PERIYAR UNIVERSITY

Salem-636011

(Reaccredited with 'A^{++}' Grade by the NAAC)

DEPARTMENT OF ENVIRONMENTAL SCIENCE

M.Sc. ENVIRONMENTAL SCIENCE

[Choice Based Credit System (CBCS)]

TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION

OBE SYLLABUS

Effective from the academic year 2023-2024 and thereafter)

M.Sc. ENVIRONMENTAL SCIENCE

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION

OBE REGULATIONS AND SYLLABUS

(*with effect from the academic year 2023-2024 on wards*)

1. Preamble

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

2. General Graduate Attributes

1. Environmental Knowledge

Apply the basic knowledge of environmental components and their interactions and to conceptualize the domains towards environmental protection and to visualize the environmental management perspectives.

2. Critical Thinking Skills

To critically analyze and evaluate the environment related issues and their sustainable management.

3. Research Skills

To improve the research-oriented skills by involving the basic, applied and field- based research works.

4. Problem Solving Skills

To identify, analyze and assess the complex environmental issues and apply the knowledge to resolve the issues.

5. Environmental Management

To improve, undertake and manage environment related works and develop a leadership quality and capacity to manage a team for carrying out assigned tasks.

6. Technical Skills

To acquire and equip with technical knowledge on critical environmental problems and devise technical strategies for the betterment of the environment.

7. Use of Modern Tools

To acquire the knowledge and working experience on modern tools in terms of instrumentation, software and research methods which can be used to assess the environmental quality.

8. Project Management

To manage and coordinate specific environmental tasks or projects and applyspecific principles and methodologies to carryout research projects.

9. Societal and Environmental Concern

To have appealing concern over the environment and its well - being, need to apply the acquired knowledge and skills for the societal upliftment.

10. Individual and Team Work

To develop the skills pertaining to work individually as well as a team in a proposed project work in order to manage the task.

11. Innovation and Entrepreneurship

To apply the acquired skills and knowledge in the field of Environmental Science to initiate small scale start-ups and up scale the process towards entrepreneurship.

3. 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 be able to apply the acquired knowledge inproviding 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.

4. Vision

Create and maintain excellence in Environmental Science and contribute knowledge and effort in bringing up rich posterity in environmental sustainability.

5. Programme Objectives and Outcomes

Programme Educational Objectives (PEOs)

Post graduates of 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 (POs)

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

PO1	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.
PO2	**PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-
PO3	**PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.
PO4	**PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills.
PO5	**PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational
PO6	**PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills
PO7	**PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur.

PO8	**PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society.
PO9	**PO9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and
PO10	**PO10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, and beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem-solving, decision making, and leadership skills that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization toward growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical, and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of society by collaborating with stakeholders for mutual benefit.

6. Candidate's eligibility for admission

Candidates who have passed the B.Sc. Degree in Environmental Science / Life Sciences/ Botany/Agricultural and allied Sciences/Zoology/ Microbiology/ Biotechnology/Biochemistry/Chemistry/Physics/Bioinformatics/HomeScience/Food Science &Nutrition of this University or an Examination of any other University accepted by the Syndicate as equivalent thereto shall be eligible for admission to M.Sc. Degree Course in Environmental Science.

7. Duration of the programme

The duration of the M.Sc. Environmental Science shall be over a period of Two Years from the commencement of the course.

8. CBCS – Structure of the Programme

The programme structure comprises two parts.

Course Component	No. of Courses	Marks	Credits
Part A (Credit Courses)			
Core Courses	11	1100	55
Core Practicals	3	300	9
Elective Courses	4	400	12
NME Courses	2	200	4
Research Project	1	200	7
Internship / Industry Activity	1	100	2
Skill Enhancement Course /Professional Competency Skill	1	100	2
Fundamentals of Human Rights	1	100	1
Credit Seminar	1	50	1
Extension Activity	1	50	1
Total		**2600**	**94**
Part B (Non - Credit Courses)			
Value Added /Add-on Courses	2	200	-

9. Curriculum structure for each semester as per course alignment

Main syllabus (Attached as Annexure I)

10. Credit Calculation

Method of teaching	Hours	Credits
Lecture	1	1
Tutorial/Demonstration	1	1
Practical/Internship/Self-Learning	2	1

CBCS– Scheme of Examinations (Semester-wise structure)

S. No.	Paper type	Paper Code	Title of the Paper	T/L	Credit	Hours /Week	Internal Marks	External Marks	Total Marks
SEMESTER - I									
1	Core I	23UPEVS1C01	Principles of Ecology	T	5	6	25	75	100
2	Core II	23UPEVS1C02	Environmental Pollution	T	5	6	25	75	100
3	Core III	23UPEVS1C03	Environmental Chemistry	T	5	6	25	75	100
4	Core Practical I	23UPEVS1L01	Lab-I: Ecological Methods, Environmental Pollution and Environmental Chemistry	L	3	6	40	60	100
5	Elective I	23UPEVS1E01	Disaster Management	T	3	4	25	75	100
		23UPEVS1E02	Environmental Laws and Policies						
			Library			2			
Sub Total					**21**	**30**	**140**	**360**	**500**
SEMESTER - II									
6	Core IV	23UPEVS1C04	Environmental Microbiology	T	5	5	25	75	100
7	Core V	23UPEVS1C05	Environmental Biotechnology	T	5	5	25	75	100
8	Core VI	23UPEVS1C06	Environmental Toxicology	T	5	5	25	75	100
9	Core Practical II	23UPEVS1L02	Lab-II: Environmental Microbiology, Biotechnology and Toxicology	L	3	6	40	60	100
10	Elective II	23UPEVS1E03	Bioremediation	T	3	4	25	75	100
		23UPEVS1E04	Biodiversity and Conservation						
11	NME I	23UPEVS1N01	MOOC/SWAYAM	T	2	3	25	75	100
12	Human Rights	23UPPGC1H01	Fundamentals of Human Rights	T	1	2	25	75	100
Sub Total					**24**	**30**	**190**	**510**	**700**

SEMESTER – III									
13	Core VII	23UPEVS1C07	Biostatistics & Research Methodology	T	5	5	25	75	100
14	Core VIII	23UPEVS1C08	Remote Sensing & GIS	T	5	6	25	75	100
15	Core IX	23UPEVS1C09	Environmental Impact Assessment	T	5	6	25	75	100
16	Core Practical III	23UPEVS1L03	Lab-III: Biostatistics, Remote sensing and GIS and EIA	L	3	6	40	60	100
17	Elective III	23UPEVS1E05	Instrumentation & Analytical Techniques	T	3	4	25	75	100
		23UPEVS1E06	Environmental Education						
18	NME II	23UPEVS1N02	Ecology and Environment	T	2	3	25	75	100
		23UPEVS1N03	Environmental Health and Safety						
		23UPEVS1N04	Environmental Pollution						
		23UPEVS1N05	Global Environmental Issues						
19	Internship	23UPEVS1I01	Internship/Industry Activity		2	-	-	100	100
Sub Total					**25**	**30**	**165**	**535**	**700**
SEMESTER – IV									
20	Core X	23UPEVS1C10	Occupational Health Hazards & Industrial Safety	T	5	5	25	75	100
21	Core XI	23UPEVS1C11	Climate Change	T	5	6	25	75	100
22	Project	23UPEVS1P01	Project work with Viva Voce	P	7	10	50	150	200
23	Elective IV	23UPEVS1E07	Natural Resource Management	T	3	4	25	75	100
		23UPEVS1E08	Microbial Enzyme Technology						
24	Skill	23UPEVS1S01	Skill Enhancement Course /Professional Competency Skill	T	2	3	25	75	100
25	Credit Seminar	23IPEVS1CS1	Credit Seminar		1	1	50	-	50
26	Extension	23UPEVS1X01	Extension Activity		1	1	50	-	50
Sub Total					**24**	**30**	**250**	**450**	**700**
					94		**745**	**1855**	**2600**

11. Examinations

Examinationsareconductedinsemesterpattern.TheexaminationfortheSemesterI &III will be held in November/December and that for Semesters II and IV will be in the month of April/May. Candidates failing in any subject (both theory, practical, and skill) will be permitted to appear for such failed subjects in the same syllabus structure at subsequent examinations within the next 5 years. Failing this, the candidate has to complete the course in the present existing syllabus structure.

12. Scheme for Evaluation and Attainment Rubrics

Evaluation will be done on a continuous basis and will be evaluated four times during the course work. The first evaluation will be in the 7th week, the condinthe11th week, thirdinthe16th week and the end–semester examination in the19th week. Evaluation may be by objective type questions, short answers, essays or a combination of these, but the end semester examination is a university main examination with a prescribed question paper pattern.

Attainment Rubrics for Theory Courses

Internal *(Max. Marks- 25)*

Attendance	Seminar	Assignment	Cycle Test	Total
5	5	5	10	25

External *(Max. Marks- 75)*

Question Paper Pattern *(Theory)*

Section	Approaches	Mark Pattern	K Level
A	One Word (Answer all questions)	20x 1=20 (Multiple Choice Questions)	K1&K2
B	100to 200words (Answer any three out of five questions)	3x 5=15 (Analytical type questions)	K3&K4
C	500to 1000words	5x 8=40 (Evaluation and Creativity type questions)	K5&K6

Attainment Rubrics for Lab Courses

Internal *(Max.Marks-40)*

Attendance	Practical Test	Periodical Performance/Observation	Total Marks
5	25	10	40

External (*Max. Marks- 60)*

Major Experiment	Minor Experiment	Spotters	Record	Viva-Voce	Total Marks
20	15	15	5	5	60

Attainment Rubrics for Research

Internal b *(Max. Marks - 50)*

Periodical Review and Results Presentation	50Marks

External *(Max. Marks - 100)*

Viva-Voce Presentation	25Marks
Dissertation	75Marks

Research Seminar:

Internal Seminar 4 - Weeks	25Marks
Final Seminar	25Marks

Passing Minimum

- There shall be no Passing minimum for Internal.
- For External Examination, the passing minimum shall be of 50% (Fifty Percentage)of the maximum marks prescribed for the paper.
- In the aggregate (External + Internal) the passing minimum shall be of50% for each Paper/Practical/Project and Viva-Voce.
- Grading shall be based on overall marks obtained (Internal + External).

13. Grading System

Performance evaluation of students is based on a ten-point scale grading system as given below:

Ten Point Scale			
Grade 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-appear
ABSENT	0.0	AAA	ABSENT

Core Paper - I

PRINCIPLES OF ECOLOGY

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
I	23UPEVS1C01	100	6	6	-	5

Objectives

- This course is to make the students to understand the basic information about the earth and environment.
- They will also learn about the interactions between the components of our environment, ecology and also about environmental issues and its sustainability.

Course Outcomes	
On the successful completion of the course, students will be able to	
CO1	Understand the scope and principles of ecology, human settlements and biosphere
CO2	Know about biomes, habitats and their diversity
CO3	Understand the different environmental compartments, structure functions in the ecosystem and community ecology.
CO4	Understand the basic principles of population ecology and their interactions
CO5	Adequate knowledge on the concepts and applications of environmental microbiology

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*						*	
CO2	*				*			
CO3	*			*				
CO4	*		*			*		*
CO5						*		*

Core Paper - I

PRINCIPLES OF ECOLOGY

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
I	23UPEVS1C01	100	6	6	-	5

Unit-I

Definition, principles and scope of ecology, human ecology and human settlements, evolution, origin of life and specification, Ecosystem stability - cybernatics and ecosystem regulation, Concept of Ecosphere and Biosphere, evolution of biosphere **(K1, K2, K3)**

Unit-II

Biomes and Habitat, Classification of biomes - Tundra, Taiga, Grassland, Desert, Evergreen and deciduous forests, Tropical rain forests and their characteristics, flora and fauna; Classification of Aquatic Habitats - Freshwater pond, Wetlands, Beels, Rivers - their characteristics, flora and fauna; Mearine Habitats - Pelagic, Benthic, Inter-tidal Estuarine; Mangroves - their characteristics, flora and fauna. **(K1, K2, K3, K4)**

Unit- III

Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, biogeochemical cycles, Community Ecology: Definition and concept of community, community diversity, structure, dominance, stratification and periodicity. Ecads and ecotypes, Edge effect and Ecological Niche, ecological succession - characteristics, types of succession, concept of climax, Significance of succession. **(K1, K2, K3, K4)**

Unit-IV

Population ecology - density, natality, mortality, survivorship curves, age

distribution, growth curves and models, r & k selection, population interactions- Neutralism, symbiosis, commensalism, Mutualism, antagonism, antibiosis, Parasitism, Predator-Prey relations, Competition - intra-specific and inter-specific, System Theory and Ecological Model. **(K1, K2, K3, K4, K5)**

Unit-V

Environmental Microbiology – concept and definitions; microbes in agriculture-soil microorganism and their functions, biological nitrogen fixation, bio-fertilizers, mycorrhiza; coastal management, criteria employed for disposal of pollutants in marine ecosystem, coastal water system and man-made reservoirs, biology and ecology of reservoirs. **(K1, K2, K3, K4, K5)**

Reference and Textbooks:

Eugene P. Odum (2017). Ecology. Oxford and IBH Publishing Co. Pvt. Ltd.

Manuel Molles (2015). Ecology: Concepts and Applications. 7th Edition. McGraw-Hill Education.

Pratibha Singh, Anoop Singh & Piyush Malaviya (2009). Text Book of Environment & Ecology-Excel Publishers.

Rana S.V.S. (2009). Essentials of Ecology and Environmental Science. Prentice Hall Publishers Ltd.

Sharma P.D. (2012). Ecology and Environment. Rastogi Publications.

Core Paper - II

ENVIRONMENTAL POLLUTION

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
I	23UPEVS1C02	100	6	6	-	5

Objectives

- To get deeper insights into fundamentals of water, air and soil pollution, monitoring and analysis of environmental pollution
- To realize, monitor and analyse the impacts of pollution, environmental problems and its control measures.

