PERIYAR UNIVERSITY

Salem - 636 011

(Reaccredited with 'A' Grade by the NAAC)

DEPARTMENT OF ENVIRONMENTAL SCIENCE

M.Sc. ENVIRONMENTAL SCIENCE

[Choice Based Credit System (CBCS)]

OBE SYLLABUS

(Effective from the academic year 2019-2020 and thereafter)

M. Sc. ENVIRONMENTAL SCIENCE

OBE REGULATIONS AND SYLLABUS

(*with effect from the academic year 2019-2020 onwards*)

1. Preamble

Growing populations and high standards of living put increasing pressure on our environment. Since the beginning of industrialization and urbanization, we have been facing with an increasing number of environmental challenges such as air, water and soil contamination, energy crisis, land degradation, deforestation, loss of biodiversity, global warming and climate change, etc., Considering the above issues, addressing environmental problems from a scientific perspective is 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 its 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***

   Improve the research-oriented skills by involving into the basic, applied and field-based research works.

4. ***Problem Solving Skills***

   Identify, analyze and assess the complex environmental issues and to apply the knowledge to solve the issues.

5. ***Environmental Management***

   To improve to undertake and manage environment related works and to 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 to 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, softwares and research methods which can be used to assess the environmental quality.

8. Project Management

To manage and coordinate specific environmental work, tasks or projects and to apply specific principles and methodologies to carry out environmental projects.

9. Societal and Environmental Concern

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

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 and to initiate small scale start-ups and upscale 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 can be able to apply the acquired knowledge in providing solutions.

- **Scientific or synthesis level (K6)**

  Students will be able to synthesize or develop new processes, products and to formulate new scientific tools related to sustainable environmental management.

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 (PO)

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

PO1	Deep knowledge in natural resources, ecosystem and their biogeochemical processes, biodiversity, Geographic Information Systems (GIS) and their importance, various elements of climate change and environmental clearance procedures.
PO2	Good understating in toxicological properties of environmental pollutants and their impact on environment, occupational diseases, nanomaterials and their toxicity.
PO3	Capability in applying microbes, plants and animals for potential environmental cleanup and energy production, and to generate value added products through waste recycling and other sustainable environmental management practices.
PO4	Acquire more knowledge and proficiency in Environmental Impact Assessment, auditing, pollution monitoring and management.
PO5	Skills in methods used for EIA studies, remote sensing and GIS to monitor the environmental issues and critically analyzing the global climate change.
PO6	Expertise to become as environmental consultant / manager at local, regional and national level industry / institution /organizations.
PO7	Capability to become an entrepreneur in the field of EIA, GIS, waste management and waste recycling, natural product, environmental safety trainer.
PO8	Qualification to be employed as a researcher / scientist / faculty in Colleges / Universities / Government sectors / Research and Development organizations.

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 / Home Science / 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 of two parts.

Course Component	No. of Courses	Hours of Learning	Marks	Credits
Part A (Credit Courses)				
Core Courses	13	845 (65 hrs per course)	1300	59
Elective Courses	2	104 (52 hrs per course)	200	8
Supportive Courses	2	78 (39 hrs per course)	200	6
Lab Course	3	234 (78 hrs per course)	300	9
Research Project	1	468 (26 hrs per week)	150	6
Field Visit	1	-	50	2
Total	**22**	**1729**	**2200**	**90**
Part B (Self-Learning Credit Courses)				
Online Courses (SWAYAM/MOOC)	2		200	8
Industry Oriented Course	2	36 (36 hrs per course)	100	2
Total	**4**		**300**	**10**

9. Curriculum structure for each semester as per courses 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	Contact Hours/week	Credits	Internal Marks	External Marks	Total Marks
SEMESTER - I								
1	Core - I	19UPEVS1C01	Ecology and Biodiversity Conservation	5	5	25	75	100
2	Core - II	19UPEVS1C02	Environmental Chemistry	5	5	25	75	100
3	Core - III	19UPEVS1C03	Environmental Microbiology	5	4	25	75	100
4	Core - IV	19UPEVS1C04	Environmental Biochemistry and Toxicology	5	4	25	75	100
5	Elective - I	19UPEVS1E01/ 02/03/04/05	Elective Paper	4	4	25	75	100
6	Practical - I	19UPEVS1P01	Practical Paper I	6	3	40	60	100
			Sub Total	**30**	**25**	**165**	**435**	**600**
SEMESTER - II								
7	Core - V	19UPEVS1C05	Environmental Pollution and Control Strategies	5	5	25	75	100
8	Core - VI	19UPEVS1C06	Environmental Geoinformatics	6	5	25	75	100
9	Core - VII	19UPEVS1C07	Climate Change and Current Issues	5	4	25	75	100
10	Elective - II	19UPEVS1E01/ 02/03/04/05	Elective Paper	4	4	25	75	100
11	Supportive – I	19UPEVS1S01/ 02/03/04	Supportive - I	3	3	25	75	100
12	Practical-II	19UPEVS1P02	Practical Paper - II	6	3	40	60	100
13	External Credit	19UPEVS1EC1	Industrial - Institution - Collaboration	1	-	20	30	50
	External Credit		Online Courses (SWAYAM/MOOC)	-	-	-	-	100
			Sub Total	**30**	**24**	**185**	**465**	**750**

SEMESTER – III								
14	Core - VIII	19UPEVS1C08	Waste Management	5	5	25	75	100
15	Core – IX	19UPEVS1C09	Environmental Impact Assessment	5	5	25	75	100
16	Core - X	19UPEVS1C10	Environmental Biotechnology	5	5	25	75	100
17	Core - XI	19UPEVS1C11	Research Methodology and Instrumentation	5	4	25	75	100
18	Supportive II	19UPEVS1S01/ 02/03/04	Supportive - II	3	3	25	75	100
19	Practical-III	19UPEVS1P03	Practical Paper - III	6	3	40	60	100
20	External Credit	19UPEVS1EC2	Industrial-Institution - Collaboration	1	-	20	30	50
	External Credit		Online Courses (SWAYAM/MOOC)	-	-	-	-	100
			Sub Total	**30**	**25**	**185**	**465**	**750**
SEMESTER – IV								
21	Core - XII	19UPEVS1C12	Environmental Law and Policies	5	4	25	75	100
22	Core - XIII	19UPEVS1C13	Environmental Health and Safety	5	4	25	75	100
23	Core - I.V.	19UPEVS1CIV	Industrial Visits / Study Tour	-	2	-	50	50
24	Core Project	19UPEVS1CPR	Research Project	20	6	50	100	150
			Sub Total	**30**	**16**	**100**	**300**	**400**
			Total	**120**	**90**	**635**	**1665**	**2500**

Elective Courses							
S.No.	**Course Code**	**Title of the Paper**	**Contact Hours/Week**	**Credits**	**Internal Marks**	**External Marks**	**Total Marks**
1	19UPEVS1E01	Energy and Environment	4	4	25	75	100
2	19UPEVS1E02	Eco-Tourism and Wild Life Management	4	4	25	75	100
3	19UPEVS1E03	Environmental Nanotechnology	4	4	25	75	100
4	19UPEVS1E04	Environmental Engineering	4	4	25	75	100
5	19UPEVS1E05	Environmental Economics	4	4	25	75	100

Self-Learning Courses / External Credit Courses							
S. No.	**Course Code**	**Title of the Paper**	**Contact Hours/Week**	**Credits**	**Internal Marks**	**External Marks**	**Total Marks**
1	19UPEVS1SL01/02	Online Courses (SWAYAM / MOOC) (Two)	-	4+4	25	75	200
2	19UPEVS1EC01/ 02	Industry Oriented Course (Two)	1	1+1	20	30	100

Supportive Courses (Non-Major Course)							
S. No.	**Course Code**	**Title of the Paper**	**Contact Hours/Week**	**Credits**	**Internal Marks**	**External Marks**	**Total Marks**
1	19UPEVS1S01	Ecology and Environment	3	3	25	75	100
2	19UPEVS1S02	Environmental Pollution	3	3	25	75	100
3	19UPEVS1S03	Environmental Health and Safety	3	3	25	75	100
4	19UPEVS1S04	Global Environmental Issues and Management	3	3	25	75	100

11. Examinations

Examinations are conducted in semester pattern. The examination for the Semester I & III will be held in November/December and that for the Semester 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 next 5 years. Failing which, 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 second in the 11th week, third in the 16th week and the end – semester examination in the 19th week. Evaluation may be by objective type questions, short answers, essays or a combination of these, but the end semester examination is a University theory examination with 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)	20 x 1 = 20 (Multiple Choice Questions)	K1, K2
B	100 to 200 words (Answer any three out of five questions)	3 x 5 = 15 (Analytical type questions)	K3, K4
C	500 to 1000 words	5 x 8 = 40 (Evaluation and Creativity type questions)	K5, K6

Attainment Rubrics for Lab Courses

Internal *(Max. Marks - 40)*

Attendance	Practical Test	Periodical Performance/Observatio	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 *(Max. Marks - 50)*

Periodical Review and Results Presentation	50 Marks

External *(Max. Marks - 100)*

Vivo-Voce Presentation	25 Marks
Dissertation	75 Marks

Passing Minimum

- There shall be no Passing Minimum for Internal.
- For External Examination, 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 of 50% for each Paper/Practical/Project and Viva-Voce.
- Grading shall be based on overall marks obtained (internal + external).

13. Grading System

Evaluation of performance of students is based on 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 COURSE – I

ECOLOGY AND BIODIVERSITY CONSERVATION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	19UPEVS1C01	100	5	4	1	0	5

Course Objectives

The purpose of this course is to gain an understanding of the value of biodiversity and drivers of its loss; current efforts to conserve biodiversity on global, national and local scales; practical issues with local conservation and organizations, policies and programmes for sustainable management of bioresources.

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 Argue the case for local action to address the global loss of biodiversity

CO6 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	*					*		*
CO6	*					*		*

CORE COURSE – I

ECOLOGY AND BIODIVERSITY CONSERVATION

UNIT I Ecology and Biodiversity **Contact Hours 12**

Ecology: Types of ecosystem – Terrestrial and Aquatic ecosystems - Ecological pyramids - Food Chain - Food Web - Energy flow (K1 & K2) - Types of Biodiversity: Species, Genetic and Ecosystem diversity – Alpha, beta, and gamma diversity (K1 & K2) – Biodiversity and ecosystem function (K4 & K5) – Megadiversity zones and Biodiversity Hot Spots in India (K2 & K3) – Ecologically Sensitive Areas (ESA) in India (K4 & K5) - Values of Biodiversity (K4 & K5) – Biodiversity Prospecting - Examples of biopiracy and bioprospecting (K2 & K5)

UNIT II Threats to Biodiversity **Contact Hours 10**

Endangered and endemic species of flora and fauna in India (K1 & K2) - Biodiversity threats under Anthropocene era: Habitat loss, fragmentation and degradation – Pollution - Overexploitation (K2, K4 & K5) - Human-Animal conflict with special reference to elephants (K2, K4 & K5) – IUCN Threat Categories – Red Data Book (K2 & K4) – Climate change on species extinction - Causes and Impacts of Invasive species to biodiversity (K2, K3, K4 & K5).

UNIT III Conservation Strategies **Contact Hours 08**

In situ conservation: Afforestation, Social Forestry, Agro-forestry, Zoos, Biosphere Reserves, National Parks, Sanctuaries, Protected Area Network, Sacred Groves and Sthalavrikshas (K1, K2 & K3) – *Ex situ* conservation: Botanical gardens, Cryopreservation, Gene Bank, Seed Bank, Pollen Bank, Sperm Bank, cDNA Bank (K1, K2 & K3) - Conservation Genomics: Environmental DNA (eDNA) for wildlife biology and biodiversity monitoring.

UNIT IV Sustainable Management of Bioresources **Contact Hours 10**

Status of global agricultural biodiversity (K2 & K4) - National Biodiversity Authority (NBA) – Functions of State Biodiversity Board (SBB) and Biodiversity Management Committee's (BMC) – People's Biodiversity Register (PBR) (K1, K2 & K4) – International Organizations and biodiversity conservation: Objectives and Targets 2011-2020 of Global Strategy for Plant Conservation (GSPC), WWF-India for priority and threatened species conservation, UNESCO - Man and Biosphere Programme (MAB), UNDP - Biodiversity Finance Initiative (BIOFIN) and UNEP – Global Environment Facility (GEF) for biodiversity conservation (K3, K4 & K5)

UNIT V Policies, Programmes and Acts for Conservation **Contact Hours 10**

Salient features of Biological Diversity Act 2002 (K2 & K3) - Status and protection of species in National and International levels – Policies implemented by MoEF & CC for biodiversity conservation - Role of CITES, IUCN and Convention on Biological Diversity (CBD) in biodiversity conservation (K2, K3 & K4) – Nagoya Protocol on Access and Benefit-Sharing – Cartagena Protocol on Biosafety - The Aichi Biodiversity Targets (K3) – Monitoring the Illegal Killing of Elephants (MIKE) programme – Strategic programme 2016-2020 for The International Consortium on Combating Wildlife Crime (ICCWC) – SAWEN and TRAFFIC Networks to combat illegal wildlife trade – Ramsar Strategic Plan 2016-2024 for wetland conservation (K4 & K5)

CORE COURSE – I

ECOLOGY AND BIODIVERSITY CONSERVATION

Text Books

1. Eugene P. Odum and Gary W. Barrett. (2004) Fundamentals of Ecology (5th Edition) Brooks/Cole Publishers.
2. Krishnamurthy K V (2003) An Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.

