MANONMANIAM SUNDARANAR UNIVERSITY TIRUNELVELI – 12

Vision

"To provide quality education to reach the un-reached"

Mission

- To conduct research, teaching and outreach programmes to improve conditions of human living
- To create an academic environment that honours women and men of all races, caste, creed, cultures and an atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity
- To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups.
- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development
- To provide quality / inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressed and differently abled

SRI PARAMAKALYANI CENTRE OF EXCELLENCE IN ENVIRONMENTAL SCIENCES

Vision

The Sri Paramakalyani Centre of Excellence in Environmental Sciences was established in Alwarkurichi in 1992. The genesis of the centre can be traced to the historical judgment of the Hon'ble Supreme Court in the case of M.C.Mehta VS Union of India and others, where the introduction of Environmental Education at undergraduate and postgraduate levels was made mandatory.

The centre faithfully adheres to the vision enshrined in the constitution of India that is" to protect and improve the natural environment including forests, lakes, rivers, and wildlife" and to "develop the scientific temper humanism and spirit of inquiry and reform. To make these lofty ideals the centre envisages developing in-depth knowledge of and technologies suitable for the country.

MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI – 12

PG Course Structure for all University Departments

(Effective from the academic year 2022-2023onwards)

Sri Paramakalyani centre for Excellence in Environmental Science

PG Programme: Environmental Science

The Following Will Be the Course Structure, Scheme and Syllabi

Eligibility:

A candidate shall be eligible for admission to Environmental Science (MSc) course if he/she has obtained Bachelor's degree (B.Sc., Environmental Science, B.Sc., Botany, Zoology, Biotechnology, Microbiology, Biochemistry, Chemistry, Geology, Biosciences, Bioinformatics, Agriculture, Horticulture, Forestry, Environmental Biology, Environmental Management, Pharmacy, BE/B. Tech in Env. Engg/Civil Eng/Chemical Eng, B. V. Sc, B. F. Sc., Wildlife Biology and any other Biological Sciences) or equivalent degree recognized by our University with eligible marks stipulated by ManonmaniamSundaranar University.

NOTE: 1

*Students of M.Sc. Environmental Sciences (CBCS) should select supportive courses offered by other Departments of the University.

DISTRIBUTION OF CREDIT:

CORE	13 X 4	**52**
PRACTICALS (Core)	6 X 2	**12**
ELECTIVES OPTIONALS	3 X 3	**9**
SKILL BASED CORE	1 x 2	**2**
SUPPORTIVE PAPERS	2 X 3	**6**
INDUSTRIAL INTENSHIP	1 X 4	**4**
FIELD WORK	1 X 3	**3**
MINI PROJECT	1 X 3	**3**
PROJECT AND VIVA-VOCE	1 X 6	**6**
TOTAL NO OF CREDITS		**96**
TOTAL NO MARKS		**2800**

1. For each theory paper 25 marks for internal & 75 marks for External.
2. There is no passing minimum for internal examination. Passing minimum for external is 50% and the total passing minimum including external & internal is altogether 50%. For internal marks, the split up is 15 marks for test, 5 marks for seminar and 5 marks for Assignment. The average of all three tests will be taken for test marks.
3. For project valuation 25 marks maximum for internal and 75 marks maximum for external and Viva Voce and thereby the total maximum for project valuation is 100.

   Grant Total for Project + Viva Voce is (25+75) 100 marks.
4. The question paper pattern for theory exam is as follows:

   SECTION A – 10 x 1 mark –10 marks

   (Two questions from each unit)

   SECTION B – 5 X 5marks – 25 marks

   (One question from each unit with either or choice)

   SECTION C – 5 X 8 marks – 40 marks

   (One question from each unit with either or choice)

   Grant Total for Internal + External is (25+75) 100 marks.