Course Outcomes

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

CO1 Learn about the air pollution sources, effects and its control techniques
CO2 Understand the sources of water pollution, its types, effects and its prevention measures
CO3 Acquire knowledge on soil pollution, its impacts over environment and its remediation techniques
CO4 Understand the problems of all kinds of wastes and its management
CO5 Know about various environmental disasters and its environmental impacts

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*				*			*
CO2		*				*		
CO3		*				*		*
CO4				*				
CO5	*				*		*	

Core Paper - II

ENVIRONMENTAL POLLUTION

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
I	23UPEVS1C02	100	6	6	-	5

Unit-I

Concepts of atmosphere and Air Pollutants (Sources and classifications - indoor, vehicular, industrial and other sources). Meterological aspects of Plume and stack dispersion, Chemical reactions of air pollution (Formation of fog and smog, acid rain). Ozone depletion - Montreal protocol; Global warming - Kyoto protocol. Air quality standards, Monitoring of air pollution (Ambient air quality monitoring, Stack monitoring; PM 10 and PM 2.5) - Cleaner technologies (Settling chamber, Cyclones, Fabric filter, Electrostatic precipitator, Wet scrubber, Control of gaseous pollutants absorption, adsorption and combustion recovery system) - online monitoring of pollution**. (K1,K2,K3,K4,K5,K6)**

Unit-II

Properties of water; physiochemical and bacteriological properties of water, drinking waterquality standards; Water pollution- Classification (ground water, river, Marine) sources and sinks, Eutrophication. Control measures of water pollution (adsorption, flocculation, ion exchange and reverse osmosis). Preventive measures in industries to avoid water pollutions (End of pipe treatments and its alternatives, online monitoring and treatment of industrial effluents). **(K1,K2,K3,K4,K5,K6)**

Unit-III

Soil pollution; Definition; broad classification, Sources and broad classification of pollution (e.g. urban areas, industrial areas, agriculture and livestock, landfills, sewage sludge, municipal solid waste dumps and hazardous waste), Soil quality and their impacts on physio-chemicalandbiologicalpropertiesofsoilandplants,SedimentPollution - Black carbon - Soil pollution control measures - On site (in situ) chemical, physical, soil vapour extraction, soil washing solidification/stabilization, electro-kinetic remediation thermal and biological methods. Off site (ex-situ, on-site and off-site): chemical methods, Physical solidification / stabilization / immobilization,

thermal, and biological (bioremediation and phytoremediation), Biostimulation, Bioaugmentation, Isolation Containment of the affected area. **.(K1,K2,K3,K4,K5,K6)**

Unit -IV

Concepts and types of municipal and Hazardous Solid Wastes (Hospital Wastes, Radioactive Wastes, industrial), Transport and waste minimization techniques (Disposal, leachate and land fill gas management Nuclear reactor safety). Legislation on management and handling of municipal solid wastes and hazardous wastes Light pollution and control measures; and Thermal pollution and control measures. Noise pollution - Sensing, Measurement, Abatement measures. **(K1,K2,K3,K4,K5)**

Unit-V

Evaluation of Industrial Disasters and Pollution - Case studies - Chemical Industries - Pesticide Industries, Bhopal Disaster, Chernobyl accident, Love canal Disaster, Oil Disasters - Exxon, British Petroleum - Gulf of Mexico; e- wastes, Impact and Remedial Measures. **(K1,K2,K3,K4)**

Reference and Text books:

Ahluwalia V.K. (2014). Environmental Pollution and Health.

TERI. (2020). The Energy and Resources Institute, Environmental Pollutionand Management. IK International Publishers Ltd.

Gupta O.P. (2019). Elements of Environmental Pollution Control. Khanna Publication.

Mark Brusseau, Ian Pepper, Charles Gerba. (2019). Environmental and Pollution Science, 3rd Edition, Academic Press

Rao. C.S. (2018). Environmental Pollution Control Engineering. 3rd Edition.New Age International Publication.

Shafi, S.M. (2005). Environmental Pollution. Atlantic Publishers and Distributors.

Core Paper - III

ENVIRONMENTAL CHEMISTRY

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
I	23UPEVS1C03	100	6	6	-	5

Objectives

- The course introduces the concept and scope of environmental chemistry including soil chemistry, chemical composition of air and water treatment technologies.
- The course also develop an understanding of basics of chemistry in relevance to environment and such as, solutions preparation, chemical reactions and their effects on the environment, to provide students with an understanding of the fundamental chemical processes occurred on environment.

Course Outcomes	
On the successful completion of the course, students will be able to	
CO1	Have knowledge of basic theories and problems of Environmental Chemistry.
CO2	Describe important chemical reactions and cyclic processes of chemical species in the atmosphere.
CO3	Demonstrate knowledge of thermodynamics, chemical equilibrium, and environmental physico-chemical processes
CO4	Understand the water pollutant chemistry and water treatment methods.
CO5	Analyze chemical processes involved in soil and know the different types of toxic, hazardous substances.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							*
CO2		*				*		
CO3		*				*		*
CO4		*						
CO5		*	*	*		*		*

Core Paper - III

ENVIRONMENTAL CHEMISTRY

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
I	23UPEVS1C03	100	6	6	-	5

Unit-I

Concept and scope of Environmental Chemistry; acid-base reactions, Stoichiometry, Gibb's energy, Chemical potential, Chemical equilibria, acid-base reactions. Solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, Radionuclides. **(K1,K2,K3,K4)**

Unit-II

Classification of elements, chemical speciation, Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermochemical and photochemical reactions in the atmosphere. **(K1,K2,K3,K4,K5)**

Unit- III

First law of thermodynamics, enthalphy, adiabatic transformations, second law of thermodynamics, Carnot's cycle, entropy, Gibb's free energy, chemical potential, phase equilibria, Gibb's Donnan equilibrium, third law of thermodynamics, enzymes catalysis, Michaelis/Mentenequation.

Unit -IV

Oxygen and ozone chemistry, Chemistry of air pollutants, Photochemical Smog Chemistry of water, concept of D.O., B.O.D., and C.O.D, water treatment: Sedimentation, Coagulation, Filtration, tertiary and advanced treatment, redox potential. **(K1,K2,K3,K4)**

Unit-V

Soil Chemistry-Chemical and mineralogical composition of soil, Physical properties of soil - texture, bulk density, permeability; Chemical properties -

cation exchange capacity, pH, macro and micronutrients. Chemical compounds-detergents and bleaching agents, Hydrocarbons, PAH, PCBs, chlorofluorocarbons, pesticides. **(K1,K2,K3,K4)**

Reference and Textbooks:

Balram Pani, (2007). Text Book of Environmental Chemistry, I.K. International Publishing House PVT. Ltd.

Dara S, Mishra D.D, (2006). A Textbook of Environmental Chemistry and Pollution Control. S. Chand Publication.

Gary W. Van Loon, Stephen J. Duffy, (2017). Environmental Chemistry: A global perspective. 4th Edition. OUP Oxford.

Girard J.E. (2015). Principles of Environmental Chemistry.

Julian E. Andrews, Peter Brimblecombe, Tim D. Jickells, Peter S. Liss, Brian Reid, (2013). An Introduction to Environmental Chemistry. Wiley-Blackwell Publication.

Rao, C.S, (2018) Environmental Pollution Control Engineering, 3rd Edition, New Age International (P) Ltd Publishers.

Elective Paper - II

DISASTER MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
I	23UPEVS1E01	100	4	4	-	3

Objectives

To understand basic concepts in Disaster Management & mitigation, Definitions and Terminologies used in Disaster Management, understand various types of Disasters and to understand Impacts of Disasters and Risk Management.

Course Outcomes

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

CO1 Develop an understanding of the different types of hazards and disaster-prone zones
CO2 Develop a basic understanding of prevention, mitigation, preparedness, response and recovery
CO3 Develop disaster assistance tools and disaster preparedness
CO4 Understand the disaster relief and recovery measures
CO5 Acquire knowledge of capacity building and institutional framework for disaster management

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*					*	*	*
CO2	*					*	*	*
CO3					*	*	*	*
CO4						*	*	*
CO5	*					*	*	*

Elective Paper - II

DISASTER MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
I	23UPEVS1E01	100	4	4	-	3

Unit-I

Definition - Hazards as natural process - Benefits and importance of disasters Nature disaster - creeping disaster- creeping disaster - Death and Damage - Evaluating hazards - Human response to hazards. Changes in Coastal zone, coastal erosion, beach protection. Coastal erosion due to natural and manmade structures**. (K1, K2, K3, K4)**

Unit-II

Major threats to coastal ecosystem - Habitat loss - Landslides-Sea level change, Degradation of water quality, Fisheries resource depletion, Earth quakes, Tsunami, Volcanic activity, Coastal flooding, Cyclones, Erosion, Sea water intrusion, Cause and preventive measures. Impact on Environment Forecasting and Warning System - Disaster Profile of India. **(K1, K2, K3, K4, K5)**

Unit-III

Disaster Management. Predisaster Planning - Toning of Disaster - prone areas - prioritization -regulations - protection measures during disaster and Post disaster. Relief Camp Organization - Survey and Assessment. Disaster Management Cycle - Vulnerability Analysis - Disaster Training - Legal Aspects - case studies for disasters and management. Technology for Disaster Management-Role of Information and communication technology, GPS, Remote sensing and Geographic Information system in Disaster Management**. (K1, K2, K3, K4, K5, K6)**

Unit - IV

Disaster Preparedness and Training. Community Preparedness in Natural Disasters-Role of information, education, communication and training-Rolesand responsibilities of different national and international agencies and government - NGO, Armed forces, Paramilitary forces, Community based organizations (CBO) - Army Training for Disaster Reduction - Role of team and co-ordination - Training needs. **(K1, K2, K3, K4, K5, K6)**

Unit V

Mitigation Strategies: Disaster Mitigation - emerging trends in disaster management - Undraft resolution on Strengthening of Coordination of Humanitarian Emergency Assistance, International Decade for Natural Disaster Reduction (IDNDR), Policy for disaster reduction, problems of financing and insurance. Training for emergency. Regulation/guidelines for disaster tolerance building structures. **(K1, K2, K3, K4, K5, K6)**

Reference and Textbooks:

David R. Godschalk, Natural Hazard Mitigation: Recasting Disaster Policy and Planning (Editor), Timothy Beatley, Phillip Berke, David J. Bowe, Edward J. Kaiser Charles C. Bohl, R. Matthew Goebel, Island press: (January 1999), ISBN 1559636025.

Natural Disaster Management, Tudor Rose, 6 Friar Lane Leicester LE15RA United Kingdom. Jeff Groman (2002). The Atlas of Natural Disasters by (Author) Publisher: Friedman/Fairfa Publishing; (March 2002).

Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.

Sharma, R.K. & Sharma, G. (2005) (ed) Natural Disaster, APH Publishing Corporation, New Delhi

Carter, N. W. Disaster Management: A disaster Manager's Handbook, Asian Development Bank, Manila. (1992).

Gautam Ashutosh 1994. Earthquake: A Natural Disaster. Ashok Publishing House. New Delhi.

Singh R. B. 2006 Natural Hazards and Disaster Management; Vulnerability and Mitigation. Raw at Publications.

Jochen Zschau, Andreas N. Kuppers (2003). Early warning Systems for Natural Disaster Reduction. Springer-Verlag, Berlin Heidelberg.

Elective Paper - II

ENVIRONMENTAL LAWS AND POLICIES

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
I	23UPEVS1E02	100	4	4	-	3

Objectives

To impart knowledge about environmental laws, regulations and policies of India and international environmental laws.

Course Outcomes	
On the successful completion of the course, students will be able to	
CO1	Understand environmental legislation and policies of National and International regime.
CO2	To learn about environmental planning concepts and international environmental issues
CO3	To develop basic understanding of Indian constitution and its fundamentals
CO4	Have an insight into major acts and rules applicable for pollution control and natural resource conservation
CO5	Apply the legislation concepts for solving the local environmental problems.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1				*		*		
CO2				*				
CO3						*		*
CO4				*		*		
CO5						*		

Elective Paper - II

ENVIRONMENTAL LAWS AND POLICIES

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
I	23UPEVS1E02	100	4	4	-	3

Unit-I

International environmental policy - environmental problems and their impact on the international system, the instruments of international environmental policy - Transnational environmental policies - the Indus River basin, the Ganga-Brahmaputra River basin system**. (K1,K2,K3)**

Unit-II

Environmental planning - concepts and approaches and strategic of environmental planning and management. International Environmental laws. Necessity for International Environmental Court. United Nations Environment Programme [UNEP] role on international environment laws. Case studies for International environmental disputes. **(K1,K2,K3,K4)**

Unit- III

Constitutional and legislative provisions: constitutional provisions and the environment, environmental protection and fundamental rights, judicial remedies and procedures, Tort law, public nuisance, the writ jurisdiction, statutory remedies, public interest litigation, Class action, freedom of information and the right to know. **(K1,K2,K3,K4)**

Unit-IV

Indian legislation to protect the environment: The Water Act of 1974, The Water Cess act of 1977, The Wildlife Act of 1972, the Air Act of 1981, The public Liability Insurance Act of 1991, the Natural Environmental Tribunal Act of1995, the national environment appellate authority act of 1997, the mines and

minerals act of 1957. Case studies one each in the protection of forests, rivers, and wildlife. **(K1,K2,K3,K4,K5)**

Unit-V

The Indian Forest Act of 1927, the forest (conservation) act of 1968, The atomic energy act of 1962, The factories act of 1948. The environmental protection act of 1986, The national environment appellate authority act of 1997. The forest conservation act 1980, The wildlife protection act 1972 (2002 amendment), Plastics Waste management Rules 2015. **(K1,K2,K3,K4,K5)**

Reference and Textbooks:

Gurudeep Singh (2005). Environmental law in India - McMillan, New Delhi.

Shyam Diwan and Armin Rosencrany, 2001, Environmental law and policy in India, Oxford University Press, New Delhi.

Pollution Control Legislations, Vol. I and II, 1999, Tamil Nadu Pollution Control Board, Chennai.

Nath B., Hens, L., Compton, P and D. Devuyst (1998), Environmental Management in Practice, Vol I, Routledge, London and New York.