Reference Books

1. Alonso A. Aguirre and Raman Sukumar (2017) Tropical Conservation. Perspectives on Local and Global Priorities, Oxford University Press, USA.
2. Chaudhuri A B and Sarkar D D (2003) Megadiversity Conservation, Flora, Fauna and Medicinal Plants of India's Hot Spots. Daya Publishing House, New Delhi.
3. Dadhich L K and Sharma A P (2002) Biodiversity –Strategies for Conservation, APH Publishing Corporation, New Delhi.
4. Kristine Bohmann, Alice Evans, M. Thomas P. Gilbert, Gary R. Carvalho, Simon Creer, Michael Knapp, Douglas W. Yu and Mark de Bruyn (2014) Environmental DNA for wildlife biology and biodiversity monitoring. Trends in Ecology and Evolution. 29:358-367.
5. Muthuchelian K (2013) Glimpses of Animal Biodiversity, Astral International (P) Ltd., New Delhi.
6. Muthuchelian K (2013) Uyir Virimam (Tamil), Pranisha Pathippagam, Madurai.
7. Muthuchelian K (2016) Bioinformatics, Barcoding and Benefit Sharing in Biodiversity Educationist Press, New Delhi.
8. Richard Frankham, Jonathan D Ballou and David A. Briscoe (2010) Introduction to Conservation Genetics, Second edition, Cambridge University Press, UK.
9. William V. Holt, Janine L. Brown and Pierre Comizzoli (2014) Reproductive Sciences in Animal Conservation. Progress and Prospects, Springer, New York.

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1. www.iucn.org
2. www.cites.org
3. www.cbd.int
4. www.wri.org
5. http://www.traffic.org
6. http://www.sawen.org
7. https://cites.org/sites/default/files/eng/prog/iccwc/ICCWC_Strategic_Programme_2016-2020_final.pdf
8. http://www.ramsar.org/sites/default/files/hb2_5ed_strategic_plan_ 2016_24_e.pdf
9. https://www.thegef.org/topics/biodiversity
10. https://www.cbd.int/gspc/strategy.shtml

CORE COURSE – II

ENVIRONMENTAL CHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	19UPEVS1C02	100	5	4	1	0	5

Course Objectives

The purpose of this course is to develop an understanding of environment, solutions preparations, chemicals, 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, hydrosphere and in lithosphere.

CO3 Demonstrate knowledge of chemical principles of various fundamental environmental phenomena.

CO4 Apply basic chemical concepts in understanding the behavior of pollutants.

CO5 Analyze chemical processes involved in air, water and soil environmental problems.

CO6 Know the different types of toxic and hazardous substances and analyze their toxicological information.

Mappings of course outcomes with programme outcomes

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

CORE COURSE – II

ENVIRONMENTAL CHEMISTRY

UNIT I Fundamentals of Environmental Chemistry Contact Hours 12

Definition - Concept and Scope (K1 & K2)- Preparation of Standard Solutions – Molarity, Molality, Normality, Percent and ppm (mg/l) Solutions (K3 & K4)- Stoichiometry - Gibb's energy - Chemical Potential - Chemical Equilibria - Acid-base Reactions: pH and pOH and Buffer Solutions - Solubility and Solubility Product - Solubility of Gases in Water - The Carbonate System - Unsaturated and Saturated Hydrocarbons – Radionuclides (K3 & K4)

UNIT II Atmospheric Chemistry Contact Hours 10

Classification of Elements (K2 & K3) – Particles, Ions and Radicals (K2) - Formation of Inorganic and Organic Particulate Matter - Thermochemical and Photochemical Reactions in the Atmosphere - Oxygen and Ozone Chemistry - Chemistry of Air Pollutants (Oxides of Carbon, Nitrogen, Sulphur) (K4 & K5).

UNIT III Aquatic Chemistry Contact Hours 08

Formation of Water (K1) - Water Resources – Sources and Types (K1) - Hydrological Cycle - Unique Properties of Water (K2) - Role of Water in the Environment (K3)- Physical, Chemical and Biological Parameters of Water – Phenomenon of Eutrophication - Concept of DO, BOD, COD - Distribution of Chemical Species in Water - Types of reactions in various water bodies including marine environment (K4 & K5)

UNIT IV Soil Chemistry Contact Hours 10

Nature of soil – Formation and Types (K1 & K2)- Mechanical, Physical and Chemical Properties of Soil: Soil Structure, Texture (K3 & K4), Inorganic and organic components of soil, Chemical properties of saline, acidic and alkaline soils (K5), Macro and Micronutrients, Humus and Organic Matter, C/N Ratio, Chemical reactions in soil (K3, K4 & K5)

UNIT V Pollutant Chemistry Contact Hours 10

Chemistry of Hydrocarbon Decay (K3)- Effects on Macro and Microorganisms (K4) – Surfactants - Cationic, anionic and non-ionic detergents, modified detergents (K1 & K5) - Pesticides: Classification, Degradation, Analysis - Pollution due to Pesticides – DDT and Endosulphan - Toxic effects of heavy metals - Ar, Cd, Pb & Hg (K3, K4 & K5)

Text Books

1. De, A.K (2007) Environmental Chemistry, Seventh Edition, New Age International Publishers.
2. Sharma, B.K and Kaur, H (1994) Environmental Chemistry, Goel Publishing House Ltd., Meerut, UP.
3. Balram Pani, (2007) Text Book of Environmental Chemistry, I.K. International Publishing House Pvt. Ltd.
4. Girard J E, (2015) Principles of Environmental Chemistry.

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

Reference Books

1. Manahan, Stanley E (2009) Fundamentals of Environmental Chemistry, 9th Edition, Boca Raton: CRC Press LLC.
2. Eugene R. Weiner (2000) Applications of Environmental Chemistry, CRC Press, LLC.
3. Ahluwalia, V K (2015) Environmental Pollution and Health, The Energy and Resource Institute (TERI).
4. Vanloon G W and Duffy S J (2011) Environmental Chemistry A Global Perspectives, 3rd Edition, Oxford University Press.
5. Ibanez, J G, Hernandez-Esparza, M, Doria-Serrano, C, Fregoso-Infante, A, and Singh, M M (2007). Environmental Chemistry. Springer Press.

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1. http://www.nptel.ac.in/courses/122106030/Pdfs/3_1.pdf
2. http://www.crystal.med.upenn.edu/sharp-lab-pdfs/sharp_EncLifeSci.pdf
3. http://www.fao.org/docrep/field/003/AC172E/AC172E04.htm
4. http://www.essentialchemicalindustry.org/materials-and-applications/surfactants.html
5. http://agriinfo.in/?page=topic&superid=5&topicid=174

Experiments for Practical

1. Measurement water quality parameters pH, acidity, alkalinity, coagulation, TSS and TDS.
2. Estimation of BOD and COD.

CORE COURSE – III

ENVIRONMENTAL MICROBIOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	19UPEVS1C03	100	5	4	1	0	5

Course Objectives

The objectives of Environmental Microbiology course are to learn the basic knowledge about Microbiology, to understand the role of microbes and microbial interactions in soil and other soil activities, to the biogeochemical cycles prevail in environment, and to enhance the skill on microbial analysis of environment.

Course Outcomes

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

CO1 Able to understand about microbes in environmental field

CO2 Understand the role of microbes in soil fertility, biogeochemical cycles, plant growth promotion

CO3 Know about the impact of microbial air and water pollutants

CO4 Understand the microbial diseases related to environment

CO5 Apply the microbial processes to clean the environment.

CO6 To enhance the skill on microbial analysis of environment

Mappings of course outcomes with programme outcomes

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

UNIT I Introduction to Microbiology Contact Hours 7

History and scope of microbiology – General structure and functions of bacteria, fungi, virus and algae – Physical and Chemical methods of sterilization techniques used in microbiology - Preparation of media for isolation and culture of microorganisms. (K1, K2)

UNIT II Geomicrobiology Contact Hours 7

Soil micoflora – Factors influencing the soil microflora – Role of microorganisms in soil fertility. Microbial interactions – Mutualism, Commensalism, Competition, Amensalism,

Parasitism and Predation. Interaction between microbes and plants: Rhizosphere, phyllosphere and mycorrhizae. (K1, K2)

UNIT III Biogeochemical Cycles Contact Hours 10

Carbon cycle - Role of microbes in Carbon cycle - Nitrogen cycle - Mechanism of biological nitrogen fixation - Ammonification, Nitrification, Denitrification - Phosphorous cycle and Sulphur cycle - Phosphate solubilization. (K3, K4, K5)

UNIT IV Air and Water-Borne Diseases Contact Hours 10

Microbial air pollutants - Bioaerosols, Aero allergens – Airborne diseases, Symptoms and preventive measures - Water pollution: Sources and nature of pollutants in water – waterborne diseases, Symptoms and preventive measures (Cholera and Typhoid). Microbial assessment of water quality - MPN technique and Biological Oxygen Demand. (K5, K6)

UNIT V Applied Microbiology Contact Hours 10

Microbial conversion of solid waste to food (Mushroom, SCP), fuels (Biogas, Ethanol), Bioleaching of Ores, Biodegradation of Lignin – Bioremediation: Types and its application – Biodeterioration of paper, wood - Metal corrosion. (K4, K5)

Text Books

1. Dubey and Maheshwari (1999) A Text Book of Microbiology, Chand Publications, New Delhi.
2. Mohapatra P K (2008) Text Book of Environmental Microbiology, I K International Publishing House Limited

Reference Books

1. Subba Rao N S (2004) Soil Microbiology.4th Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Subba Rao N S (1995) Biofertilizers in Agriculture and Forestry, 3rd Edition, Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.
3. Singh D P and Dwivedi S K (2005). Environmental Microbiology and Biotechnology. 1st Edition, New Age International (P) Ltd., Publishers, New Delhi.
4. Brock T D, Madigan M T, Martinko J M and Parker J (1994) Biology of Microorganisms, VII Ed., Prentice-Hall, New Jersy, USA.
5. Ronald M Atlas and Richard Bartha (1997) Microbial Ecology, 4th Edition, Benjamin Cummings Publishing Company, USA.

Web References

1. www.wastewatertreatment.co.in/index.php
2. www.microbialfuelcell.org
3. www.pollutionissues.com/A-Bo/Bioremediation.html
4. www.bioreactors.net
5. http://www.cpeo.org/techtree/ttdescript/biorec.htm
6. http://www.personal.psu.edu/jel5/biofilms/
7. www.rdp.cme.msu.edu

CORE COURSE – IV

ENVIRONMENTAL BIOCHEMISTRY AND TOXICOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	19UPEVS1C04	100	5	4	1	0	4

Course Objectives

The purpose of this course is to focus on understanding the role of pollutants, xenobiotics in the natural environment and to understand the basics of environmental toxicology, cell biology and biochemistry and to characterize the adverse effects of chemical substances on the ecosystem and humans.

Course Outcomes

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

CO1 Acquire broad knowledge of the field of environmental toxicology and biochemistry

CO2 Understand the basic principles, target organ toxicity and the toxicity of a select group of chemical compounds.

CO3 Synthesize and apply concepts from multiple sub-disciplines in environmental cell biology, biochemistry and toxicology.

CO4 Use technical and analytical skills to quantify the level xenobiotics in environmental compartments.

CO5 Understand the effects of xenobiotics in on human health.

CO6 Understand relationships between chemical/drug exposure and their effects on physiological systems.

CO7 Acquire skill is toxicological bioassays.

CO8 Design strategies for study of dose-response relationships

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*						
CO2		*						
CO3			*					
CO4			*					
CO5					*			
CO6				*				
CO7						*		
CO8								*

CORE COURSE – IV

ENVIRONMENTAL BIOCHEMISTRY AND TOXICOLOGY

UNIT I Basic Cell Biology **Contact Hours 10**

Prokaryotic and Eukaryotic cell structure and intracellular organelles – Cell wall, membranes, nucleolus, endosomes, peroxisomes, mitochondria, endoplasmic reticulum, plant vacuoles, plastids, microbodies and chloroplast. Cell growth and division-Meiosis and Mitosis, genotypes and phenotypes (K1, K2)

UNIT II Cellular Processes **Contact Hours 10**

Cellular permeability, diffusion, osmosis, absorption of water, transpiration, photosynthesis, Respiration, translocation of solutes, Photoperiodism and vernalisation, plant movements, Dormancy, senescence. Animal Phylogeny. (K1, K2)

UNIT III Basics of Toxicology **Contact Hours 10**

Introduction to toxicology, scope and types - Classification of toxic agents. Routes of exposure, duration and frequency of exposure, Dose response relationship - LC_{50} and LD_{50}, Margin of safety levels. Environmental Risk – Definition, Risk Characterization - Hazard Identification, Exposure Assessment Methods, Risk Assessment – National and International guidelines. Environmental Risk – Mitigation measures. (K3, K4, K5)

UNIT IV Toxicity Testing and Bioassay **Contact Hours 7**

Toxicity testing –laboratory animals, toxicity testing in animals, toxicological field studies, Concepts of Bioassay, Types and characteristics - Field based microbial bioassay, Test models and classification - Immunotoxicity, histotoxicity and cell toxicity. (K5, K6)

UNIT V Xenobiotics **Contact Hours 7**

Xenobiotics - Bioaccumulation and Biomagnifications - mechanisms of toxicity. - Drug Development and safety, Drugs and chemicals induced hepatotoxicity, food toxicity, genotoxicity, Molecular neurotoxicity. (K4, K5)

Text Books

1. Alberts B, Bray D, Hopkin K *et al.* (2009) Essential Cell Biology, 3rd edition,
2. Alberts B, Johmson A, Lewis J, Raff M, Roberts K and Walter P (2002) Molecular Biology of the Cell, Garland Science, New York.

