5. Permanent slide preparation
6. Separation of chloroplast
7. Preparation of polytene chromosome from chironomus larvae

ALLIED PRACTICAL - II
CHEMISTRY - II

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	26UPEVS2AL2	100	3	-	-	3	2

Experiments:

Organic Qualitative Analysis

1. Detection of elements – Nitrogen, Sulphur and Halogens
2. Detection of aliphatic or aromatic compounds.
3. Detection of saturated or unsaturated compounds.
4. Preliminary tests and functional group detection

[Carbonyl compounds, phenols, amines, amides, carboxylic acids, and carbohydrates]

Semester - III

CORE COURSE – III
ENVIRONMENTAL BIOCHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	26UPEVS2C03	100	5	4	1	-	5

Course Objectives

The course aims to provide comprehensive knowledge of biochemical processes and its cellular effects and also includes the concepts of pollutants biochemistry

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| C01 | Understand the structure, properties, and functions of major biomolecules |
| C02 | Learn about the enzymes, its properties and its mechanisms |
| C03 | Describe metabolic process of macromolecules |
| C04 | Understand about environmental stress factors and its responses |
| C05 | Perceive the basic biochemistry of environmental pollutants |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	M	L	M	S	L	L
CO2	S	S	M	M	M	S	L	L
CO3	S	S	S	M	M	S	M	L
CO4	S	S	S	M	S	S	M	M
CO5	S	S	S	S	S	S	S	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – III
ENVIRONMENTAL BIOCHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	26UPEVS2C03	100	5	4	1	-	5

Unit I Biomolecules Contact Hours: 10

Biochemistry: Definition and importance - *Biomolecules:* Carbohydrates (Types and Functions) - Proteins (Amino acids, peptide bond, structure and functions) - Nucleic acids (Basic structure and functions of DNA and RNA) - *Micromolecules:* Vitamins and Minerals (K1, K2, K3, K4, K5 & K6)

Unit II Enzymes Contact Hours: 12

Enzymes: Definition - Classification - Structure and Properties - *Mechanism of enzyme action:* Lock & key and Induced-fit models - *Factors affecting enzyme activity:* pH - Temperature and Substrate concentration - *Enzyme inhibition:* Competitive and Non-competitive inhibition (K1, K2, K3, K4, K5 & K6)

Unit III Macromolecules Metabolism Contact Hours: 13

Basic concept of metabolism: Catabolism and Anabolism - *Carbohydrate metabolism:* Glycolysis and TCA cycle - *Protein Metabolism:* Protein Synthesis – Transamination and Deamination - *Fatty acids and Nucleic acids:* Biosynthesis and Breakdown (K1, K2, K3, K4, K5 & K6)

Unit IV Environmental Stress and Responses Contact Hours: 14

Definition - *Stress-causing factors:* Oxidative stress and Formation of reactive oxygen species (ROS) - *Antioxidant defense systems:* Enzymatic antioxidants (Superoxide dismutase, catalase and peroxidase) and Non-enzymatic antioxidants (Vitamins and glutathione) - Stress proteins and Heat shock proteins - Biochemical adaptations of organisms to temperature, salinity, pH and drought stress (K1, K2, K3, K4, K5 & K6)

Unit V Pollutants Biochemistry Contact Hours: 11

Basic metabolism and detoxification: Heavy metals - Pesticides - Xenobiotics - Bioaccumulation and Biomagnification in food chains - *Role of biochemistry:* Bioremediation - Pollution control - Environmental monitoring (K1, K2, K3, K4, K5 & K6)

References:

Text Books & Reference Books:

1. Cunningham, W. P., & Cunningham, M. A. (2019). *Principles of environmental science*. McGraw-Hill.
2. McMurry, J., & Fay, R. C. (2018). *Environmental chemistry*. Pearson Education.
3. Nelson, D. L., & Cox, M. M. (2017). *Lehninger principles of biochemistry* (7th ed.). W. H. Freeman.
4. Sharma, P. D. (2012). *Ecology and environment*. Rastogi Publications.
5. Voet, D., Voet, J. G., & Pratt, C. W. (2016). *Fundamentals of biochemistry* (5th ed.). Wiley.

Web References

1. <https://ncert.nic.in>
2. <https://www.unep.org>
3. <https://www.who.int>
4. <https://pubchem.ncbi.nlm.nih.gov>
5. <https://www.fao.org>

ALLIED COURSE - III

BOTANY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	26UPEVS2A03	100	5	4	1	-	4

Course Objectives

The course focus on the basic concept of plant diversity, taxonomy, ethnobotany with plant biotechnology techniques and physiological mechanism

Course Outcomes

On the successful completion of the course, students will be able to

- C01** Learn the structural organizations of plant diversity kingdom
- C02** Understand the plant systematic position and importance of virtual herbarium
- C03** Know the ethnobotanical species and tissue culture techniques
- C04** Understand the morphological features of plant ecological adaptations
- C05** Acquire the functional concepts of plant anatomy and physiological process

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	M	L	M	S	L	L
CO2	S	M	M	M	M	S	M	L
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	L	S	S	L	L
CO5	S	S	M	M	M	S	L	L
Alignment: S - Strong, M - Moderate, L - Low								

ALLIED COURSE - III**BOTANY**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	26UPEVS2A03	100	5	4	1	-	4

Unit I Plant Kingdom and Diversity Contact Hours: 10

Introduction to Plant Kingdom - Salient features, structure, reproduction and life cycle and economic importance of various Plant Groups: Algae (*Chlorella* and *Sargassum*), Fungi (*Penicillium* and *Agaricus*) - Bryophytes (*Sphagnum*) Pteridophytes (*Marsilea*) - Gymnosperm (*Pinus* and *Cycas*) (K1, K2, K3, K4 & K5).

Unit II Plant Taxonomy of Angiosperms Contact Hours: 10

Plant Taxonomy: Definition - Classification of Artificial, Natural and Phylogenetic system - Systematic study and economic importance of the select families: Annonaceae - Asteraceae - Brassicaceae - Cucurbitaceae - Malvaceae Euphorbiaceae and Poaceae - Herbarium techniques (K1, K2, K3, K4 & K5).

Unit III Plant Morphology and Ecological Adaptations Contact Hours: 10

Plant Morphology: General Morphological Features of flower description - Plant parts and functions - Inflorescence and its types - Structure and types of seeds - *Ecological Plant Adaptations*: Hydrophytes - Xerophytes - Mesophytes and Halophytes (K1, K2, K3, K4 & K5).

Unit IV Plant Anatomy and Physiology Contact Hours: 10

Plant Anatomy: Monocots and Dicots - *Plant Physiology*: Nutrients uptake - Water absorption - Osmosis - *Photosynthesis*: C3, C4, CAM Cycles - Transpiration - Respiration - *Growth hormones*: Auxins - Cytokinins - Abscissic acid - Indole Acetic Acid (K1, K2, K3, K4 & K5).

Unit V Ethnobotany and Plant Biotechnology Contact Hours: 10

Ethnobotany: Scope and Concept - Status of ethnobotanical important species of India - Systems of Indigenous medicines and their availability - *Plant tissue culture*: In vitro culture methods - Somatic embryogenesis - GM Crops (K1, K2, K3, K4 & K5).

References:**Text Books & Reference Books:**

1. Bhatnagar, S. P., & Moitra, A. (2020). *Gymnosperms*. New Age International (P) Ltd.
2. Cooper, G. M. (2019). *The cell: A molecular approach*. Oxford University Press.
3. Jain, V. K. (2017). *Fundamentals of plant physiology*. Chand & Company Ltd.
4. Pandey, B. P. (1978). *Plant anatomy*. S. Chand & Co.
5. Satyanarayana, U., & Chakrapani, U. (2005). *Biochemistry*. Books and Allied (P) Ltd.
6. Sharma, O. P. (2009). *Plant taxonomy*. Tata McGraw-Hill.
7. Sharma, P. D. (2017). *Ecology and environment*. Rastogi Publications.
8. Singh, V., Pande, P. C., & Jain, D. K. (2014). *A textbook of botany*. Rastogi Publications.

Web References:

1. <https://botany.org>
2. <https://www.kew.org/science>
3. <http://www.mobot.org/MOBOT/research/APweb/>
4. <https://bio.libretexts.org>

ALLIED COURSE - III**BOTANY**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	26UPEVS2A03	100	5	4	1	-	4

5. <https://www.khanacademy.org/science/biology>

6. <https://www.ncbi.nlm.nih.gov/books>

7. <https://www.ispb.org>

SKILL BASED ELECTIVE COURSE – III

EMPLOYABILITY SKILLS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	26UPEVS2SC3	100	2	2	-	-	2

Course Objectives

The course enhances employability by developing communication, teamwork, problem-solving, professional ethics, and career readiness skills

Course Outcomes

On the successful completion of the course, students will be able to

- C01** Communicate effectively in academic and professional contexts
- C02** Demonstrate interpersonal and teamwork skills
- C03** Apply critical thinking and problem-solving skills to environmental issues.
- C04** Exhibit professional ethics, time management, and workplace discipline.
- C05** Prepare for employment or higher studies

Mappings of course outcomes with programme outcomes

COs	P01	P02	P03	P04	P05	P06	P07	P08
C01	M	S	L	L	M	M	M	S
C02	M	L	M	S	S	M	M	S
C03	L	M	S	M	L	M	M	M
C04	S	L	M	L	L	M	S	M
C05	M	M	M	L	M	M	S	S
Alignment: S - Strong, M - Moderate, L – Low								

SKILL BASED ELECTIVE COURSE – III
EMPLOYABILITY SKILLS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	26UPEVS2SC3	100	2	2	-	-	2

Unit I Communication Skills

Contact Hours: 06

Importance of communication in environmental careers - Verbal, non-verbal, and written communication - Scientific and technical communication basics - Presentation skills- Common communication barriers (K1, K2, K3, K4 & K5).

Unit II Interpersonal Skills and Teamwork

Contact Hours: 06

Interpersonal skills and emotional intelligence - Teamwork in field surveys and laboratory work - Leadership and coordination - Conflict resolution - Professional behavior and etiquette (K1, K2, K3, K4 & K5).

Unit III Problem Solving and Critical Thinking

Contact Hours: 06

Analytical thinking and reasoning - Problem-solving approaches - Environmental case studies - Decision-making techniques - Innovation in environmental solutions (K1, K2, K3, K4 & K5).

Unit IV Professional Ethics and Workplace Skills

Contact Hours: 06

Professional ethics and integrity - Time management and work discipline - Stress management - Safety awareness and responsibility - Environmental ethics and sustainability values (K1, K2, K3, K4 & K5).

Unit V Career Readiness and Skill Development

Contact Hours: 06

Career opportunities in environmental sector - Resume and cover letter preparation - Interview and group discussion skills - Digital professionalism - Lifelong learning and upskilling (K1, K2, K3, K4 & K5).

References:

Text Books & Reference Books:

1. B. Ghosh, Soft Skills and Employability Skills, McGraw Hill Education.
2. R. S. Aggarwal, Personality Development, S. Chand & Company.
3. NPTEL, Soft Skills Development, IIT Course Material

Web References:

1. <https://www.nptel.ac.in>
2. <https://www.skillsyouneed.com>
3. <https://www.indeed.com/career-advice>

CORE PRACTICAL – III
ENVIRONMENTAL BIOCHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	26UPEVS2CL3	100	4	-	-	4	2

Experiments:

1. Qualitative Analysis of Carbohydrates
2. Qualitative Analysis of Proteins
3. Determination of Enzyme Activity
4. Effect of pH on Enzyme Activity
5. Estimation of Vitamin C in Fruit Juices
6. Study of Bioaccumulation and Biomagnification Using Food Chain Models
7. Assessment of Water Quality Using Basic Biochemical Parameters

ALLIED PRACTICAL - III**BOTANY**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	26UPEVS2AL3	100	3	-	-	3	2

Experiments:

1. Plant Diversity - Preparation and Demonstration of Slides
2. Plant anatomical structures- T.S of Dicot-Root, Stem and Leaf, Monocot- Root, Stem and Leaf
3. Plant Cell Functions - Plasmolysis and Deplasmolysis
4. Plant Cell Functions - Stomatal Distribution
5. Plant Taxonomy - Flower Dissection
6. Plant Physiology - Paper chromatography experiment

Semester - IV

CORE COURSE – IV

BASICS OF MICROBIOLOGY AND BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	26UPEVS2C04	100	5	4	1	-	5

Course Objectives

The course provides the fundamental knowledge of microbiology and biotechnology, microbial nutrition along with the concepts of fermentation technology

Course Outcomes

On the successful completion of the course, students will be able to

- C01** Understand the morphology and structure of bacteria, fungi, algae and viruses
- C02** Learn the sterilization, disinfection and staining methods of microorganisms
- C03** Understand microbial nutrition and their interactions
- C04** Know the basic concepts of biotechnology and recombinant DNA technology
- C05** Learn the concepts of fermentation technology and its applications

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
C01	S	M	M	S	M	S	L	L
C02	S	S	M	S	M	S	M	L
C03	S	S	S	M	S	S	M	L
C04	S	S	S	S	M	S	M	M
C05	S	S	S	S	S	S	M	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – IV
BASICS OF MICROBIOLOGY AND BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	26UPEVS2C04	100	5	4	1	-	5

Unit I Introduction to Microbiology **Contact Hours: 11**

Evolution and development of Microbiology - Major historical milestones in the field of Microbiology - *Morphology and ultrastructure of microorganisms*: Bacteria, Yeasts, Fungi, Algae and Viruses (K1, K2, K3, K4, K5 & K6)

Unit II Sterilization Techniques **Contact Hours: 12**

Sterilization and Disinfection - Principles and importance - Methods of sterilization - Physical methods (Dry heat, moist heat, filtration and radiation) - Chemical methods of sterilization and disinfection - Measurement of microorganisms - Micrometry - Staining techniques (K1, K2, K3, K4, K5 & K6)

Unit III Microbial Nutrition and Interactions **Contact Hours: 12**

Microbial media - Classification of media - Nutritional requirements and Nutritional groups of bacteria - Bacterial growth curve - Factors influencing microbial growth - Microbial interactions - Beneficial microorganisms and their applications (Industry, agriculture, environment and health) - Harmful microorganisms and their effects on humans, animals, plants and food (K1, K2, K3, K4, K5 & K6)

Unit IV Introduction to Biotechnology **Contact Hours: 12**

Definition - Scope and importance of biotechnology - Historical development of biotechnology - Branches of biotechnology - Principles and steps involved in recombinant DNA technology - *Vectors*: Plasmids and Bacteriophages - Host systems - *Restriction endonucleases*: Types - Mechanism of action - Applications - Role of microorganisms in biotechnological processes (K1, K2, K3, K4, K5 & K6)

Unit V Fermentation Technology and Applications **Contact Hours: 13**

Introduction to fermentation technology - Types of fermentation (Batch, continuous and fed-batch) - Design, types and applications of fermenters - *Applications of biotechnology*: Medicine (Vaccines and antibiotics) - Agriculture (Transgenic crops and biofertilizers) - Industry (Enzymes and biofuels) - Ethical and biosafety issues in biotechnology (K1, K2, K3, K4, K5 & K6)

References:

Text Books & Reference Books:

1. Ananthanarayan, R., & Paniker, C. K. J. (2024). *Ananthanarayan and Paniker's textbook of microbiology* (13th ed.). Universities Press.
2. Dubey, R. C., & Maheshwari, D. K. (2022). *A textbook of microbiology* (5th ed.). S. Chand Publishing.
3. Gupta, P. K. (2014). *Elements of biotechnology* (2nd ed.). Rastogi Publications.
4. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2010). *Microbiology* (5th ed.). McGraw-Hill Education.
5. Prescott, L. M., Harley, J. P., & Klein, D. A. (2017). *Microbiology* (10th ed.). McGraw-Hill Education.

Web References:

CORE COURSE – IV
BASICS OF MICROBIOLOGY AND BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	26UPEVS2C04	100	5	4	1	-	5

1. <https://bio.libretexts.org/Bookshelves/Microbiology/>
2. <https://microbenotes.com/sterilization-physical-and-chemical-methods/>
3. https://gcwk.ac.in/econtent_portal/ec/admin/contents/
4. <https://ncert.nic.in/textbook/pdf/kebt101.pdf>
5. <https://microbenotes.com/fermentation/>

ZOOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	26UPEVS2A04	100	5	4	1	-	4

Course Objectives

The course provides the fundamental knowledge of zoology and genetics with the concepts of animal association and interaction

Course Outcomes

On the successful completion of the course, students will be able to

- C01** Understand the origin of different invertebrate and vertebrate animals.
- C02** Realize the knowledge on genetics and stem cell biology.
- C03** Recognize the development of organisms.
- C04** Know the role of different organs in organisms.
- C05** Learn the change in a population that is inherited over generations.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
C01	S	M	M	L	M	S	L	L
C02	S	S	M	M	M	S	M	L
C03	S	M	M	L	M	S	L	L
C04	S	M	M	L	M	S	L	L
C05	S	M	S	L	S	S	L	L
Alignment: S - Strong, M - Moderate, L - Low								

ALLIED COURSE – IV

ZOOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	26UPEVS2A04	100	5	4	1	-	4

Unit I Animal Classification Protozoa to Chordata

Contact Hours: 10

Classification of Animal Kingdom based on common fundamental features - Linnaeus's System of Classification - Salient Features of different Phyla in the Animal Kingdom - Comparison of invertebrates and vertebrates (K1, K2)

Unit III Genetics

Contact Hours: 10

Genetics: Mendelian Laws - Sex linked inheritance - Turner's Klinefelter's and Down Syndrome - ABO Blood group and Rh factor - Phenylketonuria and Sickle cell anemia - Introduction to stem cell biology (K1, K2)

Unit II Developmental Biology

Contact Hours: 10

Types of Eggs - Fertilization - Cleavage and Gastrulation in frog - Fetal membrane in chick - Placentation in mammals (K1, K2)

Unit IV Physiology

Contact Hours: 10

Physiological Systems: Respiration - Digestion - Circulation - Nervous - Excretion and Reproduction (K1, K2, K3)

Unit V Animal Association and Host-parasite interaction

Contact Hours: 10

Symbiotic Relationships: Mutualism - Commensalism - Parasitism - Non-symbiotic relationships - Phoresis - Predation and Competition - Types of Hosts and Parasites - Host - Parasite relationship (K4, K5)

References:

Text Books & Reference Books:

1. Rastogi, S. C. (2008). *Cell biology* (1st ed.). New Age International Publishers.
2. Verma, P. S., & Agarwal, V. K. (2006). *Cell biology, genetics, molecular biology, evolution and ecology*. S. Chand & Company Ltd.
3. Verma, P. S., & Agarwal, V. K. (n.d.). *Chordata embryology*. S. Chand & Company Ltd.
4. Verma, P. S., & Tyagi, B. S. (2010). *Animal physiology* (6th ed.). S. Chand & Company Ltd.