The ISO 14000 Handbook: Joseph Cascio. ISO 14004 - Environment l management systems: General guidelines on principles, systems andsupporting techniques (ISO 14004: 1996 (E). ISO 14001: Environmental management systems: Specification with guidance for use (ISO 14001: 1996b (E)). (International organization for standardization - Switzerland).

Core Paper - III

(Practical -I)

Lab-I: ECOLOGICAL METHODS, ENVIRONMENTAL POLLUTION AND ENVIRONMENTAL CHEMISTRY

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
I	23UPEVS1L01	100	6	-	6	3

Objectives:
The course demonstrates concepts in modern ecology, methods to analyze pollution and environmental applications.

Course Outcomes	
On the successful completion of the course, students will be able to	
CO1	Understand the basic practical procedures for ecology and field studies
CO2	Know the concept of data collection and sampling methods
CO3	Learn to do the basic water and air quality experiments
CO4	Acquire knowledge in determining the pollution indicators
CO5	Have basic understanding of environmental quality parameters

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*				*			*
CO2		*			*	*		
CO3		*				*		*
CO4		*			*			
CO5		*	*	*		*		*

List of Practical:

1. Biotic and Abiotic Component Assessment
2. Primary productivity of an aquatic ecosystem
3. Estimation of GPP and NPP
4. Field Survey and Sampling Methods
5. Ecological Data Collection
6. Ecological Data Interpretation and Presentation
7. Air Pollution Monitoring Techniques - SPM, Gaseous Pollutants.
8. Measurement of noise at different locations.
9. Soil sampling techniques and devices
10. Selection of sampling sites and collection of methods of samples
11. Determination of EC, turbidity, odour and colour in water
12. Determination of TS, TDS and TSS in water
13. Determination of Acidity and alkalinity in water
14. Determination of DO, BOD, COD and pH in water
15. Determination of Hardness in portable water **(K3,K4,K5,K6).**

Reference and Textbooks:

Barani Tharan Balamurali. S. (2016). Environmental Engineering Laboratory Manual: Create space Independent Publishing Platform.

Khopkar. S.M. Environmental Pollution Analysis. New Age International (P) Ltd., Publication.

Darrell S. Vodopich. (2009). Ecology Lab Manual. McGraw Hill.

Gopalan R (2020). A Laboratory Manual for Environmental Chemistry. Dream tech Press.

Core Paper - IV

ENVIRONMENTAL MICROBIOLOGY

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
II	23UPEVS1C04	100	5	5	-	5

Objectives

This course is designed to provide a basic understanding on microbiology and in-depth knowledge of role of beneficial and pathogenic microorganism in environment.

Course Outcomes	
On the successful completion of the course, students will be able to	
CO1	Able to understand about microbes their growth and metabolism
CO2	Understand the microbial diversity and extreme microbial environments
CO3	Understand the role of microbes in biogeochemical cycles, plant growth promotion
CO4	Know about the impact of microbial air and water pollutants and understand the microbial diseases related to the environment
CO5	Apply the microbial processes to clean the environment and to enhance the skill in microbial analysis

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*						
CO2		*						
CO3			*					
CO4			*					
CO5					*			

Core Paper - IV

ENVIRONMENTAL MICROBIOLOGY

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
II	23UPEVS1C04	100	5	5	-	5

Unit-I

Introductory microbiology; Microbiology - organisms in ature & their importance: Classification of microorganisms, Criteria for classification; nutritional types, Scope of Environmental Microbiology; microbial growth and metabolism Microbial metabolism energy production, utilization of energy & Biosynthesis. Role of microbes in human life and environment. **(K1, K2, K3, K4)**

Unit-II

Diversity of environmental microbes - Distribution - microbiology of aquatic environment (fresh, marine and other aquatic environment), microbiology of terrestrial environment. Aeromicrobiology - outdoor and Indoor, aerosols, Adaptation of microorganisms to the air environment; extremophiles (archaebacteria, acidophilic, alkalophilic, thermophilic, barophilic and osmophilic and radiodurant microbes). **(K1, K2, K3, K4, K5)**

Unit III

Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; interspecies microbial interactions, Ecological impacts of microbes, Symbiosis (Nitrogen fixation and ruminant symbiosis); microbial interactions in a biofilm, Plant - Microbe interaction (Beneficial and pathogenic), animal - microbe interactions (Beneficial and pathogenic). Role of Microorganism in Nutrient cycles. **(K1, K2, K3, K4, K5)**

Unit-IV

Bioindicator organisms in Environment-air, water and soil (Bacteria, algae, bacteriophages and other organisms). Standard criteria of indication, Bio-indication of water quality (surface and groundwater) - Coliforms-total coliforms, *E-coli, Streptococcus, Clostridium*, Concentration and detection of

virus. Microbial pathogensis (Human, Animal and Plant health), Transmission of pathogens to higher organisms - Bacterial, Viral, Protozoan, and Helminths, Control of microorganisms. **(K1, K2, K3, K4, K5)**

Unit-V

Microbial Diversity & Systematics Molecular biology methods – Microbial ecology (Metagenomics); Functional and genetic diversity of microbial communities (DNA heterogeneity by reannealing denatured environmental DNA, ARDRA, measuring metabolic capabilities using BIOLOG, microtitreplates, using DNA probes and PCR primers, in-situ hybridization of intact cells). **(K1, K2, K3, K4, K5, K6)**

Reference and Textbooks:

Bertrand, J-C., Caumette, P. and Lebaron, P. (2015). Environmental Microbiology: Fundamentals and Applications: Microbial Ecology, Springer.

Jjemba, P.K. (2004). Environmental Microbiology: Principles and Applications, Science Publishers Inc., Enfield.

Maier, R., Pepper, I. and Gerba, C. (2008). Environmental Microbiology, Academic Press.

Mitchel, R. (2009). Environmental Microbiology, 2nd edition, Wiley-Blackwell.

Mohapatra, P.K. (2008). Textbook of Environmental Microbiology, I.K. International (P)Ltd.

Pepper, I.L., Gerba, C.P. and Gentry, T.J. (2015). Environmental Microbiology, 3rd edition, Academia Press, Elsevier.

Schmidt, T.M. and Schaechter, M. (2012). Topics in Ecological and Environmental Microbiology, 3rd edition, Academia Press, Elsevier.

Uhrig, B. (2017). Environmental Microbiology, Lulu.com Publisher.

Core Paper - V

ENVIRONMENTAL BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
II	23UPEVS1C05	100	5	5	-	5

Objectives

- The course introduces knowledge of biotechnological approaches and techniques for Environmental management and remediation of various environmental pollutants.
- Impart knowledge of biotechnological approaches and techniques for Environmental management and remediation of various environmental pollutants.

Course Outcomes

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

CO1 Understand the principles and methods of DNA manipulation, gene cloning and PCR process
CO2 Understand the basic principles of biodegradation of environmental pollutants
CO3 Understand the resource recovery and related biotechnology methods
CO4 Acquire skills in manipulating the microbes for industrial purposes
CO5 Acquire knowledge on bioethics, biosafety and relevant guidelines

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*		*					
CO2	*	*						
CO3			*					
CO4	*	*	*	*			*	
CO5		*				*		

Core Paper - V

ENVIRONMENTAL BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
II	23UPEVS1C05	100	5	5	-	5

Unit-I

Emerging technology for bioremediation-Restriction endonucleases Recombinant DNA Technology, techniques of vectors-plasmid PBR322 and Lamdaphage, cosmid construction of chimeric DNA, Genomic and cDNA libraries-Polymerase Chain Reaction (PCR) and development of gene probes for environmental remediation: use of genetically altered microorganisms for fieldbiodegradation of hazardous materials. In situ technologies, Ex-situ technologies. Suicide genes. Micro-electromechanical systems (MEMS), Genosensor technology**. (K1,K2,K3,K4,K5)**

Unit-II

Microbial biodegradation-Xenobiotic compounds: Aliphatic, Aromatics, Polyaromatic Hydrocarbons, Polycyclic aromatic compounds, Pesticides, detergents, Surfactants and microbial treatment of oil pollution. Microbial Systems for Heavy Metal Accumulation, Biosorption & detoxificationmechanisms, oil spills, plastic degradation by microbes. Phytoremidiation. **(K1,K2,K3,K4,K5, K6)**

Unit-III

Biotechnology for Resource Management-New Bioremediation Technologies to Remove Heavy Metals and Radio nuclides; Oil field microbiology; Improved oil recovery; Role of environmental biotechnology in resource management - Bioremediation - energy production-mineral and energy recovery, Biosensor Technology for monitoring pollutants-Planning and management of bioremediation and environmental biotechnology processes. **(K1,K2,K3,K4,K5)**

Unit-IV

Industrial Biotechnology - Fermentation Technology - Design of Immobilized Enzyme Reactors-Packed-bed, Fluidized-bed and Membrane reactors - Application and advantages. Applications of Enzymes food, health, and other industries. Design of enzyme electrodes and their application as biosensors in

industry, health care and environment. Agricultural biotechnology-Evolutionin Agriculture-Biotechnology and Sustainable Production. (biofertilizers- Rhizobium, Azolla; Biopesticides - Bt insecticide.) modern agriculture-strategies for engineering herbicide-Resistance environment impact. Advantages and applications of biofertilizers, biopesticides and GM crops. Forestry and Biotechnology-micro-propagation; Somaclonal variations; Induction of genetic variability and heriditability; Conservation of endangered species; Biotechnology in preservation of bio-diversity; In situ and ex situ conservation through gene banks. **(K1,K2,K3,K4,K5, K6)**

Unit-V

Bioethics, Biosafety and IPR-Bioethics-ethical concerns of biotechnology research and innovation of genetically modified plants, animals and microbes, genetically modified food, stem cell research. Potential effect on Environment and Human health by transgenic plants-Risk assessment, regulation and containment - Human genome project - ICMR Ethical Guidelines for Biomedical Research on Human Subjects. Objectives and salient features of Biosafety guidelines and regulations-Rights Intellectual property rights-TRIP-GATT-Plant variety protection. **(K1,K2,K3,K4,K5, K6)**

Reference and Textbooks:

Chatterji A. K (2011). Introduction to Environmental Biotechnology. Prentice HallIndia Learning Private Limited.

Evano, G.H. and Furlong, J.C. (2004), Environmental Biotechnology - Theory and Application, John Wiley and Sons, USA.

Gareth M. Evans, Judith C. Furlong (2012). Environmental Biotechnology - Theory and Application. 2nd Edition.Wiley India Pvt Ltd.

Jjemba, P. K. (2004), Environmental Microbiology - Theory and Application, Science Pub. Inc., USA.

Olguin, C. J., Sanchez, G., Hernandez. E. (2000), Environmental Biotechnology and Cleaner Bioprocesses, Taylor & Francis.

Pepper, I. L. and Gerba, C. P. (2005), Environmental Microbiology - Laboratory Manual, Elsevier, USA.

Ratledge, C. and Kristiansen, B. (2003), Basic Biotechnology, 2nd edition, Cambridge University Press.

Viswanath Buddolla (2017). Environmental Biotechnology: Basic Concepts and Applications. Alpha Science International Ltd.

Core Paper - VI

ENVIRONMENTAL TOXICOLOGY

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
II	23UPEVS1C06	100	5	5	-	5

Objectives

This course is designed to offer an outline on toxicology, including an introduction of the major groups of pollutants, their fate in the environment, their disposition in organisms and their mechanisms of toxicity. The toxicity assessment of pollutants in biological and Environmental systems is also included.

Course Outcomes

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

CO1 Acquire broad knowledge in the field of environmental toxicology and and understand the basic principles, target organ toxicity, and the toxicity of a select group of chemical compounds.

CO2 Synthesize and apply concepts from multiple sub-disciplines in environmental cell biology, biochemistry, and toxicology.

CO3 Use technical and analytical skills to quantify the level of xenobiotics in environmental compartments and their impacts on human health.

CO4 Understand the concepts of systemic toxicology and its effects

CO5 Acquire skills in ecotoxicogenomics and modern omic approaches.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*						
CO2		*						
CO3			*					
CO4			*					
CO5					*			

Core Paper - VI

ENVIRONMENTAL TOXICOLOGY

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
II	23UPEVS1C06	100	5	5	-	5

Unit-I

Introduction to Toxicology and Toxicants: Definition of Toxicology, Toxicity and Toxicants. Classification of toxic agents - natural toxins (Animal, Plant and microbial toxins) and Anthropogenic toxicants (Chemical toxins). Classes of environmental toxicants; Inorganic ions (Metals-Hg, Anions-NO_3), Organic contaminants (Hydrocarbons and PCBs) - Organochlorine insecticides (DDTand Aldrin), Organo phosphorus insecticides (Parathion, Carbomates and Pyrethroids). Detergents, Pharmaceuticals and Personal Care Products**. (K1, K2, K3, K4)**

Unit-II

Entry, Distribution and Mode of Action: Routes of Entry - Inhalation, Absorption, Ingestion, Injection. Biodistribution, Biomagnification and Biotransformation. Types of Toxicity - Acute, Subacute and Chronic. Effects of Toxicants-Short Term and Long term. Dose Response Relationship-LC50, LD50, EC50. OSHA Permissible Exposure Limits (PELS). Mode of Action- Reactions of Toxicants with Target Molecules-Covalent Binding, Non-covalent Binding, Hydrogen Abstraction, Electron Transfer and Enzymatic Reactions.**(K1, K2, K3, K4, K5)**

Unit-III

Systemic Toxicology I: Dermal Toxicants and Effects (Primary Irritation, Sensitization, Photoallergy and Phototoxicity, Cutaneous Cancer). Respiratory Toxicants and Effects - Pulmonary (Irritation, Cellular Damage, Oedema and

Lung Cancer). Hepatotoxicants and Effects - Fatty Liver (Steatosis), Liver Necrosis, Cirrhosis, Cholestasis, Viral like Hepatitis. Nephrotoxicants and their Effects. **(K1, K2, K3, K4, K5)**

Unit-IV

Systemic Toxicology II: Neurotoxicants and Effects (Neuronopathy, Axonopathy). Effect of Toxicants on Reproductive and Cardiovascular System. Endocrine Disrupting Chemicals and their Toxicity. Immunotoxicants - Mechanisms of Immuno-toxicity, Immuno-suppression, Direct and indirect Effects of Toxicants, Immune-Mediated Diseases, (Hypersensitivity and Allergy) **(K1, K2, K3, K4, K5, K6)**

Unit-V

Ecotoxicogenomics, Toxicity Testing and Risk Assessment of Toxicants: Introduction to Toxicogenomics, Toxicoproteomics and Metabolonomics-Modification of DNA, RNA, and Protein Metabolism by Toxicants. Gene Expression Changes by Toxicants - Role of Ecotoxicogenomics for Environmental Monitoring and Toxicant Identification. Toxicity Testing Methods - Microbiol, Algal, Invertebrates and Alternative Toxicity Tests, Animal Management in Toxicological Evaluation - Extrapolation and Ethics. Definition of Risk Assessment, Elements of Risk Assessment - Categories of RiskAssessment - Retroactive and Predictive, Risk Assessor, Risk Manager, Hazard Index, NAS Paradigm and its Components. **(K1, K2, K3, K4, K5, K6)**

Reference and Textbooks:

- Bertrand, J. C, Caumette, P. and Lebaron, P. (2015). Environmental Microbiology: Fundamentals and Applications: Microbial Ecology. Springer publications.
- Walker, C.H., Hopkin, S.P., Sibly, R.M. and Peakall, D.B. (2006). Principles of Ecotoxicology, Third Edition, CRC Press (Taylor & Francis Group).