Reference Books

1. Buchanan B B, Gruissem W and Jones R L (2002) Biochemistry and Molecular Biology of Plants, ASPB, USA.
2. Cooper G M and Hausman R E (2013) The Cell: A Molecular Approach, 6th edition, Sinauer Associates, Sunderland, MA, USA.
3. David L. Nelson, Michael M. Cox (2004) Lehninger Principles of Biochemistry (1970) by Albert L. Lehninger Published 23rd April 2004 by W. H. Freeman (first published).

4. Gerald Karp (2002) Cell and Molecular Biology: Concepts and Experiments, 7th edition.
5. Klaassen, Curtis D, Casarett, Louis J, Doull, J (2013) Casarett and Doull's toxicology: the basic science of poisons (8th Edition) McGraw Hill Publishers.
6. Ted A. Loomis, A. Wallace Hayes. Loomis's Essentials of Toxicology (1996). 4th Edition, Academic Press Publishers
7. Sharma P D, Rastogi and Lamporary (1994) Environmental Biology and Toxicology, Rajpal and Sons Publishing, New Delhi.
8. Ted A Simon (2014) Environmental Risk Assessment: A Toxicological Approach. CRC Press, FL.

CORE COURSE – V

ENVIRONMENTAL POLLUTION AND CONTROL STRATEGIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	19UPEVS1C05	100	5	4	1	0	5

Course Objectives

The purpose of this course is to gain awareness of environmental pollution and an overview of causes and consequences to natural, economic and social systems, to understand the fundamental principles governing the interactions between transport of pollutants in the environment and treatment technologies.

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 Apply relevant techniques, skills and modern engineering tools to solve the environmental problems

CO4 Get exposed good practice of technologies and options used to remediate reduce/eliminate pollution of the environment

CO5 Understand problems in order to select control measures and techniques concerning atmospheric, water or terrestrial challenges

CO6 Understand the ill effects of pollution and create awareness to public on Environmental pollution and its control

Mappings of course outcomes with programme outcomes

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

CORE COURSE – V

ENVIRONMENTAL POLLUTION AND CONTROL STRATEGIES

UNIT I Air Pollution, Control & Treatment Contact Hours 12

Definition (K1) - Natural and Anthropogenic Sources (K1)- Types of Air Pollutants: Primary and Secondary - Classification of Air Pollutants (K2 & K3) - Effects of Air Pollution on Environment (K3)- Transport and Diffusion of Pollutants (Gaussian Plume Model) - Monitoring of Air Pollution (K4) - Sampling and Analysis Techniques of SOx, NOx, hydrocarbons and particulate matter (K4 & (K5) - Ambient air Quality Standards of CPCB - Air Pollution Control Methods: Particulate matter (Settling Chamber, Cyclones, Fabric Filter, Electrostatic Precipitator and Wet Scrubbers) - Gaseous Pollutants (NO_x, SO_2, CO, CO_2 and Hydrocarbons) (K4, K5 & K6).

UNIT II Water Pollution, Control & Treatment Contact Hours 12

Definition (K1) – Sources, types and effects (K1 & K2) – Water Sampling Techniques - Water Quality Parameters and Standards (K3 & K4) - Drinking and Wastewater Treatment Methods: Primary Treatment (Screening, Grit Removal, Neutralization, Coagulation, Skimming, Sedimentation) - Secondary Treatment (Aerobic – Aeration, Activated Sludge Process, Trickling Filters, Biological Contact Filters, Rotating Filters, Oxidation Ponds; Anaerobic – Anaerobic Digestion, Septic Tanks, Lagoons) - Tertiary Treatments (Ozonation, Chlorination, Activated Carbon filtration, UV, Reverse Osmosis) - Water Management Strategies: Rain Water Harvesting, Recharging of Groundwater, Reuse of Domestic and Industrial Wastewaters (K4, K5 & K6)

UNIT III Soil Pollution, Control & Remediation Contact Hours 10

Definition (K1)- Sources (Industrial, Domestic, Agricultural) (K1 & K2)- Effects of Soil Pollution on environment (K2) - Soil Sampling Devices, Methods and Analysis (K3 & K4) - Soil Remediation Techniques: *In situ* and *Ex situ* - Physical (Soil Covering, Excavation, Electrokinetic Remediation, Air Sparging, Encapsulation) - Chemical (Soil Washing, Solidification, Vitrification) - Biological (Bioremediation and Phytoremediation) (K5 & K6).

UNIT IV Noise Pollution & Control Contact Hours 8

Definition (K1) – Sources (K1 & K2) - Properties of Sound Waves, Sound Pressure Levels, Decibel, Intensity and Duration (K3) - Effects of Noise Pollution on Humans and Animals (K3 & K4)- Noise Permissible Standards of CPCB (Industrial and Domestic Zones) - Noise Control Measures (Greenbelt and Protective Instruments) (K4 & K5).

UNIT V Radiation, Thermal Pollution Control & Treatment Contact Hours 8

Definition (K1) - Sources (K1 & K2)- Radioactive Elements, Radioactive Decay, Units of Radioactivity and Radiation Dose (K3 & K4)– Monitoring – GM and Scintillation Counter - Effects of Radiation on Environment (K3, K4 & K5) - *Thermal Pollution*: Definition (K1)– Sources (K1 & K2) - Chemical and Biological Effects - Thermal Pollution from Power Plants and their Control & Treatment (K3 & K4).

CORE COURSE – V

ENVIRONMENTAL POLLUTION AND CONTROL STRATEGIES

Text Books

1. Khopkar S M (2005) Environmental Pollution Monitoring and Control, New Age International (P) Ltd Publishers.
2. Rao C S (2018) Environmental Pollution Control Engineering, 3rd Edition, New Age International (P) Ltd Publishers.
3. Avinash Chauhan (2020) Environmental Pollution and Management. IK International Publishers Ltd.
4. Singal S P (2000) Noise Pollution and Control, Narosa Publishing House, New Delhi.
5. Jeffrey Peirce J, Ruth F, Weiner P, and Aarne Vesilind (1997) Environmental Pollution Control, 4th Edition, Elsevier Science.

Reference Books

1. Yung –Tse Hung, Lawrence K wang and Nazih K Shammas (Eds.) (2012) Handbook of Environment and waste Management Vol. 1 Air and Water Pollution Control, World Scientific Press.
2. Yung –Tse Hung Lawrence K wang and Nazih K Shammas (Eds.) (2014) Handbook of Environment and Waste Management Vol. 2 Land and Groundwater Pollution Control, World Scientific Press
3. Yung –Tse Hung, Lawrence K wang and Nazih K Shammas (Eds.) (2020) Handbook of Environment and Waste Management Vol. 3 Acid rain and Greenhouse gas pollution Control, World Scientific Press
4. Mary K. Theodore, Louis Theodore, (2010) Introduction to Environmental Management, CRC Press.
5. Meuser Helmut (2013) Soil Remediation and Rehabilitation T reatment of Contaminated and Disturbed Land, Springer.
6. Spellman F R (2013) Handbook of Water and Wastewater Treatment Plant Operations, Third Edition, CRC Press, FL.

Web References

1. http://www.ilocis.org/documents/chpt55e.htm
2. http://www.bbau.ac.in/dept/UIET/Study%20Materials%20for%20TCE-0.pdf
3. https://www.jica.go.jp/jica-ri/IFIC_and_JBICI-Studies/english/publications/reports/study/topical/health/pdf/health_08.pdf
4. https://www.researchgate.net/publication/236179607_Strategies_for_Prevention_and_Control_of_Air_Pollution_in_India
5. https://iums.ac.ir/uploads/Air_Pollution_Control_Engineerin%D8%B8%E2%80%9E_95694.pdf
6. http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.agro-0c6457fb-fa78-4aa1-9eca-5f4483681a90/c/ILNS-3-2014-1-6.pdf
7. https://shodhganga.inflibnet.ac.in/bitstream/10603/21577/8/ch-5.pdf

8. https://www.mdpi.com/1660-4601/15/8/1657/pdf
9. https://udghoshna.files.wordpress.com/2014/08/noise-pollution.pdf

Experiments for Practical Course

1. Measurement of SPM, SO_2, NO_2 levels in the atmospheric air.
2. Measurement of noise levels in different locations.
3. Determination of soil properties – pH, moisture, bulk density, Nitrogen and phosphorus.

CORE COURSE – VI

ENVIRONMENTAL GEOINFORMATICS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	19UPEVS1C06	100	5	4	1	0	5

Course Objectives

The purpose of this course is to introduce the principles, processes and application of Remote sensing and GIS, and to impart practical knowledge on the use of environmental geoinformatics and its techniques for Environmental management.

Course Outcomes

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

CO1 Acquaint adequate knowledge on principles and basic concepts of environmental geoinformatics.

CO2 Understand the basic concepts of GIS and its mechanisms

CO3 Know the various types of GPS systems

CO4 Learns to interpret satellite images

CO5 Understand Image Classification Techniques, Image enhancement and interpretation methods

CO6 Use GPS for various environmental applications.

CO7 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				*				*
CO6				*	*		*	*
CO7	*				*		*	

CORE COURSE – VI

ENVIRONMENTAL GEOINFORMATICS

UNIT I Remote Sensing **Contact Hours 8**

Introduction to Remote Sensing Principles of Remote Sensing and GIS – Components of Remote Sensing Electromagnetic Radiation, EMR Spectrum- Properties –Historical Perspectives of Remote Sensing in India (K1, K2)

UNIT II GIS Concepts **Contact Hours 10**

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

UNIT III GPS Concepts **Contact Hours 10**

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

UNIT IV Image Interpretation and Analysis **Contact Hours 12**

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

UNIT V Application of Remote Sensing and GIS **Contact Hours 10**

Applications of remote sensing for land use/land cover, landscape mapping, vegetation analysis, climate change studies, flood, drought assessment desertification and water shed management. Application of GIS for environmental studies- surveying and mapping. Emerging new softwares for RS and GIS. (K4, K5, K6)

Text Books

1. Chouhan T S (2020) Geoinformatics – Fundamentals and Applications, Scientific Publishers.
2. George Joseph (2003) Fundamentals of Remote Sensing, Universities Press (India) Pvt Ltd., Hyderabad.
3. Burrough P P and McDonnel R A (1998) Principles of GIS. Oxford University Press.

Reference Books

1. Chang K T (2006) Introduction to Geographic Information Systems. The McGraw-Hill Publishers
2. Michael N Demers (2008) Fundamentals of Geographical Information Systems. John Wiley & Sons, Inc.
3. Jenson J R (1996) Introductory Digital Image Processing: Prentice Hall Series.
4. Joseph Awange and John Kiema (2013) Environmental Geoinformatics: Monitoring and Management. Springer Publications.

5. Bhatta B (2008) Remote Sensing and GIS. Oxford Publications
6. Kang Tsung Chang (2019) Introduction to Geographical Information System. 9th Edition, Mc. Graw Hill Publishers
7. Anji Reddy M (2016) Geoinformatics for Environmental Management, BS Publications.
8. Xuan Shu (2005) GIS for Environmental Applications: A Practical Approach 1st Edition, New Age International (P) Ltd., Publishers, New Delhi.

Web References

1. https://webapps.itc.utwente.nl/librarywww/papers_2009/general/principlesremotesensing.pdf
2. https://crisp.nus.edu.sg/~research/tutorial/intro.htm
3. https://learn.canvas.net/courses/464/pages/unit-6-dot-2-basic-principles
4. http://www.ai.soc.i.kyoto-u.ac.jp/field_en/english_textbook/RemoteSensing_1.pdf
5. http://www.creaf.cat/earth-observation/gis-and-remote-sensing-methodologies-and- applications
6. https://gisgeography.com/100-earth-remote-sensing-applications-uses/
7. https://dphu.org/uploads/attachements/books/books_4518_0.pdf

Experiments for Practical Course

1. Installation of Software
2. Toposheet and Satellite Imagery Acquisition
3. Georeferencing of toposheet/ Satellite Imagery
4. Digitization Techniques
5. Creation of Vector Layers
6. Raster Image Processing
7. Image Classification Techniques
8. Study Map Representation/Creation

CORE COURSE – VII

CLIMATE CHANGE AND CURRENT ISSUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	19UPEVS1C07	100	5	4	1	0	4

Course Objectives

The purpose of this course is to focus on improving understanding of the climate system and climate science and the impacts of climate change, mitigation and/or adaptation to climate change and related issues.

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 Sources and impacts of climate change due to anthropogenic activities especially 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 successes and failures of past National and International efforts to address climate change mitigation and adaptation

CO6 Know how decisions about carbon emissions and other human activities might impact future climate during Anthropocene era

Mappings of course outcomes with programme outcomes

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

CORE COURSE – VII

CLIMATE CHANGE AND CURRENT ISSUES

UNIT I Meteorological Elements for Climate Change Contact Hours 10

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

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

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

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

Global Air Quality and CO_2 concentration scenario - Role of air pollutants in climate change – *Sources of greenhouse gases*: Coal burning, Transportation sectors (vehicle, railways, shipping and aviation) - Ozone depleting substances – Facts and figures of current global warming scenarios in the world – *Extreme events of climate change*: - El Niño, La Niña and El Niño Southern Oscillation (ENSO) – Recent extreme events in the world – Global consequences of El Niño – *Impacts of climate change*: Changes in the SW and NE monsoon patterns in India – Melting of ice glaciers and Sea levels - Water scarcity - Food security – Species extinction – Human health – Civil Wars and Migration – Global swarming: Locust plaque (K2, K3, K4& K5)

UNIT IV Climate Classification, Measurement of Climate Change and Weather forecasting Contact Hours 08

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

UNIT V Global/National Action Plans to Combat Climate Change Issues Contact Hours 08

Key steps taken by UNFCCC to combat climate change: Kyoto Protocol – Copenhagen Accord 2009 - Cancun Agreements 2010 to establish Green Climate Funds – Paris Climate Agreement 2015, Intended Nationally Determined Contribution (INDC) to cut greenhouse gas emissions at CoP 21 – Montreal Protocol for ODS, Kigali Amendment 2016 to phase out hydrofluorocarbons (HFC) – Green climate funds – Clean Development Mechanism (CDM) – Climate Change Information Network (CC:iNet) – National Action Plan on Climate Change (Eight missions) – Recent initiatives related to climate change adaptation and mitigation in India (K4 & K5)

CORE COURSE – VII

CLIMATE CHANGE AND CURRENT ISSUES

Text Books

1. Donald Ahrens C and Robert Henson (2016) Meteorology Today: An Introduction to Weather, Climate, and the Environment. Eleventh Edition, Brooks/Cole, Cengage Learning, USA.
2. Galvin JFP (2016) An Introduction to the Meteorology and Climate of the Tropics. John Wiley & Sons Ltd., UK.