Web References:

1. <https://ncert.nic.in/textbook/pdf/kebo104.pdf>
2. <https://egyankosh.ac.in/bitstream/123456789/102037/1/Unit-1.pdf>
3. <https://ncert.nic.in/textbook/pdf/kebo102.pdf>
4. <https://www.ncbi.nlm.nih.gov/books>
5. <https://bio.libretexts.org>

SKILL BASED ELECTIVE COURSE – IV

ENTREPRENEURIAL SKILLS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	26UPEVS2SC4	100	2	2	-	-	2

Course Objectives

The course aims to develop entrepreneurial competencies by integrating sustainability, green business concepts, and environmental problem-solving approaches

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| CO1 | Understand the role of entrepreneurship in sustainable development |
| CO2 | Identify eco-friendly business opportunities |
| CO3 | Apply basic business planning and financial concepts to green enterprises |
| CO4 | Understand regulatory, ethical and environmental compliance aspects |
| CO5 | Develop an entrepreneurial mindset for creating sustainable ventures. |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
C01	M	L	M	L	S	S	M	L
C02	M	M	S	M	S	M	M	M
C03	M	M	S	M	S	M	M	M
C04	M	L	M	S	S	M	S	L
C05	M	M	S	M	S	M	M	S
Alignment: S - Strong, M - Moderate, L – Low								

SKILL BASED ELECTIVE COURSE – IV**ENTREPRENEURIAL SKILLS**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	26UPEVS2SC4	100	2	2	-	-	2

Unit I Introduction to Green Entrepreneurship**Contact Hours: 06**

Concept of entrepreneurship and sustainable development - Green entrepreneurship and environmental enterprises - Role of entrepreneurs in environmental protection - Green economy and circular economy- Case studies of eco-entrepreneurs (K1, K2, K3, K4 & K5).

Unit II Environmental Business Opportunities**Contact Hours: 06**

Renewable energy and energy efficiency enterprises - Waste management and recycling businesses - Water resource management services - Organic farming and eco-products - Environmental consultancy and auditing (K1, K2, K3, K4 & K5).

Unit III Business Planning for Environmental Enterprises**Contact Hours: 06**

Components of a green business plan - Market analysis for eco-products and services - Cost estimation and pricing strategies - Financial planning and funding basics - Risk assessment in environmental businesses (K1, K2, K3, K4 & K5).

Unit IV Regulations, Policies and Support Systems**Contact Hours: 06**

Environmental laws and compliance requirements - Licenses and approvals for environmental ventures - Government schemes supporting green entrepreneurship - Role of MSMEs, NGOs and incubation centers - Environmental ethics and corporate responsibility (K1, K2, K3, K4 & K5).

Unit V Entrepreneurial Skills and Sustainable Growth**Contact Hours: 06**

Leadership and decision-making skills - Innovation and eco-design thinking - Marketing of green products and services - Scaling up sustainable enterprises - Challenges and opportunities in environmental entrepreneurship (K1, K2, K3, K4 & K5).

References:**Text Books & Reference Books:**

1. Vasant Desai, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House.
2. Poornima M. Charantimath, Entrepreneurship Development, Pearson Education.
3. Geoffrey G. Meredith et al., Entrepreneurship and Small Business Management, McGraw Hill.

Web References:

1. <https://www.startupindia.gov.in>
2. <https://www.msme.gov.in>
3. <https://www.unep.org/explore-topics/green-economy>

CORE PRACTICAL – IV
BASICS OF MICROBIOLOGY AND BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	26UPEVS2CL4	100	4	-	-	4	2

Experiments:

1. Good Microbiology laboratory practices (GLPs) & Laboratory safety (Dos and Don'ts),
2. Preparation of basic liquid (Nutrient broth) and solid media (Nutrient Agar and Potato Dextrose Agar) for cultivation of bacteria and fungi.
3. Pure culture techniques for isolation and purification of microorganisms
 - a. Pour plate method
 - b. Spread plate method
 - c. Streak plate method
4. Staining Techniques
 - a. Simple staining
 - b. Gram Staining
 - c. Fungal staining (Lacto-phenol cotton blue)
5. Isolation of Genomic DNA from bacteria
6. Agarose Gel Electrophoresis
7. Production of Bio fertilizers - Rhizobium, Azotobacter

ALLIED PRACTICAL - IV
ZOOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	26UPEVS2AL4	100	3	-	-	3	2

Experiments:

1. Museum Specimen Study – Unicellular and Multicellular organisms
2. Study of Living Cells-Buccal smear and ABO blood grouping
3. Minor Dissections
4. General Method of Microscopic Preparations
4. Cytological Study – Pathological Slides
5. Dissection- Mouth parts of Cockroach and other Insects

Semester - V

ENVIRONMENTAL POLLUTION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2C05	100	5	4	1	-	5

Course Objectives

The course provides knowledge about various environmental pollutants, their effects, monitoring techniques and the interactions involved in their transport within the environment

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| CO1 | Learn about the atmospheric pollutants, sources, types and monitoring techniques |
| CO2 | Understand the water pollutants, sources, sampling methods, quality standards and its impacts |
| CO3 | Know about the pollutants and its impacts on soil quality and environment. |
| CO4 | Acquire the knowledge about noise pollution and its impacts on humans and environment. |
| CO5 | Understand the thermal and radiation pollution and its impacts on environment |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	S	S	S	S	M	M
CO2	S	S	S	S	S	S	S	M
CO3	S	S	S	M	S	S	M	L
CO4	S	M	S	M	S	M	M	L
CO5	S	M	S	S	S	S	S	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – V
ENVIRONMENTAL POLLUTION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2C05	100	5	4	1	-	5

Unit I Air Pollution **Contact Hours: 14**

Air pollution - Natural and anthropogenic sources of pollution - Types of Air pollutants - History of air pollution (Air pollution episode, global and India) - Effects of air pollution on environment - Meteorology based transport and diffusion of pollutants - Behavior of pollutants in the atmosphere - Air pollution standards (NAAQS) - Air pollution index - Methods of monitoring, Sampling and Control of air pollution (K1, K2, K3, K4, K5 & K6)

Unit II Water Pollution **Contact Hours: 14**

Water pollution - Types and sources - Effects of water pollutants (Trace metals and organic substances) - Eutrophication - Physico-chemical and Bacteriological sampling techniques - Water quality and standards (APHA and BIS) – Sources of Ground water and marine pollution - Ecological and Economic impacts of water pollution - Control of water pollution - Water harvesting techniques (K1, K2, K3, K4, K5 & K6)

Unit III Soil Pollution **Contact Hours: 12**

Soil Pollution - Sources (industrial, domestic and agricultural) - Types of contaminants (pesticides and heavy metals) - Processes contributing to soil quality degradation (Erosion, physical and chemical degradation) - Detrimental effects of soil pollutants on flora, fauna and ground water - Soil quality parameters - *Soil sampling*: Methods and Devices - Soil pollution control methods (K1, K2, K3, K4, K5 & K6)

Unit IV Noise Pollution **Contact Hours: 10**

Noise Pollution: Definition – Sources, sound pressure level, decibels, intensity, frequencies, duration, pitch, noise-monitoring-sound level meter and noise indices - Noise exposure levels and effects on humans and animals - Permissible standards (WHO) (K1, K2, K3, K4, K5 & K6)

Unit V Thermal and Radioactive Pollution **Contact Hours: 10**

Thermal Pollution: Sources - Effects on aquatic environment and control measures - *Radioactive Pollution*: Definition - Radioactivity - Biological effects of radiation and ecosystem - Radiation exposure standards (IAEA) and Preventive measures - Radiation monitoring devices (K1, K2, K3, K4, K5 & K6).

References

Text Books & Reference Books:

1. Brusseau, M., Pepper, I., & Gerba, C. (2019). *Environmental and pollution science* (3rd ed.). Academic Press.
2. Chauhan, A. (2020). *Environmental pollution and management*. IK International Publishers.
3. Khopkar, S. M. (2005). *Environmental pollution monitoring and control*. New Age International.
4. Rao, C. S. (2018). *Environmental pollution control engineering* (3rd ed.). New Age International.
5. Shafi, S. M. (2005). *Environmental pollution*. Atlantic Publishers and Distributors.

Web References:

CORE COURSE – V
ENVIRONMENTAL POLLUTION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2C05	100	5	4	1	-	5

1. https://www.neaspec.org/sites/default/files/Air_Pollution_Handbook.pdf
2. <https://www.nios.ac.in/media/documents/313courseE/L34.pdf>
3. <https://egyankosh.ac.in/bitstream/123456789/82827/1/Unit-11.pdf>
4. <https://gppanchkula.ac.in/wp-content/uploads/2020/01/EVS.pdf>
5. <https://www.egyankosh.ac.in/bitstream/123456789/7021/3/Unit-4.pdf>

CORE COURSE – VI
NATURAL RESOURCES MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2C06	100	5	4	1	-	5

Course Objectives

The course provides comprehensive knowledge on the classification, conservation, sustainable utilization, and management of natural resources

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| C01 | Understand the concept, classification, and importance of natural resources |
| C02 | Explain the sustainable utilization of land and water resources |
| C03 | Understand the significance of forest and wildlife resources |
| C04 | Know the basic concepts of mineral and energy resource management |
| C05 | Acquire knowledge on legislation and policies related to natural resources |

Mappings of course outcomes with programme outcomes

C0s	P01	P02	P03	P04	P05	P06	P07	P08
C01	S	L	M	L	S	M	L	L
C02	S	M	S	M	S	S	M	M
C03	S	M	S	L	S	S	M	L
C04	S	S	S	S	S	S	M	M
C05	M	L	M	L	S	S	S	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – VI
NATURAL RESOURCES MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2C06	100	5	4	1	-	5

Unit I Introduction Contact Hours: 12

Natural resources: Concept and Significance - *Classification of natural resources:* Renewable and Non-renewable - Biotic and abiotic resources - Natural capital - Resource scarcity - Carrying capacity and Concept of sustainability - Linkages between natural resources - Economy and Human well-being (K1, K2, K3, K4, K5 & K6)

Unit II Land and Water Resource Management Contact Hours: 12

Land resources: Land use patterns and Soil types - Soil degradation - Soil erosion and Desertification - Causes and impacts of land degradation on ecosystems and agriculture - Soil conservation measures and Sustainable land management practices - Land degradation neutrality (LDN) - *Water resources:* Surface water and Groundwater resources - Water scarcity - Overexploitation - Pollution - Integrated water resource management - Watershed management - Rainwater harvesting (K1, K2, K3, K4, K5 & K6)

Unit III Forest and Wildlife Resources Contact Hours: 12

Forest resources: Types of forests - Forest ecosystems and Ecosystem services - Causes and impacts of deforestation and forest degradation - Forest fires - Sustainable forest management - Afforestation and Social forestry practices - *Wildlife resources:* Floral and Faunal resources in India - *Conservation strategies:* Protected areas and wildlife corridors (K1, K2, K3, K4, K5 & K6)

Unit IV Mineral and Energy Resource Management Contact Hours: 12

Mineral resources: Classification and distribution - Open-cast and Underground mining and their ecological consequences - Sustainable mining practices - *Energy resources:* Renewable and non-renewable sources - Environmental impacts of energy production and Consumption - Renewable energy technologies - Energy conservation strategies (K1, K2, K3, K4, K5 & K6)

Unit V Policies, Community Participation and Sustainable Resource Management Contact Hours: 12

Natural resource management policies and legislation in India - Role of institutions, Governance and Stakeholders in resource management - Community participation - Indigenous knowledge and traditional practices in conservation - Integrated natural resource management (INRM) approaches - Central and State govt. policies and Initiatives (K1, K2, K3, K4, K5 & K6)

References:

Text Books & Reference Books:

1. Cunningham, W. P., & Cunningham, M. A. (2019). *Principles of environmental science*. McGraw-Hill.
2. Food and Agriculture Organization. (2016). *Natural resource management and sustainable development*. FAO Publications.
3. Miller, G. T., & Spoolman, S. (2018). *Living in the environment*. Cengage Learning.
4. Sharma, P. D. (2012). *Ecology and environment*. Rastogi Publications.

CORE COURSE – VI
NATURAL RESOURCES MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2C06	100	5	4	1	-	5

5. Singh, J. S., Singh, S. P., & Gupta, S. R. (2017). *Ecology, environment and resource conservation*. Anamaya Publishers.

Web References:

1. <https://moef.gov.in>
2. <https://www.fao.org>
3. <https://www.unep.org>
4. <https://www.worldbank.org>
5. <https://www.niti.gov.in>

CORE COURSE – VII

BIOSTATISTICS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2C07	100	5	4	1	-	5

Course Objectives

The course aims to provide fundamental knowledge on the biostatistics concepts including descriptive and inferential statistics. It also gives adequate knowledge on probability distribution and statistical testing methods

Course Outcomes

On the successful completion of the course, students will be able to

- C01** Know the basic methods in statistics and methods of data collection
- C02** Understand the basic principles of descriptive statistics
- C03** Learn the applications of probability distribution
- C04** Understand the basic principles of inferential statistics
- C05** Learn the statistical tools for environmental studies.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	S	M	L	L	M	L	L
CO2	M	S	M	L	L	M	L	L
CO3	M	S	S	M	L	M	L	L
CO4	M	S	S	M	M	M	L	M
CO5	S	S	S	S	M	S	M	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – VII

BIOSTATISTICS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2C07	100	5	4	1	-	5

Unit I Introduction and Data Types Contact Hours: 10

Definition and scope of biostatistics - Role of statistics in research - *Types of data*: Qualitative vs Quantitative - *Levels of measurement*: Nominal, ordinal, interval and ratio - Data collection - Sampling techniques - Sources of bias and data quality (K1, K2, K3, K4, K5 & K6)

Unit II Descriptive Statistics Contact Hours: 12

Frequency distributions and cross - Tabulations - *Measures of central tendency*: Mean, median and mode - *Measures of dispersion*: Range, variance, standard deviation, skewness and kurtosis - Percentiles and quartiles - *Graphical representation*: Histograms, boxplots, bar charts, pie charts and pictogram (K1, K2, K3, K4, K5 & K6)

Unit III Probability Distribution Contact Hours: 12

Probability rules and axioms - Conditional probability and independence - *Probability Distribution*: Binomial, Poisson and Normal distribution - Introduction to Central Limit Theorem (K1, K2, K3, K4, K5 & K6)

Unit IV Inferential Statistics Contact Hours: 12

Point and interval estimation - *Hypothesis testing framework*: Null and alternative hypothesis - Type I and type II errors - Confidence intervals for means and proportions - t-tests (one sample, independent and paired) - Chi-square tests for independence and goodness of fit ((K1, K2, K3, K4, K5 & K6)

Unit V Correlation, Regression & ANOVA Contact Hours: 14

Correlation: Types - Methods of study (scatterplot and graphs) - Coefficient of correlation (Pearson's) - Testing significance - *Regression*: Types (linear and polynomial) - Regression equations and regression lines and its properties - Analysis of Variance (ANOVA) for comparing means (One way, two way and multiple) - *Introduction to statistical softwares*: SPSS, MATLAB and R statistics (K1, K2, K3, K4, K5 & K6)

References

Text Books & Reference Books

1. Daniel, W. W., & Cross, C. L. (2019). *Biostatistics: A foundation for analysis in the health sciences* (11th ed.). John Wiley & Sons.
2. Gurumani, N. (n.d.). *An introduction to biostatistics* (2nd ed.). MJP Publishers.
3. Pagano, M., & Gauvreau, K. (2000). *Principles of biostatistics* (2nd ed.). Duxbury Press.
4. Rosner, B. (1982). *Fundamentals of biostatistics*. Duxbury Press.
5. Zar, J. H. (2010). *Biostatistical analysis* (5th ed.). Pearson Prentice Hall.

Web References

1. <https://www.itl.nist.gov/div898/handbook/>
2. <https://www.khanacademy.org/math/statistics-probability>
3. <https://stats.idre.ucla.edu/>
4. <https://www.coursera.org/browse/data-science/biostatistic>
5. <http://biostatcourse.fiu.edu/>

ECOTOURISM

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2EL1	100	4	3	1	-	4

Course Objectives

The course aims to provide knowledge on the importance of ecotourism its impacts, development and management practices

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| C01 | Know the principles and concept of ecotourism |
| C02 | Able to understand the types and benefits of ecotourism |
| C03 | Know interesting places of ecotourism |
| C04 | Evaluate the impacts of ecotourism on the environment |
| C05 | Understand the management of ecotourism in India |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	L	M	L	S	M	M	L
CO2	S	M	M	L	S	S	M	L
CO3	M	L	M	L	S	M	L	M
CO4	S	S	S	M	S	S	M	M
CO5	S	M	S	M	S	S	S	S
Alignment: S - Strong, M - Moderate, L - Low								

CORE ELECTIVE COURSE – I**ECOTOURISM**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2EL1	100	4	3	1	-	4

Unit I Tourism Contact Hours: 10

Tourism: Scope, definitions, objectives and significance - *Classification of tourism:* Religious, cultural, heritage, monumental, adventure, mass and sustainable tourism - Consumptive & non consumptive tourism - Implications of tourism (K1, K2, K3, K4, K5 & K6)

Unit II Ecotourism Contact Hours: 10

Ecotourism: Definition and objectives - Guiding principles for ecotourism by MoEF&CC - India's rich natural and ecotourism resources - *Key connections between ecotourism and biodiversity:* Economic incentives for conservation, alternative livelihoods, awareness, education and protection of ecosystems (K1, K2, K3, K4, K5 & K6)

Unit III Ecotourism Development Contact Hours: 10

Key aspects of ecotourism development: Environmental conservation and management - Community involvement and benefits - Educational experience - Economic viability - Cultural preservation - Strategic planning and governance (K1, K2, K3, K4, K5 & K6)

Unit IV Impacts of Ecotourism Contact Hours: 10

Positive Impacts: Environmental conservation - Economic development - Education and awareness - Cultural preservation and sustainable infrastructure - *Negative Impacts:* Environmental degradation - Wildlife disturbance - Cultural erosion - Economic leakage and over tourism (K1, K2, K3, K4, K5 & K6)

Unit V Ecotourism Development Agencies and Bodies Contact Hours: 10

The International Ecotourism Society (TIES) - Responsible Tourism Society of India (RTSOI) - Global Sustainable Tourism Council (GSTC) - Central and state government agencies and initiatives - Nonprofit/ Foundation networks (K1, K2, K3, K4, K5 & K6)

References:**Text Books & Reference Books:**

1. Agarwal, A. N. (1980). *Indian agriculture*. Vikas Publishing House.
2. Bhatia, A. K. (1978). *Tourism in India*. Sterling Publishers.
3. Dasmann, R. F. (1968). *Environmental conservation*. John Wiley & Sons.
4. Mukherjee, N. (2008). *Ecotourism and sustainable development*. Cybetech Publications.
5. Sinha, P. C. (2003). *Encyclopedia of ecotourism* (Vols. 1–3). Anmol Publications.
6. Weaver, D. B. (2001). *The encyclopedia of ecotourism*. CABI Publishing.

Web References:

1. <https://files.acquia.undp.org/public/migration/>
2. https://www.incredibleindia.org/newsite/cms_page.asp?pageid=994
3. <https://www.nativescience.org/html/eco-tourism.html>
4. <https://www.wcsindia.org/>
5. <https://envfor.nic.in/divisions/9-10.pdf>
6. http://www.ceeraindia.org/documents/lib_tabofcon_160300.htm

SKILL BASED ELECTIVE COURSE – V

INDUSTRIAL SKILLS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2SC5	100	2	2	-	-	2

Course Objectives

The course aims to provide essential industrial skills, practical knowledge of environmental regulations, monitoring techniques, safety practices and professional competencies.