- Daniel A. Vallero. (2005). Environmental Contaminants-Assessment and Control, Academic Press.
- David J. Hojjman, Barnett A. Rattner, G. Allen Burton, Jr., and John Cairns, Jr. (2000).
- Handbook of Ecotoxicology, CRC Press (Taylor & Francis Group).
- Morton Lippmann. (2000). Environmental Toxicants-Human Exposure and Their Health Effects, John Wiley and Sons Publication.
- Katalin Gruiz, Tams Meggyes and Eva Fenyvesi. (2014). Environmental Toxicology -Engineering Tools for Environmental Risk Management, CRC Press (Taylor & Francis Group).
- Samkacew and Byung-MuLee. (2013). LU's Basic Toxicology (Fundamentals, Target Organs and Risk Assessment), Sixth Edition, CRC Press (Taylor & Francis Group).
- MichaelC.Newman. (2001). Fundamentals of Ecotoxicology, Lewis Publishers.
- Ming-Ho Yu. (2004). Environmental Toxicology - Biological and Health Effects of Pollutants, Second Edition, CRC Press (Taylor & Francis Group).
- Pepper I. L, Gerba C.P and Gentry T. J. (2015). Environmental Microbiology. 3rd Edition, Academia Press.
- Robert Burke. (2000). Hazardous Materials Chemistry for Emergency Responders, Lewis Publishers.
- Schmidt, T. M. and Schaechter, M. (2012). Topics in Ecological and Environmental Microbiology.3rd Edition, Academia Press.
- Wayne. G. Landis, Ming Ho Yu. (2002). 3rd Ed. Introduction to Environmental Toxicology, Lewis Publishers, CRC press, New York.

Elective Paper -III

BIOREMEDIATION

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
II	23UPEVS1E03	100	4	4	-	3

Objectives

As an introduction course, it includes an overview of the bioremediation process; describe the typical bioremediation strategies for contaminated environment; explore the applications of bioremediation technologies; discuss the factors that influence the bioremediation rates; and introduce success cases in the application of bioremediation technology to contaminated sites.

Course Outcomes

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

CO1 Understand the principles, types and factors influencing bioremediation
CO2 Acquire knowledge on bioremediation of inorganic pollutants
CO3 Explore the knowledge on waste utilization and management
CO4 Understand the advanced technologies in bioremediation
CO5 Explore the knowledge related to GEM and transgenics

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*		*			*	*	*
CO2	*		*	*		*	*	*
CO3			*	*	*	*	*	*
CO4			*			*	*	*
CO5	*		*			*	*	*

Elective Paper -III

BIOREMEDIATION

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
II	23UPEVS1E03	100	4	4	-	3

Unit-I

Bioremediation - factors affecting bioremediation, types. Organic pollutants - aerobic andanaerobicdegradationoforganicpollutants-degradationofaliphatic, aromatic, polyaromatic and chlorinated compounds, biotechniques for air pollution batement and odour control - bioscrubbers, biobeds, biotrickling filters, biodeterioration. **(K1, K2, K3, K4)**

Unit-II

Bioremediation of inorganic pollutants - Heavy metals and radionuclides - microbial interaction with metallic elements - molecular mechanism of metal resistance, biosorption and biotransformation of metals and radionuclides, biomining, Nitrate-Nitrification and denitrification-Phosphate-Biological Phosphate removal, Phytoremediation. **(K1, K2, K3, K4, K5)**

Unit-III

Waste utilization and management, Bioplastics, Biosensor technology, Biofuels, Vermitechnology, SCP, Biofertilizer. **(K1, K2, K3, K4)**

Unit-IV

Molecular techniques in bioremediation pathway construction - Biochemical background, Operon deregulation, Vectors, Hybrid pathways and enzymes, Noncatabolic Genes for catabolic pathway construction, Rational enzyme redesign. **(K1, K2, K3, K4)**

Unit-V

GEM - degradative plasmids, promoting GEM survival - implications for bioremediation, preventing GEM survival - suicide contaminant systems - GMOs in food production - transgenic crops - Biosafety - Bioethics - Patents - Patent laws and regulation. **(K1, K2, K3, K4, K5)**

Reference and Textbooks:

Ronaldl. Crawford and Don. Crawford, 1996, Bioremediation - Principles and Applications, Cambridge University Press.

Nuzhat Ahmed, Fouad M. Qureshi and Obaid Y. Khan, 2006 Industrial and Environmental Biotechnology - Horizon Press

Paul. A. Rochelle, 2001 Environmental Molecular Biology, Horizon Press.

Elective Paper - IV

BIODIVERSITY AND CONSERVATION

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
II	23UPEVS1E04	100	4	4	-	3

Objectives

Biodiversity describes the organisms in the natural environment, which provide the ecosystem services that form our natural capital: fresh water, clean air, soil fertility and biological pest control. Biodiversity is fundamental to the future sustainability of the world's natural resources. Conservation of biodiversity, on economic grounds alone, needs to become core business in the management of our natural resources.

Course Outcomes

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

CO1 Understand the relationship between biodiversity and ecosystem functions

CO2 Understand the direct and indirect values of biodiversity resources and their bioprospecting opportunities

CO3 Outline the factors responsible for the threats and loss of global biodiversity

CO4 Understand the various *in situ* and *ex situ* conservation measures and make critical judgments on the conflict between conservation and development

CO5 Know more knowledge about the recent policies and programmes for sustainable management of bioresources and apply the rules and recommendations related to environmental protection

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2		*						
CO3	*					*		*
CO4	*					*		*
CO5	*					*		*

Elective Paper - IV

BIODIVERSITY AND CONSERVATION

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
II	23UPEVS1E04	100	4	4	-	3

Unit-I

Scope and Constraints of Biodiversity Science: Biological Diversity: Species - Origin of new species, Description of new species, Community and ecosystem diversity, Genetic diversity- Systematics in Diversity - Environment and Genetic Variations - Biological Classification - Phylogenetic Relationship - Ecological Biodiversity Species Concept - Biological and Phylogenic Concepts; Species Inventory - Biodiversity hot spots. IUCN categories - Red databook.Case Studies - Deciduous Forests-Desert Lizard communities - Marine and Coral Reef-Fish Communities-Island species - Western and Eastern Ghats - Himalayas. **(K1,K2, K3, K4, K5)**

Unit-II

Species Diversity: Global Distribution of Species - Tropical species diversity - Diversity in terrestrial, marine and freshwater - Micro-organisms - lower and higher plants - lower and higher invertebrates and vertebrates; Species extinction and Endangered species; Monitoring indicator species and habitats; Threats to biodiversity: Extinction - Past rate of Extinction - Human Caused Extinctions - Endemic species - Extinction rates - Man and animal conflicts. **(K1,K2, K3, K4, K5)**

Unit-III

Habitats and Ecosystem: History of ecosystem ecology, Human induced Ecosystem change, Urban Ecosystem Classification - Ecosystem mapping, tropical forests, grasslands, wetlands, coral reefs, mangroves; Habitat lass: Habitat destruction - Fragmentation and degradation - desertification - Habitat restoration; Invasive Species: their introduction pathways, biological impacts of

invasive species on terrestrial and aquatic systems; Impacts of Exploitation on Target and Non-target Terrestrial and Aquatic species and Ecosystems. **(K1,K2, K3, K4, K5, K6)**

Unit-IV

Values of Biodiversity Instrumental/Utilitarian value and their categories, Direct use value; Indirect/Non-consumptive use value, Introduction to Ecological Economics; Monetizing the value of Biodiversity; Intrinsic Value; Ethical and aesthetic values, Anthropocentrism, Biocentrism, Ecocentrism and Religions; Intellectual Value; Economics of Ecosystem, Green Revolution, Food Plants, medicinal and ornamental plants, animal uses -livestock and fisheries. **(K1,K2, K3, K4, K5)**

Unit-V

Conservation and Management National Legislation - Protection of Wild flora and Fauna-Protection of National Habitats - National and International Protected Areas - Current Practices in Conservation - in situ Conservation and ex situ Conservation of Threatened Species –Biodiversity Act 2002 - Forest protection Act-Forest conservation Act 1980 – Multilateral Treaties – Biodiversity Conventions. Environmental ethics – Biodiversity - Socio - Political Perspective; Community conserved Areas (CCAs) - Range and significance of CCAs. Conservation and sustainable development - traditional societies - Government action local legislation - national laws - National Biodiversity Act and National Biodiversity Authority. International approaches to conservation and sustainable development-On going problems – possible responses - role of conservation biologists. **(K1,K2, K3, K4, K5, K6)**

Reference and Textbooks:

Chaudhuri, A.B. and D.D. Sarkar (2003), Megadiversity Conservation, Flora, Fauna and Medicinal Plants of India's hotspots, Daya Publishing House, Delhi.

Singh, M.P., B.S. Singh and Soma S. Dey (2004), Conservation of Biodiversity and Natural Resources. Daya Publishing House, Delhi.

Dadhich L. K. and A. P. Sharma (2002), Biodiversity - Strategies for Conservation, APH Publishing Corporation, New Delhi.

Khan, T. I and Dhari N Al Ajmi (1999), Global Biodiversity - Conservation Measure, Pointer Publishers, Jaipur.

Krishnamurthy, K. V (2003), An Advanced Textbook on Biodiversity - Principles and Practice, Oxford and IBH Publishing, New Delhi.

Krishnamurthy, K. V., 2003, An advanced Textbook on biodiversity, Oxford and IBH Book. Co., New Delhi.

Hall, B. K. and Hallgrimsson, B., 2014. Evolution, 5th Edition, Johnes and Bartlett India Pvt. Ltd. New Delhi.

Ridley, M. 2004, Evolution, 3rd Edition, Blackwell Science Ltd; Blackwell Publishing company, USA.

Core Practical Paper - II

Lab-II: ENVIRONMENTAL MICROBIOLOGY, BIOTECHNOLOGY AND TOXICOLOGY

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
II	23UPEVS1L02	100	6	-	6	3

Objectives

The course provides practical guidelines on conducting experiments across the entire spectrum of environmental toxicology, biotechnology and microbiology.

Course Outcomes	
On the successful completion of the course, students will be able to	
CO1	Understand the basic techniques in microbiology
CO2	Know the enumeration methods of microfloral
CO3	Learn to isolate DNA from various samples
CO4	Acquire knowledge in toxicological experiments
CO5	Have basic understanding of environmental case studies and pollutant modeling

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*				*			*
CO2		*			*	*		
CO3		*				*		*
CO4		*			*			
CO5		*	*	*		*		*

Core Practical Paper - II

Lab-II: ENVIRONMENTAL MICROBIOLOGY, BIOTECHNOLOGY AND TOXICOLOGY

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
II	23UPEVS1P02	100	6	-	6	3

1. Good Microbiology laboratory practices: Laboratory safety (Dos and Don'ts),
2. To prepare basic liquid (Nutrient broth) and basic solid media (Nutrient Agar and Potato) and fungi.
3. To learn pure culture techniques used for isolation and purification of microorganisms a. Pour plate method. Spread plate method. Streak plate method.
4. To perform different staining methods to study morphological and structural characteristics of bacteria and fungi a. Simple staining b. Gram Staining c. Fungal staining (Lacto-phenol cotton blue).
5. Enumeration of microbes from soil and air
6. Examination of Mycorrhizae – VAM.
7. Isolation of genomic DNA from bacteria.
8. Isolation of genomic DNA from plant.
9. Isolation of genomic DNA from animal tissue.
10. Survey of degradative plasmids in microbes growing in polluted environment.
11. Estimation of reducing sugars in toxic waste.
12. Estimation of protein from toxic waste.
13. Case studies on environmental effects of pesticides.
14. Modeling of pollutant dispersion.
15. Toxico-genomic and pharmaco-genomic evaluation of pollutants.

(K3, K4, K5, K6).

Reference and Textbooks:

Alexander N. Glazer Hiroshi Nikaido. (1995). Microbial Biotechnology, WH Freeman and Company, NY, USA.

Bernaral R. Glick and Jack **J.** (1994). Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM Press. Washington, DCUSA.

Brown, T. A. (1995). Gene cloning-An introduction-Chapman & Hall, London.

David Woolley, Adam Woolley. (2013). A Guide to Practical Toxicology: Evaluation, Prediction, and Risk. 2nd Edition. Taylor and Francis Publication.

Dr. RatnaTrivedi. (2016). PracticalManual of Environmental, Microbiology and Biotechnology. Academic press.

Glazer and Nikaido. (1995). Microbial Biotechnology. W.H Freeman & Co., NewYork.