Reference Books

1. Alberto Troccoli, Laurent Dubus and Sue Ellen Haupt (2014) Weather Matters for Energy. Springer, New York.
2. Cowie J (2007) Climate Change: Biological and Human Aspects, Cambridge University Press, UK. 32
3. Dogra N and Srivastava S (2012) Climate Change and Disease Dynamics in India, TERI, New Delhi.
4. Filho WL (2012) Climate Change and the Sustainable Use of Water Resources, Springer-Verlag, Berlin, Heidelberg.
5. Friel S (2019) Climate Change and the People's Health (Vol. 2). Small Books Big Ideas in Popul.
6. John Turner and Gareth J Marshall (2011) Climate Change in the Polar Regions. Cambridge University Press, UK.
7. Kala CP and Silori CS (2013) Biodiversity Communities and Climate Change, TERI, New Delhi.
8. Lawrence A. Palinkas (2020) Global Climate Change, Population Displacement, and Public Health. The Next Wave of Migration. Springer Nature Switzerland.
9. Newman J, Anand M, Henry H, Hunt S and Gedalof Z (2011) Climate Change Biology, CAB International, Cambridge, MA, USA.
10. Marselle MR, Stadler J, Korn H, Irvine KN & Bonn A (2019) Biodiversity and health in the face of climate change (p. 481). Springer Nature.
11. Parry M L (2019). Climate Change and World Agriculture. Routledge.
12. Quaschning VV (2019) Renewable Energy and Climate Change. John Wiley & Sons.
13. Ramesh Chandrappa, Sushil Gupta and Umesh Chandra Kulshrestha (2011) Coping with Climate Change. Principles and Asian Context. Springer-Verlag, Berlin.

Web References

1. http://www.un-redd.org/
2. http://unfccc.int/
3. https://www.ipcc.ch
4. https://www.co2.earth/
5. http://www.climatecentral.org/
6. http://climate.nasa.gov/
7. http://www.who.int/mediacentre/news/
8. http://aqicn.org/map/

Experiments for Practical Course

1. Collection of meteorological data from authenticated government websites and analyse the Scenario.
2. Analyse the air quality data in the city.

CORE COURSE – VIII

WASTE MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	19UPEVS1C08	100	5	4	1	0	5

Course Objectives

The purpose of this course is to understand the problems of different kinds of wastes and understand the proper collection, segregation and reduction methods for municipal waste, biomedical waste, hazardous waste, e-waste, industrial waste etc., To identify waste nature and proper disposal methods for each type of wastes and identify the energy producing wastes and recovery of the energy from the wastes using different techniques

Course Outcomes

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

CO1 Understand health and environmental issues related to solid waste management; Select the appropriate method for solid waste collection, transportation, redistribution and disposal

CO2 Become aware of Environment and health impacts solid waste mismanagement

CO3 Understand engineering, financial and technical options for waste management and wealth from waste management techniques

CO4 Understand industrial specific wastes and their efficient management

CO5 Describe methods of disposal of hazardous solid waste

CO6 Understand the energy recovery and industrial specific treatment techniques

Mappings of course outcomes with programme outcomes

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

CORE COURSE – VIII

WASTE MANAGEMENT

UNIT I Municipal waste Management Contact Hours 12

Wastes – Introduction, Definition, Sources and Classification (K1 & K2); Municipal Solid Wastes – Source, Types, Per Capita Generation, Global Scenario Wastes (K3); Collection and Transportation Methods, Waste Processing and Material Recovery (TMRF), (K4) Effects of Municipal Solid Wastes on Environment. Disposal Methods- Aerobic and Anaerobic methods (Landfill, Composting, Burning, Incineration, Pyrolysis, Anaerobic Digestion) (K5 & K6)

UNIT II Hazardous & Radioactive Waste Management Contact Hours 10

Hazardous waste – Introduction (K1 & K2), Characteristics (K3), Classification of Hazardous Waste (Industrial, Hospital and Domestic) – Labeling and Handling of Hazardous Solid Wastes (Segregation, Recovery of Hazardous Waste Substances) (K3 & K4) - Hazardous Wastes Disposal Techniques (K5). *Radioactive Wastes*: Sources, Types (K1 & K2), Effects (K3), Control and Disposal Methods (K4 & K5)

UNIT III Biomedical, plastic & e-waste Waste Management Contact Hours 12

Biomedical Wastes: Sources, Types of Biomedical Wastes (K1 & K2), Impacts of Biomedical Wastes on Environment (K3 & K4) – Labeling and transport (K4), Control Measures and disposal of Biomedical Wastes (K5). *Plastic Wastes*: Sources, Types (K1 & K2), Facts & Figures of Plastic Waste Scenarios in National & International (K3, K4), Effects of Plastic Wastes on Environment, Control Measures of Plastic Wastes (K5 & K6). *E-wastes*: Sources, Types of e-wastes (K2) – Impacts of e-wastes on Environment (K3) - Control measures of e-wastes (K4).

UNIT IV Energy Recovery from Wastes Contact Hours 8

Composting, vermicomposting, mushroom cultivation, fly ash bricks, Coir bricks, biogas; Microbial fuel cells - Production of methane, ethanol, electricity (K3, K4 & K5).

UNIT V Industrial Waste Management Contact Hours 8

Paper and Pulp, Tanneries, Textiles, Thermal Power Plants, Mining and Ore Processing, Refineries, Iron Casting, Cement and Asbestos. Waste sludge dewatering and its disposal (K3, K4,K5,K6).

Text Books

1. Kinnaman T C and Takeuchi K (2014) Handbook on Waste Management, Edward Elgar Publishing, UK.
2. Ramesha Chandrappa and Jeff Brown (2012) Solid Waste Management: Principles and Practice, Springer Science and Business Media Publishers.
3. Bhide and Sundaresan (2000) Solid Waste Management in Developing Countries – Indian National Scientific Documentation Center, New Delhi.
4. Basarkar Shishir (2009) Hospital Waste Management: A Guide for Self-Assessment and Review, JAYPEEDIGITAL

5. Surendra Kumar (2009) Solid Waste Management, Northern Book Centre

Reference Books

1. Hieronymi C K, Kahhat R and Williams E (2012) E-waste Management: From waste to resource. Routledge Taylor Francis Group Publishers.
2. Lagrega M D, Buckingham P L and Evans J V (2001) Hazardous Waste Management, McGraw Hill Int. Ed. New York.
3. Lie D H F and Liptak B G (2000) Hazardous Wastes and Solid Wastes, Lewis Publishers, New York
4. John Pitchel (2014) Waste Management Practices, Municipal, Hazardous, and Industrial, 2nd Edition, CRC Press
5. Subramanian M N (2019) Plastic Waste Management Processing and Disposal, 2nd Edition, Scrivener Publishing.

Web References

1. http://www.cpeo.org/techtree/ttdescript/pyrols.htm
2. www.satavic.org/vermicomposting.htm
3. http://web.mit.edu/urbanupgrading/urbanenvironment/sectors/solid-waste-landfills.html
4. www.cement.org/waste/wt_apps_radioactive.asp
5. www.ipma.co.in/recycle.asp
6. linkinghub.elsevier.com/retrieve/pii/S026974910600042X
7. 7.https://www.researchgate.net/publication/42339862_Biomedical_waste_management_An_overview
8. https://aces.nmsu.edu/pubs/_g/G314.pdf
9. http://cbs.teriin.org/pdf/Waste_Management_Handbook.pdf
10. https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/E-Learning/Moocs/Solid_Waste/W2/Solid_waste_management_UNEP_2005.pdf

Experiments for Practical Course

1. Segregation of wastes.
2. Composting techniques of wastes
3. Energy recovery from wastes – methane production
4. Waste utilization techniques for value added products – fly ash bricks, mushroom beds, coir bricks.

CORE COURSE – IX

ENVIRONMENTAL IMPACT ASSESSMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	19UPEVS1C09	100	5	4	1	0	5

Course Objectives

The purpose of this course is to introduce the methodology of environmental impact assessment (EIA) as a vital tool for sound environmental management and decision-making and to provide an overview of the concepts, methods, issues and various forms and stages of the EIA process.

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 about the methods used for EIA studies

CO4 Communicate both orally and in written form the key aspects of EIA

CO5 Understand how to liaise with and the importance of stakeholders in the EIA Process and access different case studies/examples of EIA in practice

CO6 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	*			*	*	*	*	*
CO6	*			*	*	*	*	*

CORE COURSE – IX

ENVIRONMENTAL IMPACT ASSESSMENT

UNIT I Introduction to EIA Contact Hours 12

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

UNIT II EIA Methodologies Contact Hours 10

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

UNIT III Public Participation, Preparation and Review of EIA Report Contact Hours 10

Objectives of People's Participation - Advantages and Disadvantages of People's Participation - People's Participation Techniques: Public Hearing - Preparation and Review of EIA Report: EIA Reports Content - Basis and Criteria for Evaluation of EIA Reports and EIA (K2, K3 & K4)

UNIT IV EIA case studies for major development projects Contact Hours 08

Major Highways Projects - Airport - River valley Projects – Mining and quarrying - Thermal and Hydroelectric Power Projects - Cement Industries (K3, K4, K5 & K6)

UNIT V Environmental Management System Contact Hours 12

Environmental Management System: Core elements of EMS - Benefits of EMS - Certification body assessments of EMS - Documentation for EMS – ISO 14001 standard – PDCA (Plan-Do-Check-Act) in ISO 14001 Certification – Corporate Social Responsibility (CSR) Plan in India (K4, K5 & K6)

Text Books

1. Canter LW (1996) Environmental Impact Assessment. McGraw Hill, New York.
2. EIA Manual (2001) Ministry of Environment, Forest and Climate Change, New Delhi.

Reference Books

1. Anjaneyulu Y and Valli Manickam (2007) Environmental Impact Assessment Methodologies, 2nd Edition, B.S. Publications (ISBN: 978-81-7800-144-9).
2. Bregman JI (1999) Environmental Impact Statements. Lewis Publishers, London.
3. Carroll B, Fothergill J, Murphy J and Turpin T (2019) Environmental Impact Assessment Handbook: A practical guide for planners, developers and communities. ICE Publishing.
4. Christopher S and Mark Y (2007) Environmental Management Systems, (third edition), Earthscan Publications, First South Asian Edition.

5. David L G and Stanley B D (2001) ISO 14000Environmental Management, Prentice Hall.
6. Eccleston C H (2000) Environmental Impact Assessment - A Comprehensive Guide to Project and Strategic Planning, John Wiley and Sons, NY.
7. Hart SL (2019) Improving impact assessment: Increasing the relevance and utilization of scientific and technical information. Routledge.
8. Peter Wathern (2015) Environmental Impact Assessment: Theory and Practice, Taylor & Francis, London
9. Singleton R, Castle, P and Sort, D (1999) Environmental Assessment, Thomas Telford Publishing, London.
10. Whitelaw K and Butterworth (1997) ISO 14001: Environmental System Handbook.

Journal articles

1. Chowdhury, N. (2014). Environmental impact assessment in India: Reviewing two decades of jurisprudence. IUCN Academy of Environmental Law eJournal, 5, 28-32.
2. Singh, G. G., Lerner, J., Mach, M., Murray, C. C., Ranieri, B., St-Laurent, G. P.... & Chan, K. M. (2020). Scientific shortcomings in environmental impact statements internationally. People and Nature, 2(2), 369-379.

Web References

1. http://environmentclearance.nic.in/
2. www.fao.org/docrep/V8350E/v8350e06.htm
3. http://www.moef.nic.in/division/eia-manual
4. http://www.moef.nic.in/circulars
5. https://www.adb.org/documents/adb-environmental-assessment-guidelines
6. http://environmentclearance.nic.in/writereaddata/Draft_EIA_2020.pdf
7. http://environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/ GuidanceManual.htm

Experiments for Practical Course

1. Preparation of EIA report for environmental clearance (EC)
2. Preparation of checklists for EIA study

CORE COURSE – X

ENVIRONMENTAL BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	19UPEVS1C10	100	5	4	1	0	5

Course Objectives

The purpose of this course is to acquaint students with knowledge in environmental biotechnology for gene cloning, to acquire skills in bioremediation of environmental pollutants, to apply the skills in developing innovative biotechnological processes for waste conversion, resource recovery, and production of bioproducts bioresources.

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 bioremediation of environmental pollutants.

CO3 Explain the role of microbes in degradation of environmental pollutants

CO4 Acquire skills in manipulating the microbes for biodegradation of pollutants

CO5 Develop processes for waste bioconversion to value-added products.

CO6 Apply the process for recovery of resources from different wastes.