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| CO1 | Understand the structure, functioning, and requirements of industries. |
| CO2 | Apply basic industrial monitoring and analytical techniques. |
| CO3 | Interpret environmental standards, regulations and compliance requirements. |
| CO4 | Demonstrate workplace safety, professional ethics and communication skills. |
| CO5 | Apply skills effectively in industrial sectors |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	L	M	M	M	S	M	L
CO2	M	S	M	S	M	M	M	L
CO3	M	M	S	M	S	M	S	S
CO4	L	L	M	M	M	M	S	S
CO5	M	S	S	S	M	M	M	M
Alignment: S - Strong, M - Moderate, L – Low								

SKILL BASED ELECTIVE COURSE – V**INDUSTRIAL SKILLS**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2SC5	100	2	2	-	-	2

Unit I Introduction to Environmental Industries Contact Hours: 06

Overview of environmental industries and sectors - Roles of environmental professionals in industry - Industrial processes and environmental impacts - Pollution sources and control measures - Industry-academia linkage (K1, K2, K3, K4 & K5).

Unit II Industrial Monitoring Techniques Contact Hours: 06

Air, water, and soil quality monitoring - Sampling methods and quality control - Use of basic analytical instruments - Data recording and reporting - Introduction to laboratory safety practices (K1, K2, K3, K4 & K5).

Unit III Environmental Regulations and Compliance Contact Hours: 06

Overview of major environmental laws and standards - Environmental Impact Assessment (EIA) basics - Consent, authorization, and compliance procedures - Environmental auditing and reporting - Corporate environmental responsibility (K1, K2, K3, K4 & K5).

Unit IV Industrial Safety and Professional Practices Contact Hours: 06

Occupational health and safety - Hazard identification and risk assessment - Waste handling and hazardous material management - Emergency preparedness and response - Professional ethics and teamwork (K1, K2, K3, K4 & K5).

Unit V Industrial Skills and Career Readiness Contact Hours: 06

Industrial communication and documentation - Technical report writing - Basics of project management - Environmental consultancy practices - Career opportunities in environmental industries (K1, K2, K3, K4 & K5).

References:**Text Books & Reference Books:**

1. Peavy, H. S., Rowland, D. R., & Technobanoglous, G., Environmental Engineering, McGraw Hill.
2. C. S. Rao, Environmental Pollution Control Engineering, New Age International.
3. Michael D. LaGrega, Hazardous Waste Management, McGraw Hill.

Web References:

1. <https://www.cpcb.nic.in>
2. <https://www.unep.org>
3. <https://www.osha.gov>

CORE PRACTICAL – V
ENVIRONMENTAL POLLUTION,
NATURAL RESOURCE MANAGEMENT AND BIOSTATISTICS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	26UPEVS2CL5	100	6	-	-	6	3

Experiments:

1. Determination of Water pH and Temperature
2. Determination of Total Dissolved Solids (TDS) in Water
3. Ambient Air Quality Monitoring
4. Noise Level Measurement
5. Soil Quality Assessment
6. Land Use and Land Cover Survey
7. Estimation of Water Consumption and Water Audit
8. Study of Local Biodiversity
9. Assessment of Rainwater Harvesting Potential
10. Collection and Classification of Environmental Data
11. Calculation of Descriptive Statistics
12. Graphical Presentation and Correlation Analysis

Semester - VI

CORE COURSE – VIII
ENVIRONMENTAL GEOSCIENCES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VI	26UPEVS2C08	100	5	4	1	-	5

Course Objectives

The course aims to provide fundamental knowledge on earth systems, soil formation, climate dynamics and hydrogeology.

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| C01 | Explain Earth's system components and earth formation processes |
| C02 | Describe the earth system dynamics and climate mechanisms |
| C03 | Understand the weathering and soil formation processes |
| C04 | Explain about earth system geochemistry and natural hazards |
| C05 | Acquire knowledge on hydrology and hydrogeology concepts |

Mappings of course outcomes with programme outcomes

C0s	P01	P02	P03	P04	P05	P06	P07	P08
C01	S	M	M	L	M	S	L	L
C02	S	M	S	M	S	S	L	L
C03	S	M	M	L	M	M	L	L
C04	S	S	S	M	M	S	M	M
C05	S	S	S	S	S	S	M	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – VIII
ENVIRONMENTAL GEOSCIENCES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VI	26UPEVS2C08	100	5	4	1	-	5

Unit I Earth Origin and Differentiation Contact Hours: 10

Origin of earth: Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere - *Concept of minerals and rocks:* Formation of igneous and metamorphic rocks - *Formation of landforms:* Tectonics including plate tectonics and climatic forces (K1, K2, K3, K4, K5 & K6)

Unit II Earth System Dynamics and Climate Mechanisms Contact Hours: 12

Concept of steady state and equilibrium - Energy budget of the earth - *Earth's thermal environment and seasons:* Coriolis force, pressure gradient force, frictional force, geo-strophic wind field and gradient wind - *Climates of India:* Western disturbances, Indian monsoon, droughts, *El Nino* and *La Nina* - Concept of residence time and rates of natural cycles - Geophysical fields (K1, K2, K3, K4, K5 & K6)

Unit III Weathering Processes and Soil Formation Contact Hours: 12

Weathering: Definition, weathering reactions, erosion, transportation and deposition of sediments - *Soil formation and properties:* Soil forming minerals, process of soil formation, identification and characterization of clay minerals, soil physical and chemical properties, soil types and climate control on soil formation, cation exchange capacity and mineralogical controls (K1, K2, K3, K4, K5 & K6)

Unit IV Earth System Geochemistry and Natural Hazards Contact Hours: 13

Geochemical classification of elements - Abundance of elements in bulk earth, crust, hydrosphere and biosphere - Partitioning of elements during surficial geologic processes - Geochemical recycling of elements – Paleoclimate - *Natural Hazards:* Catastrophic geological hazards - floods, landslides, earthquakes, volcanism, avalanche, tsunami and cloud bursts (K1, K2, K3, K4, K5 & K6)

Unit V Hydrogeology and Aquifer Processes Contact Hours: 13

Distribution of water in earth - *Hydrology and hydrogeology:* Major basins and groundwater provinces of India, Darcy's law, groundwater fluctuations, hydraulic conductivity, groundwater tracers, land subsidence, effects of excessive use of groundwater, groundwater quality and ground water pollution - Ghyben-Herzberg relation between fresh-saline water (K1, K2, K3, K4, K5 & K6)

References

Text Books & Reference Books:

1. Buol, S. W., Southard, R. J., Graham, R. C., & McDaniel, P. A. (2011). *Soil genesis and classification* (6th ed.). Wiley.
2. Drever, J. I. (1997). *The geochemistry of natural waters: Surface and groundwater environments* (3rd ed.). Prentice Hall.
3. Fetter, C. W. (2001). *Applied hydrogeology* (4th ed.). Prentice Hall.
4. Tarbuck, E. J., Lutgens, F. K., & Tasa, D. (2019). *Earth: An introduction to physical geology* (14th ed.). Pearson.
5. Wallace, J. M., & Hobbs, P. V. (2006). *Atmospheric science: An introductory survey* (2nd ed.). Academic Press.

Web References:

CORE COURSE – VIII
ENVIRONMENTAL GEOSCIENCES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VI	26UPEVS2C08	100	5	4	1	-	5

1. <https://cgwb.gov.in>
2. <https://mausam.imd.gov.in>
3. <https://www.ipcc.ch>
4. <https://www.noaa.gov>
5. <https://www.usgs.gov>

CORE COURSE – IX

ENVIRONMENTAL ANALYTICAL TECHNIQUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VI	26UPEVS2C09	100	5	4	1	-	5

Course Objectives

The course aims to introduce knowledge and skills in analysis of environmental pollutants in environmental matrices, including extraction, sample preparation and instrumentations analysis, theory and techniques in quantitative and qualitative methods

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|--|
| C01 | Explain the principles and fundamentals of environmental analytical methods. |
| C02 | Demonstrate understanding of classical analytical techniques |
| C03 | Describe the working principles of spectroscopy and chromatography |
| C04 | Apply analytical methods for monitoring environmental quality |
| C05 | Apply Instrumental techniques for environmental analysis |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
C01	S	M	M	M	M	M	L	L
C02	S	S	M	S	L	M	M	L
C03	S	S	S	S	M	S	M	M
C04	S	S	S	S	S	S	M	M
C05	M	S	S	M	M	S	M	S
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – IX
ENVIRONMENTAL ANALYTICAL TECHNIQUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VI	26UPEVS2C09	100	5	4	1	-	5

Unit I Fundamentals of Environmental Analysis Contact Hours: 12

Introduction to environmental analytical chemistry - Sampling techniques (Air, water and soil) - Sample preservation and storage - Errors in analysis (Systematic and random errors) - Calibration, standards and validation - Quality assurance (QA) and quality control (QC) (K1, K2, K3, K4, K5 & K6)

Unit II Classical Analytical Techniques Contact Hours: 12

Volumetric analysis (acid-base, redox, complexometric titrations) - Gravimetric analysis - Determination of alkalinity, hardness, chloride, DO, BOD and COD - Total solids, suspended solids and turbidity - Soil pH and organic matter determination (K1, K2, K3, K4, K5 & K6)

Unit III Spectroscopy and Chromatography Contact Hours: 12

Principles of spectroscopy (UV-Visible, IR) - Atomic Absorption Spectroscopy (AAS) - Flame photometry - Gas chromatography (GC)- High Performance Liquid Chromatography (HPLC) - Introduction to Mass Spectrometry (MS) (K1, K2, K3, K4, K5 & K6)

Unit IV Environmental Monitoring Techniques Contact Hours: 12

Air quality monitoring (PM, SO₂, NO_x, CO) - Water quality analysis (Nutrients, heavy metals and pesticides) - Soil contamination analysis - Noise monitoring - Remote sensing and GIS in environmental monitoring (K1, K2, K3, K4, K5 & K6)

Unit V Instrumental Analytical Techniques Contact Hours: 12

Electrochemical methods (pH meter, conductivity meter) - Ion chromatography - ICP-OES/ICP-MS (overview) - Biosensors in environmental analysis - Statistical tools in environmental data interpretation - Laboratory safety and waste management (K1, K2, K3, K4, K5 & K6)

References

Text Books & Reference Books:

1. APHA. (2017). *Standard methods for the examination of water and wastewater* (23rd ed.). American Public Health Association.
2. Harris, D. C. (2016). *Quantitative chemical analysis* (9th ed.). W. H. Freeman.
3. Manahan, S. E. (2017). *Environmental chemistry* (10th ed.). CRC Press.
4. Sawyer, C. N., McCarty, P. L., & Parkin, G. F. (2003). *Chemistry for environmental engineering and science* (5th ed.). McGraw-Hill.
5. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). *Principles of instrumental analysis* (7th ed.). Cengage Learning.

Web References:

1. <https://www.epa.gov>
2. <https://www.who.int>
3. <https://cpcb.nic.in>
4. <https://www.usgs.gov>
5. <https://www.neeri.res.in>

GLOBAL ENVIRONMENTAL ISSUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VI	26UPEVS2EL2	100	4	3	1	-	4

Course Objectives

The course focuses on major global environmental issues including population explosion, biodiversity loss, pollution, energy use, climate change and global initiatives

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| C01 | Identify important global, national and local issues relating to population |
| C02 | Understand the global consequences of climate change |
| C03 | Acquire knowledge on overexploitation of natural resources |
| C04 | Understand various global disasters and their effective management |
| C05 | Acquire knowledge on global initiatives for environmental issues |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
C01	S	M	S	L	S	S	M	M
C02	S	M	S	M	S	S	M	M
C03	S	S	S	M	S	S	M	L
C04	S	S	S	S	S	S	S	M
C05	S	M	S	M	S	S	S	S
Alignment: S - Strong, M - Moderate, L - Low								

CORE ELECTIVE COURSE – II
GLOBAL ENVIRONMENTAL ISSUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VI	26UPEVS2EL2	100	4	3	1	-	4

Unit I Human Population and Environment **Contact Hours: 10**

Basic demographic concepts: Growth, fertility, mortality and migration - Population growth and explosion - Urbanization - Poverty, food security and waste disposal - Environmental degradation and public health issues - Development versus environment (K1, K2, K3, K4, K5 & K6).

Unit II Global Atmospheric Changes **Contact Hours: 10**

Global air quality - Air quality index (AQI) and CO₂ concentration scenario - Current status and projections of global warming scenario in the world - El Niño, La Niña and ENSO - Global consequences (K1, K2) - Ozone depleting substances (ODS) - Acid rain - Persistent organic pollutants (POPs) - Impact of air pollutants on human health (K1, K2, K3, K4, K5 & K6).

Unit III Overexploitation of Natural Resources **Contact Hours: 10**

Environment in anthropocene era - Ecological footprint - Earth overshoot day - *Water resources:* Status of groundwater quality in India - Desertification - *Soil and mineral resources:* Global threats for soil quality - Loss of organic carbon (K3) - Mineral resources exploitation (K1, K2, K3, K4, K5 & K6).

Unit IV Global Disasters **Contact Hours: 10**

Natural disasters - Global earthquake prone zones - Active volcanic belts - Dormant and extinct volcanoes in the world - *Flash Floods:* Causes, impacts and case studies - Forecasting and warning of natural disasters - *Manmade disasters:* Oil spills, forest fire, industrial and nuclear disasters (K1, K2) - Recent global disasters (K1, K2, K3, K4, K5 & K6).

Unit V Global Initiatives **Contact Hours: 10**

Climate action and energy: Key outcomes of CoPs meetings - *Waste management:* Schemes and initiatives - Outcomes of CoPs meetings on biodiversity conservation - UNCLOS treaty - Land degradation neutrality (LDN) by UNCCD - *Integrated disaster risk reduction:* The Sendai framework (2015 - 2030). (K1, K2, K3, K4, K5 & K6).

References:

Text Books & Reference Books:

1. Dogra, N., & Srivastava, S. (2012). *Climate change and disease dynamics in India*. TERI Press.
2. Harris, F. (2012). *Global environmental issues* (2nd ed.). John Wiley & Sons.
3. Hyndman, D. W., & Hyndman, D. (2005). *Natural hazards and disasters*. Cengage Learning.
4. Long, A. (2021). *Global environmental issues* (2nd ed.). Kendall Hunt Publishing.
5. Modak, P. (2018). *Environmental management towards sustainability*. CRC Press.
6. Mondal, P., & Dalai, A. K. (2017). *Sustainable utilization of natural resources*. CRC Press.
7. Morand, S., Lajaunie, C., & Satrawaha, R. (2017). *Biodiversity conservation in Southeast Asia: Challenges in a changing environment*. Routledge.

CORE ELECTIVE COURSE – II
GLOBAL ENVIRONMENTAL ISSUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VI	26UPEVS2EL2	100	4	3	1	-	4

8. Pouloupoulos, S. G., & Inglezakis, V. J. (2016). *Environment and development: Basic principles, human activities, and environmental implications*. Elsevier.
9. Quaschnig, V. V. (2019). *Renewable energy and climate change*. John Wiley & Sons.
10. Raveendranathan, D. (2018). *Development lead to pollution and depletion of natural resources*. Notion Press.
11. Singh, R. P., Singh, A., & Srivastava, V. (2017). *Environmental issues surrounding human overpopulation*. IGI Global.
12. Sonwani, S., & Saxena, P. (2022). *Greenhouse gases: Sources, sinks and mitigation*. Springer.
13. Thangavel, P., & Sridevi, G. (2015). *Environmental sustainability: Role of green technologies*. Springer.
14. Walther, J. V. (2014). *Earth's natural resources*. Jones & Bartlett Learning.

Web References:

1. <https://www.ipcc.ch/report/ar6/wg2/>
2. <https://www.undrr.org/implementing-sendai-framework>
3. <https://unfccc.int/process-and-meetings/the-paris-agreement>
4. <https://www.cbd.int/gbf/>
5. <https://www.stateofglobalair.org/sites/default/files/soga-2018-report.pdf>
6. www.who.int/airpollution/
7. <https://unfccc.int/>
8. <https://.indiaenvironmentportal.org.in/>
9. <https://www.footprintnetwork.org/our-work/earth-overshoot-day>
10. <https://www.elsevier.com/data/assets/pdf.../ElsevierDisasterScienceReport-PDF.pdf>
11. www.siteresources.worldbank.org/INTDISMGMT/Resources/0821363328.pdf
12. https://link.springer.com/chapter/10.1007/978-981-10-1866-4_2
13. <https://climate.nasa.gov/>
14. <https://pressbooks.bccampus.ca/environmentalissues/>

CORE PRACTICAL – VI
ENVIRONMENTAL GEOSCIENCES AND
ENVIRONMENTAL ANALYTICAL TECHNIQUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VI	26UPEVS2CL6	100	6	-	-	6	3

Experiments:

1. Identification of Common Minerals and Rocks
2. Study of Soil Profiles and Soil Horizons
3. Determination of Soil Texture
4. Determination of Soil pH and Electrical Conductivity
5. Estimation of Soil Moisture Content
6. Preparation and Interpretation of Weather Data
7. Groundwater Level Survey
8. Calibration and Use of pH Meter
9. Determination of Water Alkalinity by Titration
10. Determination of Water Hardness by EDTA Method
11. Determination of Chloride in Water Samples
12. Determination of Turbidity and Total Dissolved Solids (TDS)

Semester - VII

BIODIVERSITY AND CONSERVATION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1C01/26UPEVS2C10	100	5	4	1	-	5

Course Objectives

The course provides adequate knowledge on types, values and threats to biodiversity and explains the concepts of conservation, bioresource management and its related legal policies

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|--|
| C01 | Learn the types, values and importance of biodiversity |
| C02 | Understand the various threats to biodiversity |
| C03 | Know the in-situ and ex-situ conservation strategies of biodiversity |
| C04 | Understand the methods of bioresources management |
| C05 | Know the policies, programmes and acts for biodiversity conservation |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	L	M	L	S	M	M	L
CO2	S	M	S	L	S	M	M	L
CO3	S	M	S	M	S	S	M	M
CO4	S	S	S	M	S	S	M	M
CO5	M	L	M	L	M	S	S	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE - I/X
BIODIVERSITY AND CONSERVATION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1C01/26UPEVS2C10	100	5	4	1	-	5

Unit I Introduction

Contact Hours: 10

Types of Biodiversity: Species, Genetic and Ecosystem diversity - Alpha, beta and gamma diversity (K1, K2) - Biodiversity and ecosystem function (K4, K5) - Megadiversity zones and Biodiversity Hot Spots in India (K2, K3) - Endangered and endemic species of flora and fauna in India (K1, K2) - Values of Biodiversity (K4, K5) - Bioprospecting and biopiracy - Role of Traditional/Indigenous Knowledge System for bioprospecting (K2, K5 & K6)

Unit II Threats to Biodiversity

Contact Hours: 12

IUCN Threat Categories - Red Data Book (K2, K4) - *Biodiversity threats under Anthropocene era:* Habitat change - Habitat destruction and Habitat fragmentation - Overexploitation (K2, K4, K5) - Climate change on species extinction - Causes and Impacts of Invasive species to biodiversity (K2, K3, K4, K5) - Threats to soil biodiversity (K2, K4, K5) - Impacts of plastic pollution on marine biodiversity resources - Human-Animal conflict with special reference to elephants (K3, K4, K5& K6)

Unit III Conservation Strategies

Contact Hours: 12

In situ conservation: Protected area network, National parks, Sanctuaries, Community reserves and Conservation reserves - Biosphere reserves, Sacred groves (K1, K2, K3) - *Ex-situ conservation:* Botanical gardens, Zoos and Aquariums, Cryopreservation, Gene bank, Seed bank, Pollen bank, Sperm bank, Reintroduction and Reinforcement - Captive breeding (K1, K2, K3)

Unit IV Sustainable Management of Bioresources

Contact Hours: 13

National Biodiversity Authority (NBA) – Functions of State Biodiversity Board (SBB) and Biodiversity Management Committee's (BMC) – People's Biodiversity Register (PBR) (K3, K4, K5, K6) – *International Organizations and their roles for biodiversity conservation:* Convention on Biological Diversity (CBD), CITES and IUCN - WWF-India for priority and threatened species conservation - UNESCO Man and Biosphere Programme (MAB) - UNDP Biodiversity Finance Initiative (BIOFIN) - UNEP Global Environment Facility (GEF) for biodiversity conservation (K3, K4, K5& K6)

Unit V Policies, Programmes and Acts for Conservation

Contact Hours: 13

Salient features of Biological Diversity Act 2002 and Biological Diversity (Access and Benefit Sharing) Regulation, 2025 (K2, K3) - Status and protection of species in National and International levels - Policies implemented by MoEF & CC for biodiversity conservation (K2, K3, K4) - Nagoya protocol on access and benefit-sharing - Cartagena protocol on biosafety - Monitoring the Illegal Killing of Elephants (MIKE) programme - SAWEN and TRAFFIC Networks - National Red List Roadmap 2025-2030 *CBD CoP15 outcomes:* Kunming-Montreal Global Biodiversity Framework (GBF) - CoP26 Climate Summit pledge to end deforestation by 2030 – CITES CoP20 outcomes (K4, K5& K6)

CORE COURSE - I/X
BIODIVERSITY AND CONSERVATION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1C01/26UPEVS2C10	100	5	4	1	-	5

References:

Text Books & Reference Books:

1. Cardinale, B., & Murdoch, J. D. (2025). *Conservation biology* (2nd ed.). Oxford University Press.
2. Krishnamurthy, K. V. (2023). *An advanced textbook on biodiversity: Principles and practice*. Oxford and IBH Publishing.
3. Maiti, P. K., & Maiti, P. (2017). *Biodiversity: Perception, peril and preservation* (3rd ed.). PHI Learning.
4. Miller, G. T., & Spoolman, S. (2023). *Environmental science* (16th ed.). Cengage Learning.
5. Sher, A., & González-Sargas, E. (2026). *An introduction to conservation biology* (4th ed.). Oxford University Press.