Jayanta Kumar Patra, Gitishree Das, Swagat Kumar Das, and Hrudayanath Thatoi. (2020). A Practical Guide to Environmental Biotechnology (Learning Materials in Biosciences). Springer publication.

Outcomes

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

- Explain the role of microbes in degradation of environmental pollutants.
- Acquireskillsinmanipulatingthemicrobesforbiodegradationofpollutants.
- Develop processes for waste bioconversion to value-added products.
- Become an entrepreneur/researcher in the areas of environmental biotechnology.

Non Major Elective Course- I

Ecology and Environment

Semester	Paper Code	Marks	Hours/Wee	L	T	P	Credit
III	23UPEVS1N02	100	3	3	-	-	2

Course Objectives

To introduce and provide basic knowledge on the concept and principles of Environmental Science, ecology and ecosystems, and to give adequate knowledge on natural resources, biodiversity and their conservation.

Course Outcomes

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

CO1 Understand the basic concept and functions of environment, ecology and ecosystem.

CO2 Understand the different environmental compartments and their structure and functions in the ecosystem.

CO3 Obtain more knowledge about population ecology and its specific relationships.

CO4 Understand the significance and need for environmental protection and sustainability.

CO5 Adequate knowledge on the status of available natural and biodiversity resources and their conservation.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2	*							
CO3	*							
CO4	*		*			*		*
CO5	*					*		*

Non-Major Elective Course- I

Ecology and Environment

Semester	Paper Code	Marks	Hours/Wee	L	T	P	Credit
III	23UPEVS1N02	100	3	3	-	-	2

Unit I Environment and Ecology

Ecology: History, Scope and Importance - Components and structure of the environment: Atmosphere, Hydrosphere, Lithosphere and Biosphere **(K1, K2 & K3)**

Unit II Ecosystem

Types of ecosystem - Terrestrial and aquatic ecosystem - Structure and functional aspects of the ecosystem: Food Chain, Food Web, Ecological pyramids, Energyflows - Productivity of an ecosystem - Biogeochemical cycles (Carbon, Nitrogen, Sulphur, and Phosphorous) - Ecological succession: Types and stages **(K1, K2 & K3)**

Unit III Population Ecology

Levels of Organization, Population characteristics: Density, Natality, Mortality, Survivorship curves, Age distribution, Growth curves - Population interactions: Co-evolution, Neutralism, Symbiosis, Commensalism, Mutualism, Antagonism, Antibiosis, Parasitism, Predation, and Inter and Intraspecific competitions **(K1, K2 & K3)**

Unit IV Natural Resources and Conservation

Classification and significance of natural resources - Soil, Forest, Water, Wildlife and Mineral resources - Conservation strategies of natural resources **(K2, K3 & K4)**

Unit V Biodiversity and Conservation

Types of Biodiversity: Species, Genetic, and Ecosystem diversity - Megadiversity Nation and Hot Spots in India (K2 and K4) - Biodiversity Conservation: *In situ* and *Ex-situ* conservation measures - Values of Biodiversity: Food, Medicine, Raw Material, Aesthetic and Cultural values - Biopiracy and Bioprospecting **(K3, K4 & K5)**

References

Text Books

1. Sharma P D (2015) Ecology and Environment (12th Edition). Rastogi Publications, New Delhi.
2. Eugene P. Odum and Gary W. Barrett (2004) Fundamentals of Ecology (5th Edition) Brooks/Cole Publishers.
3. Krishnamurthy KV (2003) An Advanced Textbook on Biodiversity - Principles and Practice, Oxford and IBH Publishing, New Delhi.

Reference Books

1. Rana SVS (2005) Essentials of Ecology and Environmental Sciences, Prentice-Hall of India Private Limited, New Delhi, India.
2. Muthuchelian K (2013) Glimpses of Animal Biodiversity, Astral International (P) Ltd., New Delhi.
3. Muthuchelian K (2013) Uyir Virimam (Tamil), Pranisha Pathippagam, Madurai.
4. Muthuchelian K (2016) Bioinformatics, Barcoding and Benefit Sharing in Biodiversity. Educationist Press, New Delhi.
5. Richard Frankham, Jonathan D. Ballou and David A. Briscoe (2010) Introduction to Conservation Genetics, Second edition, Cambridge University Press, UK.
6. Santosh Kumar Upadhyay and Sudhir P Singh (2021) Bioprospecting of Plant Biodiversity for Industrial Molecules, John Wiley & Sons Ltd., USA.
7. Tim Burt and Des Thompson (2020) Ecology, Biodiversity and Conservation, Cambridge University Press, UK.

Web References

1. http://www.newagepublishers.com/samplechapter/000964.pdf
2. www.ecosystem.org/types-of-ecosystems
3. www.ecologyconnections.ca/pop3research.php
4. http://ocw.korea.edu/ocw/college-of-life-sciences-and-biotechnology/general-biology/PDF/10-1GeneralBiol%20CH50.pdf
5. www.uic.edu/classes/bios/bios101/competitionmurray.PPT
6. www.india.gov.in/topics/environment-forest/natural-resources
7. www.jamaicachm.org.jm/BHS/conservation.htm

Non-Major Elective Course- I

ENVIRONMENTAL HEALTH AND SAFETY

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
III	23UPEVS1N03	100	3	3	-	2

Course Objectives

To understand the role of environmental health, protection, safety at work, occupational health and safety, compliance and best practices.

Course Outcomes

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

CO1 Understand the importance of maintaining a safe workplace, safety standards and with regulatory requirements

CO2 Acquire knowledge on industrial pollution and environmental diseases

CO3 Understand the workplace injury, its prevention, risk management, incident investigations and the role of safety in the business community

CO4 Understand the acute and chronic health effects of exposure to physical, chemical and biological agents in the workplace.

CO5 Demonstrate knowledge of different types of exposure and biological effects, exposure guidelines and basic workplace monitoring

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*			*				
CO2		*						
CO3		*		*				
CO4		*					*	
CO5	*			*			*	

Non-Major Elective Course- I

ENVIRONMENTAL HEALTH AND SAFETY

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
III	23UPEVS1N03	100	3	3	-	2

Unit I Environmental Health

Concept and scope - Global and regional perspectives - Basic requirements for a healthy environment - Environmental quality, human exposure and health impact - impact of environmental factors on human health, Health and Safety Act, Environmental factors in community, occupational and residential settings impact health.

Unit II Industrial Pollution and Chemical Safety

The extent of industrial pollution, Public exposure from industrial sources, Hazards by industry, Major chemical contaminants at the workplace, Industrial environmental accidents - Concept of threshold limit values - Air sampling strategies - Personal exposure monitoring.

Unit III Environmental Diseases

Asbestosis, Silicosis, Sycosis, Asthma, Fluorosis, Arsenicosis and Allergies; Epidemiological issues - Malaria and Kala-azar, Covid19.

Unit IV Occupational Safety and Health

Occupational hygiene/safety and disease; Principles and methods of occupational health, Health problems due to industrial dust, heat, chemicals, noise, toxic gases and metals, Health hazards in agriculture - Pesticide impacts on the environment and human health - Personal protective equipment, Viral and bacterial infections, Training for Safety and Health.

Unit V Environmental Health Hazard, Risk Assessment and Management

Hazard and risk, Biological, chemical, physical and psychological health hazard; Health risk assessment and management - Current environmental risk assessment methods - Major agencies and organizations involved in environmental health protection - Safety andHealth Management System model - Participation and Representation, Training, Awareness and competence; Document Control: Safety and Health Management System records: Operational Control - Workplace Precautions.

References

Text Books

1. Shaw J. Chadwick (1998) Principles of Environmental Toxicology, Taylor& Francis Ltd.
2. AnnaleeYassi, TordKjellstr"om, Theo de Kok, Tee Guidotti (2001) Basic Environmental Health, Oxford University Press.

Reference Books

1. Shaw, J. Chadwick (1998) Principles of Environmental Toxicology, Taylor& Francis Ltd.
2. Annalee Yassi, Tord Kjellstr"om, Theo de Kok, Tee Guidotti (2001) Basic Environmental Health, Oxford University Press.
3. Monroe T. Morgan (2003) Environmental Health, Third Edition, Thomson/Wadsworth Publishers.

4. Koren H (2002) Handbook of Environmental Health and Safety - Principle and Practices, Fourth Edition, Lewis Publishers, CRC Press.
5. Risk assessment- A Practical Guide, (1993) Institution of Occupational Safety and Health, United Kingdom.

Web References

1. www.ehs.ucsb.edu/
2. www.ifc.org/ehsguidelines
3. slintec.lk/wp-content/uploads/2011/08/HealthSafetyManual.pdf

Core Paper - VII

BIOSTATISTICS AND RESEARCH METHODOLOGY

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
III	23UPEVS1C07	100	5	5	-	5

Objectives

To impart understanding on the concepts of biostatistics and to improve the Computing knowledge of the statistical methods related to environment.

Course Outcomes

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

CO1 Know the basic of statistics and data interpretation methods

CO2 Understand the concepts and types of sampling methods

CO3 Understand the tests of significance and its relevant statistical tools.

CO4 Apply the statistical knowledge and through software and data base management.

CO5 Learn the basic concepts of research methodology.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2							*	*
CO3				*				*
CO4					*			*
CO5					*		*	*
CO6	*			*		*	*	

Core Paper - VII

BIOSTATISTICS AND RESEARCH METHODOLOGY

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
III	23UPEVS1C07	100	5	5	-	5

Unit-I

Basic statistics: Schemes for Classification-Tabulation and representation of data-science population numerical data in science-Sampling theory-Measures of central tendency and dispersion-Correlation and regression-Analysis-Probability-Theoretical distribution-Analysis of one way variance-Methods of analyzing oceanographic data and filtering of scientific data. **(K1,K2, K3, K4, K5)**

Unit-II

Sampling Methods: Probability sampling, random sampling, systematic sampling, stratified sampling, cluster sampling and multi stage sampling. Non-probability sampling: Convenience sampling, judgement sampling, quota sampling. **(K1,K2, K3, K4, K5)**

Unit-III

Tests of Significance - Mass and alternative hypothesis - error level of significance - Equal and Unequal Sampling - t, z, x2 test, Analysis of variance -One way ANOVA - Two way ANOVA - Regression and correlation - simple and multiple. Introduction to environmental system analysis, Approaches to development of models, models of population growth and interaction -variousmodels. **(K1,K2, K3, K4, K5, K6)**

Unit-IV

Applications of Computer in Environmental Science and Management - Data Analysis using packages (SPSS): Editing, Data Tabulation, Descriptive

statistics, Multivariate Analysis - Correlation - Regression - Cluster analysis - Factor Analysis - PCA, Graph Plotting, Computational databases and environmental management. **(K1,K2, K3, K4, K5, K6)**

Unit-V

Scientific documentation: Methods of literature collection, design, planning and execution of investigation, Preparation of scientific documents, general articles, research papers, review articles, editing of research papers, methods of citation, collection of literatures, including web-based methods, bibliography and thesis writing. Presentation techniques, effective communication skill. **(K1,K2, K3, K4,)**

Reference and Textbooks:

Arvind Shende and Vijay Upagade. (2010). Research Methodology. S. Chand Publications.

Bliss, G.I. (1970), Statistics in Biology. McGraw Hill Book Company, Vol. I and II. New Delhi.

Byron S Gottfried (1996), Programming with C, Hill Publishing Co, New Delhi.

Gupta S.P. (2014), Statistical Methods. Sultan Chand & Sons Publications.

Gupta,S.P. (1996), Statistical Methods, Sultan Chand & Sons Publications, New Delhi.

Haynes, R (1982), Environmental Science Methods, Chapman & Hall, London.

Khan, I.A and Kanum, A. (1994), Fundamentals of Bio-Statistics, Ukaaz Publication, Hyderabad.

Kothari, C.R. (1996), Quantitative Techniques, Vikas Publishing Housing Pvt Ltd, Hyderabad.

Kothari, C.R. (1989), Research Methodology - Methods and Techniques. Wiley Eastern, New Delhi.

Miller, J. (1989), Statistics for Advanced Level, Cambridge University Press. Rastogi V.B. (2009). Fundamentals of Statistics.ANE Books.

Snedcor, G.W. and Cochran, W.G. (1982), Statistical Methods, Academic Press. Vittal, R.R. (1986), Business Mathematics and Statistics, Murgham Publications.

Wardlaw, A.C. (1985), Practical Statistics for Experimental Biologists. Wiley Chichester.

Sharma, B.A.V., Ravindra Prasad, D. and Satyanarayana, P (1989), Research Methods in Social Sciences. Sterling Publishers Pvt. Ltd.

Wayne W. Daniel, Chad L. Cross. (2014), Biostatistics: Basic Concepts and Methodology for the Health Sciences.10th Edition. Wiley Publication.

Core Paper - VIII

REMOTE SENSING & GIS

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
III	23UPEVS1C08	100	6	6	-	5

Objectives

To teach the principles and applications of spatial information technologies viz RS, GPS and GIS about the distribution of resources. To give hands-on trainingon the uses of GIS software in environmental studies.