CO7 Become an entrepreneur/researcher in the areas of environmental biotechnology.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2	*	*						
CO3			*					
CO4	*	*	*	*			*	
CO5		*				*		
CO6	*					*		
CO7		*					*	*

CORE COURSE – X

ENVIRONMENTAL BIOTECHNOLOGY

UNIT I Structure and DNA Modifying Enzymes Contact Hours 12

Introduction to Biotechnology - Organization of Bacterial Genome - Structure of DNA – Restriction Enzymes: Nomenclature - Classification - Restriction and Methylation - Type II Restriction Endonuclease - Use of Restriction Endonucleases - Restriction Mapping and its Applications - DNA Modifying Enzymes - Nucleases - Polymerases - DNA Ligases. (K1, K2, K3)

UNIT II Gene Cloning and PCR Techniques Contact Hours 10

Gene Cloning - Overview, Cloning vectors - Plasmids, phages and cosmids, phagemids, Ti plasmids and viral vectors M13 - Cloning strategies, cloning and selection of individual genes – PCR - Working principle, types and applications. Environmental genome (K1, K2, K3).

UNIT III Environmental Applications Microbes Contact Hours 10

Use of microbes in environmental decontamination - Biodegradation - Biosorption - Biotransformation - Bioaugmentation - Biostimulation - Rhizoremediation, Mycoremediation - Phycoremediation - Bioleaching and Biomining - MEOR - Bioremediation pollutants: Heavy metals, PAHs, VOCs - Bioindicators and biosensors for detection of pollution (K1, K2, K3).

UNIT IV Biotechnology for Waste Treatment Contact Hours 10

Biotechnology for Waste Management - Sewage treatment - Activated Sludge Process - Anaerobic Treatment - Sludge stabilization - Aerobic Composting, Anaerobic Digestion, Biogas Production, Algal Cultivation: Nutrient Removal. Solid Waste Treatment - Biocomposting - Vermicomposting - Air Pollution Control - Bioscrubber, Biofilters (K3, K4, K5, K6).

UNIT V Microbial Bioproducts Contact Hours 10

Microbial bioproducts for environmental cleanup - Microbial biomass - Biosorbents - Biosurfactants - Microbial enzymes: lignocellulases, lipases, dioxygenases - Bioflocculants - Bioplastics - Biofertilizers - Biopesticides - Microbial fuels: Bioethanol, Biobutanol, and Biohydrogen (K4, K5, K6).

Text Books

1. Mohapatra P K (2008) Text Book of Environmental Biotechnology. IK International Publishers Ltd
2. Thakur I K (2013) Environmental Biotechnology: Basic Concepts and Applications. 2nd Edition.
3. Brown T A (1995) Gene cloning - A introduction - Chapman & Hall, London.

CORE COURSE – X

ENVIRONMENTAL BIOTECHNOLOGY

Reference Books

1. Alexander N Glazer and Hiroshi Nikaido (1995) Microbial Biotechnology, WH Freeman and Company, NY, USA.
2. Bernaral R. Glick and Jack J. Pastemak (1994) Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM Press. Washington, DC USA.
3. Brown T A (1995) Gene cloning - A introduction - Chapman & Hall, London.
4. Kreuzer and Massey (2001) rDNA & Biotechnology. A guide for Teachers, 2nd Edition, ASM Press, Washington DC, USA.
5. Old R W and Primrose S B (1994) Principles of Gene Manipulation. Blackwell Scientific Publications, Oxford, UK.
6. Primrose SB (1994) Molecular Biotechnology, 2nd edition, Blackwell Scientific Publications, UK.
7. Singh D P and Dwivedi S K (2005) Environmental Microbiology and Biotechnology. 1st Edition, New Age International (P) Ltd., Publishers, New Delhi.
8. Fulekar M H (2010) Environmental Biotechnology, CRC Press.
9. Cheremisinoff N P (1997) Biotechnology for Waste and Wastewater Treatment. Science Direct.

Web References

1. www.microbialfuelcell.org
2. www.pollutionissues.com/A-Bo/Bioremediation.html
3. www.bioreactors.net
4. http://enhs.umn.edu/current/5103/gm/harmful.html
5. www.wastewatertreatment.co.in/index.php
6. http://archive.industry.gov.au/Biotechnologyonline.gov.au/enviro/environment.html
7. https://preventioncdnndg.org/eco-quartier/biomethanization-2/
8. https://www.nrel.gov/workingwithus/learning.html
9. https://www.epa.gov/recycle/composting-home
10. https://www.epa.gov/remedytech/green-remediation-best-management-practices-bioremediation

Experiments for Practical Course

1. Isolation of Genomic DNA and Agarose Gel Electrophoresis.
2. DNA Restriction Analysis and Mapping.
3. PCR Amplification of Bacterial 16S rRNA gene.
4. Biodegradation of organic pollutants - Phenol, Synthetic Dyes.
5. Aerobic treatment of wastewater.
6. Sewage sludge conditioning and sludge dewatering.
7. Production of Biosurfactants.
8. Biocomposting of sewage sludge.
9. Production of Microbial enzymes - Cellulase / Protease / Lipase / Ligninases.
10. Production of Biofertilizer - Rhizobium, Azotobacter.

CORE COURSE – XI

RESEARCH METHODOLOGY AND INSTRUMENTATION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	19UPEVS1C11	100	5	4	1	0	5

Course Objectives

The purpose of this course is to acquaint students about various types of research methods, instruments and their working principles, data process, report generation and to train the students to handle various research instruments.

Course Outcomes

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

CO1 Know the types of research and scientific databases, report writing and plagiarism.

CO2 Chose the research that they want to carryout.

CO3 Identify and design their research problems.

CO4 Understand the principles of research methods and instruments required for their research experiments.

CO5 Apply their knowledge on instrumentation for environmental analysis, and field works and data collection.

CO6 Apply the software's and statistical analysis methods and data interpretation.

Mappings of course outcomes with programme outcomes

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

CORE COURSE – XI

RESEARCH METHODOLOGY AND INSTRUMENTATION

UNIT I Research Methods **Contact Hours 8**

Basics of Fundamental and Applied Research, Types, scope, hypothesis. (K1, K2) Concept of research articles, research papers, reviews, scientific popular articles; Components of a Research Article (title, author-line, address, abstract, summary, hypothesis, keywords, introduction, methodology, observations, discussion, conclusion, citing relevant work of others); Reference protocols; Copyright Act (in brief), Plagiarism, Cheating / academic frauds; process of reviewing; Concept of Impact factor; H-Index, i-10 index and SCI Impact factor for journals. (K1, K2, K3)

UNIT II Basic Analytical Equipments **Contact Hours 8**

Principle, Working mechanism and environmental applications of pH Meter, Conductivity meter, Nephlometer. (K1, K2, K3) Basic principles and applications of light and electron microscopes. Types, function and applications of centrifuges. (K4, K5) Principle, types and environmental application of elctrophoretic techniques and radio immune assay techniques. (K4, K5)

UNIT III Spectroscopy Methods **Contact Hours 12**

Electromagnetic radiation - Interaction of electromagnetic radiation with matter, Spectrophotometry - Principles and working mechanism, types and applications of Colorimeter, UV-Visible spectrophotometer, Fluorimeter, Flame photometer, AAS, AES, ICP-MS, IR, NMR spectrophotometer and XRD spectrometer. (K3, K4, K5)

UNIT IV Chromatography & Mass Spectrometry **Contact Hours 12**

Principle and concept of chromatography- stationary phase, mobile phase, partition and adsorption, coefficients. (K1, K2, K3) Working principle, instrumentation and environmental applications of Thin layer and Ion exchange chromatography, HPLC, HPTLC, LC-MS, and GC-MS 9 (K4, K5, K6)

UNIT V Statistical Analyses **Contact Hours 10**

Statistical Analysis: Sampling Methods and Data Collection – Questionnaire Survey, Experiments and Field works. (K3, K4) Measures of central tendency: Mean, Median and Mode- Merits and demerits. Measures of dispersion: Range, Standard Deviation, Variance, Skewness and Kurtosis; Distribution- Normal, *t* test and *chisquare* test, Difference among means - ANOVA. (K3, K4, K5) Correlation and Regression - Linear and Multiple. Introduction to statistical Softwares (SPSS, R, MATLAB) (K3, K4, K5, K6)

Text Books

1. Rt Kumar (2010) Research Methodology: A Step-by-Step Guide for Beginners, SAGE Pub.
2. Gurumani N (2006) Research Methodology for Biological Science. MJP Publishers.

CORE COURSE – XI

RESEARCH METHODOLOGY AND INSTRUMENTATION

Reference Books

1. Christian G D (2001) Analytical Chemistry, 5th edition, John Wiley and Sons Inc., India
2. Khopkar S M (1993) Environmental Pollution analysis, Wiley Eastern Ltd.
3. Manahan SE (2007) Environmental Chemistry, 7th edition, Lewis Publications, Florida, USA.
4. Banerjee P K (2004) Introduction to Biostatistics. S. Chand and Co., New Delhi.
5. Manly, Bryan F J (2001) Statistics for Environmental Science and Management, Chapman and Hall / CRC Press, Boca Raton, FL, USA.
6. Skoog D A, Holler F J and Nieman T A (1980) Principles of Instrumental Analysis –5th edition, Thomson Asia Pvt., Singapore.
7. Vogel A I (1998) Quantitative Analysis, 6th edition, Prentice Hall Inc., Willard H H, Merrit L L and Dean J A (1976) Instrumental Methods of Analysis, 5th edition, Van Nostrand Reinhold.
8. Rastogi V B (2007) Fundamentals of Biostatistics. Ane Books India, New Delhi.
9. Wilson K and Walker J (2010) Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, Cambridge University Press.

Web References

1. https://www.bio.umass.edu/biology/forms/content/499e-research-methodology
2. www.computerhope.com/os.htm
3. http://www.fao.org/docrep/005/ac665e/ac665e05.htm#TopOfPage
4. http://www.rss.hku.hk/plagiarism/page2s.htm
5. https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/bes2.1258
6. www.fao.org/docrep/W7295E/w7295e08.htm
7. https://chemistrynotesblog.wordpress.com/seperation-techniques/introduction-to-separation-techniques-2/
8. https://www.epa.gov/sites/production/files/2015-05/documents/402-b-04-001b-14-final.pdf
9. https://en.wikibooks.org/wiki/Proteomics/Protein_Identification_-_Mass_Spectrometry/Types_Mass_Spectrometry

Experiments for Practical Course

1. Preparing a scientific report and plagiarism checking.
2. Measurement of Turbidity using Nephlometer.
3. Demonstration of ICP-MS and heavy metals analysis.
4. Nanomaterials characterization using XRD.
5. Quantification of organic pollutants using HPLC.
6. Quantification of organic pollutants using GC-MS.
7. Statistical Data Analysis – Mean, Standard Deviation, Standard Error
8. Statistical Data - Analysis of Variance (ANOVA)

CORE COURSE - XII

ENVIRONMENTAL LAWS AND POLICIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	19UPEVS2C12	100	5	4	1	0	5

Course Objectives

The purpose of this course is to introduce the students to the vast field of Laws and Policies both at the national and international level relating to environment.

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 Have an insight into major acts and rules applicable for pollution control and natural resource conservation.
CO3 To develop the skills needed for interpreting laws, policies and judicial decisions about the environment.
CO4 Know regulations applicable to industries and other organizations with significant environmental aspects.
CO5 Apply the legislation concepts for solving the local environmental problems.
CO6 Get knowledge of the legal system operating in India.
CO7 Be in a position to prepare compliance reports for getting environmental clearance
CO8 Prepare the environmental management system for an organization.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1				*		*		
CO2				*				
CO3						*		*
CO4				*		*		
CO5						*		
CO6							*	
CO7				*				*
C08						*		*

CORE COURSE - XII

ENVIRONMENTAL LAWS AND POLICIES

UNIT I Environmental Legislation **Contact Hours 12**

Definition of environment and pollutants, central and state boards for the prevention and control of environmental pollution, powers and functions of pollution control boards, penalties and procedure, duties and responsibilities of citizens for environmental protection. (K1, K2)

UNIT II Laws and Acts guarding **Contact Hours 10**

Wildlife Protection Act 1972, The Water (Prevention and Control of Pollution) Act 1974. Prevention and Control of Air Pollution Act 1981, Forest Conservation Act 1981, Environment (protection) Act 1986, Hazardous waste (Management and Handling) Rules, 1989, Bio-Medical Waste (Management and Handling) Rules, 1998. Issues involved in enforcement of environmental legislation, public awareness, public interest litigations (PILs) and its role in control of environmental pollution in India. (K1, K2, K3)

UNIT III Environmental Movement in India **Contact Hours 10**

Movements related to Environment Sacredgroves, Bishnoi tradition, Chipko movement, Tehridam, Sardar Sarovar, Narmada dam, Almatti dam, Silent Valley. Supreme Court Cases – Ratlam Municipality, Ganga Action Plan, Taj Trapezium, Delhi CNG, Tamil Nadu Tanneries, Doon Valley, Span motels private limited case, Oleum gas case (K1, K2, K3)

UNIT IV International Environmental Treaties and Conventions **Contact Hours 10**

StockholmConferenceonHumanEnvironment,1972, Ramsar Convention on Wetlands 1971, Montreal Protocol, 1987, Basel Convention (1989,1992), Earth Summit at Rio de Janeiro 1992, Kyoto Protocol 1997, Earth Summit at Johannesburg 2002. Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade 21, Convention on Desertification 1996, Convention on Biodiversity & Cartagena Protocol on Biosafety (K1, K2, K5, K6)

UNIT V Major Initiatives/Policies **Contact Hours 8**

Issues involved in enforcement of environmental legislation, public awareness, public interest litigations (PILs) and its role in control of environmental pollution in India. (K4, K5, K6)

Text Books

1. Leelakrishnan P (2000) Environmental Law in India, Butterworths India Publishers.
2. Maheshwara Swamy N (2010) Textbook on Environmental Law, Asia Law House Publishers.
3. Environmental Administration & Law - Paras Diwaa.
4. Environmental Planning, Policies & Programs in India - K.D. Saxena.
5. Shyam Divan and Armin Rosencranz, 2005, Environmental Law and Policy in India, Oxford University Press, New Delhi.
6. Leelakrishnan P (2008) Environmental Law Case Book, Lexis Nexis, Butterworths.