5. **PRACTICAL EXAMINATIONS Total: 100 marks.**

   QUESTION PAPER PATTERN

QUESTIONS	**INTERNAL – 50 marks**	**EXTERNAL – 50 marks**	**TOTAL**
1. MAJOR	15	15	30
2. MINOR	10	10	20
3. SPOTTERS	15 (5 spotters, each 3 marks)	15 (5 spotters, each 3marks)	30
4. RECORD	5	5	10
.VIVA-VOCE	5	5	10
TOTAL	**50**	**50**	**100**

6. **Program Outcomes (POs)**

After completion of the program, the students will be able to:

1. Obtain fundamental aspects of earth formation, components of ecosystem, climate change, disaster and mitigation, and increase their knowledge in environmental analysis, modelling and techniques in practical approach. They will learn to operate and handle various Instruments and conversion of waste into useful products.
2. Learn about natural resources and energies including land, and water, biodiversity and its conservation strategies and effects of exploitations. Gain knowledge about environmental pollution and health related hazards and know the various control technologies of pollution and importance of ecotourism.
3. Develop skillsfor environmental design and management through laws and policies.Acquire knowledge in the preparation, planning and implementation of environmental science related projects and apply statistics. Students can be able to handling and operating of various instruments
4. Apply their practical knowledge in various research related to environmental problems and create awareness among individuals and peoples about need for protection of environment by conducting forestry programs and importance of biopesticides, biofertilizers and organic farming with help of funding agencies at national, international and regional level.
5. Find job opportunities in pollution control boards (CPCB and SPCB), UPSC, and will get opportunities in research and development laboratories, environmental monitoring, environmental consultants, NEERI, EIA, forest department. Further student have the ability to find job in effluent treatment plants, water purification in municipal councils/ corporation, agro-industries and to pursue higher studies in environment related research fields.

7. **Program Specific Outcomes (PSOs)**

1. Acquire knowledge in ecosystem, population, community and industrial ecology, importance and conservation aspects of biodiversity, conversion of waste into eco-friendly products, ecosystem restoration and bioremediation techniques.
2. Make students knowledgeable about bioethics, bio-safety and IPR. Develop skills in natural energy sources (conventional and non – conventional resources), green energy sources, biomass energy sources, and concepts of energy audit. Create environmental awareness programs on conservation of forest, aquatic systems, make wild life conservation projects and implement through education and communication. Further, students will able to understand about ecotourism, ecotourism spots, its types and conservation strategies.

3. Understand the use of bio-indicators on bio-monitoring of ecological systems. Further, educate the students on source, classification, and impact of air, water, soil, noise, thermal, marine and radioactive pollution, further students will develop the knowledge through historical movements for protecting environment.
4. Recognize the various control measures of pollution problems and gain technical skills and knowledge of the various environmental toxicants and toxicity testing methods. In addition also get the knowledge of sustainable management of wastes, environmental hazards and disasters, prediction, management, mitigation and awareness.
5. Acquire knowledge in various statistical methods for applying in scientific communication through environmental modeling further students will be able to gain information regarding writing scientific reports and familiar in research methods and learn to EIA.
6. Learn the principle and working of various instruments used in the qualitative and quantitative environmental and molecular analysis techniques. The students could understand the processing of RS, GIS and GPS tools to assess various environmental components such as distribution of forest area including vegetation and wild animals, land and water resource area distribution and mapping etc.
7. Create knowledge in soil formation process, distribution of water, Indian monsoon and natural hazards prediction and mitigation. Further the student will be able to understand the microbes -metal interactions, biodegradation process, hazardous wastes, and uses of biotechnological approaches in pollution control. The students will acquire technical knowledge about the fundamentals and impact of industrial effluent and treatments, recycling of waste, and learn to operate of pollution control devices technology.
8. Through Dissertation, student can identify a particular environmental problem, review the literature for finding the gaps, develop research methodology, collect data and carry out data analysis and interpretation for finding a suitable solution and acquire the ability to write the research findings in the form of structured thesis and communicate the research results through oral or poster presentations.