Course Outcomes

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

CO1 Acquire adequate knowledge on principles and basic concept of environmental geoinformatics

CO2 Understand the basic concept of GIS and its mechanisms and know the various types of GPS systems

CO3 Learn to interpret satellite images and understand Image Classification Techniques, Image enhancement

CO4 Use GPS for various environmental applications

CO5 Able to apply the tools of remote sensing and GIS for environmental disaster management and conservation

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*				*		*	
CO2				*				
CO3				*	*		*	*
CO4				*	*			*
CO5				*				*

Core Paper - VIII

REMOTE SENSING & GIS

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
III	23UPEVS1C08	100	6	6	-	5

Unit-I

Elements of photographic systems and computer applications. Land stat. IRS and other satellite systems- satellite data. Principles involved in thermal IR image and microwave image interpretation. Applications of different types of images in earth Sciences, Environmental Sciences, Archeology, Marine studies, Forestry, Soils, Hazard management etc**. (K1,K2,K3,K4)**

Unit-II

Concepts and foundations of remote sensing-History of remote sensing-Electro-magnetic energy - Properties and interaction with the earth. Atmospheric windows. Black, white and grey bodies, sources of EMR. Image interpretations. Aerial photo-classification based on attitude of camera lens, distortions caused due to flight irregularities, overlaps, scale, relief displacement and its effects. Photo recognition elements. Different types of photographs. **(K1,K2, K3,K4, K5)**

Unit-III

Introduction to Geographical Information Systems and GIS software, Fundamentals of GIS: Layers and features, Raster/Vector- Geo referencing and projection, Spatial data and GIS basics; Data attributes and spatial topology, Projection/Image registration, Digitization and data attributes-map data representation, GPS. **(K1,K2,K3,K4,)**

Unit-IV

GIS Applications: Resources mapping, Inventory and monitoring natural resources, Land cover mapping, Wetland mapping - Applications to Agriculture -Water Management, Specific Applications-Infrastructure - Ground Water. GPS applications-Principles of Accuracy - Database Creation - Networking of Data. **(K1,K2,K3,K4)**

Unit-V

Remote sensing applications - Impact Assessment - Pollution Monitoring - Water - Air - Ocean Pollution - Land Degradation - Desertification - Industry - Mining - Ground Water Modeling- Damage Assessment - Coastal and Marine applications - Future Sensors - Satellite System -ENVISAT - Megha Tropiques - TRMM - EOS Missions - Integral Earth Observation Studies - Global Change - Case studies. **(K1,K2,K3,K4, K5)**

Reference and Textbooks:

Barrett, E.C and Curtis, L.F. (1982). Introduction to Environmental Remote Sensing, Basudeb Bhatta (2008). Remote Sensing and GIS. OUP India.

Danson, F.M and Plummer, S.E. (1995), Advances in Environmental Remote Sensing, Space Remote Sensing Systems - An Introduction, Chen, H.S (1985).

Fischer, M.M and Nijkamp, P. (1993). Geographic Information Systems, Spatial Modeling and Policy Evaluation, Springer-Verlag.

Jensen. (2013). Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education India.

Kramer **J.** Herbert. (2002). Observation of Earth and its Environment - Survey of Missions and Sensors Springer-Verlag.

George **J.** (2003). Fundamentals of Remote Sensing, Universities Press (India) Ltd., Hyderguda, Hyderabad

Martin W. Benjamin L. and Stefan D. (2016). Remote Sensing and GIS for Ecologists: Using Open-Source Software (Data in the Wild). Pelagic Publication.

Muralikrishna, I.V. (1995). Remote Sensing and GIS for Environmental Planning, Tata - McGraw Hill.

Roody, M. and Curran, P.J. (1994). Environmental Remote Sensing from Regional and Global Scales, Published by John Wiley, Chichester. pp. 238.

Singh, R.B. (1992). Environmental Monitoring of Remote Sensing and GIS, Geocartho International Centre, Honk Hong.

William K Pratt. (2001). Digital Image Processing, John Wiley & Sons.

Core Paper - IX

ENVIRONMENTAL IMPACT ASSESSMENT

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
III	23UPEVS1C09	100	6	6	-	5

Objectives

This course tells about the need of industry and society to predict and include environmental concerns and risks while developing projects. The course also describes the modern tools and techniques to evaluate the environmentalimpacts and outlines. Various management options needed to mitigate these risks.

Course Outcomes

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

CO1 Explain the major principles and components of EIA processes

CO2 List and comply with the environmental clearance procedures in India

CO3 Understand the methods used for EIA studies

CO4 Understand how to liaise with and the importance of stakeholders in the EIA process and access different case studies/examples of EIA in practice

CO5 Summarize the EIA report with suitable environmental management plan

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*			*	*	*	*	*
CO2	*			*	*	*	*	*
CO3	*			*	*	*	*	*
CO4	*			*	*	*	*	*
CO5	*			*	*	*	*	*

Core Paper - IX

ENVIRONMENTAL IMPACT ASSESSMENT

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
III	23UPEVS1C09	100	6	6	-	5

Unit-I

Fundamental of EIA: Definition and Evaluation of EIA in India - Types of Impact- Characteristics - Steps of EIA - Sustainable Development- Framework for EIA, Screening, Scoping and Baseline Studies, Significance and Importance of Impacts, Impact Prediction -Mitigation Aspects - Assessment of Alternatives, Public Hearing, Decision Making - Techniques for Assessment of Impacts on Physical Resources, Ecological Resources, Human use Values and Quality of Life Values**. (K1, K2, K3, K4, K5)**

Unit-II

EIA Methodologies: Checklist Methodologies - Adhoc Method - Network Methods -Matrix Methods - Map Overlay Method - Preparing EIA - Interacting Parameters Interaction -Environment and Development Activities - Comparative Studies on Methodology. Prediction and Assessment of Impacts on Biological, Surface Waters, Ground Water, Air, Noise, Radiation Hazards. **(K1, K2, K3, K4, K5)**

Unit III

Environmental Laws and Acts: Environmental Policies - National and International Trends, Changes in Global Perspective, International Treaties. National Policies: National Environmental Policy, National Forest Policy, National Water Policy, Rehabilitation and Resettlement Policy; Evolution of Environmental Legislation in India, Legal Provisions for Environmental Protection; Various Acts, Rules and Regulations. Notifications Issued under

Various Acts and Rules. Environmental Standards, Criteria for Standards Setting. Public Liability Insurance Act and Legal Aspects Relating to Hazardous and Toxic Substances. Role of National Green Tribunals. **(K1, K2, K3, K4, K5, K6)**

Unit-IV

Environmental Ethics: Implementation of International Emission Trading, Resource Consumption Patterns and the need for Equitable Utilization - Equity - Disparity in the Northern and Southern Countries, Urban and Rural Equity Issues - The need for General Equity, Preserving Resources for Future Generation - The Rights of Animals- Preparation of Environmental Management Plan and Criteria for Selection of Environmental Factors, Alternatives - Policies of World Summit 1972, RIO Conference Agenda 21, Montreal Protocol, Kyoto Protocol, Climate Change Mitigation. **(K1, K2, K3, K4, K5, K6)**

Unit-V

Case Studies: Land Clearing Projects - Dam Sites - EIA for Aquaculture, Steel, Mines, Hydro Thermal, Nuclear, Oil and Gas based Power Plants - Highway Projects - Industrial Projects. Damage to Coral Reefs in Oceans. **(K1, K2, K3, K4)**

Reference and Textbooks:

Bregmam J.I. (1999). Environmental Impact Statements, Lewis Publishers, London.

Charles H. Eccleston. (2011). Environmental Impact Assessment: A Guide to Best Professional Practices. CRC Press.

Eccleston C.H. (2000). Effective Environmental Assessment, Lewis Publishers, London.

Eranch Bharucha. (2005). Textbook of Environmental Studies, University Grants Commission

Jane Holder and Maria Lee. (2007). Environmental Production, Law and Policies, Second Edition.

John Glasson. (2005). Introduction to Environmental Impact Assessment, Natural and Built Environment Series. Routledge, Taylor and Francis.

Khandeshwar S.R, Raman N.S, Gajbhiye A.R. (2019). Environmental Impact Assessment. Dreamtech Press.

Larry W. Canter. (2013). Environmental Impact Assessment, John Wiley and Sons.

Ramachandran S. (2019). Environmental Impact Assessment. Airwalk Publications.

SingletonR, Castle Pand Sort D. (1999). Environmental Assessment, Thomas Telford Publishing London.

Suresh K. Dhameja. (2005). Environmental Science and Engineering, Published by Sanjeev Kumar Kataria, Delhi.

Elective - V

INSTRUMENTATION & ANALYTICAL TECHNIQUES

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
III	23UPEVS1E05	100	3	3	-	3

Objectives

The purpose of this course is 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

CO1 Understand the basics OF spectrophotometry and microscopy

CO2 Understand the concepts of chromatographic techniques

CO3 Know the principles and applications of electrophoresis and centrifugation

CO4 Understand the instrumental techniques of minor equipment

CO5 Learn the concepts of biomolecular separation techniques

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2		*		*				
CO3	*	*						
CO4				*	*			
CO5			*	*		*		

Elective - V

INSTRUMENTATION & ANALYTICAL TECHNIQUES

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
III	23UPEVS1E05	100	3	3	-	3

Unit-I

Principles and application of Spectrophotometry - UV-Visible spectrophotometry, Spectrofluorimetry, Titrimetry, Gravimetry, Colourimetry, Infrared spectrophotometry, NMR, ESR, Microscopy-phase, light and flourscence microscopes, Scanning and Transmission electron microscopes**. (K1, K2, K3, K4)**

Unit-II

Chromatographic techniques - Paper chromatography, thin layer chromatography, ion exchange chromatography, Column chromatography, Atomic absorption spectrophotometer, cytophotometry and flow cytometry, Fixation and staining, Principles and techniques of nucleic acid hybridization and Cot curves, Principle of biophysical method used for analysis of biopolymer structure, Hydrodynamics methods, Plasma Emission spectroscopy. **(K1, K2, K3, K4, K5)**

Unit-III

Electrophoresis, SDS-PAGE, Agarose gel electrophoresis, solid and liquid scintillation, autoradiography, X-ray florescence, Flame photometry, Gas-Liquid chromatography, High pressure liquid chromatography, Ultracentrifugation **(K1, K2, K3, K4, K5, K6)**

Unit -IV

Conductometry, voltammetry, turbidimetry, pH meter, meteorological monitoring devices, portable gas analyser, calorimeter, Neutron activation analysis. **(K1, K2, K3, K4, K5, K6)**

Unit-V

Methods for measuring nucleic acid and protein interactions, DNA fingerprinting, Molecular markers RFLP, AFLP, RAPD, Sequencing of proteins and nucleic acids, southern, northern, western blotting techniques, and PCR-polymerase chain reaction. **(K1, K2, K3, K4, K5)**

Reference and Textbooks:

Uppadahay, A., Uppadahay, N., and Nath, N. (2016). Biophysical Chemistry, Principles and Techniques, Himalaya Pub. House, NewDelhi.

Sawyer, C.N., McCarty, P.L. and Parkin, G.F. (2002). Chemistry for Environmental Engineering and Science, McGraw-Hill Education.

Rupa, H.H. and Krist, H. (1998). Laboratory Manual for the Examination of Water, Wastewater and soil, VCH Publication, NewYork.

Sharma, B.K. (2001). Analysis, Goel Publishing House, Meerut, India.

Elective Paper - VI

ENVIRONMENTAL EDUCATION

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
III	23UPEVS1E06	100	3	3	-	3

Objectives

The course focuses on Introduction to basic principles of environmental health and safety practices and creating awareness of public and occupational healthand safety requirements associated with the environment. The purpose of this course is to understand the role of environmental health, protection, safety at work, occupational health and safety, compliance and best practices.

Course Outcomes

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

CO1 Knowledge in the concepts and scope, basic requirements for healthy environment, environmental quality, human exposure and health impact
CO2 Knowledge about Environmental Disease present study in Fluorosis and Allergies; Epidemiological issues
CO3 Knowledge of understand course will equip student with basic knowledge on safety issues
CO4 Evaluate the impacts of mass media and awareness tools
CO5 To understand the significance of SDGs

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2		*						
CO3				*				
CO4	*		*				*	
CO5		*				*		

Elective Paper - VI

ENVIRONMENTAL EDUCATION

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
III	23UPEVS1E06	100	3	3	-	3

Unit-I

Definition, concept, policy, history and practices: What is environmental education - Major requirements of environmental education - Interdisciplinary, Psycological, cultural and physical - Interrelatedness - Flexibility - Non dogmatic-Emphasis on problem solving - Practice what you preach - present status: history, Primary level, secondary level, third level, and training for professionals. Content of environmental Education - Philosophy and environmental ethics - Political sensitivities - Scientific ethics and Bioethics in mangrove environment - Endangered species - Animal cruelty**. (K1,K2,K3,K4,K5)**

Unit-II

Role of institution: Teachers preparation and curriculum development for Environmental Education – Environmental education school level, Universities, R & D Institutions - Education for physical planners - Environmental management education - Teaching and learning strategies for environmental education - Role of non-governmental organization in Environmental Education

- Role of regional, global organizations involved in living and non - living resources and its management programme. **(K1,K2,K3,K4,K5)**

Unit-III

Community and environmental education. Coastal rural development-Women's role - poverty and environment - Population education and its relationship with environmental education - Environmental awareness among children of rural and non-formal education centers - Community based

resource management. Environmental Hazards: Causes and effects of environmental hazards, effect of human activities on environment - environmental pollution - global and local (Soil pollution, water pollution, air pollution, noise pollution) - Green House effect - Ozone layer depletion - acid rain, pillar melting, rise of sea level and their implications - Mitigation efforts environmental prospective - International co-operation Support Policies and systems. **(K1,K2,K3,K4,K5,K6)**

Unit-IV

Mass media in environmental and eco-tourism: Radio - Television - Newspapers - Cinema - Poster and Banners - Man media - Public interaction models - Evaluation of environmental education. Eco-tourism: Principle and concept - Ecotourism potential - Nature conservation - Training, education awareness through ecotourism - Community based resource management - Managing the protected area through ecotourism awareness. Conservation Strategy and policy statement on environment and development: Environmental problems - Action taken, Constraints and agenda for action - Development policies. **(K1,K2,K3,K4,K5)**

Unit-V

Sustainable Development and Environmental Awareness - Learning to live in harmony with nature - environmental education for development, conservation of soil, water, forests, wildlife, energy resources, movement to save environment, eco-friendly Technology - Alternate sources of energy - Waste management - Population and environment. **(K1,K2,K3,K4,K5)**

Reference and Textbooks:

Canter, E.W. (1977). Environmental Impact Assessment. McGraw Hill Co., New York.

Fedron, E. (1980): Man and Nature, Progress Publishers, Moscow

Kormondy, E.(1991). Concept of Ecology, Prentice Hall of India, New Delhi.

Odem, E.P. (1975). Ecology, Oxford and IBH Publishing Co., New Delhi.