7. Mohanty S K (2011) Environment and Pollution Law, Universal Law Publishing Co. Pvt. Ltd.
8. Shastri S C (2008) Environmental Law, (2nd Edn.), Eastern Book Company, Lucknow.
9. Singh Gurdip (2004) Environmental Law in India, McMillan & Co.
10. Shantakumar S (2005) Introduction to Environmental Law, (2nd Edn.), Wadhwa & Company, Nagpur.
11. Sahasranaman P B (2008) Handbook of Environmental Law in India, Oxford University Press (India).

Reference Books

1. Gurudeep Singh (2005) Environmental Law in India, McMillan, New Delhi.
2. Shyam Diwan and Armin Rosencrany (2001) Environmental Law and Policy in India, Oxford University Press, New Delhi.
3. Singh G (1995) Environmental Law: International & National Perspectives.
4. Tamil Nadu Pollution Control Board (1999) Pollution Control Legislation Vol. I and II, Chennai.
5. Maheshwara Swamy (2008) Textbook on Environmental Law, (2nd Edn.), Asia Law House, Hyderabad,
6. Khan I A (2002) Environmental Law, (2nd Edn.), Central Law Agency, Allahabad.
7. Asthana D K and Meera Asthana (2001) Environment Problems and Solutions, (2nd Edn.), S. Chand & Co. Ltd., New Delhi.
8. Shantakumar S (2005) Introduction to Environmental Law, (2nd Edn.), Wadhwa & Company, Nagpur.
9. Shastri S C (2008) Environmental Law, (3rd Edn.), Eastern Book Company, Lucknow.

Web References

1. cpcb.nic.in/
2. www.tnpcb.gov.in/
3. www.thesummitbali.com/
4. envfor.nic.in/legis/legis.html
5. edugreen.teri.res.in/explore/laws.htm
6. envfor.nic.in/legis/crz/crznew.html
7. rti.gov.in/
9. www.ngosindia.com/resources/pil.php

Practicals - Environmental Laws and Policies

1. Case studies on effective utilization of environmental laws: oil refineries, petrochemical industry.
2. Comparative analysis of various mega building projects and its impact assessment.
3. Impact assessment of green belts.
4. Visits-sanctuaries, reserves
5. Pollution Control Board Visits and Reports.

CORE COURSE - XIII

ENVIRONMENTAL HEALTH AND SAFETY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	19UPEVS1C13	100	5	4	1	0	5

Course Objectives

Introduction to basic principles of environmental health and safety practices and creating awareness of public and occupational health and 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 of the Industrial pollution and chemical safety in public exposure from industrial sources, Hazards by industry major chemical contaminants at workplace. Industrial environmental accidents.

CO3 Knowledge of understand the Environmental Disease present study in Fluorosis and Allergies; Epidemiological issues.

CO4 Knowledge of understand course will equip student with basic knowledge on safety issue related with explosion, pollutant release in water and air, and to implement measure during outbreak of flu epidemic at work place.

CO5 Knowledge of understand of occupational Safety and Health. Principles and methods of occupational health, Health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals, Health hazard in agriculture - Pesticides and environment, Pesticides and human health.

CO6 Disease ecology with special reference to vector and water borne diseases Genotoxicity and epigenetic approach Occupational toxicology and health Xenobiotics and endocrine disruption

Mappings of course outcomes with programme outcomes

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

CORE COURSE - XIII

ENVIRONMENTAL HEALTH AND SAFETY

UNIT I Environmental Health **Contact Hours 12**

Environmental health criteria, Scope of International Programme on Chemical Safety (IPCS). Effects of mercury, lead, chromium, cadmium, arsenic and nitrate on human health. Water borne diseases; Prevention and protection of community health from water borne diseases. Air borne bio-allergens; present in the ambient air, seasonal changes, mode of dispersal, disease intensity and control (K1, K2)

UNIT II Industrial Pollution and Chemical Safety **Contact Hours 10**

Extent of industrial pollution, Public exposure from industrial sources, Hazards by industry, Major chemical contaminants at workplace, Industrial environmental accidents. (K2, K3, K4)

UNIT III Occupational Hazards **Contact Hours 10**

Health consequences of different occupations- Anthracosis, Silicosis, Asbestosis; Concept of stress, Stress related diseases, Stress management, Stress, strain and general adaptive syndrome; Industrial Environmental Psychology; Cardio- respiratory response during high altitude acclimatization; Effect of climate on performance, Pandemics. (K4, K5)

UNIT IV Occupational Safety and Health **Contact Hours 10**

Effects of Physical Environment on Accidents, Crime, Suicide and Diseases of Man: Effects of temperature, humidity, ionization, ultra violet radiation and acidity of air on skin, lungs, throat, nose, eye, nervous system. Effects of weather and climate on diseases, mental processes, working efficiency, traffic and industrial accidents, behaviour, suicide and suicide attempts, effect of thermal stress and altitude on the action of drug. (K4, K5, K6)

UNIT V Environmental Health Management **Contact Hours 10**

Occupational health practice: Investigation, monitoring, control, characteristics and hazards of radioactive materials, dispersion of radioactive materials, risk assessment techniques for accidental release of toxic and inflammable materials, hazard analysis, potential risk, conceivable release mechanisms and release rates, fire and explosion hazards and simplified models for their assessment, Examples of occupational health hazards: nasal cancer, asbestosis, bronchitis, heart disease, occupational health services. (K4, K5, K6)

Text 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. Standard Methods for Examination of Water and Wastewater, American Public Health Association (APHA).

4. A comprehensive laboratory manual for Environmental Sciences and Engineering by P.R. Sreemahadevan Pillai. New Age International Publishers.

5. Chemical and biological methods for water pollution studies by R.K. Trivedi
6. Handbook of water and waste water analysis by S.K. Maiti. Soil and air analysis by S.K. Maiti.

Reference Books

1. Monroe T. Morgan (2003) Environmental Health.
2. Koren, H. (2002) Handbook of Environmental Health and Safety.
3. Institution of Occupational Safety and Health, United Kingdom- A Practical Guide, 1993.

Web References

1. www.ehs.ucsb.edu/
2. www.ifc.org/ehsguidelines
3. www.slintec.lk/wp-content/uploads/2011/08/HealthSafetyManual.pdf
4. https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporatesite/sustainability-at-ifc/policies-standards/ehs-guidelines
5. https://www.ncbi.nlm.nih.gov/books/NBK55873/

Practicals- Environmental Health and Safety

1. Population modeling using Leslie's matrix.
2. Case studies on environmental issues and human health: ozone, water resources.
3. Awareness studies on environmental disasters.
4. Basic Hygiene and safety standards.
5. Potable water quality assessment.
6. Study of environmental carcinogens.
7. Experiments on eco-toxicity, genotoxicity and cytotoxicity; *In vitro* toxicity assay.

ELECTIVE COURSE – I

ENERGY AND ENVIRONMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I / II	19UPEVS1E01	100	4	3	1	0	4

Course Objectives

The purpose of this course is to understand the various forms of conventional and non-conventional energy resources and effective utilization of their resources. Further, to explore the knowledge pertaining to various biological energy resources and their feedstocks, conversion technologies and conservation practices.

Course Outcomes

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

CO1 Understand the different types of energy sources and the interrelationship with energy-environment-sustainable development.

CO2 Understand the global fossil fuels energy resources utilization and their impact on environment and economy and need for coal phase out scenario

CO3 Identify the alternative source of energy including nuclear energy resources

CO4 Explore more knowledge related to various renewable energy resources in India and existing novel technologies used for energy conservation in an efficient manner.

CO5 Identify the suitable technologies for green buildings in terms of energy conservation and energy audit for sustainable environmental management

CO6 Understand the recent initiatives and policy framework by different organizations and MNRE, MoEF & CC and other Ministries

Mappings of course outcomes with programme outcomes

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

ELECTIVE COURSE – I

ENERGY AND ENVIRONMENT

UNIT I Energy sources **Contact Hours 10**

Introduction to nexus between Energy, Environment and Sustainable Development (K1 & K2) - Potential and perspectives of various energy sources in India (K3 & K4) - Classification of energy resources - Conventional and Non-conventional, Renewable and Non- renewable energy (K1, K2, K3 & K4) – Environmental implications of energy resources (K4 & K5)

UNIT II Non-renewable Energy Sources **Contact Hours 12**

Fossil fuels (Coal, petroleum, LPG and natural gas) – Composition and Classification of coal, crude oil and natural gas – Consumption and demands of coal, crude oil and natural gas – Environmental and economic impacts of fossil fuel consumption (K3 & K4) – Global coal phase out scenario (K4, K5 & K6) - Nuclear energy – fission and fusion (K1 & K2)

UNIT III Renewable Energy Sources **Contact Hours 14**

Solar, wind, geothermal, hydel and tidal energy sources (K1 & K2) - *Ocean Thermal Energy Conversion (OTEC)*: Principle and generation (K3 & K4) – Global energy consumption pattern – Applications of solar and wind energy - Present scenario and recent initiatives of renewable energy sources in India (K4, K5 & K6)

UNIT IV Waste to Energy **Contact Hours 10**

Bioenergy - Biomass energy as an energy source - Characteristics of biomass (K1 & K2) - Energy plantations - Biomass conversion technologies (K3 & K4) - *Types of biofuels*: Biodiesel, bioethanol, biogas, biohydrogen - Importance, production, technologies and applications (K4, K5 & K6) - India's Bioenergy Policy (K3 & K4)

UNIT V Energy Conservation **Contact Hours 08**

Energy conservation – Principles and approach (K1 & K2) - Energy conservation in buildings - Green buildings - Solar passive architecture, eco-housing (K3, K4, K5 & K6) - Energy audit (K4 & K5) - National and International norms (K2)

Text Books

1 Anuja Dahiya (2015) Bioenergy - Biomass to Biofuels. Academic Press, UK.

2 Balasubramanian Viswanathan (2017) Energy Sources. Fundamentals of Chemical Conversion Processes and Applications. Elsevier, Netherlands.

3 Bansal N K (2014) Non-Conventional Energy Resources, Vikas Publishing House Pvt Ltd., New Delhi.

4 Bhatia S C and Gupta R K (2018) Textbook of Renewable Energy. Woodhead Publishing India Private Limited, New Delhi.

5 Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala (2019) Fundamentals and Applications of Renewable Energy. McGraw-Hill Education.

6 Sawhney GS (2012) Non-Conventional Energy Resources, PHI Learning Private Limited, New Delhi.

ELECTIVE COURSE – I

ENERGY AND ENVIRONMENT

Reference Books

1. David B. Rutledge (2020) Energy: Supply and Demand. Cambridge University Press, UK.
2. Ehrlich R (2013) Renewable Energy. A First Course. CRC Press, Boca Raton, USA.
3. Galanakis CM (2020) Biobased Products and Industries. Elsevier, Netherlands.
4. Jacobson MZ (2020) 100% Clean, Renewable Energy and Storage for Everything. Cambridge University Press, UK.
5. Mitra M and Nagchaudhuri A (2020) Practices and Perspectives in Sustainable Bioenergy. A Systems Thinking Approach. Springer Nature India Private Limited.
6. Nikolay Belyakov (2019) Sustainable Power Generation. Current Status, Future Challenges, and Perspectives. Academic Press, UK.
7. Pandey A, Larroche C, Dussap C-G, Gnansounou, Khanal SK and Ricke S (2019) Biofuels: Alternative Feedstocks and Conversion Processes for the Production of Liquid and Gaseous Biofuels. Academic Press, UK.
8. Simon CA (2020) Alternative Energy. Political, Economic and Social Feasibility. Second Edition, Rowman & Littlefield, USA.
9. Thomas L (2020) Coal Geology, Third Edition, Wiley.
10. Tyagi H, Chakraborty PR, Powar S and Agarwal AK (2020) Solar Energy. Systems, Challenges, and Opportunities. Springer Nature Singapore Pte Ltd.

Journal Articles

1. Alalwan H A, Alminshid A H and Aljaafari H A (2019). Promising evolution of biofuel generations. Subject review. *Renewable Energy Focus*, 28, 127-139.
2. Bhagea R, Bhoyroo V and Puchooa D (2019). Microalgae: the next best alternative to fossil fuels after biomass. A review. *Microbiology Research*, 10(1).
3. Gong J, Li C and Wasielewski MR (2019) Advances in solar energy conversion. *Chemical Society Reviews*, 48(7), 1862-1864.
4. Lu M and Lai J H (2019) Building energy: a review on consumptions, policies, rating schemes and standards. *Energy Procedia*, 158, 3633-3638.
5. Srivastava R K, Shetti N P, Reddy K R and Aminabhavi T M (2020). Biofuels, biodiesel and biohydrogen production using bioprocesses. A review. *Environmental Chemistry Letters*, 1-24.
6. Vargas S A, Esteves G R T, Maçaira P M, Bastos B Q, Oliveira FLC and Souza RC (2019). Wind power generation: A review and a research agenda. *Journal of Cleaner Production*, 218, 850-870.
7. Wang H, Lei Z, Zhang X, Zhou B and Peng J (2019). A review of deep learning for renewable energy forecasting. *Energy Conversion and Management*, 198, 111799.