Web References:

1. <http://www.iucn.org>
2. <http://www.cites.org>
3. <http://www.cbd.int>
4. <http://www.wri.org>
5. <http://www.sawen.org>

CORE COURSE - II/XI
ENVIRONMENTAL CHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1C02/26UPEVS2C11	100	5	4	1	-	5

Course Objectives

The course aims to provide an understanding of the air, water, soil, pollutant and green chemistry concepts

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| C01 | Describe the important chemical reactions and cyclic processes of chemical species in the atmosphere. |
| C02 | To acquire knowledge about physico chemical and biological properties of water and its reactions in water bodies. |
| C03 | Understand the soil quality parameters and its importance for maintaining the soil quality. |
| C04 | To know the different types of toxic, hazardous substances and analyze their toxicological information. |
| C05 | To acquire knowledge of principles, goals and applications of green chemistry. |

Mappings of course outcomes with programme outcomes

[illegible]

CORE COURSE - II/XI
ENVIRONMENTAL CHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1C02/26UPEVS2C11	100	5	4	1	-	5

Unit I Atmospheric Chemistry

Contact Hours: 10

Atmosphere: Structure and Composition - Particles, Ions and Radicals - *Tropospheric Chemistry:* Formation of inorganic and organic particulate matter - *Chemistry of Air Pollutants:* SO₂, NO_x, CO₂ (Acid rain, photochemical smog, greenhouse effect and global warming) - *Stratospheric chemistry:* Chapman mechanism and catalytic process of ozone destruction - Role of CFCs in ozone depletion - Nox - Halogen cycles (K1, K2, K3, K4, K5 & K6)

Unit II Aquatic Chemistry

Contact Hours: 14

Formation of water - Sources and Types of water resource - Hydrological cycle - Unique properties of water - Role of water in the environment - *Physical, chemical and biological properties of water:* Temperature, colour, odour, total dissolved solids and total suspended solids, alkalinity, acidity and hardness - Concept of DO, BOD and COD - *Chemistry of metals in aqueous systems:* Metal complex formation and chelation - Types of reactions in various water bodies including marine environment (K1, K2, K3, K4, K5 & K6)

Unit III Soil Chemistry

Contact Hours: 13

Nature, Formation and Major types of Soil - *Physicochemical properties of soil:* Soil structure, Texture, Inorganic and organic components of soil - Chemical properties of saline, Acidic and Alkaline soils, Macro and Micronutrients in soil and their functions - Relation between organic carbon and organic matter - C/N Ratio - NPK in soil - Chemical reactions in soil (K1, K2, K3, K4, K5 & K6)

Unit IV Pollutant Chemistry

Contact Hours: 13

Pesticides: Classification - Degradation - Analysis - Pollution due to pesticides - DDT and Endosulfan - *Hydrocarbons:* Classification - Hydrocarbon decay - Effects of hydrocarbon on macro and microorganisms - *Heavy metals:* As, Cd, Pb & Hg (K1, K2, K3, K4, K5 & K6)

Unit V Green Chemistry

Contact Hours: 10

Green chemistry - Introduction - Principles (12) - Concept of atom economy in green synthesis - Cleaner production - Green chemical strategies for sustainable development - Applications of green chemistry - Environment and Industries - Eco friendly waste treatment (K1, K2, K3, K4, K5 & K6)

References

Text Books & Reference Books:

- De, A. K. (2017). *Environmental chemistry* (8th ed.). New Age International.
- Doble, M., & Kruthiventi, A. K. (2007). *Green chemistry and engineering*. Book chapter.
- Manahan, S. E. (2022). *Environmental chemistry* (11th ed.). CRC Press.
- Pani, B. (2017). *Text book of environmental chemistry*. I. K. International Publishing House.
- Sharma, B. K. (2019). *Environmental chemistry*. Goel Publishing House.

CORE COURSE - II/XI
ENVIRONMENTAL CHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1C02/26UPEVS2C11	100	5	4	1	-	5

Web References:

1. <https://ebooks.inflibnet.ac.in/esp08/chapter/12-atmospheric-chemistry/>
2. <https://egyankosh.ac.in/bitstream/123456789/79935/1/Unit-6.pdf>
3. <https://www.egyankosh.ac.in/bitstream/123456789/79936/1/Unit-7.pdf>
4. <https://www.epa.gov/greenchemistry/basics-green-chemistry>
5. <https://egyankosh.ac.in/bitstream/123456789/86848/1/Unit-1.pdf>

CORE COURSE – III/XII

ENVIRONMENTAL GEOINFORMATICS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1C03/26UPEVS2C12	100	5	4	1	-	5

Course Objectives

The course introduces principles, processes and application of Remote Sensing and GIS

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| C01 | Acquaint adequate knowledge on principles of environmental geoinformatics |
| C02 | Understand the basic concepts of GIS and its data structures |
| C03 | Learn about GPS technologies and its applications |
| C04 | Understand the techniques of image interpretation and analysis |
| C05 | Learns to apply the tools of environmental geoinformatics |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	M	M	M	S	L	L
CO2	S	S	S	S	S	S	M	L
CO3	S	S	S	S	S	S	M	M
CO4	S	S	S	S	S	S	M	M
CO5	S	S	S	S	S	S	M	S
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – III/XII
ENVIRONMENTAL GEOINFORMATICS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1C03/26UPEVS2C12	100	5	4	1	-	5

Unit I Remote Sensing **Contact Hours: 12**

Introduction – Principles, components and types of Remote Sensing – Electromagnetic Radiation, EMR Spectrum- Properties and interactions –Remote Sensing Satellites and Platforms - Historical Perspectives of Remote Sensing in India (K1, K2, K3, K4, K5 & K6).

Unit II GIS Concepts **Contact Hours: 12**

Introduction to Geographical Information Systems (GIS) -Components of GIS- Data structures: vector, raster and topology- Conversion of Vector and Raster Data – Geo referencing, Digitization and data attributes – map projections - map data representation (K1, K2, K3, K4, K5 & K6).

Unit III GPS Concepts **Contact Hours: 10**

Introduction to Global Positioning Systems (GPS)- Error Sources and Positioning methods - GPS Satellite System - Types of GPS machines and its applications for surveying and mapping- Global Navigation Satellite System (K1, K2, K3, K4, K5 & K6).

Unit IV Image Interpretation and Analysis **Contact Hours: 14**

Principles of visual Interpretation of aerial photos and satellite imagery- Image Registration - Recognition Elements and Interpretation keys- *Image Enhancement Techniques*: Linear, Non- linear Contrast Enhancement and Filtering - *Principles of Image Classification*: Supervised and Unsupervised Classification (K1, K2, K3, K4, K5 & K6).

Unit V Application of Remote Sensing and GIS **Contact Hours: 12**

Applications of remote sensing for land use/land cover, landscape mapping, vegetation analysis, climate change studies, pollution monitoring studies, resource mapping, flood, drought assessment desertification and water shed management - Application of GIS for environmental studies- field surveying and mapping - Emerging new software's for RS and GIS (K1, K2, K3, K4, K5 & K6).

References:

Text Books & Reference Books:

1. Burrough, P. A., & McDonnell, R. A. (1998). *Principles of geographical information systems*. Oxford University Press.
2. Chang, K. T. (2006). *Introduction to geographic information systems*. McGraw-Hill.
3. Chouhan, T. S. (2020). *Geoinformatics: Fundamentals and applications*. Scientific Publishers.
4. Jensen, J. R. (1996). *Introductory digital image processing*. Prentice Hall.
5. Joseph, G. (2003). *Fundamentals of remote sensing*. Universities Press.

Web References:

1. https://webapps.itc.utwente.nl/library/principles_remotesensing.pdf
2. <https://crisp.nus.edu.sg/~research/tutorial/intro.htm>
3. <https://learn.canvas.net/courses/464/pages/unit-6-dot-2-basic-principles>
4. http://www.ai.soc.i.kyoto-u.ac.jp/RemoteSensing_1.pdf
5. <http://www.crea.cat/gis-and-remote-sensing-methodologies-and-applications>

CORE COURSE – IV/XIII
INDUSTRIAL HEALTH AND SAFETY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1C04/26UPEVS2C13	100	5	4	1	-	5

Course Objectives

The course aims to provide the students with theoretical knowledge and practical skills in occupational health, industrial safety, hazard recognition and control, statutory requirements, and management systems

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|--|
| CO1 | Explain fundamentals of occupational health, industrial hazards and industrial hygiene principles. |
| CO2 | Identify, measure and assess physical, chemical, biological and ergonomic workplace hazards. |
| CO3 | Design and recommend control measures and emergency response plans. |
| CO4 | Interpret and apply major national and international safety standards, codes and legal frameworks. |
| CO5 | Develop basic industrial safety audits, risk assessments and workplace health surveillance plans. |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
C01	S	M	M	L	M	S	M	L
C02	S	S	S	S	S	S	M	M
C03	S	S	S	S	S	S	S	M
C04	S	M	S	M	S	S	S	S
C05	S	S	S	S	S	S	S	S
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – IV/XIII
INDUSTRIAL HEALTH AND SAFETY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1C04/26UPEVS2C13	100	5	4	1	-	5

Unit I Introduction Contact Hours: 12

Concepts: Occupational health, industrial safety and industrial hygiene (Anticipation, recognition, evaluation and control) - Health - Disease - Work relationship - Types of occupational diseases (chemical, physical, biological, ergonomic and psychosocial) - Risk, hazard, exposure and dose-response - Hierarchy of controls - Safety culture, safety attitudes, human factors and behavioral safety (K1, K2, K3, K4, K5 & K6)

Unit II Work Place Hazards Contact Hours: 12

Physical hazards: Noise, vibration, heat, radiation, measurement and control - *Chemical hazards:* Industrial toxicants, routes of exposure, TLV, OELs, MSDS and sampling methods - *Biological hazards:* Workplace infections, bioaerosols, control and immunization - *Ergonomic hazards:* MSDs, workstation design, repetitive strain assessment - *Instruments and field methods:* Gas sampling, noise meters, dosimeters, air sampling pumps and basic analytical approaches (K1, K2, K3, K4, K5 & K6)

Unit III Control Measures, Prevention and Protection Contact Hours: 12

Engineering controls: Ventilation (local exhaust), isolation and substitution - *Administrative controls:* Work rotation, training and SOPs - *PPE:* Selection, limitations, maintenance and fit testing - *Fire safety:* Process, safety basics, explosion control and confined space entry procedures - Occupational health surveillance and medical management of exposures (K1, K2, K3, K4, K5 & K6)

Unit IV Safety Management and Risk Assessment Systems Contact Hours: 12

Safety management systems (OHSAS / ISO 45001 principles) and implementation - *Hazard identification and risk assessment tools:* HIRA, JSA, Fault Tree Analysis (FTA) and HAZOP overview - Incident investigation, root cause analysis, near-miss reporting, KPIs and auditing - Training, behavioral safety programmes, contractor management and permit systems (K1, K2, K3, K4, K5 & K6)

Unit V Legal Regulatory and Safety Compliances Contact Hours: 12

Overview of national laws (India): Occupational Safety, health and working conditions code (Related factory/mines rules) - Labour regulations - Role of Directorate General, Factory Advice Service & Labour Institutes (DG-FASLI) - International instruments and conventions (ILO conventions, WHO recommendations) - Ethical, social and economic dimensions of workplace safety (K1, K2, K3, K4, K5 & K6)

References:

Text Books & Reference Books:

1. Friend, M. A., & Kohn, J. P. (2023). *Fundamentals of occupational safety and health* (8th ed.). Bernan Press.
2. Halдар, S. K. (2022). *Occupational health and hygiene in industry*. CBS Publishers & Distributors.
3. Jain, R. K., & Rao, S. S. (2022). *Industrial safety, health and environment management systems*. Khanna Publishers.
4. Kamatchi Sankaran, S., & Prabakaran, T. (2022). *Industrial safety: A textbook*.

CORE COURSE – IV/XIII
INDUSTRIAL HEALTH AND SAFETY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1C04/26UPEVS2C13	100	5	4	1	-	5

5. Taxmann's Editorial Board (Ed.). (2025). *Taxmann's new labour & industrial laws*. Taxmann Publications.

Web References:

1. <https://labour.gov.in>
2. <https://www.ilo.org>
3. <https://www.who.int>
4. <https://www.osha.gov>
5. <https://www.nsc.org>

CORE ELECTIVE – I/III

WILDLIFE MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1EL1/26UPEVS2EL3	100	4	3	1	-	4

Course Objectives

The course focuses on the principles, strategies and conservation methods for the protection of wildlife resources

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| C01 | Understand the importance of wildlife resources |
| C02 | Acquire knowledge on wildlife ecology and its research techniques |
| C03 | Understand the concepts of wildlife conservation strategies |
| C04 | Know the causes and impacts of human wildlife conflicts |
| C05 | Gain knowledge on statutory policies for wildlife conservation |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	L	M	L	S	M	M	L
CO2	S	S	S	S	S	S	M	L
CO3	S	M	S	M	S	S	M	M
CO4	S	S	S	M	S	S	S	M
CO5	S	M	S	L	S	S	S	S
Alignment: S - Strong, M - Moderate, L - Low								

CORE ELECTIVE – I/III
WILDLIFE MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1EL1/26UPEVS2EL3	100	4	3	1	-	4

Unit I Introduction

Contact Hours: 10

Historical background of wildlife - Values of wildlife and valuable products of forests and wild animals - Important wild animals of India - Causes of extinction of forests and wildlife (Direct and Indirect) - Importance and necessity of conservation of wildlife and forests - Principles of conservation and management - Conservation ethics and world wildlife conservation strategies (K1, K2, K3, K4, K5 & K6)

Unit II Wildlife Ecology and Research Techniques

Contact Hours: 10

Wildlife behavior: Group living, selfishness and altruism - Evolutionary stable strategies - *Wildlife Habitat Ecology:* Measuring wildlife habitat and wildlife corridors - *Research Techniques:* Census methods (Direct and indirect methods), radio telemetry and GPS tracing (K1, K2, K3, K4, K5 & K6)

Unit III Conservation Strategies

Contact Hours: 10

In situ methods: Protected area network (PAN), sacred groves and biosphere reserves - *Ex situ methods:* Gene banks, seed banks, germplasms, cDNA library, cryopreservation, zoos and aquariums and botanical gardens - Captive breeding - Species recovery - Rehabilitation - Reintroduction (Project Cheetah) - Traditional ecological knowledge (TEK) for conservation (K1, K2, K3, K4, K5 & K6)

Unit IV Human-Wildlife Conflict Management

Contact Hours: 10

Causes: Habitat shrinkage, fragmentation, encroachment and pollution - *Mitigation Measures:* Habitat barriers, translocation, compensation and TEK awareness - Role of IoTs and AI in conflict management (TrailGuard AI, HACMS, Ele-fence and m-Twiga) (K1, K2, K3, K4, K5 & K6)

Unit V Policies, Legislation and International Conventions

Contact Hours: 10

Legislations: Wildlife (Protection) Act 1972, Biodiversity Act 2002 *Conventions:* CITES (Trade), CBD (Biodiversity), CMS (Migratory Species) and Ramsar (wetlands) - *Organizations:* IUCN, WWF, WII, BNHS and MoEF&CC - SAWEN network - Apps and Tools (Wildlife Sentinel and WOOD ID) - Key outcomes of CITES CoP20 - Case studies on wildlife management (K1, K2, K3, K4, K5 & K6)

References:

Text Books & Reference Books:

1. Avery, T. E., & Burkhardt, H. E. (1983). *Forest measurements*. McGraw-Hill.
2. Chaturvedi, A. N., & Khanna, L. S. (1994). *Forest mensuration*. International Book Distributors.
3. Dhyani, S. N. (1994). *Wildlife management*. Rawat Publications.
4. Jerram, M. R. K., & Bourne, R. (1980). *Elementary forest mensuration*. Natraj Publications.

CORE ELECTIVE – I/III
WILDLIFE MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1EL1/26UPEVS2EL3	100	4	3	1	-	4

5. Khan, T. I., & Al-Ajmi, D. N. (1999). *Global biodiversity conservation measures*. Pointer Publishers.
6. Nautiyal, S., & Kaul, A. K. (1999). *Forest biodiversity and its conservation practices in India*. Oriental Enterprises.
7. Sinha, P. C. (1998). *Wildlife and forest conservation*. Anmol Publications.