SEM	Subject Code	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
I		1	Core:1	Environmental Biology	4	4	25	75	100
		2	Core:2	Environmental Biotechnology and microbiology	4	4	25	75	100
		3	Core:3 (e-PATHSHALA)	Energy and Environment	4	4	25	75	100
		4	Major Practical –I	Major Practical – I (Environmental Biology)	4	2	50	50	100
		5	Major Practical – II	Major Practical – II (Environmental Biotechnology and microbiology)	4	2	50	50	100
		6	Skill based Course (Mandatory)	Environmental analysis and techniques	2	2	25	75	100
		7	Elective – 1	Any one	3	3	25	75	100
				1. Contemporary Environmental issues					
				2.Bio Monitoring And Ecological Assessment					
				3. Eco-Tourism					
			Subtotal		**25**	**21**	**225**	**475**	**700**

SEM	Subject Code	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
II		8	Core:4	Environmental Pollution and Control	4	4	25	75	100
		9	Core:5	Environmental Disaster Management	4	4	25	75	100
		10	Core:6	Statistics for Environmental Sciences	4	4	25	75	100
		11	Major Practical – III	Major Practical – III Environmental Disaster Management	4	2	50	50	100
		12	Major Practical – IV	Major Practical – IV Environmental Pollution and control	4	2	50	50	100
		13	Elective – 2	Any one	3	3	25	75	100
				1. Restoration Ecology					
				2. Environment and Human Health					
				3. Environmental Education and communication					
		14	Supportive course (Mandatory)	Environmental Toxicology	3	3	25	75	100
		15	Field Work			2	50	50	100
			Subtotal		**26**	**24**	**275**	**525**	**800**

SEM	Subject Code	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
III		16	Core:7	Instrumentation and Research methodology	4	4	25	75	100
		17	Core:8	Remote Sensing, GIS and Environmental Modelling	4	4	25	75	100
		18	Core:9	Environmental Geosciences	4	4	25	75	100
		19	Core:10	Hazardous Waste And Solid Waste Recycling Techniques	4	4	25	75	100
		20	Major Practical – V	Major Practical – V Instrumentation and Research methodology	4	2	50	50	100
		21	Major Practical – VI	Major Practical – VI Remote Sensing, GIS and Environmental Modelling	4	2	50	50	100
		22	Elective	Any one 1. Vermi and Mushroom culture 2.Environmental chemistry 3.Non-Conventional Energy	3	3	25	75	100
		23	MOOCs	Online Course from Swayam, MOOC NPTEL etc.https://nptel.ac.in/	3	3	25	75	100
		24	Mini Project			3	50	50	100
			Subtotal		**30**	**29**	**300**	**600**	**900**

SEM	Subject Code	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
IV		25	Core:11	Pollution Control Engineering And Bioremediation	4	4	25	75	100
		26	Core:12 (e-PATHSHALA)	Analytical Chemistry	4	4	25	75	100
		27	Core:13	Environmental Assessment, Management and Legislation	4	4	25	75	100
		28		Industrial Internship		4	50	50	100
		29	Major Project	Project and Viva-Voce	4	6	50	50	100
			Subtotal		**20**	**22**	**175**	**325**	**500**
			Grant Total		**101**	**96**	**925**	**1925**	**2800**

SEMESTER – I

CORE 1: ENVIRONMENTAL BIOLOGY

Course code:

L	T	P	C
4	-	3	4

Course Objectives

- To study the structure, functions and classification of ecosystem
- To study about Population ecology and Community Ecology
- To understand the biodiversity and its importance and conservation
- To know the concept of industrial ecology and hotspots

Course outcomes

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	State basic elements of ecology and environmental factors.	K1
CO2	Explain about ecosystem dynamics, functions, classifications and interactions of the organisms in ecosystem.	K2
CO3	Apply biodiversity and its conservation strategies, and gain knowledge in hotspots	K3
CO4	Apply their knowledge in ecosystem restoration	K3
CO5	Explain the importance and impact of biogeochemical cycles	K4
CO6	Make connections and interrelations between various disciplines in the environment.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Ecosystem Structure and functions 8Hrs (5L+3P)