Web References

1. https://www.iea.org/reports/global-energy-review-2020.
2. https://climateanalytics.org/media/report_coal_phase_out_2019.pdf
3. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC111438/acd_in_metis_final.pdf
4. https://www.worldgbc.org/what-green-building
5. https://beeindia.gov.in/sites/default/files/ctools/TR-EnergyAudits.pdf

ELECTIVE COURSE – II

ECOTOURISM ECO-TOURISM AND WILD LIFE MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I / II	19UPEVS1E02	100	4	3	1	0	4

Course Objectives

To understand the principles and importance of ecotourism, to learn the impacts and management practices of ecotourism. To know about the impacts and management issues of ecotourism

Course Outcomes

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

CO1 Know the principles and concept of ecotourism
CO2 Able to understand the types and benefits of ecotourism
CO3 Know interesting places of ecotourism
CO4 Evaluate the impacts of ecotourism on the environment
CO5 To understand the different parts of ecotourism in India
CO6 Relate wildlife resources with Ecotourism
CO7 Acquire the knowledge on management of Ecotourism

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*				*			
CO2					*			
CO3					*			
CO4						*		
CO5					*			
CO6				*				
CO7								*

UNIT I Introduction to Ecotourism **Contact Hours 12**

Principles of Ecotourism – Types of Ecotourism – Concepts of Ecotourism – Origin of Ecotourism – Objectives of Ecotourism – Benefits of Ecotourism – Trends affecting Ecotourism. Concepts of Tourism - Classification – Religious Tourism – Cultural Tourism – Heritage Tourism – Monumental Tourism – Adventure Tourism – Mass Tourism – Sustainable Tourism – Consumptive and Non-Consumptive Tourism (K1, K2)

UNIT II Interesting Eco-tourism **Contact Hours 12**

Places of interests of Ecotourism – Ecocircuit of the Western Ghats – Infrastructural facilities for Ecotourism – Maintenance of Ecological Centers –

ELECTIVE COURSE – II

ECOTOURISM ECO-TOURISM AND WILD LIFE MANAGEMENT

Important Biosphere Reserves. Target group of Ecotourism – Ecotourism and Conservation – Study of different Ecosystem – Rainforest Ecotourism – Mountain Ecotourism – Polar, Islands and Coasts Ecotourism – Wilderness – Marine Ecosystem. (K2, K5, K6)

UNIT III Impact of Eco-tourism **Contact Hours 10**

Impact of Ecotourism – Economic Impacts (Fiscal Impacts, Concept and Methods) – Types and Degree of Impacts from Ecotourism activities – Socio-cultural Impacts – Ecotourism related organization – Ecotourism Research - Disasters and Ecotourism (K5, K6)

UNIT IV Wildlife Conservation **Contact Hours 10**

Wildlife conservation - Protected Areas Network in India - Goals of management, Strategies for planning. Factors influencing wildlife management such as habitats, population, behaviour, food habits, health, etc. - Tools for data collection and analysis. (K1, K2, K3)

UNIT V Wildlife Management **Contact Hours 10**

Human land-use and wildlife management units - Important projects for the conservation of wildlife in India - Role of local communities in wildlife management – Man-wildlife conflicts - Poaching of wildlife - Wildlife conservation laws - The Wildlife (Protection) Act, 1972 (2002 amendment). (K4, K5, K6)

Text Books

1. Dasman R F (1968) Environmental Conservation: John Wiley and Sons, New York.
2. Mukherjee N (2008) Ecotourism and Sustainable Development. Cybertech Publications, New Delhi.

Reference Books

1. Agarwal A N (1980) Indian Agriculture, Vikas Publishing House, New Delhi.
2. Weaver D B (2001) The Encyclopedia of Ecotourism, CABI, Publishing.
3. Sinha P C (2003) Encyclopedia of Ecotourism, Vol-I, II & III, Anmol publications Pvt. Ltd, New Delhi.
4. Bhatia A K (1978) Tourism in India, Sterling Publishers, New Delhi.

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

ELECTIVE COURSE – IX

ENVIRONMENTAL NANOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I / II	19UPEVS1E03	100	4	3	1	0	4

Course Objectives

The purpose of this course is to provide background, principles, development of nanomaterials and their applications pertaining to remediation of environmental contaminants, water purification, and to understand the impact of nanomaterials on environment.

Course Outcomes

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

CO1 Understand the background about on nanotechnology and its importance
CO2 Understand different types of nanomaterials and their use
CO3 Obtain knowledge on synthesis the nanomaterials by different methods
CO4 Acquire knowledge on characterization and properties of the nanomaterials
CO5 Understand the application nanomaterials for degradation of environmental pollutants
CO6 Apply knowledge and skills in nano remediation, and water purification
CO7 Understand the impact of nanomaterials on environment.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*						
CO2		*						
CO3		*						
CO4			*					*
CO5			*		*			
CO6		*	*			*	*	*
CO7		*			*	*		

ELECTIVE COURSE – IX

ENVIRONMENTAL NANOTECHNOLOGY

UNIT I Introduction to Nanotechnology Contact Hours 08

Introduction to Nanoscience and Nanotechnology - Nanoscale Properties - Electrical, Optical, Chemical - Engineered Nanomaterials - Carbon based nanomaterials (K1, K2) - Fullerins, Carbon Nanotubes; Metal based Nanomaterials - Metal and Metal oxide Nanoparticles; Dendrimers - Nanocomposites - Nonporous materials. (K1, K2)

UNIT II Synthesis of Nanomaterials Contact Hours 12

Introduction to synthesis of nanomaterials - Bottom-up approach - Top-down approach - Physical methods - ball milling, melt mixing, physical vapour deposition, sputter deposition, evaporation; Chemical methods - chemical reduction, sol-gel method, photochemical synthesis, electrochemical synthesis, emulsion synthesis, sonochemical methods, microwave assisted synthesis; Biological methods - Green synthesis of nanoparticles using Bacteria - Fungi -Actinomycetes- Plants and plant metabolites. (K1, K2, K3)

UNIT III Characterization of Nanomaterials Contact Hours 08

Nanomaterials characterization using Spectrometer - UV-Vis, FT-IR, Fluorescence Spectrophotometer, Raman Spectroscopy; Electron Microscopy - TEM, SEM, Cryo-SEM, Scanning Probe Microscopy (AFM, STM), Confocal Microscopy, Diffraction Techniques (XRD, Synchrotron). (K2, K3, K4)

UNIT IV Environmental Applications of Nanomaterials Contact Hours 12

Nanomaterials for environmental remediation – Nanoscale zero-valent iron (NZVI), Titanium dioxide nanoparticles - Bimetallic nanoparticles - Silver nanoparticles - Metal oxide nanoparticles - Nanoadsorbents - Nanocatalysts - Nanoflocculant. Degradation and transformation of environmental pollutants - Halogenated Organic Solvents, Persistent Organic Pollutants, PPCPs, dyes, explosives, toxic heavy metals - arsenic and chromium. Nanoremediation - Ground Water Remediation - Permeable Reactive Barrier - Air purification - Soil remediation. (K3, K4, K5, K6)

UNIT V Nanotoxicity and Environmental Impacts Contact Hours 10

Routes of nanomaterials into the water environment, Hazardous effects of nanomaterials on Human and Animal Health (K1, K2). Impacts of nanomaterials on environmental microbial community - bioaccumulation - cytotoxic - genotoxic - effects of engineered nanoparticles. (K4, K5)

Text Books

1. Pradeep T (2012) A Textbook of Nanoscience and Nanotechnology, Tata McGraw-Hill Education (India).
2. Murty B S, Shankar P, Raj B, Rath B B, and Murday, J (2013) Textbook of Nanoscience and Nanotechnology.

Reference Books

1. Pradeep T (2008) Nano: The Essentials - Understanding Nanoscience and Nanotechnology, Tata Mc. Graw Hill Professional.
2. Rao C N R, Muller A, Cheetham A K (2004) The Chemistry of nanomaterials: Synthesis, Properties and Applications.

3. Niemeyer C M, Mirkin C A (2004) Nanobiotechnology: Concepts, Applications and Perspectives, Wiley VCH.
4. Mirkin C A, Niemeyer C M (2007) Nanobiotechnology - II more concepts and applications, Wiley VCH.
5. Z.hang T C, Hu Z, Surampalli R, Tyagi R D, Lai K C K, and Lao I Mc (2009) Nanotechnologies for Water Environment Applications. American Society of Civil Engineers (ASCE) Publications.
6. Mark Wiesner and Jean-Yves Bottero (2007) Environmental Nanotechnology: Applications and Impacts of Nanomaterials, McGraw, Hill Professional.
7. Simeonova P P, Opopol N, and Luster M.I. (2006) Nanotechnology - Toxicological Issues and Environmental Safety, Springer.
8. Poole C P, Jr. Owens F J (2003) Introduction to Nano Technology Wiley India Pvt. Ltd.

Web References

1. http://www.gogreenmechanisms.com/service/environment-audit/
2. http://cpcbenvis.nic.in/scanned%20reports/PROBES%2050%20Guidelines%20for%20Environmental%20Audit.pdf
3. http://kb.icai.org/pdfs/PDFFile5b28e322df0fd2.63902464.pdf
4. https://www.sciencedirect.com/topics/engineering/ecodesign
5. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/cleaner-production
6. https://www.gdrc.org/sustdev/concepts/02-c-prod.html
7. http://www.cprac.org/en/sustainable/production/cleaner
8. https://isoconsultantkuwait.com/2019/06/21/iso-140012015-environment-management-system/

ELECTIVE COURSE – IV

ENVIRONMENTAL ENGINEERING

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I / II	19UPEVS1E04	100	4	3	1	0	4

Course Objectives

The purpose of this course is to teach the students about the background of engineering principles, designs and methods to solve the environmental problems like wastewater treatment, sludge stabilization and biogas production, and to monitor environmental pollutants.

Course Outcomes

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

CO1 Understand the complex environmental issues use of various engineering strategies to apply to solve environmental issues

CO2 Understand the basic principles and methods of environmental engineering

CO3 Identify the suitable treatment methods for wastewater treatment and sludge stabilization

CO4 Understand the process of biogas production from sewage sludge.

CO5 Use their acquired knowledge to design the reactors for sewage and sludge treatment.

CO6 Monitor the environmental pollutants and control the treatment process

Mappings of course outcomes with programme outcomes

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

ELECTIVE COURSE – IV

ENVIRONMENTAL ENGINEERING

UNIT I An Overview of Wastewater Treatment and Disposal Contact Hours 10

Environmental sanitation, wastewater - wastewater quantity and quality-characteristics - treatment required - preliminary, primary, secondary, and tertiary treatments - sedimentation - effluent disposal - chlorination - sludge stabilization - biosolids. (K1, K2) Sewer system - design of sewers, estimation of sewage flow, sewage collection, and odour control. (K3, K4)

UNIT II Pre and Primary Wastewater Treatment Plant Contact Hours 8

Principle and design of screening, equalization tank, grit chambers, rectangular and circular coagulation and flocculation tank, sedimentation tank. Chemically Enhanced Primary Treatment (CEPT) - Design for a Small Community level. (K2, K3, K5, K6)

UNIT III Aerobic Treatment of Wastewater Contact Hours 8

Principles and design of aerobic biological treatment of sewage - Activated sludge process, Oxidation Ditch, Aerobic lagoons, Trickling filters, Sequencing batch reactors, Fluidized-bed bioreactors - Nutrient removal and pathogen reduction. (K2, K3, K5, K6)

UNIT IV Anaerobic Treatment of Wastewater and Sludge Contact Hours 10

Design of facilities for anaerobic treatment of wastewater and sludge (K5) - Anaerobic digesters and septic tanks, Anaerobic filters, Up-flow anaerobic sludge blanket reactor - Sludge thickening and digestion -Biogas production - Sludge dewatering process, Biosolids - drying and disposal. (K5, K6)

UNIT V Air Pollution and Control Equipments Contact Hours 8

Principle and design of minimum stack height - Settling chamber - Cyclone collector - Fabric filter and Electrostatic Precipitators (ESP) - Bio scrubbers (K4, K5, K6).

Text Books

1. Venugopala Rao P (2002) Textbook of Environmental Engineering PHI Learning Pvt. Ltd
2. Basak N N (2017) Environmental Engineering Tata McGraw Hill Publishing Company
3. Weiner R F and Matthews R A (2003) Environmental Engineering 4th Edition, Butterworth and Heinemann Press.

Reference Books

1. Air Pollution Control Technology Manual (1998) Overseas Environmental Cooperation Center, Japan
2. Anne Maczulak (2010) Environmental Engineering: Designing a Sustainable Future, Infobase Publishing, NY, USA
3. Louis Theodore (2008) Air Pollution Control Equipment Calculations, John Wiley & Sons, NJ, USA.

4. Mihelcic J R, Fry L M, Myre E A, Phillips L and Barkdoll BD (2009) Field Guide to Environmental Engineering for Development Workers - Water, Sanitation, and Indoor Air, American Society of Civil Engineers, USA
5. Pawlowski A, Dudzinska M R and Pawlowski L (2013) Environmental Engineering, CRC Press, Boca Raton, FL, USA
6. Mackenzie L. Davis, David A. Cornwell, (2014) Introduction to Environmental Engineering 5th Edition, McGraw Hill.
7. Nelson D L (2016) Textbook of Environmental Engineering, CBS Publishers
8. Dugal K N (2008) Element of Environmental Engineering, S Chand Publishing.