Purdom, P.W. and Anderson. Environmental Science, Charles E. Merril Publishing Co.,

Saxena, A.B. (1996): Education for the Environmental Concerns, Implications and Practices, Radha Publication, New Delhi.

Sharma, P.D. (1993). Environmental Biology, Rastogi & Co., Meerut.

Core Practical - III

Lab-III: BIOSTATISTICS & RESEARCH METHODOLOGY, REMOTE SENSING & GIS AND EIA

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
III	23UPEVS1L03	100	6	-	6	3

Objectives

The course deals with environmental audit, GIS data quality issues, GIS data analysis, integration and linkage of Remote Sensing and GIS besides including statistical tools used in research.

Course Outcomes	
On the successful completion of the course, students will be able to	
CO1	Know to calculate the descriptive statistics of the data sets
CO2	Know to do parametric statistical tests
CO3	Learn to acquire toposheets and satellite imagery
CO4	Acquire knowledge RS Image processing techniques and map creation
CO5	Have basic understanding of EIA Methods and tools

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*				*			*
CO2		*			*	*		
CO3		*				*		*
CO4		*			*			
CO5		*	*	*		*		*

Core Practical - III

Lab-III: BIOSTATISTICS & RESEARCH METHODOLOGY, REMOTE SENSING & GIS AND EIA

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
III	23UPEVS1P03	100	6	-	6	3

1. Calculation of mean, median and mode,
2. Calculation of standard deviation.
3. Statistical Data Analysis - Mean, Standard Deviation, Standard Error
4. Statistical Data-Analysis of Variance (ANOVA)
5. Preparation of simple Vector map, Toposheet reading and GPS field survey.
6. Visual Interpretation of Geomorphic features from the Satellite image and Aerial photographs
7. Toposheet and Satellite Imagery Acquisition
8. Geo referencing of toposheet/Satellite Imagery
9. Creation of Vector Layers
10. Raster Image Processing
11. Image Classification Techniques
12. Study Map Representation/Creation
13. Case studies on effective utilization of environmental laws: oil refineries, petrochemical industry.
14. Comparative analysis of various mega-building projects and their impact assessment.
15. Impact assessment of green belts.
16. Visits-sanctuaries, reserves
17. Pollution Control Board Visits and Reports

(K3, K4, K5, K6)

Reference and Textbooks:

Arvind Shende and Vijay Upagade. (2010). Research Methodology. S. Chand Publications.

Charles H. Eccleston. (2011). Environmental Impact Assessment: A Guide to Best Professional Practices. CRC Press.

Gupta S.P. (2014). Statistical Methods. Sultan Chand & Sons Publications.

Martin Wegmann, Benjamin Leutner, and Stefan Dech. (2016). Remote Sensing and GIS for Ecologists: Using Open-Source Software (Data in the Wild). Pelagic Publication.

Outcomes

On successful completion of the course, Students gain knowledge about mapping technology, concepts of maps, and all relevant terminology which are necessary for a beginner to develop their skills in this new and upcoming technology.

Non-Major Elective Course- II

Environmental Pollution

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	23UPEVS1N04	100	3	3	-	-	2

Course Objectives

To gain awareness of environmental pollution and its types, sources, effects, monitoring & and control techniques, and to understand the fundamental principles governing the interactions between transport of pollutants in the environment.

Course Outcomes	
On the successful completion of the course, students will be able to	
CO1	Learn about the air, water and soil pollutants, sources and its effects
CO2	Have clear understanding on the air, water, noise and radiation standards and its techniques
CO3	Understand the different impacts on environment from various pollutants
CO4	Understand the emerging contaminants and their impacts on the environment
CO5	Apply relevant techniques, skills and modern engineering tools to solve the environmental problems

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*						
CO2				*				
CO3		*		*				
CO4		*	*	*				*

Non-Major Elective Course- II

Environmental Pollution

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	23UPEVS1N04	100	3	3	-	-	2

Unit I Introduction

Environment: Introduction and Scope, Components of Environment: Structure and composition of Atmosphere, Hydrosphere, Lithosphere, and Biosphere - Pollution: Definition, Sources, Types, Pollution-related diseases and control measures. **(K1,K2,K3)**

Unit II Air Pollution

Sources (Natural, Anthropogenic, Stationary, mobile, and Area-specific), Types of Air Pollutants (Primary and secondary; Organic and Inorganic) - History of air pollution, Transport and diffusion of pollutants - Atmospheric reactions: Ozone formation and depletion, Acid rain, Photochemical Smog - Effects of air pollutants in the environment - Methods of monitoring and control of air pollution: SO_2, NOx, CO, SPM. **(K1, K2, K3, K4)**

Unit III Water Pollution

Types, sources (Point and Non-point), and Water pollution episodes) - Eutrophication - Water sampling - Water quality and standards - Wastewater treatment technologies. *Marine Pollution*: Sources of marine pollution and its control) - Effects of pollutants on human beings, plants, and animals. Emerging Water Pollutants: Microplastics, Personal Care Products, and Nanomaterials. **(K1, K2,K3,K4)**

Unit IV Soil Pollution

Sources - Soil sampling methods - Soil quality: Soil organic carbon, Soil organic matter, Mineral nutrients - Effects of soil pollution on the environment - Soil pollution control and remediation techniques. **(K1,K2,K3)**

Unit V Noise, Thermal, and Radiation Pollution

Sources of noise pollution - Measurement and indices - Effects and control measures (K3 & K4). Thermal Pollution - Sources & Effects - Radiation Pollution - Sources, Measurement, Units and control techniques. **(K1,K2,K3,K4)**

References

Text Books

1. Shafi S M (2005) Environmental Pollution. Atlantic Publishers & Dist.

Reference Books

1. Khitoliya R K (2012) Environmental Pollution, 2nd edition, S. Chand Publishing.
2. Khopkar, S M (2013) Environmental Pollution: Monitoring and Control, New Age International Publishers.

3. Cunningham W P and Cunningham M A (2004) Principles of Environment Science. Enquiry and Applications. 2nd ed. Tata McGraw Hill, New Delhi.
4. Sharma B K (2000) Environmental Chemistry, Goel Publishing House, Meerut
5. Pardeep Singh, Ajay Kumar and Anwesha Borthakur (2019) Abatement of Environmental Pollutants Trends and Strategies, Elsevier Science.
6. Hemen Sarma, Delfina C. Dominguez, Wen-Yee Lee (2022) Emerging Contaminants in the Environment Challenges and Sustainable Practices, Elsevier Science.

Web References

1. www.uccee.org/Environmental_Pollution.html
2. www.who.int/topics/environmental_pollution/en/
3. www.nrdc.org/water/environment.nationalgeographic.com/environment
4. www.noisecontrol.com/the-common-causes-of-noise-pollution
5 www.conserve-energy-future.com/causes-and-effects-of-soil-pollution.php

Non-Major Elective Course- II

GLOBAL ENVIRONMENTAL ISSUES

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
III	23UPEVS1N05	100	3	3	-	2

Course Objectives

To focus on major global environmental issues including population explosion, biodiversity loss, pollution, energy use, climate change, and best environmental technologies for sustainable development. To know how they are managed in various settings around the world.

Course Outcomes

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

CO1 Clearly identify important global, national, and local issues relating to population, food, and the environment

CO2 Understand the global consequences of climate change

CO3 Acquire knowledge pertaining to the overexploitation of natural and biodiversity resources

CO3 Understand various global disasters and their effective management

CO4 Acquire knowledge related to sustainable environmental management practices

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1				*		*		
CO2				*				
CO3						*		*
CO4				*		*		

Non-Major Elective Course- II

GLOBAL ENVIRONMENTAL ISSUES

Unit I Human Population and Environment

Basic demographic concepts: Growth, fertility, mortality and migration - Overview of population growth - Population distribution - Urbanization - Poverty, Food security, Waste Disposal - Environmental degradation and Public health - Development and Modernization versus Environment - Pandemic and social issues (K1, K2)

Unit II Global Atmospheric Changes

Global Air Quality, Air Quality Index and CO_2 concentration scenario - Sources of greenhouse gases - Greenhouse effect and Global warming - Facts and figures of current global warming scenario in the world - El Niño and La Niña - Global consequences of El Niño (K1, K2) - Ozone-depleting substances (ODS) - Acid Rain - Persistent Organic Pollutants (POPs) - Impact of Air pollutants on human health (K3)

Unit III Overexploitation of Natural Resources

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, Land Degradation Neutrality (LDN) (K3), Mineral resources exploitation - Biodiversity Resources: Megadiversity Nation and Hot spots in India – Bioprospecting and biopiracy - Threats to biodiversity resources (K1, K2)

Unit IV Global Disasters

Types of disasters - Earthquake: Origin of Earthquake, magnitude and intensity - Global Earthquake prone zones - Effects of earthquake - Volcanoes: Types of volcanic eruptions - Active volcanic belts in the world - Flash flood - Flood management strategies - Regions of flood prone zones in the World and India - Forecasting and warning of natural disasters - Manmade disasters: Oil spills, Forest fire, Industrial and Nuclear disasters (K1, K2) - Public health disaster: Covid-19 Pandemic - Microplastics - Case study: Recent globaldisasters

Unit V Sustainable Environmental Management

Renewable energy resources: Solar, Wind, Hydroelectric and Biomass - Sustainable agricultural practices (Biofertilizers and Biopesticides) - National Action Plan on Climate Change (Eight missions) - Recent initiatives related to climate change adaptation and mitigation in India - UNDP Sustainable Development Goals 2030 (K4)

References

Text Books

1. Frances Harris (2012) Global Environmental Issues, 2nd edition, John Wiley & Sons Ltd., UK.
2. Stavros G. Poulopoulos and Vassilis J. Inglezakis (2016) Environment and Development: Basic Principles, Human Activities, and Environmental Implications. Elsevier, Netherlands.
3. Amy Long (2021) Global Environmental Issues, 2nd edition, Kendall Hunt Publishing Company.

Reference Books

1. Donald Hyndman and David (2005) Hyndman Natural Hazards & Disasters, Cengage Learning, USA.
2. John V. Walther (2014) Earth's Natural Resources, Jones & Bartlett Learning, USA.

Non-Major Elective Course- II

GLOBAL ENVIRONMENTAL ISSUES

3. Prasad Modak (2018) Environmental Management towards Sustainability, CRC Press, FL, USA.
4. Prasenjit Mondal and Ajay K. Dalai (2017) Sustainable Utilization of Natural Resources, CRC Press, FL, USA.
5. Rajeev Pratap Singh, Anita Singh, VaibhavSrivastava (2017) Environmental Issues Surrounding Human Overpopulation, IGI Global, USA.
6 Raveendranathan D (2018) Development lead to Pollution and Depletion of Natural Resources, Notion Press, Chennai.
7 Serge Morand, Claire Lajaunie, RojchaiSatrawaha (2017) Biodiversity Conservation in Southeast Asia: Challenges in a Changing Environment, Earthscan from Routledge, UK.
8. Thangavel P and Sridevi G (2015) Environmental Sustainability: Role of Green Technologies, Springer, India.
9. Dogra N and Srivastava S (2012) Climate Change and Disease Dynamics in India, TERI, New Delhi.
10. Quaschning VV (2019) Renewable Energy and Climate Change. John Wiley & Sons.
11. Saurabh Sonwani and Pallavi Saxena (2022) Greenhouse Gases: Sources, Sinks and Mitigation, Springer, Singapore.

Web References

1. https://www.stateofglobalair.org/sites/default/files/soga-2018-report.pdf
2. www.who.int/airpollution/
3. https://unfccc.int/
4. re.indiaenvironmentportal.org.in/files/part%20II%20groundwater%20CPCB.pdf
5. https://www.footprintnetwork.org/our-work/earth-overshoot-day
6. https://www.elsevier.com/data/assets/pdf.../ElsevierDisasterScienceReport-PDF.pdf
7. www.siteresources.worldbank.org/INTDISMGMT/Resources/0821363328.pdf
8. https://link.springer.com/chapter/10.1007/978-981-10-1866-4_2
9. www.ipcc.ch/
10. https://climate.nasa.gov/
11. https://pressbooks.bccampus.ca/environmentalissues/

Core Paper - X

OCCUPATIONAL HEALTH HAZARDS AND INDUSTRIAL SAFETY

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
IV	23UPEVS1C10	100	5	5	-	5

Objectives

The students on exposure to this course will understand the different types of hazards disasters possible in the industries. Focus has been made on the safety and management practiced in industries by highlighting certain casestudies.

Course Outcomes

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

CO1 Understand the types of health hazards and its impacts
CO2 Acquire knowledge on industrial pollution and environmental diseases
CO3 Understand the workplace injury, its prevention, risk management, incident investigations and the role of safety in the business community
CO4 Understand the acute and chronic health effects of exposure to physical, chemical and biological agents in the workplace.
CO5 Understand major case studies related to occupational health and industrial safety

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*			*				
CO2		*						
CO3		*		*				
CO4		*					*	
CO5	*			*			*	

Core Paper - X

OCCUPATIONAL HEALTH HAZARDS AND INDUSTRIAL SAFETY

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
IV	23UPEVS1C10	100	5	5	-	5

Unit-I

Health Hazards: Physical Hazards - Noise, Risk Factors, Occupational Damage, Ioninzing and Non-ionizing Radiation - Types and Effects, Hazards of Microwaves and Radio Waves, Lasers. Chemical Hazards - Introduction - Properties of Chemicals, Dust, Gases, Fumes, Mist, Vapours, Smoke and Aerosols. Route of Entry to Human System. Biological and Ergonomical Hazards - Classification of Bio hazardous Agents - Bacterial, Rickettsial, Chlamydial, Viral Fungal and Parasitic**. (K1, K2,K3,K4)**

Unit-II

Health Disorders: Occupational Diseases, Silicosis, Asbestosis, Pneumoconiosis, Siderosis, Anthracosis, Aluminosis, Byssinosis, Bagassosis and Anthrax. Heavy Metals - Lead, Nickel, Chromium and Manganese Toxicity, Gas Poisoning (CO, Ammonia, H_2S) - Their Effects and Prevention. **(K1,K2,K3,K4)**

Unit-III

Industrial Safety Measures: First Aid - Principles, Rules and Training, Personal Protective Equipments (PPE) - Respiratory and Non Respiratory Devices, Maintenance of Machines and Equipments, Fire Extinguishers - Types and Handling, Fire Detection and Alarm Systems, Water Spray Systems for Explosions. **(K1,K2,K3,K4, K5)**

Unit-IV

Plans, Polices and Rules Related to Industrial Safety: Threshold Limit Values (TLV),The Factories Act, 1948, International Labour Organization (ILO)

Convention, Safety Health and Environment (SHE), BIS on Safety and Health 15001-2000, OSHA, OHSAS-18001. National Policy on Occupational Safety, Health and Environment at Work - Indian Electricity Act 2003, Indian Explosive Act - 1984. Hazardous Materials Transportation Rules. **(K1,K2,K3,K4, K5).**

Unit-V

Case Studies: Major Industrial Disasters in India - The Bhopal Gas Tragedy 1984, Chasnala Mining Disaster 1975, Jaipur Oil Depot Fire 2009, Korba Chimney Collapse 2009, Mayapuri Radiological Incident 2010, Bombay Docks Explosion 1994, Disasters in the Rest of the World - Spyros Disaster 1978, Oppau Explosion, Germany 1921, Courrieres Mine Disaster, France 1906, Chernobyl Disaster, Ukraine 1986, Halifax Explosion, Canada 1917, Benxihu Colliery Explosion 1942. **(K1,K2,K3,K4, K5, K6)**

Reference and Textbooks:

Della D.E. and Giustina. (1996). Safety and Environmental Management, Van Nostrand Reinhold International Thomson Publishing Inc.