Web References:

1. <https://www.gfc.state.ga.us/resources/publications/ForestsAndWildlife.pdf>
2. https://www.woodlandstewardship.org/page_id=1154.html
3. <https://www.forestasyst.org/wildlife.html>
4. <https://www.bookstore.ksre.ksu.edu/pubs/MF2899.pdf>
5. <http://www.fao.org/biotech/inforestry>
6. <https://www.fs.usda.gov/pnw/units/infor>
7. <https://ntca.gov.in/cheetah>
8. <https://gradestack.com/Management.../Forests-and-Wildlife/15038-2998-4773-study-wtw.html>

CORE ELECTIVE COURSE – I/III

ENERGY AND ENVIRONMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1EL2/26UPEVS2EL4	100	4	3	1	-	4

Course Objectives

The course aims to provide comprehensive knowledge on renewable and non-renewable energy resources, waste to energy conversion and energy conservation methods

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|--|
| CO1 | Understand the different types of energy sources |
| CO2 | Know the various types of non-renewable resources and its impacts |
| CO3 | Understand different types of renewable resources and its generation methods |
| CO4 | Acquire knowledge on waste to energy conversion techniques |
| CO5 | Understand the principles of energy conservation |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	M	L	S	M	L	L
CO2	S	S	S	M	S	S	M	L
CO3	S	S	S	S	S	S	M	M
CO4	S	S	S	S	S	S	M	M
CO5	S	M	S	M	S	S	S	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE ELECTIVE COURSE – I/III
ENERGY AND ENVIRONMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1EL2/26UPEVS2EL4	100	4	3	1	-	4

Unit I Energy sources Contact Hours: 9

Introduction to nexus between energy, environment and sustainable development- Potential and perspectives of various energy sources in India *Classification of energy resources*: Renewable and non - renewable energy (K1, K2, K3 & K4, K5 & K6)

Unit II Non-renewable Energy Sources Contact Hours: 10

Fossil fuels: Coal, petroleum, LPG and natural gas, composition and classification of coal, crude oil and natural gas - Consumption and demands of coal, crude oil and natural gas - Environmental and economic impacts of fossil fuel consumption (K3 & K4) - Global coal phase out scenario (K4, K5 & K6) - *Nuclear energy*: Fission, fusion process, environmental impacts (K1 & K2)

Unit III Renewable Energy Sources Contact Hours: 11

Solar, wind, geothermal, hydel and tidal energy sources (K1 & K2) - *Ocean Thermal Energy Conversion (OTEC)*: Principle and generation (K3 & K4) - *Critical issues*: Intermittency, grid integration and energy storage solutions - Global energy consumption pattern - Present scenario and recent initiatives of renewable energy sources in India - *The future energy Sectors*: Green hydrogen and EV transition (K4, K5 & K6)

Unit IV Waste to Energy Contact Hours: 10

Bioenergy: Biomass energy as an energy source, characteristics of biomass (K1 & K2) - Energy plantations - Biomass conversion technologies (K3 & K4) - *Types of biofuels*: Biodiesel, bioethanol and biohydrogen - Production technologies and applications (K4, K5 & K6) - India's bioenergy and biofuel policies (K3 & K4)

Unit V Energy Conservation Contact Hours: 10

Energy conservation: Principles and approach (K1 & K2) - *Energy conservation in buildings*: Green buildings, solar passive architecture, eco-housing and GRIHA norms (K3, K4, K5 & K6) - *Energy audit*: Types and methodology (K4 & K5), National and International norms - Energy service companies (ESCOs), National & International standards and protocols (ECBC, ISO 50001) (K5 & K6).

References:

Text Books & Reference Books:

1. Bansal, N. K. (2014). *Non-conventional energy resources*. Vikas Publishing House.
2. Belyakov, N. (2019). *Sustainable power generation: Current status, future challenges, and perspectives*. Academic Press.
3. Bhatia, S. C., & Gupta, R. K. (2018). *Textbook of renewable energy*. Woodhead Publishing India.
4. Cengel, Y. A., Kanoglu, M., & Cimbala, J. M. (2019). *Fundamentals and applications of renewable energy*. McGraw-Hill Education.
5. Dahiya, A. (2015). *Bioenergy: Biomass to biofuels*. Academic Press.
6. Ehrlich, R. (2013). *Renewable energy: A first course*. CRC Press.
7. Galanakis, C. M. (2020). *Biobased products and industries*. Elsevier.

CORE ELECTIVE COURSE – I/III
ENERGY AND ENVIRONMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1EL2/26UPEVS2EL4	100	4	3	1	-	4

8. Jacobson, M. Z. (2020). *100% clean, renewable energy and storage for everything*. Cambridge University Press.
9. Mitra, M., & Nagchaudhuri, A. (2020). *Practices and perspectives in sustainable bioenergy: A systems thinking approach*. Springer.
10. Pandey, A., Larroche, C., Dussap, C. G., Gnansounou, E., Khanal, S. K., & Ricke, S. C. (2019). *Biofuels: Alternative feedstocks and conversion processes for the production of liquid and gaseous biofuels*. Academic Press.
11. Rutledge, D. B. (2020). *Energy: Supply and demand*. Cambridge University Press.
12. Sawhney, G. S. (2012). *Non-conventional energy resources*. PHI Learning.
13. Simon, C. A. (2020). *Alternative energy: Political, economic and social feasibility* (2nd ed.). Rowman & Littlefield.
14. Thomas, L. (2020). *Coal geology* (3rd ed.). Wiley.
15. Tyagi, H., Chakraborty, P. R., Powar, S., & Agarwal, A. K. (2020). *Solar energy: Systems, challenges, and opportunities*. Springer.
16. Viswanathan, B. (2017). *Energy sources: Fundamentals of chemical conversion processes and applications*. Elsevier.

Web References:

1. <https://www.iea.org/reports/global-energy-review-2020>.
2. https://climateanalytics.org/media/report_coal_phase_out_2019.pdf
3. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC111438/acd_in_metis_final.pdf
4. <https://www.worldgbc.org/what-green-building>
5. <https://beeindia.gov.in/sites/default/files/ctools/TR-EnergyAudits.pdf>
6. <https://www.irena.org/Innovation-Outlook-Energy-Storage>
7. <https://www.iea.org/energy-system/low-emission-fuels/hydrogen>
8. <https://www.smartgrid.gov/>

CORE PRACTICAL – I/VII
BIODIVERSITY AND CONSERVATION, ENVIRONMENTAL CHEMISTRY,
ENVIRONMENTAL GEOINFORMATICS and INDUSTRIAL HEALTH AND SAFETY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/VII	26UPEVS1CL1/26UPEVS2CL7	100	6	-	-	6	3

Experiments:

1. Determination of frequency, abundance and density of plants by Count Quadrat method
2. Vegetation sampling technique by Belt and Line Transect methods
3. Determination of species diversity in a community by different diversity indices (Shannon-Weiner Index and Simpson's Index)
4. Assessment of green belt areas in Periyar University Campus and their carbon sequestration potential
5. Determination of pH and Conductivity of Water and Soil Samples
6. Determination of Alkalinity and Acidity of Water
7. Determination of COD and BOD of Polluted Water
8. Estimation of Organic Matter in Soil
9. Georeferencing of Toposheet
10. Creation of Vector Layers - Digitization Techniques
11. Preparation of Study Area Map through GIS
12. Interpretation of Satellite Images
13. GIS-Based Land Use Classification- Supervised and Unsupervised
14. Workplace Hazard Identification and Risk Assessment (HIRA)
15. Personal Protective Equipment (PPE) Selection and Usage

Semester - VIII

ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1C05/26UPEVS2C14	100	5	4	1	-	5

Course Objectives

The course aims to provide the basic knowledge about microbes and its interactions in the various environmental components, bioremediation of environmental pollutants and production of microbial bioproducts

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|--|
| C01 | Understand the basic concepts of environmental microbiology and its diversity |
| C02 | Explain the microbial interactions and their roles in biogeochemical cycles |
| C03 | Learn the fundamental techniques involved in environmental biotechnology |
| C04 | Explore the applications of microbes in pollution control and environmental remediation |
| C05 | Understand the microbial processes in waste treatment and the production of useful bioproducts |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	M	L	M	S	L	L
CO2	S	S	S	M	S	S	M	L
CO3	S	S	M	S	M	S	M	L
CO4	S	S	S	S	S	S	M	M
CO5	S	S	S	S	S	S	M	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – V/XIV**ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1C05/26UPEVS2C14	100	5	4	1	-	5

Unit I Introduction**Contact Hours: 10**

Introduction and Scope of Environmental Microbiology - Microbial growth and metabolism - Soil microflora - Factors influencing the soil microflora - Role of microorganisms in soil fertility - Extremophiles (Archaeobacteria, acidophilic, alkalophilic, thermophilic, barophilic, osmophilic and radiodurant microbes) (K1, K2, K3, K4, K5 & K6)

Unit II Microbial Interactions and Biogeochemical Cycles**Contact Hours: 12**

Microbial interactions: Mutualism, Commensalism, Competition, Amensalism, Parasitism and Predation - Interactions of microbes with plants, animals and humans - *Microbial role in Biogeochemical cycles:* Carbon, Nitrogen, Phosphorus and Sulphur cycles - Mycorrhizae and its ecological significance - Bioluminescence in microbes (K1, K2, K3, K4, K5 & K6)

Unit III Environmental Biotechnology**Contact Hours: 13**

Scope of Environmental Biotechnology - Restriction Enzymes - *DNA Modifying Enzymes:* Nucleases, Polymerases and DNA Ligases - *Gene Cloning:* Overview - *Cloning vectors:* Plasmids, phages, cosmids, phagemids, Ti plasmids and viral vectors M13 - Cloning strategies, cloning and selection of individual genes - *Polymerase Chain Reaction:* Working principle, types and applications (K1, K2, K3, K4, K5 & K6)

Unit IV Environmental Applications of Microbes**Contact Hours: 13**

Bioindicators and biosensors for detection of pollution - Use of microbes in environmental decontamination of pollutants - *In situ bioremediation strategies:* Bioventing, biosparging, bioaugmentation, biostimulation and bioslurping - *Ex situ bioremediation strategies:* Land Farming, composting, biopiles and bioreactors - Bioleaching and Biomining - Microbial Enhanced Oil Recovery (MEOR) - Microbial Fuel Cells (MFCs) (K1, K2, K3, K4, K5 & K6)

Unit V Biotechnology for Waste Treatment & Microbial Bioproducts**Contact Hours: 12**

Biotechnology for Waste Management - Sewage treatment - Activated Sludge Process - Anaerobic Treatment - Sludge stabilization - Aerobic Composting, Anaerobic Digestion and Biogas Production - *Microbial bioproducts:* Biosorbents, Biosurfactants, Bioflocculants, Bioplastics, Biofertilizers and Biopesticides (K1, K2, K3, K4, K5 & K6)

References:**Text Books & Reference Books:**

1. Atlas, R. M., & Bartha, R. (1998). *Microbial ecology: Fundamentals and applications* (4th ed.). Benjamin/Cummings Publishing.
2. Brown, T. A. (1995). *Gene cloning: An introduction*. Chapman & Hall.
3. Mohapatra, P. K. (2008). *Text book of environmental biotechnology*. IK International Publishers.
4. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2006). *Microbiology* (5th ed.). McGraw-Hill Education.
5. Prescott, L. M., Harley, J. P., & Klein, D. A. (2017). *Microbiology* (10th ed.). McGraw-Hill Education.

CORE COURSE – V/XIV
ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1C05/26UPEVS2C14	100	5	4	1	-	5

Web References:

1. <https://www.sciencedirect.com/science/chapter/edited-volume/abs/pii/B9780123946263000016>
2. [https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_\(Boundless\)](https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(Boundless))
3. <https://egyankosh.ac.in/bitstream/123456789/95583/1/Unit-1.pdf>
4. <https://microbenotes.com/microbial-biotechnology-environmental-applications/>
5. <https://asm.org/articles/2023/august/microbial-biotech-in-waste-management>

CORE COURSE – VI/XV

POLLUTION CONTROL STRATEGIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1C06/26UPEVS2C15	100	5	4	1	-	5

Course Objectives

The course gives awareness of environmental pollution, control and treatment technologies

Course Outcomes

On the successful completion of the course, students will be able to

- C01** Learn various methods of air pollution control techniques.
- C02** Gain knowledge about water treatment technologies
- C03** Understand about soil pollution and its control, treatment methods
- C04** Learn the various control measures available for radiation pollution.
- C05** Know about noise and thermal pollution control and treatment techniques.

Mappings of course outcomes with programme outcomes

COs	P01	P02	P03	P04	P05	P06	P07	P08
C01	S	S	S	S	S	S	M	M
C02	S	S	S	S	S	S	M	M
C03	S	S	S	S	S	S	M	M
C04	S	M	S	S	S	S	S	M
C05	S	M	S	S	S	M	M	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – VI/XV
POLLUTION CONTROL STRATEGIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1C06/26UPEVS2C15	100	5	4	1	-	5

Unit I Air Pollution Control and Treatment Contact Hours: 10

Air pollution control methods: Particulate matter (Settling chamber, cyclones, fabric Filter, electrostatic precipitator and wet scrubbers) - Gaseous pollutants (NO_x, SO₂, CO, CO₂ and Hydrocarbons) (K1, K2, K3, K4, K5 & K6).

Unit II Water Pollution Control and Treatment Contact Hours: 14

Drinking water - Filtration, chlorination, reverse osmosis and ozonation - *Wastewater Treatment Methods:* Primary treatment (Screening, grit removal, neutralization, coagulation, skimming and sedimentation) - Secondary treatment (Aerobic - Aeration, activated sludge process, trickling filters, biological contact filters, rotating filters and oxidation ponds; Anaerobic – anaerobic digestion, septic tanks and lagoons) - Tertiary treatments (Ozonation, chlorination, activated carbon filtration, UV and reverse osmosis) - Nutrients removal (K1, K2, K3, K4, K5 & K6).

Unit III Soil Pollution Control and Treatment Contact Hours: 12

Soil pollution control - *Soil remediation techniques:* In situ and Ex situ - Physical (Soil Covering, excavation, electrokinetic remediation, air sparging and encapsulation) - Chemical (Soil washing, Solidification and Vitrification) - Biological (Bioremediation and Phytoremediation) (K1, K2, K3, K4, K5 & K6).

Unit IV Radiation Pollution Control and Treatment Contact Hours: 11

Radioactivity and Radiation - Radiation Units - Radiation sources - Radiation Protection - Time - Distance - Shielding - Exposure and Contamination - Controlled area - Collection, storage and disposal (K1, K2, K3, K4, K5 & K6).

Unit V Noise, Thermal Pollution Control and Treatment Contact Hours: 13

Noise Control Measures - Greenbelt and Protective Instruments - Elimination - Substitution - Engineering Control - Administrative Controls - Personal Protective Equipment's - Selection of hearing protection device - Thermal Pollution - Cooling ponds - Cooling Towers - Beneficial use of waste heat (K1, K2, K3, K4, K5 & K6).

References:

Text Books & Reference Books:

1. Chauhan, A. (2020). *Environmental pollution and management*. IK International Publishers.
2. Hung, Y.-T., Wang, L. K., & Shamma, N. K. (Eds.). (2012). *Handbook of environment and waste management: Vol. 1. Air and water pollution control*. World Scientific Press.
3. Khopkar, S. M. (2005). *Environmental pollution monitoring and control*. New Age International.
4. Peirce, J. J., Vesilind, P. A., & Weiner, R. F. (1997). *Environmental pollution and control* (4th ed.). Elsevier.
5. Rao, C. S. (2018). *Environmental pollution control engineering* (3rd ed.). New Age International.

CORE COURSE – VI/XV
POLLUTION CONTROL STRATEGIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1C06/26UPEVS2C15	100	5	4	1	-	5

Web References:

1. <https://www.bbau.ac.in/dept/UIET/Study%20Materials%20for%20TCE-0.pdf>
2. <https://www.bbau.ac.in/dept/UIET/TCE-033%20%20epdf>.
3. <https://www.studyiq.com/articles/radioactive-pollution/>
4. <https://sathee.iitk.ac.in/article/geography/noise-pollution-and-prevention/>
5. <https://courseware.cutm.ac.in/wp-content/uploads>

**CORE COURSE – VII/XVI
ENVIRONMENTAL IMPACT ASSESSMENT**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1C07/26UPEVS2C16	100	5	4	1	-	5

Course Objectives

The course provides knowledge about EIA methodologies and its roles in various decision-making in environmental impact projects

Course Outcomes

On the successful completion of the course, students will be able to

- CO1** Know the components of EIA processes and environmental clearance procedures in India
- CO2** Understand about the methods used for EIA studies
- CO3** Learn to prepare EIA report and understand about public participation in EIA process
- CO4** Communicate the key aspects of EIA process in various developmental projects
- CO5** Understand core elements of Environmental Management System (EMS) Corporate Social Responsibility (CSR) in EMS

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	S	M	S	S	S	M
CO2	S	S	S	M	S	S	M	M
CO3	S	S	S	M	S	S	S	S
CO4	M	M	S	L	S	S	S	S
CO5	S	M	S	M	S	S	S	S
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – VII/XVI
ENVIRONMENTAL IMPACT ASSESSMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1C07/26UPEVS2C16	100	5	4	1	-	5

UNIT I Introduction Contact Hours: 14

Definition - Principles of EIA - Short-term and Long-term objectives - Evolution of EIA worldwide and in India - *Types of EIA*: Rapid EIA, Comprehensive EIA and Strategic EIA - Projects subject to EIA (Category A, B1 and B2) - Steps in EIA process - Objectives of the Standard Terms of Reference (TOR) - Stages and time frame for obtaining Environmental Clearance from MoEF & CC according to EIA notification 2006 – Merits and Demerits of EIA (K1, K2 & K3) - Overview of EIA 2020 Draft (K1, K2, K3, K4, K5 & K6)

UNIT II EIA Methodologies Contact Hours: 12

Assessment of impacts: Air, water, soil, noise, biological, social, cultural, economical, and environmental factors (K5 & K6) - *EIA Methodologies*: Adhoc Method - Checklist Approach - Matrix Methods - Network Methods - Overlay Method (K1, K2, K3, K4, K5 & K6)

UNIT III Public Participation, Preparation and Review of EIA Report Contact Hours: 12

Public participation: Objectives of people's participation, public hearing in EIA - Advantages and disadvantages of people's participation - *Preparation and review of EIA Report*: EIA reports content - Basis and criteria for evaluation of EIA Reports (K1, K2, K3, K4, K5 & K6)

UNIT IV EIA Case Studies for Major Development Projects Contact Hours: 10

Major highways projects - Airport - River valley projects - Mining and quarrying - Thermal and hydroelectric power projects - Cement industries (K1, K2, K3, K4, K5 & K6)

UNIT V Environmental Management System Contact Hours: 12

Environmental Management System (EMS): Core elements of EMS - Benefits of EMS - ISO 14001 standard - PDCA (Plan-Do-Check-Act) in ISO 14001 Certification - *Life Cycle Assessment (LCA)*: Stages in LCA - *Key LCA types*: Cradle-to-Grave, Cradle-to-Gate, Cradle-to-Cradle, Gate-to-Gate and Well-to-Wheel - *Environmental auditing*: Pre audit, onsite audit and post audit activities - Benefits of environmental auditing - Corporate Social Responsibility (CSR) plan in India (K1, K2, K3, K4, K5 & K6)

References:

Text Books & Reference Books:

1. Anjaneyulu, Y., & Manickam, V. (2020). *Environmental impact assessment methodologies* (3rd ed.). B.S. Publications.
2. Anji Reddy, M. (2017). *Environmental impact assessment: Theory and practice*. BS Publications
3. Bhateria, R., Sharma, M., Singh, R., & Kumar, S. (2024). *Environmental impact assessment: A journey to sustainable development*. Springer Nature.
4. Canter, L. W. (1995). *Environmental impact assessment* (2nd ed.). McGraw Hill.
5. Ministry of Environment, Forest and Climate Change. (2001). *EIA manual*.