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1. www.microbialfuelcell.org
2. www.pollutionissues.com/A-Bo/Bioremediation.html
3. www.bioreactors.net
4. http://enhs.umn.edu/current/5103/gm/harmful.html
5. www.wastewatertreatment.co.in/index.php
6. http://archive.industry.gov.au/Biotechnologyonline.gov.au/enviro/environment.html
7. https://preventioncdnndg.org/eco-quartier/biomethanization-2/
8. https://www.nrel.gov/workingwithus/learning.html
9. https://www.epa.gov/recycle/composting-home
10. https://www.epa.gov/remedytech/green-remediation-best-management-practices-bioremediation

ELECTIVE COURSE V

ENVIRONMENTAL ECONOMICS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I / II	19UPEVS1E05	100	4	3	1	0	4

Course Objectives

The purpose of this course is to make the students to learn the basic concepts of environmental economics, and about micro and macroeconomics, to know about cost benefit analysis, economic benefits of environmental resources, to understand the valuation methods and economic analysis of environmental systems.

Course Outcomes

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

CO1 Understand the basic concept and principles of environmental economics

CO2 Learn the concept of micro and macroeconomics and its influential factors

CO3 Knows the cost benefit analysis of the environmental systems and its resources

CO4 Learn about the economic factors and cost benefits of natural resources

CO5 Acquire skills to valuate an environmental system and its regulations

CO6 Apply the knowledge of environmental economics valuation needs

CO7 Become an analyst in in the areas of environmental economics

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*					*	*	*
CO2	*				*			
CO3			*	*				
CO4		*				*	*	
CO5	*				*			
CO6			*	*		*		*
CO7	*						*	*

ELECTIVE COURSE V

ENVIRONMENTAL ECONOMICS

UNIT I Environmental Economics Contact Hours 8

Introduction to Environmental Economics – Central Themes, Ecology, Environment and its Economical Perspectives, Current State of Environment, Sustainable Development: Basic Issues, Concepts, Definitions Approaches, Rules and Indicators. (K1, K2))

UNIT II Micro and Macro Economics Contact Hours 5

Externality, Public goods, Asymmetric Information, Environmental problem as an Externality, Environmental Conservation as a Public Good, Concepts on Green National Income Sustainable Development - Weak notion - Strong Notion, Practising Sustainable Development. (K1, K2, K3)

UNIT III Cost-Benefit Analysis Contact Hours 7

Use of microbes in environmental decontamination - Biodegradation - Biosorption - Biotransformation - Bioaugmentation - Biostimulation - Rhyzoremediation, Mycoremediation - Phycoremediation - Bioleaching and Biomining - MEOR - Bioremediation pollutants: Heavy metals, PAHs, VOCs - Bioindicators and biosensors for detection of pollution. (K1, K2, K3)

UNIT IV Natural Resources Economy Contact Hours 7

Introduction to Damage and Benefit Estimation: Objections to CB Analysis Benefit "Routes" – A Brief Review, Demand shifts: Complementarity, Cost Shifts: Averting, Replacing or Curing Expenditure, Travel Cost and Its Relation to Environmental Quality, Hedonic Pricing, Direct Methods of Benefit Estimation. (K3, K4)

UNIT V Environmental valuation, and Enforcement Contact Hours 5

Theory of Environmental Valuation- Introduction to Methods of Valuation. Theory of Regulation and instruments of Regulation, Elements of a Monitoring and Enforcement System Economics of Monitoring and Enforcement, Major Laws and policies for enforcement. (K5, K6)

Text Books

1. Nick Hanley, Jason F. Shogren and Ben White (2013) Environmental Economics In Theory and Practice, MacMillan Press Ltd. Hampshire.
2. Karpagam M (2019) Environmental Economics: A Textbook, Sterling Publishers.
3. Rabindra N Bhattacharya (2002) Environmental Economics 1st Edition- Oxford Publishers.

ELECTIVE COURSE V

ENVIRONMENTAL ECONOMICS

Reference Books

1. Hanley Shogren and White (1997), Environmental Economics in Theory and Practice, MacMillan India Ltd.
2. Hussen Ahmed M (2000), Principles of Environmental Economics: Economics, Ecology and Public Policy, Routledge, New York. Kadekodi, Gopal K. (2004) Ed." Environment Economics in Practice. Oxford University Press, New York.
3. Kolstad D Charles (2004) Environmental Economics. Oxford University Press, UK.
4. Joshi M V (1995) Theories and Approaches of Environmental Economics, Atlantic Publishers.
5. Stephen Smith (2011) Environmental Economics: A Very Short Introduction, OUP Publishers UK.
6. Philip E Graves (2014) Environmental Economics, An Integrated Approach, CRC Press, UK.
7. Alfred Endres (2010) Environmental Economics - Theory and Policy, Cambridge University Press.

Web References

1. https://www.epa.gov/environmental-economics
2. https://www.pnas.org/content/116/12/5233
3. https://www.nber.org/papers/w18794.pdf
4. https://www.oas.org/dsd/publications/Unit/oea71e/ch05.htm
5. http://ietd.inflibnet.ac.in/bitstream/10603/194/6/15_chapter5.pdf

SUPPORTIVE COURSE – I

ECOLOGY AND ENVIRONMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II / III	19UPEVS1S01	100	3	3	0	0	3

Course Objectives

The purpose of this course is 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 concepts and functions of environment, ecology and ecosystem.
CO2 Understand the different environmental compartments and their structure and functions in ecosystem.
CO3 Obtain more knowledge about population ecology and their inter and intraspecific Relationships.
CO4 Understand the significance and need for environmental protection and sustainability.
CO5 Adequate knowledge on the status of available natural resources and biodiversity and its conservation principles.

Mappings of course outcomes with programme outcomes

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

UNIT I Introduction **Contact Hours 8**

Environmental Science - Definition, Scope and Importance - *Components of the environment*: Atmosphere, Hydrosphere, Lithosphere and Biosphere – Structure and composition - History and scope of Ecology - Terminologies in ecology (K1, K2 & K3)

UNIT II Ecosystem **Contact Hours 10**

Types of ecosystems – Terrestrial and aquatic ecosystems, Structure and functional aspects of ecosystem - Food Chain, Food Web, Energy flows, Ecological pyramids - Productivity of an ecosystem - Biogeochemical cycling - Ecological succession (K1, K2 & K3)

SUPPORTIVE COURSE – I

ECOLOGY AND ENVIRONMENT

UNIT III Population Ecology Contact Hours 10

Population ecology - Levels of Organization, population characteristics - density, natality, mortality, survivorship curves, age distribution, growth curves and models - Population interactions - Co-evolution, Neutralism, symbiosis, commensalism, mutualism, antagonism, antibiosis, parasitism, predation; competition- inter and intra specific (K1, K2 & K3)

UNIT IV Natural Resources Contact Hours 8

Classification and significance of natural resources – Soil, forest, water, wildlife and minerals - Concepts and approaches of natural resource conservation - Natural resources of India - Legal provisions to conserve natural resources in India (K2, K3 & K4)

UNIT V Biodiversity Contact Hours 9

Types of Biodiversity - Species, Genetic, Community and Ecosystem diversity Megadiversity zones and Hot Spots (K2 and K4) - Biodiversity *Conservation*: *In situ* and *Ex situ* conservation measures - *Use of Biodiversity:* Food, medicine, raw material, aesthetic and cultural value – Bioprospecting (K3, K4 & K5)

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.

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. india.gov.in/topics/environment-forest/natural-resources
7. www.jamaicachm.org.jm/BHS/conservation.htm

SUPPORTIVE COURSE – II

ENVIRONMENTAL POLLUTION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II / III	19UPEVS1S02	100	3	3	0	0	3

Course Objectives

The purpose of this course is to gain awareness of environmental pollution and its types, sources, effects, monitoring & 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 To understand the type impacts on environment from each of the pollutant

CO4 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		*	*	*				*

UNIT I Environmental Pollution Contact Hours 6

Environmental pollution – Types (K1& K2), causes and effects (K3) - Sources of pollution – Point and non-point sources (K2 & K3) - Classification of pollutants (K3) - Contaminant types - Control measures and management perspectives for environmental pollution (K4 & K5)

UNIT II Air Pollution Contact Hours 8

Air pollution - Natural and anthropogenic sources of pollution (K1 & K2) - Primary and secondary pollutants (K3) - Transport and diffusion of pollutants - Behavior of pollutants

in the atmosphere (K3 & K4)– Effects on environment - Methods of monitoring and control of air pollution - SO_2, NOx, CO, SPM (K3, K5 & K6).

UNIT III Water Pollution **Contact Hours 8**

Water pollution – Types, sources and consequences of water pollution (K2 & K3) - Physico-chemical and bacteriological sampling (K3 & K4)- Water quality and standards - Sewage and wastewater treatment and recycling (K4). *Marine Pollution*: Sources of marine pollution and its control (K2 & K4) - Effects of pollutants on human beings, plants, and animals (K3 & K4)

UNIT IV Soil Pollution **Contact Hours 6**

Soil pollution - chemical and bacteriological sampling as analysis of soil quality (K3 & K4) - Effects and remediation techniques for Soil pollution 9K4 & K5)

UNIT V Noise and Radiation Pollution **Contact Hours 6**

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

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

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

SUPPORTIVE COURSE – III

ENVIRONMENTAL HEALTH AND SAFETY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II / III	19UPEVS1S03	100	3	3	0	0	3

Course Objectives

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

CO2 Acquire knowledge on the 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 exposures to chemical, physical and biological agents in the workplace.

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

CO6 Understand the significance occupational health, its issues and risk assessment.

Mappings of course outcomes with programme outcomes

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

UNIT I Environmental Health **Contact Hours 5**

Concept and scope; Global and regional perspectives; Basic requirements for healthy environment; Environmental quality, human exposure and health impact – impact of environmental factors on human health. (K1, K2)

SUPPORTIVE COURSE – III

ENVIRONMENTAL HEALTH AND SAFETY

UNIT II Industrial Pollution and Chemical Safety Contact Hours 8

Extent of industrial pollution, Public exposure from industrial sources, Hazards by industry, Major chemical contaminants at workplace, Industrial environmental accidents (K1, K2)

UNIT III Environmental Diseases Contact Hours 7

Asbestosis, Silicosis, Sycosis, Asthma, Fluorosis and Allergies; Epidemiological issues - Malaria and Kala -azar (K, K2, K4)

UNIT IV Occupational Safety and Health Contact Hours 7

Occupational hygiene/ safety and disease; Principles and methods of occupational health, Health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals, Health hazard in agriculture - Pesticides and environment, Pesticides and human health. (K, K2, K4)

UNIT V Environmental Health Hazard and Risk Assessment Contact Hours 5

Hazard and risk, Biological, chemical, physical and psychological health hazard; Health risk assessment and management. (K5, K6)

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

SUPPORTIVE COURSE – IV

GLOBAL ENVIRONMENTAL ISSUES AND MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II / III	19UPEVS1S04	100	3	3	-	-	3

Course Objectives

To focus on major global environmental issues including population explosion, biodiversity loss, pollution, energy use, climate change and best environmental technologies for a 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 Explain the causes and consequences of the issues identified above

CO3 Communicate environmental issues in a professional manner

CO4 Understand how to work in a team in a scholarly and professional setting

Mappings of course outcomes with programme outcomes

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

UNIT I Human Population and Environment Contact Hours 5

Basic demographic concepts: Growth, fertility, mortality and migration - Overview of population growth – Population distribution and Urbanization - Poverty, food security and environmental degradation – Development vs Environment. (K1, K2)

UNIT II Global Atmospheric Changes Contact Hours 10

Global Air Quality and CO_2 concentration scenario -Role of air pollutants in climate change – Sources of greenhouse gases - Ozone depleting substances – Facts and figures of current global warming scenarios in the world - El Niño and La Niña – Global consequences of El Niño (K1, K2)

SUPPORTIVE COURSE – IV

GLOBAL ENVIRONMENTAL ISSUES AND MANAGEMENT

UNIT III Overexploitation of Biological Resources Contact Hours 10

Overexploitation of natural resources: Ecological footprint – Earth Overshoot Day - Water resources: Status of groundwater quality in India – Desertification. Soil Resources: Global threats for soil quality - Loss of organic carbon. Biodiversity Resources: Biodiversity Hot spots in India – Bioprospecting – Factors influencing biodiversity loss. (K1, K2)

UNIT IV Global Disaster Episodes Contact Hours 10

Geological Disasters: Earthquake: Origin of Earthquake, its magnitude and intensity - Earthquake prone zones in India - Effects of earthquake. Volcanoes: Types of volcanic eruptions - Active volcanic belts in the world - Nature and magnitude of volcanic hazards. Hydrological hazards: Flash flood - Flood management strategies - Regions of flood prone zones in India – Flood forecasting and warning – Man -made disasters: Oil spills – Forest fire. (K1, K2)

UNIT V Sustainable Environmental Management Contact Hours 10

Utilization of renewable energy resources – Solar, Wind, Hydroelectric and Biomass energy resources – Phytotechnologies for soil and water decontamination programmes – 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 - The Global 200: Priority Ecoregions for Global Conservation – UNDP Sustainable Development Goals 2030 Agenda. (K4)

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.

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.
3. Prasad Modak (2018) Environmental Management towards Sustainability, CRC Press, FL, USA.
4. PrasenjitMondal 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.

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5. https://www.footprintnetwork.org/our-work/earth-overshoot-day
6. https://www.elsevier.com/__data/assets/pdf.../ElsevierDisasterScienceReport-PDF.pdf
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8. https://link.springer.com/chapter/10.1007/978-981-10-1866-4_2
9. www.ipcc.ch/
10. https://climate.nasa.gov/