Goetsch D.L. (1999). Occupational Safety and Health for Technologists, Engineers and Managers, Prentice Hall.

Hommadi, A. H. (1989). Environmental and Industrial Safety, I.B.B Publication, New Delhi.

Kolluru R. V. (1994). Environmental Strategies - Hand Book, Mc Graw Hill Inc., New York.

Walsh, W. and Russell, L. (1984). ABC of Industrial Safety, Pitma Publishing United Kingdom.

Core Paper - XI

CLIMATE CHANGE

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
IV	23UPEVS1C11	100	6	6	-	5

Objectives

To impart the knowledge of fundamental scientific principles, concepts and global Perspective underlying climatic change.

Course Outcomes

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

CO1 Understand the climate and climate change processes at local to global scales

CO2 Understand the sources and impacts of climate change due to anthropogenic activities including energy utilization.

CO3 Understand the existing novel technologies used for measurement of climate change and weather forecasting

CO4 Understand the recent initiatives and policy framework by UNFCCC, IPCC, CoP, MoEF & CC and other Ministries

CO5 Evaluate the pros and cons of past National and International efforts to address climate change mitigation and adaptation

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*			*		*	*	*
CO2	*			*		*	*	*
CO3	*				*	*	*	*
CO4	*	*			*	*	*	*
CO5	*				*	*	*	*

Core Paper - XI

CLIMATE CHANGE

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
IV	23UPEVS1C11	100	6	6	-	5

Unit-I

Climate change - concept of climate change - Atmosphere-atmospheric motion, Earth's rotation: Coriolis effect, global atmospheric circulation. Human Impacts on climate - greenhouse gas emissions, Fossil - fuel emissions scenarios, IPCC. Greenhouse effect; Water vapor and climate, Carbon cycle. sea level rise - Carbon pools and their relative significance. Ozone depletion -stratosphericozone shield and Ozone hole - Impact of Climate Change on environment and biodiversity and their implications. **(K1,K2,K3,K4,K5,K6)**

Unit-II

Adaptation and Mitigation Responses and policies of climatic changes - Emissions trading/carbon credit schemes. International adaptation initiatives and programs - renewable energy, green building, energy efficiency and reducing consumption - low carbon economy. Integrated mitigation for development and planning through low emission development strategies - Climate Change and sustainable development. Role of Governments, Business, NGOs, other Institutions in adapting to, and mitigating climate change **(K1,K2,K3,K4,K5)**

Unit-III

The Climate Change Policy Frame work - The Montreal Protocol - Provisions of the United Nations Framework Convention on Climate Change (UNFCCC) - structure of the UNFCCC, and different party groups under the convention - Annex I, Annex II and Non-Annex I countries. Paris agreement. The Kyoto

protocol and its associated bodies. IPCC - working group I, working group II and working group III. **(K1,K2,K3,K4,K5)**

Unit-IV

Social connection to climatic change: Climate change and Carbon credits-CDM-Initiatives in India. Climate justice, Immigration issues. Environmental movements; The classic case of earth day. Main climate change negotiations evolved over the past years and highlights of some key issues relevant to future climate change regime. **(K1,K2,K3,K4,K5,K6)**

Unit-V

Climatic change and Socio-economic implications: Economic importance - drought and desertification - fishing and forestry - changes in monsoon pattern industries - Food productions-health care - tourism - transport at ion and energy consideration. Carbon tax and mission trading, Green fiscal policy **(K1,K2,K3,K4,K5)**

Reference and Textbooks:

Botkin, D.B. and Keller, E.A. (2007). Environmental Science: Earth as a Living Planet, 6th edition, John Wiley & Sons, USA.

Botkin, D.B. and Keller, E.A. (2014). Environmental Science: Earth as a Living Planet. 9th Edition. John Wiley & Sons.

Burroughs, W.J. (2007). Climate Change: A Multidisciplinary Approach. 2nd Edition. Cambridge University Press.

Chasek, P.S. (2004). The Global Environment in the Twenty-First Century-Prospects for International Co-operation, Manas Publications, New Delhi.

Claussen, E. (2001). Climate Change: Science, Strategies and Solutions, Arlington VA.

Climate Change: A Multidisciplinary Approach, 2nd edition, Cambridge University Press.

Dash, S.K. (2007). Climate Change - An Indian Perspective, Cambridge University Press, India, Pvt Ltd, New Delhi.

Dodds, F. and Middleton, T. (2002). Earth Summit, a New Deal, Earth scan Publications Ltd., UK.

Enger, E.D. and Smith, B.F. (2006). Environmental Science: A Study of Interrelationships.

11th edition, McGraw Hill Inc., USA.

Hardy, John, T. (2003). Climate Change: Causes, Effects, Solutions Wiley and Sons, USA.

Ranade, P.S. (2008). Climate Change and Biodiversity: Perspectives and Mitigation Strategies-ICFAI University press.

Ranade, P.S. (2008). Climate Change and Biodiversity: Perspectives and Mitigation Strategies. ICFAI University press.

Elective Paper - VII

NATURAL RESOURCE MANAGEMENT

Semester	Paper Code	Marks	Hours/Wee	T	P	Credit
IV	23UPEVS1E07	100	4	4	-	3

Objectives

The course deals with Waste treatment technologies for resource and energy recovery to deliver value-added products.

Course Outcomes

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

CO1 Understand the different types of natural resources and their significance in ecosystem

CO2 Extensive knowledge pertaining to the sustainable utilization of natural resources

CO3 Develop an objective view of the nature of Earth's resources, particularly the non-renewable resources

CO4 Explain how and where the Earth's resources are generated, how they are overexploited, and how these activities impact Earth's environment

CO5 Develop perspectives on sustainability by looking into different ways of conservation of the precious natural resources and their management

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*				*	*	*	*
CO2	*				*	*	*	*
CO3	*					*	*	*
CO4	*				*	*	*	*
CO5	*			*	*	*	*	*

Elective Paper - VII

NATURAL RESOURCE MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
IV	23UPEVS1E07	100	4	4	-	3

Unit-I

Forest - Forest types, role of forest, Forest products - demand and supply,Tribal and forest, Forest management. Classification of forest land, Administrative classification of forests, Classification of forests for management, social forestry, community forestry. Indian forest policy and Forest conservation. National Forestry Action Plan - 1999: An Overview**. (K1,K2,K3,K4,K5)**

Unit-II

Wildlife - Importance of wildlife, abuse and depletion of wildlife, Wildlife conservation-classification of scarce wildlife, Methods of wildlife conservation, Endangered species of India, Wildlife conservation in India, Legislation: WLPA - 1972 and 2002 Amendment, development and Impact of wildlife, National Parks and Sanctuaries, GO's and NGO's in Wildlife conservation, Eco-tourism. **(K1,K2,K3,K4,K5)**

Unit-III

Energy - Energy requirement, Impact of energy utilization on the environment. Conventional sources of energy: Coal, Oil and Natural gas, Thermal power, Firewood, Hydropower, Nuclear power. Non-Conventional Sources of Energy: Solar energy, Wind energy, Ocean/Tidal energy, Geothermal energy, Biomass based energy, Dendro thermal energy, Energy from urban waste, Bagasse based energy. **(K1,K2,K3,K4,K5,K6)**

Unit-IV

The nature of soil, characteristics and value. Soil formation, soil profile and soil classification. Soil fertility. Soil conservation and sustainable agriculture:

nature of soil erosion; factors affecting soil erosion by water and its control. Alternative agriculture, sustainable agriculture. Land use and environmental problems of soil. Soil surveys and Land use planning. **(K1,K2,K3,K4,K5)**

Unit-V

Water-Surface and groundwater, Water management, Rain water harvesting, Watershed management. Aquaculture - Inland water resources and their economic potential with respect to fisheries. Freshwater fish culture, Establishment and management of fish farm. Fishery as Self-employment Avenue (small scale industry), Govt. schemes, Training and incentives. **(K1,K2,K3,K4,K5,K6)**

Reference and Textbooks:

Sasikumar, K. (2009). Solid Waste Management. Prentice Hall India Learning Private Limited. Patwardhan, A.D. (2017). Industrial Wastewater Treatment. PHI Learning Publication.

Ramanathan Jagbir Singh, A.L. (2019). Solid Waste Management: Present and Future Challenges. Dream tech Press.

Pachauri, R.K. and Sridharan, P.V. (1997). Looking back to Think Ahead: Geen India 2047, The Energy Research Institute, New Delhi.

Dasmann, R.F. (1976). Environmental Conservation, John Willey & Sons, New York.

Wasi Ullah, Gupta, S.K. and Dalal, S.S. (1972). Hydrological Measurements for Watershed Research, Jugal Kishore & Company.

Murty, J.V.S. (2017). Watershed Management, New Age International Publishers.

Todd, T.K. and Mays, L.W. (2011). Groundwater Hydrology, Wiley.

Agarwal, V.C. (2012). Groundwater Hydrology, PHI Learning.

Kle, G.A. (1991). Conservation of natural resources, Prentice Hall Publ. Co., New Jersey.

Owen, O.S., Chiras, D.D. and Reganold, J.P. (1998). Natural resource conservation management for a sustainable future, Prentice Hall.

Elective Paper VIII

Microbial Enzyme Technology

Semester	Paper Code	Marks	Hours/Week	T	P	Credit
IV	23UPEVS1E08	100	4	4	-	3

Course Objectives

To provide the students with knowledge, understanding, analytical skills in enzymes, their functions, catalytic mechanisms, kinetics, and enzyme applications in various fields.

Course Outcomes

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

CO1 Understand the types, classification, sources, and mechanisms of enzymes and enzyme properties.

CO2 Describe methods of isolation, purification and characterization of enzymes and their kinetics.

CO3 Distinguish the different processes employed in enzyme immobilization and stabilization.

CO4 Identify the various types of enzymes applied in different industries.

CO5 Recognize the role of enzymes in various environmental applications.

Mappings of course outcomes with programme outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*		*					
CO2	*		*					
CO3			*	*				
CO4			*					
CO5		*	*	*			*	*

Unit I: Introduction to Enzymes

Enzymes - Classification, chemical and structural components, sources, types, general properties and functions - Structure: primary, secondary, tertiary and quaternary structure of enzymes - Mechanisms of enzyme action - Techniques used in enzymatic analysis - Commercial values of enzymes. (K1, K2, K3)

Unit II: Enzyme Production, Purification and Characterization

Enzyme production methods - enzyme production media - Submerged fermentation (SmF)

and solid-state fermentation (SSF) - Optimization of enzyme production - Methods of enzyme purification: Isolation and chromatographic fractionation - Characterization of enzymes and enzyme kinetics. (K1, K2, K3, K4)

Unit III: Enzyme immobilization

Methods of enzyme immobilization - Physical adsorption, ionic and covalent bonds, binding, entrapment, encapsulation, and cross-linking. Organic and inorganic enzyme immobilization carriers - Natural and synthetic enzyme carriers - Stabilization and Application of immobilized enzymes. (K3, K4, K5)

Unit IV: Industrial Applications of Enzymes

Overview of applications of enzymes in biotechnology and various industries – Industrial enzymes - Biotransformation and biocatalysis with crude enzymes, purified enzymes, immobilized enzymes, and whole cell biocatalyst. Extremozymes and their applications. (K1, K2, K30

Unit V: Environmental Applications of Enzymes

Microbial enzymes in environmental applications - Enzymes for soil decontamination and detoxification - Enzymes for water and wastewater treatment and remediation - Enzymes for dehalogenation of organic pollutants - Enzyme catalyzed transformation and detoxification of heavy metals - Role of enzymes in pollution monitoring - Enzymes for waste management.

References

Aditya Arya, Amit Kumar, Jayanti Jha (2018) Understanding Enzymes: An Introductory Text. Drawing Pin Publishing, New Delhi, India. ISBN: 9788193674000.

Devasena, T. (2010) Enzymology, Oxford University Press, India. ISBN: 9780198064435

Khan, M Y. and Khan F. (2015) Principles of Enzyme Technology, PHI Learning Pvt Ltd. ISBN: 9788120350410.

Nicholas C. Price (2009) Fundamentals of Enzymology, 3rd Edition. Oxford University Press. ISBN: 9780198064398.

Prasad N K. Enzyme Technology: Pacemaker of Biotechnology (2012) Prentice-Hall of India Pvt. Ltd. ISBN: 9788120342392.

Shanmugam S. and Sathishkumar T. (2009) Enzyme Technology. I K International Publishing House Pvt. Ltd. ISBN: 9789380026053