CORE COURSE – VII/XVI
ENVIRONMENTAL IMPACT ASSESSMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1C07/26UPEVS2C16	100	5	4	1	-	5

Web References:

1. <http://environmentclearance.nic.in/>
2. <http://www.moef.nic.in/division/eia-manual>
3. <https://www.adb.org/documents/adb-environmental-assessment-guidelines>
4. http://environmentclearance.nic.in/writereaddata/Draft_EIA_2020.pdf
5. <http://environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/GuidanceManual.htm>

CORE COURSE – VIII/XVII

ENVIRONMENTAL TOXICOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1C08/26UPEVS2C17	100	5	4	1	-	5

Course Objectives

The course introduces the basic toxicological principles, toxicity mechanism and testing methods along with risk assessment and management strategies

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| C01 | Understand fundamental toxicology concepts |
| C02 | Explain how toxicants enter, distribute, transform and leave organisms |
| C03 | Describe major fate processes affecting environmental toxicants |
| C04 | Design and interpret toxicity tests and assess toxicological impacts |
| C05 | Learn the basic risk assessment steps, regulations and risk management strategies |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	M	L	M	S	L	L
CO2	S	S	S	M	M	S	M	L
CO3	S	S	S	M	S	S	M	L
CO4	S	S	S	S	S	S	S	M
CO5	S	S	S	M	S	S	S	S
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – VIII/XVII
ENVIRONMENTAL TOXICOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1C08/26UPEVS2C17	100	5	4	1	-	5

Unit I Introduction

Contact Hours: 12

Definition, History and Scope of Environmental toxicology - *Branches:* Ecotoxicology - Human toxicology - Molecular toxicology - *Types of toxicants:* Organic, inorganic, persistent organic pollutants and emerging contaminants - Sources and pathways of environmental toxicants - *Terminology:* Dose, toxicant, toxic effect, response curves, toxicokinetics and toxicogenomics (K1, K2, K3, K4, K5 & K6)

Unit II Mechanisms of Toxicity

Contact Hours: 12

Absorption - Distribution - Metabolism and Excretion (ADME) of toxicants - Biotransformation (Phase I & Phase II reactions) - Cellular and Molecular mechanisms of toxicity - *Dose-response relationships:* Quantal, Threshold, LD₅₀, LC₅₀, Bioavailability, Bioaccumulation and Biomagnification (K1, K2, K3, K4, K5 & K6)

Unit III Fate and Transport of Toxicants

Contact Hours: 12

Movement of toxicants in air, water, soil and sediments - *Chemical fate processes:* Volatilization - Adsorption - Degradation - Environmental persistence and half-lives - Exposure pathways and receptor exposure - Biomonitoring principles (K1, K2, K3, K4, K5 & K6)

Unit IV Toxicity Assessment

Contact Hours: 12

Local and systemic toxicity - Acute and Chronic toxicity testing - Bioassays and biomarkers - Ecotoxicological testing (Standard organisms and endpoints) - Population, community and ecosystem effects - *Toxicity interactions:* Additivity - Synergism - Antagonism (K1, K2, K3, K4, K5 & K6)

Unit V Risk Assessment, Regulation and Management

Contact Hours: 12

Human and ecological risk assessment frameworks: Hazard identification - Exposure assessment - Dose-response assessment - Risk characterization - *Regulatory toxicology:* Standards and guidelines (OSHA, OECD, FDA, WHO) - *Risk management strategies:* Avoidance, reduction, transfer and acceptance (K1, K2, K3, K4, K5 & K6)

References

Text Books & Reference Books:

1. Hughes, W. W. (n.d.). *Essentials of environmental toxicology*.
2. Klaassen, C. D. (Ed.). (n.d.). *Casarett & Doull's toxicology: The basic science of poisons*.
3. Loomis, T. A., & Hayes, A. W. (1996). *Loomis's essentials of toxicology* (4th ed.). Academic Press.
4. Sharma, P. D. (1994). *Environmental biology and toxicology*. Rajpal and Sons.
5. Simon, T. A. (2014). *Environmental risk assessment: A toxicological approach*. CRC Press.

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1. https://academic.oup.com/toxsci/article/120/suppl_1/S49/1616424
2. <https://www.hindawi.com/journals/bmri/2017/4627872/>
3. [https://iubmb.onlinelibrary.wiley.com/doi/pdf/10.1016/0307-4412\(81\)90131](https://iubmb.onlinelibrary.wiley.com/doi/pdf/10.1016/0307-4412(81)90131)
4. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/downloads/
5. <https://envirotox.in/pdf>

CORE ELECTIVE COURSE – II/IV

DISASTER MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1EL3/26UPEVS2EL5	100	4	3	1	-	4

Course Objectives

The course focuses on different types of disasters and their impacts and its management strategies

Course Outcomes

On the successful completion of the course, students will be able to

- CO1** Understand the types of disasters and disaster-prone zones.
- CO2** Know different types of geological hazards and its impacts
- CO3** Understand the impacts of hydrological and meteorological hazards.
- CO4** Acquire knowledge on biological disasters and its risks
- CO5** Know about disaster management cycle and its legal frameworks

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	S	M	S	S	M	L
CO2	S	S	S	M	S	S	M	L
CO3	S	S	S	S	S	S	M	M
CO4	S	S	S	M	S	S	S	M
CO5	S	S	S	M	S	S	S	S
Alignment: S - Strong, M - Moderate, L - Low								

CORE ELECTIVE COURSE – II/IV**DISASTER MANAGEMENT**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1EL3/26UPEVS2EL5	100	4	3	1	-	4

UNIT I Introduction**Contact Hours: 08**

Key Terms, definitions and concepts related to disaster - Hazard, Risk, Vulnerability, Exposure, Coping Capacity, Resilience, Conflict, Emergencies and related terms - Methods of hazard, vulnerability and capacity assessment (HVCA) - Basics of vulnerability and risk assessment - Concepts of exposure - Sensitivity - Adaptive capacity (K1, K2, K3, K4, K5 & K6)

UNIT II Geological Hazards**Contact Hours: 11**

Earthquake: Origin of Earthquake, its magnitude and intensity - Earthquake prone zones in India - Effects of earthquake - Earthquake prediction and control. *Volcanoes*: Types of volcanic eruptions - Active volcanic belts in the world - Nature and magnitude of volcanic hazards - Prediction of volcanic eruptions - Mitigation of volcanic hazards. *Mass movement hazards*: Landslides and Snow avalanche hazards (K1, K2, K3, K4, K5 & K6)

UNIT III Hydrological and Meteorological Hazards**Contact Hours: 12**

Hydrological Hazards - *Floods*: Flooded geographical land types – Flash flood - Flood management strategies - Regions of flood prone zones in India – Flood forecasting and warning. *Droughts*: Types of droughts - *Drought assessment parameters*: Drought indices (meteorological indices, hydrological indices and agriculture index) - Preventive measures and preparedness plan for drought mitigation - Meteorological hazards - *Cyclones*: Tropical cyclones & Local storms – Heat waves and cold waves - Glacial Lake Outburst Flood (GLOF) – Lightning – Wildfires (K1, K2, K3, K4, K5 & K6)

UNIT IV Biological Disasters**Contact Hours: 08**

Biological hazards: Types and risk groups - Biological warfare and Bioterrorism - Threats, Capacity building, Response - Biosafety and Biosecurity - Agrocime and Agroterrorism - Epidemics and Pandemics with case studies (K1, K2, K3, K4, K5 & K6)

UNIT V DM Cycle, Legal Framework, Policies and Governance**Contact Hours: 11**

Disaster Management Cycle (Mitigation, preparedness, response and recovery) - Disaster Management Act 2005 - National policy on disaster management 2009 - National disaster management plan 2019 - Sendai framework for disaster risk reduction 2015 -2030 – *Institutional arrangements in disaster management*: National disaster management authority (NDMA) - State and district disaster management authorities - National disaster response force (NDRF) - Role of artificial intelligence, unmanned aerial vehicles (UAVs) and robotics - Social media in disaster management (K1, K2, K3, K4, K5 & K6)

CORE ELECTIVE COURSE – II/IV**DISASTER MANAGEMENT**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1EL3/26UPEVS2EL5	100	4	3	1	-	4

References**Text Books and Reference Books:**

1. Bhattacharya, T. (2017). *Disaster science and management*. Tata McGraw Hill Education.
2. Dhage, S. (2024). *Disaster management in India: Study guide*.
3. Hyndman, D. W., & Hyndman, D. (2025). *Natural hazards and disasters* (6th ed.). Cengage Learning.
4. Kumar, P., & Kumar, M. (2025). *A textbook of disaster management*. SPI Publications.
5. Mondal, D., & Basu, D. (2019). *Disaster management: Concepts and approaches* (1st ed.). CBS Publishers & Distributors.
6. Paul, B. K., & Juran, L. (Eds.). (2025). *The Routledge handbook of disaster response and recovery*. Taylor & Francis.
7. Sharma, S. C. (2019). *Disaster management* (2nd ed.). Khanna Book Publishing.

Web References:

1. <http://www.nidmindia.nic.in>
2. <http://www.cambridge.org>
3. <http://epdweb.engr.wise.sedu/dmc>
4. http://www.worldbank.org/html/fpd/dmf/risk_managemnt.htm
5. <https://nidm.gov.in/modules.asp>

CORE ELECTIVE COURSE – II/IV
ENVIRONMENTAL MANAGEMENT SYSTEMS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1EL4/26UPEVS2EL6	100	4	3	1	-	4

Unit I Introduction

Contact Hours: 10

Concepts and objectives of EMS - Historical evolution and drivers (Regulatory, market and social) - Regulatory frameworks and environmental policy - Environmental performance vs. environmental management - Sustainable development and corporate environmental responsibility (ESGs) (K1, K2, K3, K4, K5 & K6)

Unit II ISO 14001 & EMS Standards

Contact Hours: 10

ISO 14001:2015 structure and high-level requirements (PDCA cycle) - *Key clauses*: Context of organization, leadership, planning, support, operation, performance evaluation and improvement - Integration with other management systems (ISO 9001, OHSAS/ISO 45001) - Environmental aspects and impacts identification (K1, K2, K3, K4, K5 & K6)

Unit III EMS Implementation

Contact Hours: 10

EMS planning and documentation (manuals, procedures and records) - Environmental objective setting and target formulation - Operational control and standard operating procedures (SOPs) - Risk assessment and operational risk control - Legal and other requirements (compliance obligations) (K1, K2, K3, K4, K5 & K6)

Unit IV EMS Auditing & Performance Evaluation

Contact Hours: 10

Internal and external EMS auditing principles: Audit planning, execution, reporting and corrective actions, key performance indicators (KPIs) and environmental metrics - Monitoring, measurement, analysis and evaluation - Management review and continual improvement (K1, K2, K3, K4, K5 & K6)

Unit V Strategic EMS, Sustainability & Emerging Trends

Contact Hours: 10

Leadership commitment and organizational change for EMS - Corporate sustainability reporting (GRI, ESG metrics) - Life Cycle Assessment (LCA) and environmental footprinting - Digital tools for EMS (software, data analytics, IoT) - *Case studies*: Industry best practices and global benchmarks (K1, K2, K3, K4, K5 & K6)

References:

Text Books & Reference Books:

1. Dahlstrom, R., & Massoud, J. (2002). *Implementing ISO 14001: A practical, business-focused approach*. McGraw-Hill.
2. Desrochers, M., & Hoffmann, A. (1998). *EMS in practice: Case studies*. International Institute for Sustainable Development.
3. Johnson, R. H. (Ed.). (1997). *ISO 14000: Environmental management handbook*. McGraw-Hill.
4. United Nations Environment Programme. (n.d.). *Environmental management systems: An implementation guide for small and medium-sized organizations*. UNEP.
5. Young, A. S. (1996). *Environmental performance evaluation*. Wiley.

CORE ELECTIVE COURSE – II/IV
ENVIRONMENTAL MANAGEMENT SYSTEMS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1EL4/26UPEVS2EL6	100	4	3	1	-	4

Web References:

1. <https://www.unep.org/resources>
2. <https://www.iso.org/iso-14000-family.html>
3. <https://www.epa.gov/ems/implementation>
4. <https://www.globalreporting.org>
5. <https://www.unep.org/resources>

CORE PRACTICAL – II/VIII
ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY,
ENVIRONMENTAL POLLUTION CONTROL STRATEGIES,
ENVIRONMENTAL IMPACT ASSESSMENT and ENVIRONMENTAL TOXICOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II/VIII	26UPEVS1CL2/26UPEVS2CL8	100	6	-	-	6	3

Experiments:

1. Enumeration of Microorganisms from Soil and Water
2. Examination of Mycorrhizae – VAM
3. Isolation of genomic DNA from plant
4. Biodegradation of organic pollutants - Phenol, Synthetic Dyes
5. Production of Biosurfactants
6. Jar Test for Coagulation and Flocculation
7. Demonstration of Water Filtration Techniques
8. Demonstration of Stack Monitoring Techniques
9. Noise Level Monitoring
10. Preparation of different checklist methods for EIA studies in Mining industry
11. Preparation of simple check list for EIA in Cement industry
12. Preparation of Leopold Matrix method for Thermal Power project
13. Preparation of EIA report for environmental clearance as per EIA notification 2006
14. Estimation of LD₅₀ for a toxicant
15. Toxicity Assessment of a toxicant using Seed Germination Bioassay

Semester - IX

WASTE MANAGEMENT

Course Objectives

Course Outcomes

CO1 Gain adequate knowledge of municipal solid wastes and its disposal methods

C02 Know the management techniques of hazardous and radioactive wastes

C03 Learn the categorization of biomedical waste and its disposal methods

C04 Understand the management techniques of plastic and e-wastes

C05 Understand the industrial specific treatment techniques and energy recovery

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	S	M	S	S	M	L
CO2	S	S	S	S	S	S	S	M
CO3	S	S	S	M	S	S	S	M
CO4	S	S	S	S	S	S	M	M
CO5	S	S	S	S	S	S	M	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE COURSE – IX/XVIII**WASTE MANAGEMENT**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1C09/26UPEVS2C18	100	5	4	1	-	5

Unit I Municipal Solid Waste Management**Contact Hours: 14**

Municipal solid wastes (MSW): Definition, source, types, classification, characterization, composition, per capita generation and global scenario - Methods of collection, storage and transportation, waste processing and material recovery (K4) - *Disposal methods:* Aerobic and anaerobic methods (Landfill, sanitary landfill, composting, burning, incineration, pyrolysis and anaerobic digestion) - Management of leachate and landfill gas, Dumpsite rehabilitation - Rules and regulation of MSW, creating public awareness, role of NGO's (K1, K2, K3, K4, K5 & K6)

Unit II Hazardous & Radioactive Waste Management**Contact Hours: 14**

Hazardous waste: Definition, characteristics and classification (Industrial, hospital and domestic) (K1, K2, & K3) - Labelling and handling of hazardous solid wastes (Segregation, recovery of hazardous waste substances) (K3 & K4) - Rules and regulation of hazardous waste - Hazardous wastes disposal techniques (K5) - *Radioactive wastes:* Sources, classification and characterization (K1 & K2) - Radiation units, measurements (K3), effects, control and disposal Methods (Treatment, conditioning, storage and disposal) - Legal framework and regulations (K1, K2, K3, K4, K5 & K6)

Unit III Biomedical Waste Management**Contact Hours: 10**

Biomedical wastes: Sources and types (K1 & K2) - Impacts of biomedical wastes on environment (K3 & K4) - Biomedical waste management rules, 2016 and Amendments - Labelling and transport (K4) - Control measures and disposal (K5) .

Unit IV Plastic & e-waste Management**Contact Hours: 11**

Plastic wastes: Sources, types (K1 & K2) and global Scenario (K3, K4) - Plastic waste management rules 2016 - Effects of plastic wastes and micro plastics on marine life, wildlife, human health and environment - Control measures - 'R' strategies (R0 to R9) Construction of plastic roads - Alternate to plastics (K5 & K6) - *E-wastes:* Sources, types and composition (K2) - Impacts on environment (K3) - Control measures - Recycling and recovery technologies (K3 & K5).

Unit V Industrial Waste Management & Energy Recovery**Contact Hours: 11**

Cradle to Grave processes in pulp and paper, tanneries, textiles, thermal power plants, mining and ore processing, refineries, iron casting, cement, sugar, distillery, pharmaceuticals and asbestos - Sludge dewatering and its disposal - *Energy recovery:* Heat, electricity and fuel recovery (K1, K2, K3, K4, K5 & K6)

References:**Text Books & Reference Books:**

1. Basarkar, S. (2009). *Hospital waste management: A guide for self-assessment and review*. Jaypee Digital.
2. Bhide, A. A., & Sundaresan, B. B. (2000). *Solid waste management in developing countries*. Indian National Scientific Documentation Center.
3. Chandrappa, R., & Brown, J. (2012). *Solid waste management: Principles and*

CORE COURSE – IX/XVIII**WASTE MANAGEMENT**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1C09/26UPEVS2C18	100	5	4	1	-	5

practice. Springer.