Ecology as an inter-disciplinary science - Origin of life and speciation - Human Ecology and Settlement - Ecosystem Structure and functions: Structures - Biotic and Abiotic components. Functions - Energy flow in ecosystems, energy flow models, food chains and food webs. Biogeochemical cycles, Ecological succession.Species diversity, Concept of ecotone, edge effects, ecological habitats and niche - Ecosystem stability and factors affecting stability - Ecosystem services

UNIT II: Ecosystem classification: 8Hrs (5L+3P)

Basis of Ecosystem classification, Types of Ecosystem: Desert (hot andcold), forest, rangeland, wetlands, lotic, lentic, estuarine (mangrove), Oceanic.Biomes: Concept, classification and distribution. Characteristics of different biomes: Tundra, Taiga, Grassland, Deciduous forest biome, Highland Icy Alpine Biome, Chapparal, Savanna, Tropical Rain forest.

UNIT III: Population ecology and Community Ecology 10Hrs (7L+3P)

Population ecology: Characteristics of population, concept of carrying capacity, population growth and regulations. Population fluctuations, dispersion and metapopulation

Concept of 'r' and 'k' species.Keystone species.Community ecology: Definition, community concept, types and interaction - predation, herbivory, parasitism and allelopathy. Biological invasions.

UNIT IV: Biodiversity and its conservation 10Hrs (7L+3P)

Definition, types, importance of biodiversity and threats to biodiversity. Concept and basis of identification of 'Hotspots'; hotspots in India.Measures of biodiversity. Strategies forbiodiversity conservation: in situ, ex situ and in vitro conservation. National parks, Sanctuaries, Protected areas and Sacred groves in India. Concepts of gene pool, biopiracy and bio-prospecting.Concept of restoration ecology.Extinct, Rare, Endangered and Threatened flora and fauna of India.

UNIT V Industrial Ecology 10Hrs (7L+3P)

Concept of Industrial Ecology, Toxicology and Microbiology: Absorption, distribution and excretion of toxic agents, acute and chronic toxicity, concept of bioassay, threshold limit value, margin of safety, therapeutic index, biotransformation. Major water borne diseases and air borne microbes.

Major Practical – VI

Environmental Biology Practical

L	T	P*	C
4	-	4	4

1. Estimation of Species Abundance of Plants
2. Study of Transpiration and Water Balance in Plants
3. Assessment of Chlorophyll Content in Plants
4. Identification of fauna and flora (4 each) of terrestrial, freshwater and marine ecosystems;

5. Identification of phytoplankton and zooplankton (either freshwater or marine).
6. Qualitative estimation of phytoplankton by Lacky's Drop Method and Zooplankton by Sedgwick-Rafter Cell method
7. Estimation of primary productivity – Light and dark bottle method – effects of depth and light
8. Community study: quadrant method; flora and fauna study by frequency, density and abundance – line transect method.
9. Visit to In situ or Ex situ Conservation Centre/ Social Service Organization/ Environmental Education Centre
10. Calculation of Biodiversity Index.
11. Construction of Ecological pyramids of different ecosystems.
12. Productivity of aquatic ecosystem by plankton study.
13. Study of wetland flora and fauna.

References

1. Ecology and Environment: P.D. Sharma., Rastogi Publication.
2. Fundamental of Ecology: E. P. Odum,W. B. Sauders Company, USA
3. Ecology, 2nd Edition by Paul Colinvaux, Wiley.
4. Ecology: From Individuals to Ecosystems by Michael Begon& Colin R. Townsend & John L.Harper; Blackwell publishing.
5. Ecology: Theories and Applications (4th Edition) by Peter Stiling; Prentice Hall.
6. Text Book of Environmental Studies, ErachBharucha, Orient longmanPvt. Ltd., Ernakulam.