4. Kinnaman, T. C., & Takeuchi, K. (Eds.). (2014). *Handbook on waste management*. Edward Elgar Publishing.

5. Kumar, S. (2009). *Solid waste management*. Northern Book Centre.

Web References:

1. <http://www.cpeo.org/techtree/ttdescript/pyrols.htm>
2. <http://web.mit.edu/urbanupgrading/urbanenvironment/sectors/solid-waste-landfills.html>
3. http://www.cement.org/waste/wt_apps_radioactive.asp
4. https://www.researchgate.net/publication/42339862_Biomedical_waste_management
5. http://cbs.teriin.org/pdf/Waste_Management_Handbook.pdf

CORE COURSE – X/XIX

CLIMATE CHANGE AND CURRENT ISSUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1C10/26UPEVS2C19	100	5	4	1	-	5

Course Objectives

The course explores climate system functioning, climate change drivers, mitigation and adaptation of climate change and related issues

Course Outcomes

On the successful completion of the course, students will be able to

- CO1** Understand the meteorological elements influence on climate change
- CO2** Acquire the knowledge about various atmospheric processes in climate science
- CO3** Explore more knowledge in sources and impacts of climate change
- CO4** Understand the existing novel technologies used for measurement of climate change and weather forecasting
- CO5** Understand the recent initiatives and policy framework by UNFCCC, IPCC, MoEF & CC and other Ministries

Mappings of course outcomes with programme outcomes

[illegible]

CORE COURSE – X/XIX
CLIMATE CHANGE AND CURRENT ISSUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1C10/26UPEVS2C19	100	5	4	1	-	5

UNIT I Meteorological Elements for Climate Change Contact Hours: 10

Structure of atmosphere: Vertical structure of atmosphere - *Atmospheric stability:* Adiabatic process - Air Temperature, Humidity, *Condensation:* Dew and Frost, Fog, and clouds - *Clouds:* Classification of clouds - *Precipitation processes:* Collision and Coalescence process and Ice-crystal or Bergeron process - Cloud seeding - Precipitation types (Rain, snow, Sleet and freezing rain, snow grains and snow pellets, hail) - *Air Pressure and Winds:* Atmospheric pressure - Forces that influence the wind (Pressure gradient force, Coriolis force, centripetal force, friction) (K1, K2, K3, K4, K5 & K6)

UNIT II Atmospheric Circulation, Air masses and Fronts Contact Hours: 12

Atmospheric circulation: Hadley circulation - Intertropical Convergence Zone (ITCZ) – Jet streams - *Global wind patterns:* Trade winds, Westerlies and Polar Easterlies - *Thermal circulations:* Sea and land breezes, Mountain and valley breezes, Katabatic winds, Chinook (Foehn) winds, Santa Ana winds, Desert winds - *Air masses:* Classification and characteristics of air masses - Types of air masses - *Fronts:* Type of fronts: Stationary fronts, cold fronts, warm fronts, occluded fronts (K1, K2, K3, K4, K5 & K6)

UNIT III Air Quality and Consequences of Climate Change Contact Hours: 12

Global Air Quality and CO₂ concentration scenario - Role of air pollutants in climate change - *Sources of greenhouse gases:* Coal burning, Transportation sectors (vehicle, railways, shipping and aviation) - Facts and figures of current global warming scenarios in the world - El Niño, La Niña and El Niño Southern Oscillation (ENSO) - *Impacts of climate change:* State of India's Climate in 2025 - Changes in the SW and NE monsoon patterns in India - Melting of ice glaciers and Sea levels - Water scarcity - Food security - Species extinction - Human health - Civil Wars and Migration - Global swarming: Locust plague (K1, K2, K3, K4, K5 & K6)

UNIT IV Climate Classification, Measurement of Climate Change and Weather forecasting Contact Hours: 10

Classification of climate: Koppen's and Thornthwaite' scheme - *The measurement of climate change:* Tree rings, ice cores, ocean sediments, pollen records, Boreholes and other proxy measurements - *Weather forecasting tools:* AWIPS computer work station, Doppler radar data, meteogram, satellites and weather forecasting - *Types of forecasts:* Nowcast, short-range forecasts, medium and long-range forecasts (K1, K2, K3, K4, K5 & K6)

CORE COURSE – X/XIX
CLIMATE CHANGE AND CURRENT ISSUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1C10/26UPEVS2C19	100	5	4	1	-	5

UNIT V Global/National Action Plans to Combat Climate Contact Hours: 10
Change Issues

Key Takeaways from CoPs Meetings: Kyoto Protocol - Copenhagen Accord 2009 - Cancun Agreements 2010 to establish Green Climate Funds - Paris Climate Agreement 2015; Intended Nationally Determined Contribution (INDC) at CoP 21 - Key outcomes of CoP 26 to CoP 30 - Montreal Protocol for ODS, Kigali Amendment 2016 to phase out hydrofluorocarbons (HFC) - Green climate funds - Clean Development Mechanism (CDM) - National Action Plan on Climate Change (Eight missions) - Recent initiatives related to climate change adaptation and mitigation in Tamil Nadu and India (K1, K2, K3, K4, K5 & K6)

References:

Text Books & Reference Books:

1. Ahrens, C. D., & Henson, R. (2022). *Meteorology today: An introduction to weather, climate, and the environment* (13th ed.). Cengage Learning.
2. Fletcher, W. D., & Smith, C. B. (2024). *The global climate crisis: What to do about it*. Elsevier.
3. Khalil, M. A. K. (2022). *Global climate change and human life*. Wiley & Sons.
4. Letcher, T. (2025). *Indicators of climate change* (1st ed.). Elsevier.
5. Sammonds, P., Guppy, L., & Sun, T. (2026). *Climate and natural hazards risks* (1st ed.). Elsevier

Web References:

1. <https://unfccc.int/>
2. <https://www.ipcc.ch>
3. <https://www.co2.earth/>
4. <https://www.climatecentral.org/>
5. <https://wmo.int/sites/default/files/2025>

RESEARCH METHODOLOGY AND INSTRUMENTATION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1C11/26UPEVS2C20	100	5	4	1	-	5

Course Objectives

The course aims to impart the concepts of Research Methods and Instrumentation techniques related to environment.

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|---|
| C01 | Know the concepts and methods of research, scientific reports |
| C02 | Understand the principles and method of imaging techniques |
| C03 | Understand the principles and extraction and separation techniques |
| C04 | Understand the principles and apply the chromatographic techniques |
| C05 | Understand the principles and apply the spectrophotometric techniques |

Mappings of course outcomes with programme outcomes

COs	P01	P02	P03	P04	P05	P06	P07	P08
C01	S	S	S	M	M	S	S	S
C02	S	S	M	S	L	S	M	M
C03	S	S	S	S	M	S	M	L
C04	S	S	S	S	M	S	M	M
C05	S	S	S	S	M	S	M	M
Alignment: S - Strong, M - Moderate, L - Low								

CORE PAPER – XI/XX**RESEARCH METHODOLOGY AND INSTRUMENTATION**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1C11/26UPEVS2C20	100	5	4	1	-	5

Unit I Research Methods**Contact Hours: 12**

Research: Types, Scope, hypothesis, outcomes - Search engines - Experimental findings and interpretations - Collection of data and analysis – Basic Statistical Tests - *Types of articles:* Research, review, short communications, scientific popular articles, reports, commentary note and editorial note - Components of a research article - *Citing of references:* Types and softwares - Publication ethics - Plagiarism - Journal impact factor - *Citation index:* h index and i-10 index (K1,K2, K3, K4, K5 & K6).

Unit II Imaging Techniques**Contact Hours: 12**

Basic principles of microscopy - Sample preparation techniques for light and electron Microscopes - *Light microscopes:* Simple, compound fluorescent, Phase contrast and confocal - *Electron microscope:* SEM and TEM (K1,K2, K3, K4, K5 & K6).

Unit III Separation Techniques**Contact Hours: 12**

Centrifugation - Principle and instrumentation - *Centrifuges:* Types and applications - *Electrophoretic techniques:* Principles, types and applications - *Extraction methods:* Principles, methods of Liquid-Liquid and Solid-Liquid Extraction. (K1,K2, K3, K4, K5 & K6).

Unit IV Chromatographic Techniques**Contact Hours: 10**

Principle and concept of chromatography: stationary phase, mobile phase, partition and adsorption, coefficients (K1, K2, K3) - Instrumentation and applications of thin layer, Ion-exchange, GC, HPLC, GC-MS and LC-MS (K1,K2, K3, K4, K5 & K6).

Unit V Spectrophotometric Techniques**Contact Hours: 14**

Electromagnetic Radiation: Concept and application in spectrophotometry - *Principle, Components, and Applications:* UV-Vis Spectroscopy - Fluorescence Spectroscopy - Fourier transform infrared spectroscopy (FTIR) - Mass spectrometry - X-ray diffraction (XRD) - Atomic Absorption Spectrometry (AAS) – Inductively Coupled Mass Spectrometry (ICP-MS) (K1,K2, K3, K4, K5 & K6).

References**Text Books & Reference Books:**

1. Gurumani, N. (2011). *Research methodology for biological science*. MJP Publishers.
2. Kumar, R. (2010). *Research methodology: A step-by-step guide for beginners*. SAGE.
3. Currell, G. (Ed.). (2003). *Liquid chromatography–mass spectrometry: An introduction*. John Wiley & Sons.
4. Dean, J. R. (2021). *Instrumental methods of analysis* (3rd ed.). BSP Publications.
5. Duarte, R. M. B. O., & Duarte, A. C. (Eds.). (2018). *Multidimensional analytical techniques in environmental research*. Elsevier.

CORE PAPER – XI/XX**RESEARCH METHODOLOGY AND INSTRUMENTATION**

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1C11/26UPEVS2C20	100	5	4	1	-	5

6. Shivhare, B., Jadhav, N. N., Vegesna, S., Lakshmi, R., & Malviya, Y. (2022). *Textbook of modern analytical techniques*. Shashwat Publication.
7. Webster, G., & Kott, L. (Eds.). (2020). *Chromatographic methods development*. Jenny Stanford Publishing.

Web References:

1. <https://www.euacademic.org/BookUpload/9.pdf>
2. <https://uou.ac.in/sites/default/files/slm/EVS-505.pdf>
3. https://en.wikipedia.org/wiki/Analytical_Sciences_Digital_Library
4. <https://microbenotes.com/chromatography-principle-types-and-applications/>
5. <https://pmc.ncbi.nlm.nih.gov/articles/PMC5206469/>

ENVIRONMENTAL NANOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1EL5/26UPEVS2EL7	100	4	3	1	-	4

Course Objectives

The course aims to provide the fundamental knowledge on the environmental significance of nanoscience and technology

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|--|
| C01 | Understand the background of nanotechnology and its importance |
| C02 | Understand different types of nanomaterials and their use |
| C03 | Obtain knowledge on synthesis and characterization of the of nanomaterials |
| C04 | Acquire knowledge on environmental applications of nanomaterials |
| C05 | Understand the environmental impacts of nanomaterials and nanoremediation techniques |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
C01	S	M	M	M	M	S	S	L
C02	S	M	S	M	S	S	M	M
C03	S	S	S	S	M	S	M	M
C04	S	S	S	S	S	S	M	M
C05	S	S	S	S	S	S	M	S
Alignment: S - Strong, M - Moderate, L - Low								

CORE ELECTIVE COURSE – III/V
ENVIRONMENTAL NANOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1EL5/26UPEVS2EL7	100	4	3	1	-	4

Unit I Introduction to Nanotechnology Contact Hours: 08

Nanoscience and Nanotechnology: Definition, principles and applications - *Nanoscale Properties:* - Mechanical, Electrical, Optical and Chemical - Environmental regulations of nanomaterials - *Nanotechnology:* Health risk and ethics (K1, K2, K3, K4, K5 & K6)

Unit II Types of Nanomaterials Contact Hours: 11

Natural Nanomaterials: Nano biomaterials, natural adsorbents, polymer adsorbents, viral adsorbents, biopolymers and nanobacterium - *Engineered Nanomaterials:* Carbon-based nanomaterials (Fullerenes, carbon nanotubes and graphenes) - Metal-based nanomaterials (Metal and metal oxide nanoparticles) - Dendrimers - Nanocomposites - Nonporous materials (K1, K2, K3, K4, K5 & K6)

Unit III Nanomaterials - Synthesis and Characterization Contact Hours: 12

General methods for synthesis of nanomaterials: Bottom-up approach - Top-down approach - *Physical methods:* Ball milling, melt mixing, physical vapour deposition, sputter deposition and evaporation - *Chemical methods:* Chemical reduction, sol-gel method, photochemical synthesis, electrochemical synthesis, emulsion synthesis, sonochemical methods and microwave-assisted synthesis - *Biological methods:* Green synthesis (Bacteria, fungi and plants metabolites) - Characterization - SEM, TEM, XRD, Spectroscopy, BET and GC –MS (K1, K2, K3, K4, K5 & K6)

Unit IV Environmental Applications of Nanomaterials Contact Hours: 11

Nanomaterials for environmental remediation: Nanoscale zero-valent iron (NZVI), Titanium dioxide nanoparticles - Bimetallic nanoparticles - Silver nanoparticles - Metal oxide nanoparticles - Nanoadsorbents - Nanocatalysts – Nanoflocculant - *Nanoremediation:* Halogenated organic solvents, POPs, PPCPs, dyes, explosives and heavy metals – Carbon capture – Advanced membrane technologies - Nano biosensors - types and applications (K1, K2, K3, K4, K5 & K6)

Unit V Environmental Impacts of Nanomaterials Contact Hours: 08

Nanomaterials: - Environmental contamination, exposure, behavior, risks and impacts in water and soil environment - Harmful effects of engineered nanomaterials on human, animal health - *Nanotoxicity:* cytotoxic and genotoxic effects (K1, K2, K3, K4, K5 & K6)

References:

Text Books & Reference Books:

1. Joo, S. H. (2016). *Applying nanotechnology for environmental sustainability*. IGI Global.
2. Lofrano, G., Libralato, G., & Brown, J. (2017). *Nanotechnologies for environmental remediation*. Springer.

CORE ELECTIVE COURSE – III/V
ENVIRONMENTAL NANOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1EL5/26UPEVS2EL7	100	4	3	1	-	4

3. Mazari, S. A., Mubarak, N. M., & Tripathi, M. (2022). *Nanomaterials for carbon dioxide capture and conversion technologies*. Elsevier.
4. Mirkin, C. A., & Niemeyer, C. M. (2007). *Nanobiotechnology II: More concepts and applications*. Wiley-VCH.
5. Niemeyer, C. M., & Mirkin, C. A. (2004). *Nanobiotechnology: Concepts, applications and perspectives*. Wiley-VCH.
6. Poole, C. P., Jr., & Owens, F. J. (2003). *Introduction to nanotechnology*. Wiley India.
7. Pradeep, T. (2008). *Nano: The essentials—Understanding nanoscience and nanotechnology*. Tata McGraw-Hill.
8. Rao, C. N. R., Muller, A., & Cheetham, A. K. (2004). *The chemistry of nanomaterials: Synthesis, properties and applications*. Wiley-VCH.
9. Sharma, V. K., & Shami, N. (2013). *Sustainable nanotechnology and the environment: Advances and achievements* (ACS Symposium Series No. 1124). American Chemical Society.
10. Simeonova, P. P., Opopol, N., & Luster, M. I. (2006). *Nanotechnology: Toxicological issues and environmental safety*. Springer.
11. Surampalli, R. Y., Zhang, T. C., Hu, Z., Tyagi, R. D., Lai, K. C. K., & Ong, S. K. (2009). *Nanotechnologies for water environment applications*. American Society of Civil Engineers.
12. Patel, P. S., Patel, V., & Patel, B. (2018). *Characterization tools and techniques for nanomaterials*. [Publisher not specified].
13. Norton, J. (2019). *Green nanotechnology*. Callisto Reference.

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1. <https://netl.doe.gov/carbon-management/carbon-capture>
2. <https://www.nanolc.org/>
3. <https://doi/10.1021/bk-2013-1124>
4. <https://www.sciencedirect.com/topics/engineering/nanofiltration-membrane>
5. <http://www.gogreenmechanisms.com/service/environment-audit/>
6. <http://cpbenvvis.nic.in/scanned%20reports/PROBES%2050%20Guidelines%20for%20Environmental%20Audit.pdf>
7. <http://kb.icaai.org/pdfs/PDFFile5b28e322df0fd2.63902464.pdf>
8. <https://www.sciencedirect.com/topics/engineering/ecodesign>
9. <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/cleaner-production>
10. <http://www.gdrc.org/sustdev/concepts/02-c-prod.html>
11. <http://www.cprac.org/en/sustainable/production/cleaner>

CORE ELECTIVE COURSE – III/V
ENVIRONMENTAL LAW AND POLICIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1EL6/26UPEVS2EL8	100	4	3	1	-	4

Course Objectives

The course introduces the Indian environmental laws and rules along with the international treaties and national policies

Course Outcomes

On the successful completion of the course, students will be able to

- | | |
|------------|--|
| C01 | Understand the constitutional provisions for environmental protections |
| C02 | Have an insight into major acts for pollution control and natural resource conservation. |
| C03 | Understand various rules and regulations related to environmental protection |
| C04 | Know various international conventions and treaties for environment |
| C05 | Know the national missions and policies for protecting environment |

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
C01	S	M	S	L	S	S	S	M
C02	S	M	S	M	S	S	S	M
C03	S	S	S	M	S	S	S	M
C04	S	M	S	L	S	S	S	S
C05	S	M	S	M	S	S	S	S
Alignment: S - Strong, M - Moderate, L - Low								

CORE ELECTIVE COURSE – III/V
ENVIRONMENTAL LAW AND POLICIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1EL6/26UPEVS2EL8	100	4	3	1	-	4

Unit I Environmental Legislation Contact Hours: 10

Constitutional provisions in India (Article 48A and 51A (g)): Duties and responsibilities of Indian citizens for environmental protection - Environmental regulatory framework in India - Central and state boards for the prevention and control of environmental pollution - Constitution, powers and functions of pollution control boards (K1, K2, K3, K4, K5 & K6).

Unit II Indian Environmental Laws and its recent amendments Contact Hours: 10

Wildlife protection act, 1972 - Water (Prevention and control of pollution) act, 1974 - Forest conservation act, 1980 - Air (Prevention and control of pollution) act, 1981 - Environmental (Protection) act, 1986 - The biological diversity act 2002 - National green tribunal act 2010 (K1, K2, K3, K4, K5 & K6).

Unit III Rules for Environmental Protection in India Contact Hours: 10

Coastal regulation zones (CRZ) 1991 - Noise pollution (Regulation and control) rules, 2000 - National environmental policy, 2006 - National water policy, 2012 - The bio-medical waste management rules, 2016 - The solid waste management rules, 2016 - The e-waste (Management) rules 2016 - Plastic waste management rules, 2022 - Vehicular emission norms in India - Environment protection (Management of Contaminated Sites) rules, 2025 (K1, K2, K3, K4, K5 & K6).

Unit IV International Treaties and Conventions Contact Hours: 10

Ramsar convention on wetlands (1971) - Stockholm conference on human environment 1972 - Montreal protocol 1987 - Basel convention (1989, 1992) - Earth summits - 1992, 2002, 2022 - Global environmental facility (GEF) - Convention on biodiversity (1992) - UNFCCC, IPCC, UNEP, IGBP - Kyoto protocol 1997, Clean development mechanism (CDM), Copenhagen summit 2009, COP 25 Paris agreement 2015, IPCC AR6 synthesis report 2023 - UNDP Sustainable Development Goals (SDGs) 2030 (K1, K2, K3, K4, K5 & K6).

Unit V Major Initiatives/Policies from Union and State Governments Contact Hours: 10

National policies for environmental protection in India: National river conservation plan (NRCP) - National Ganga river basin authority (NGRBA): Ganga action plan phase I and II - Green India mission - National environmental assessment and monitoring authority (NEAMA) - National green corps (NGC) - National missions on environment – National EV policy - National policy on biofuels, 2018 and 2022 - National hydrogen policy 2022 (K1, K2, K3, K4, K5 & K6).

CORE ELECTIVE COURSE – III/V
ENVIRONMENTAL LAW AND POLICIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1EL6/26UPEVS2EL8	100	4	3	1	-	4

References:

Text Books & Reference Books:

1. Asthana, D. K., & Asthana, M. (2001). *Environment: Problems and solutions* (2nd ed.). S. Chand.
2. Divan, S., & Rosencranz, A. (2001). *Environmental law and policy in India*. Oxford University Press.
3. Divan, S., & Rosencranz, A. (2005). *Environmental law and policy in India*. Oxford University Press.
4. Khan, I. A. (2002). *Environmental law* (2nd ed.). Central Law Agency.
5. Leelakrishnan, P. (2000). *Environmental law in India*. Butterworths India.
6. Leelakrishnan, P. (2008). *Environmental law case book*. LexisNexis Butterworths.
7. Maheshwara Swamy, N. (2008). *Textbook on environmental law* (2nd ed.). Asia Law House.
8. Maheshwara Swamy, N. (2010). *Textbook on environmental law*. Asia Law House.
9. Paras Diwan. (n.d.). *Environmental administration and law*.
10. Saxena, K. D. (n.d.). *Environmental planning, policies and programs in India*.
11. Shantakumar, S. (2005). *Introduction to environmental law* (2nd ed.). Wadhwa.
12. Shastri, S. C. (2008). *Environmental law* (3rd ed.). Eastern Book Company.
13. Singh, G. (1995). *Environmental law: International and national perspectives*.
14. Singh, G. (2005). *Environmental law in India*. Macmillan.
15. Tamil Nadu Pollution Control Board. (1999). *Pollution control legislation* (Vol. 1-2).

Web References:

1. <https://www.Cpcb.nic.in/>
2. <https://www.tnpcb.gov.in/>
3. <https://www.thesummitbali.com/>
4. <https://www.envfor.nic.in/legis/legis.html>
5. <https://www.edugreen.teri.res.in/explore/laws.html>
6. <https://www.envfor.nic.in/legis/crz/crznew.html>
7. <https://www.rti.gov.in/>
8. <https://www.www.ngosindia.com/resources/pil.php>

CORE PRACTICAL – III/IX
WASTE MANAGEMENT, CLIMATE CHANGE AND CURRENT ISSUES and
RESEARCH METHODOLOGY AND INSTRUMENTATION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III/IX	26UPEVS1CL3/26UPEVS2CL9	100	6	-	-	6	3

Experiments:

1. Municipal Solid Waste Characterization
2. Determination of Moisture Content in Solid Waste
3. Preparation and Monitoring of Compost
4. Vermicomposting of Organic Waste
5. Household Waste Audit
6. Identification and Segregation of Biomedical, Plastic and E-Waste
7. Analysis of existing scenarios of weather and forecast datasets obtained from TAWN in any agricultural block of your district
8. Analysis of weather datasets obtained from TAWN in Special Protected Agricultural Zones in Tamil Nadu
9. Analysis of weather datasets obtained from TAWN in different agro-climatic zones in Tamil Nadu
10. Trends in global major greenhouse gases (CO_2 , CH_4 , N_2O and SF_6) from datasets of NOAA, USA
11. Literature Survey and Reference Management
12. Paper Chromatography of Plant Pigments
13. Colorimetric Determination Using UV-Visible Spectrophotometer
14. Demonstration of GC and HPLC Analysis
15. Demonstration of SEM and TEM Analysis

Mandatory Courses

MANDATORY COURSES

DISASTER MANAGEMENT (NIDM Mandatory Course)

Semester	Paper Code	Marks	Hours/Week	L	T		P	Credit
I & II	26UPEVS2DM1	100	1	1	-		-	1

SEMESTER – II			
All UG Programme-Part-IV			
DISASTER MANAGEMENT			
UNIT	Learning Objectives		
CO1	To introduce the basic concepts of disaster, hazard, vulnerability, and risk.		
CO2	To understand the types and causes of various natural and anthropogenic disasters.		
CO3	To provide knowledge of disaster management strategies, phases, and mitigation techniques.		
CO4	To understand the types, causes, effects and mitigation of Man- made and industrial hazards.		
CO5	To familiarize students with institutional frameworks like NDMA, NDRF and SDMA with awareness and preparedness in handling the disasters effectively.		
Unit	Details	No. of Hours	Course Objectives
I	Fundamentals of Disaster Management Concept of disaster and hazard: definition and distinctions. Types of disasters: Natural - geological, hydrological, climatological; Biological and Man-made. Disaster Management Cycle: preparedness, response, recovery and mitigation. Risk and Vulnerability analysis: Types of vulnerability, Risk and Resilience.	12	CO1
II	Geological Disasters Earthquakes: causes, effects, and mitigation strategies. Tsunami: generation, impact zones, and early warning systems. Volcanoes: types, causes, effects, and risk zones. Landslides: mechanisms, triggers, and mitigation.	12	CO2
III	Hydrological, Climatological and Biological Disasters Hydrological Disasters: Avalanches - definition, causes and facts. Floods - causes, types, impacts, and flood control measures. Climatological Disasters: global warming, climate change, droughts, cyclones - types, effects and warning systems. Biological Disasters: epidemics and pandemics - causes, spread and control measures (e.g., COVID-19, Dengue, Cholera etc.,).	12	CO3
IV	Man-Made and Industrial Disasters Man-Made Disasters: Famine, Transport - road, rail and air accidents, Conflicts, Terrorism and their impact on society. Industrial Disasters - chemical, nuclear, mine explosion, pollution, acid rain and oil spills. Urban Disasters - stampede, building collapse and effluence. Fire accidents - causes, effects, and safety regulations.	12	CO4
V	Disaster Management Framework and Institutions in India Disaster prone regions of India. National Disaster Management Act and Policy. Role of NDMA, NDRF and SDMA. Disaster preparedness plan - awareness, mitigation and management.	12	CO5

MANDATORY COURSES

	preparedness plan - awareness, mitigation and management.		
UNIT	Learning Outcomes		
I	Know about the Nature of Disasters and Hazards.		
II	Know about the Earthquakes, Volcanic Eruption and Landslides etc.,		
III	Understand the Causes and effects of Cyclones, Floods, and Droughts.		
IV	Acquired the knowledge of Fire Accidents, Explosions, Road Accidents and Stampede.		
V	Know about the Role Agencies in Disaster Management.		
Text books/References:			

1	Kapur, A. (2010). Vulnerable India: A Geographical Study of Disasters. SAGE India Pvt. Ltd., New Delhi.
2	Vulnerability Atlas of India (1997). Building Materials & Technology Promotion Council, Ministry of Urban Development, Government of India, New Delhi.
3	Singh, R.B. (2006). Natural Hazards and Disaster Management: Vulnerability and Mitigation (Edited Volume). Rawat Publications, New Delhi.
4	Modh, S. (2010). Managing Natural Disaster: Hydrological, Marine and Geological Disasters. Macmillan, New Delhi.
5	Srivastava, H.N. & Gupta, G.D. (2006). Management of natural disasters in developing countries. Delhi: Daya Publishers.
6	Coppola, D. P, (2007). Introduction to international disaster management. London: Elsevier Science (B/H).
7	David Alexander. (1999). Natural disasters. London: Kluwer Academic
8	Murthy, D.B.N. (2012) Disaster management. New Delhi: Deep and Deep Publication
9	Gupta H.K. (2003). <i>Disaster Management</i> . University Press.
10	Sharma, R.K. and Sharma, G. (2014). <i>Natural Disaster</i> . APH Publishing.
11	Alexander, D. (2002). <i>Principles of Emergency Planning and Management</i> . Oxford University Press.
12	Singh, R.B. (2006). <i>Natural Hazards and Disaster Management</i> . Rawat Publications.
WEB SOURCE	
1	NDMA Guidelines (available at: www.ndma.gov.in)
2	NIDM (available at: www.nidm.gov.in)
3	NDRF (available at: www.ndrf.gov.in)
4	SDMA (available at: www.cra.tn.gov.in)

Summary of Course Outcomes (COs):

CO	Course Outcome Statement	Bloom's Level	Mapped POs
CO1	Understand disaster types and the disaster management cycle	Understand (L1, L2)	PO1, PO6, PO7
CO2	Analyze geological disasters and their management strategies	Analyze (L4)	PO1, PO2, PO6, PO7
CO3	Evaluate hydro-meteorological disaster impacts and responses	Evaluate (L5)	PO1, PO2, PO6, PO7
CO4	Identify and assess causes and responses to man-made disasters	Analyze (L4)	PO1, PO5, PO6, PO8
CO5	Apply institutional framework knowledge for disaster risk reduction in India	Apply (L3)	PO3, PO4, PO7, PO8

MANDATORY COURSES

ENVIRONMENTAL STUDIES (UGC Mandatory Course)

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	26UPEVS2ES1	100	1	1	-	-	1

Unit 1: Introduction to environmental studies

Multidisciplinary nature of environmental studies; components of environment – atmosphere, hydrosphere, lithosphere and biosphere.

Scope and importance; Concept of sustainability and sustainable development.

Unit 2: Ecosystems

What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chain, food web and ecological succession. Case studies of the following ecosystems: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 3: Natural Resources: Renewable and Non-renewable Resources

Land Resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.

Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).

Heating of earth and circulation of air; air mass formation and precipitation.

Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit 4: Biodiversity and Conservation

Levels of biological diversity: genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity hot spots

India as a mega-biodiversity nation; Endangered and endemic species of India

Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit 5: Environmental Pollution

Environmental pollution: types, causes, effects and controls; Air, water, soil, chemical and noise pollution

Nuclear hazards and human health risks

Solid waste management: Control measures of urban and industrial waste..

Pollution case studies.

Unit 6: Environmental Policies & Practices

MANDATORY COURSES

Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.

Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; International agreements; Montreal and Kyoto protocols and conservation on Biological Diversity (CBD). The Chemical Weapons Convention (CWC).

Nature reserves, tribal population and rights, and human, wildlife conflicts in Indian context

Unit 7: Human Communities and the Environment

Human population and growth: Impacts on environment, human health and welfares.

Carbon foot-print.

Resettlement and rehabilitation of project affected persons; case studies.

Disaster management: floods, earthquakes, cyclones and landslides.

Environmental movements: Chipko, Silent valley, Bishnios of Rajasthan.

Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.

Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Unit 8: Field work

Visit to an area to document environmental assets; river/forest/flora/fauna, etc.

Visit to a local polluted site – Urban/Rural/Industrial/Agricultural.

Study of common plants, insects, birds and basic principles of identification.

Study of simple ecosystems-pond, river, Delhi Ridge, etc.

Suggested Readings:

1. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R.1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
3. Gleeson,B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
4. Gleick, P.H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J. Gary K. Meffe, and Carl Ronald carroll. Principles of Conservation Biology.Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.
7. McCully, P.1996. Rivers no more: the environmental effects of dams(pp. 29-64). Zed Books.
8. McNeil, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
9. Odum, E.P., Odum, h.T. & Andrews, J.1971. Fundamentals of Ecology. Philadelphia: Saunders.

MANDATORY COURSES

10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M.L. 2001. Environmental law and policy in India. Tripathi 1992.
14. Sengupta, R. 2003. Ecology and economics: An approach to sustainable development. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.
17. Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.
18. Warren, C.E. 1971. Biology and Water Pollution Control. WB Saunders.
19. Wilson, E.O. 2006. The Creation: An appeal to save life on earth. New York: Norton.
20. World Commission on environment and Development. 1987. Our Common Future. Oxford University Press.
21. www.nacwc.nic.in
22. www.opcw.org

MANDATORY COURSES

HUMAN RIGHTS (UGC Mandatory Course -Self Study)

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VIII/II	26UPPGC1H01	100	-	-	-	-	1

Course Objective

To impart the basic ideas about Human Rights at post graduations level. This paper provides different aspects of human rights which includes children and women. Students can learn not only their basic rights but also can understand the duties to be carried out in the days to come.

Unit I: Introduction to Human Rights

Human Rights: Meaning Definitions – Origin and Growth of Human Rights in World – Need and types of Human Rights – Constitutional Provision for Protection of Human Rights – UNHRC (United Nations Human Rights Commission).

Unit II: Classification of Human Rights

Right to Liberty – Right to life – Right to Equality – Rights to Dignity – Right against Exploitation – Right to work – Right to Personal Freedom – Right to Freedom of Expression – Right to Education – Right to information – Right to Clean Environment.

Unit III: Rights of Women and Children

Rights of Women – Gender Equity – Female Feticide and Infanticide and Sex Selective Abortion – Physical Assault and Sexual Harassment – Domestic Violence – Violence at Work Place – Right for Equal Pay – Remedial Measures.

Rights to Children – Protection of Rights – Survival Rights – Participation Rights – Development Rights – Role of UN Convention on Rights of Children.

Unit: IV: Multi – Dimensional aspects of Human Rights

Labour Rights – Bonded Labour – Child Labour – Contract Labour – Migrant Labour – Domestic Women Labour – Rights of Ethnic Refugees – Problems and Remedies – Role of Trade Union in protecting the Rights of Labourers.

Unit V: Grievance and Redressal Mechanism

Redressal Mechanisms at National and International Levels – Structure and Functions of National and State level Human Rights Commission – Rights to Information Act, 2005 – Formation of UNO, Universal Declaration of Human Rights, 1948 – Human Rights Act, 1993 – Constitutional Remedies and Directives Principles of State Policy.

MANDATORY COURSES

References:

1. Baradat Sergio and Swaronjali Ghosh. Teaching of Human Rights : Dominant Publishers and distributors, New Delhi,2009.
2. Roy A.N. Human Rights Achievements and challenges : Vista international Publishing house, Delhi, 2005.
3. Asish Kumar das and Prasant Kumar Mohanty. Human Rights in India: Sarup and Sons. New Delhi. 2007.
4. Bani Borgohain. Human Rights Social Justice and Political Challenge. Kaniska Publishers and distributors New Delhi,2007
5. Velan, G.Human Rights and Development Issues: The associated publishers, Ambala cantt.2008.
6. Meena, P.K.Human Rights theory and practice: Murali Lal and Sons, New Delhi, 2008.
7. Bhavani Prasad Panda. Human Rights Development and environmental law: Academic excellence, Delhi,2007.
8. Vishwanathan. V.N.Human Rights – Twenty First Century Challenges: Kalpaz Publications, New Delhi,2008.
9. Ansari, M.R. Protecting Human Rights: Max Ford Books, New Delhi, 2006.
10. Rao, M.S.A. Social Movements in India – Social Movements and Social Transformation in India Vol.1 & 2: Manohar publications, New Delhi.1978.

MANDATORY COURSES

PEACE EDUCATION (UGC Mandatory Course -Self Study)

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IX/III	26UPGEN1V01	100	-	-	-	-	1

Learning Objectives

After completing this course, the student teacher will be able to

- Acquire the knowledge of Nature, concepts, aims and objectives of peace education.
- Narrate the developments in peace education in India and Abroad.
- Acquire the knowledge of Education for peace.
- Develop skill to integrate peace education in the present curriculum.
- Understand dimensions of culture of peace.
- Understand the suitable methods of teaching peace education.
- Understand the models of Conflict Resolutions.

Course Content :

UNIT-I Peace Education

Peace education – Meaning, Definition, Concepts, Scope; Aims and objectives– at different level of Education - its relevance to the present global scenario; Human Miseries in the Modern World and Quest for Peace - Understanding Peace in the individual, social and international context, Gandhian concept of peace - Approaches to peace, Balance of Power, Establishment of Institutions, Pacifism and Education.

UNIT-II Historical Development of Peace Education

Historical Development of Peace Education in the world - Creation of United Nations, UNESCO, UNICEF, UNO-UNDP (United Nation Development Programmes), UNEP (United Nation Environment Programmes), UNHCR (United Nation High Commissioner for Refugees High Commissioner for Human Rights). Amnesty International –International Committee of Red cross –NGOs; Peace Education in India and its development. Gandhiji's contributions to peace movement: Non – Violence, Non – Aligned Movement– Nuclear Disarmament -Arms Reduction.

UNIT-III Education for peace

Paradigm shift from Peace Education to Education for Peace - Concept and Meaning of Education for Peace - Curriculum Development: Stage specific Approach – Early childhood, Elementary Stage, Secondary Stage, Higher Secondary Stage, Higher Education stage and Adult Education stage.

UNIT-IV Integrating Peace Education in the curriculum

Major Media of Integration: Subject context, subject perspectives, Curricular and Co – Curricular activities, staff development, Class room and School management.

UNIT-V Promoting Culture Of peace

Culture of peace – Focal areas – Fostering culture of peace through education promoting inner peace, understanding, tolerance, solidarity – Participatory Communication – democratic participation, gender equality – sustainable Economic and Social development – Non – Violence, International peace and security.

MANDATORY COURSES

UNIT-VI Pedagogy of Education for Peace

Teaching Methodologies - Enquiry method, Value clarification, Jurisprudential model of Teaching, Role playing, Dramatics and Literacy Activities, Yoga and Meditation, Sports and Games, Counseling. Teacher Education for Peace - Teacher as a Role Model.

UNIT-VII Conflict Resolution

Bases of conflicts – Positive and negative aspects of conflicts – Types of conflicts – Conflict Resolution – Conflict Management; Model of Conflict Resolution: Dual Concern Model: A Concern for self (assertiveness), A Concern for others (empathy); Styles: Avoidance conflict – yielding conflict, competitive conflict – co-operation conflict, conciliation conflict. Thomas and Kilmann's style – Competitive, collaborative, compromising – Accommodating, Avoiding.

Mode of Transaction: Lecture, Discussion, Demonstration, Field Trip, Presentation by students, Online Mode: Google Meet, Zoom, WebEx.,

Course Outcomes:

After completing this course, the student teacher has attained the ability to

- Acquire the knowledge of Nature, concepts, aims and objectives of peace education.
- Narrate the developments in peace education in India and Abroad.
- Acquire the knowledge of Education for peace.
- Develop skill to integrate peace education in the present curriculum.
- Understand dimensions of culture of peace.
- Understand the suitable methods of teaching peace education.
- Understand the models of Conflict Resolutions

REFERENCE

- Bernard Jessie., (1957). The Sociological study of conflict” International sociological Association, The Nature of conflict, UNESCO Paris.
- Barash, P. David (2000). Approaches to Peace, Oxford University Press, New York. Galtung, Johan, (1984). The Struggle for Peace Gujarat Vidyapith, Ahmedabad.

Recommended SWAYAM Courses

RECOMMENDED LIST OF SWAYAM COURSES

MOOC- I & MOOC- II-(Mandatory Course-Self Study)

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V& VII/I	26UPEVS2MO1& 26UPEVS2MO2/ 26UPEVS1MO1	100	-	-	-	-	1 & 2

S No	Course	Institution/ Instructor	Duration	Relevance
1	Environmental Science	IIT Kharagpur	12 Weeks	Comprehensive environmental science course covering sustainability, pollution, climate change, ecology, waste management, and environmental laws.
2	Environmental Impact Assessment	IIT Roorkee	12 Weeks	EIA process, methodologies, public participation, environmental management, and report preparation.
3	Climate Change Science	IISc Bangalore	8 Weeks	Climate system, greenhouse effect, climate modelling, and future climate projections.
4	Fundamentals of Ecology	IISER Pune	8 Weeks	Population ecology, community ecology, ecosystems, biogeochemistry, and Anthropocene ecology.
5	Introduction to Environmental Engineering and Science	IIT Faculty	12 Weeks	Environmental pollution, wastewater treatment, sustainability, circular economy, and green design.
6	Environmental Quality Monitoring and Analysis	NPTEL	12 Weeks	Environmental monitoring techniques, sampling, analysis, and interpretation of environmental data.
7	Climate Hazards and Disaster Mitigation	IIT Indore	8 Weeks	Floods, droughts, heat waves, disaster risk assessment, and mitigation strategies.
8	Sustainable Engineering Concepts and Life Cycle Analysis	IIT Faculty	8 Weeks	Sustainability assessment, Life Cycle Assessment (LCA), industrial ecology, and circular economy.
9	Basic Environmental Engineering and Pollution Abatement	IIT Roorkee	12 Weeks	Air, water, and solid waste pollution control technologies and environmental engineering design.
10	Environment and Development	IIT Guwahati	8 Weeks	Environmental ethics, sustainable development, natural resource management, and policy issues.