Mapping of COs to POs and PSOs

	ENVIRONMENTAL BIOLOGY												
	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	L	L	M	H	M	H	L	L	H	M	H
CO2	H	H	L	L	M	H	L	L	L	L	H	M	H
CO3	H	M	M	H	H	H	M	L	M	L	M	M	H
CO4	H	M	L	H	H	H	L	M	L	L	L	M	H
CO5	H	L	L	H	H	H	L	L	L	L	L	M	H
CO6	H	L	M	H	H	H	M	L	M	L	L	M	H

L/M/H L – Low; M – Medium; H - High

Core 2: ENVIRONMENTAL BIOTECHNOLOGY AND MICROBIOLOGY

Course code:

L	T	P	C
4	-	4	4

Course Objectives

1. To teach the students about the environmental microbiology, biotechnology and bioremediation.
2. To teach about the genetically engineered microorganisms in bioremediation process and intellectual property rights.

Course outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Focus knowledge of environmental microbiology, biotechnology and uses of microorganisms in wastewater treatment	K4
CO2	Apply the microorganisms to production of various enzymes, proteins and biogas	K3
CO3	Understand the process of conversion waste into useful products like fertilizers, biogas and remediation of petroleum and heavy metals	K2
CO4	Apply their knowledge in remediation of pollutants using genetically engineered microorganisms	K3
CO5	Know the scope and importance of intellectual property rights	K5

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **10Hrs (7L+3P)**

Scope and Role of environmental Microbiology –Concept of Microbial Ecology– Succession and Colonization of Microbes in Environment – biogeochemical cycles – root nodule formation – detection of faecal contamination – microbes-microbes interactions; plant-microbes interactions; wastewater treatment; Soil Humus;

UNIT II **10Hrs (7L+3P)**

Microbiology of water, air and soil- Microorganisms in extreme environments– microbial treatment of wastewater – use of microorganisms in methane production

from agro industrial waste (Biogas, ethanol, hydrogen and biopolymer) – production of single cell protein; production of enzymes like cellulase, proteases, amylases, alcohol and acetic acid production.

UNIT III **10Hrs (7L+3P)**

Bioremediation: in-situ and Ex-situ bioremediation,bioremediation of hydrocarbons, bioremediation of dyes, bioremediation of paper and pulp industry; bioremediation of heavy metals, xenobiotics and coal waste; bioaugmentation; Phytoremediation - Abatement of different types of pollution using plants,types of phytoremediation, mechanism involved with case studies -Petroleumpollutant biodegradation.

UNIT IV **8hrs (5L+3P)**

Role of BT in Environment Protection: Biotechnological methods for pollution detection – biomineralization - GEMs in biotreatment of waste and environment safety – Bt pesticide – biofertilizer – Vermicomposting – mushrrom production – gene banks for conservation of biodiversity – biomining – microbial leaching, biosensors – microbial enhanced oil recovery –

UNIT V **8hrs (5L+3P)**

Biosafety and IPR: Introduction, Implications of IPRs on commercialization of biotechnology products, copy rights, trade secrets, patents and geographical indications; WIPO; GATT and Trade related IPRs; Patent status; significance of patents in India. Biosafety; guidelines and different levels of biosafety levels.

References

1. Environmental Biotechnology: A Bio systems Approach - Daniel Vallero
2. Environmental Biotechnology (Oxford Higher Education)- B.C. Bhattacharyya and RintuBanerje
3. Environmental Biotechnology - Dr Alan H. Scragg
4. Environmental Biotechnology: Theory and Application - Gareth M. Evans and Judith C. Furlong
5. R.C.Dubey2014. A Textbook of Biotechnology. S. Chand and Company LTD, New Delhi. ISBN No – 81–219–2608–4.
6. Cambell, 1983, Microbial control of pollution, Blackwell Scientific Publication
7. A.K. Chatterji , Introduction to Environmental Biotechnology, Prentice – Hall of India, Newyork
8. A.G. Murugesan and C.Rajakumari, 2005, Environmental Science and Biotechnology – Theory and Techniques, MJP Publishers

9. J.C. Fry et al., 1992. Microbial Control of Pollution, Cambridge University Press
10. R.C.Dubey and D.K.Maheswari, 1999. A Textbook of Microbiology. S. Chand and Company LTD, New Delhi. ISBN No – 81–219–1803–0.

Major Practical - VII

ENVIRONMENTAL BIOTECHNOLOGY AND MICROBIOLOGY

L	T	P*	C
-	-	4	2

1. Different types of culture media preparation
2. Enumeration of microbes from water or soil sample.
3. Pure culture – Different streaking techniques.
4. Staining techniques: grams staining and lactophenol cotton blue staining
5. Screening and isolation of enzyme producers like cellulase, proteases, amylase
6. Bioproduction of industrially important enzyme, and alcohol from wastes
7. Immobilization of Microbial cells
8. Recovery of toxic metal ions of an industrial effluent by immobilized cells.
9. Bioremediation – Treatment of dye by immobilization
10. Isolation of genomic DNA from plant and bacteria
11. Isolation and purification of degradative plasmid of microbes growing in polluted environments. (DEMO)
12. Visit to a nearby vermicomposting laboratory

Mapping of COs to POs and PSOs

ENVIRONMENTAL BIOTECHNOLOGY													
	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	H	H	H	H	H	M	M	H	L	H	H
CO2	M	M	H	H	H	H	H	L	L	M	L	H	H
CO3	H	H	M	M	H	L	H	M	L	L	L	H	H
CO4	H	H	L	L	H	H	H	L	L	L	M	H	H
CO5	M	H	L	H	H	H	H	M	L	L	L	H	H

L/M/H L – Low; M – Medium; H – High

Core 3: ENERGY AND ENVIRONMENT (e-pathashala)

L	T	P*	C
4	-	3	4

Objective:

1. To educate the students on energy resources in environment.
2. To impart understanding on energy efficiency and energy audit.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Learn basics of energy sources and its types and properties	K1
CO2	Understand the principle of generation of tidal, ocean thermal, geothermal, and wind energy	K2
CO3	Apply the principles of nuclear energy	K3
CO4	Create knowledge in conversion of biomass into fuels	K6
CO5	Understand about emission of carbon dioxide, effects and reduction methods	K2
CO6	Describe about energy audit and energy conservation	K1

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **6Hrs (6L+0P)**

Sun as an energy source, solar radiation, fossil fuel classification and composition, physicochemical properties of fuel, calorific value of fuel, renewable energy resources

UNIT II **8Hrs (6L+0P)**

Hydropower as an energy source, principles of generation of tidal energy, principles of generation of ocean thermal energy conversion, geothermal energy, principles and applications of wind power, components and types of wind turbines,

UNIT III **8Hrs (6L+0P)**

Principles of solar energy generation, applications of solar energy, solar collectors, solar photovoltaic system, solar pond, Nuclear energy from fission, nuclear fusion of energy, prospects of nuclear energy in India, principles of energy conversion using magnetic fields,

UNIT IV **8Hrs (8L+0P)**

Biomass as an energy source, types of biofuels, energy conversion routes from biomass. Thermochemical conversion – technologies-gasification, pyrolysis technology for bioenergy production, biodiesel production from lipids, anaerobic digestion and biogas production, ethanol as a source of energy, urban waste to resource recovery and recycling for energy, hydrogen as a fuel for future and fuel cell.

UNIT V **9Hrs (9L+0P)**

Emission of carbon-dioxide from energy consumption in developed and developing countries, environmental implications of energy use, energy use pattern in world and India, radioactive forcing and global warming, impact of large scale exploitation of solar energy and wind energy, impact of large scale exploitation of hydropower and other renewable energy sources.

Energy efficiency and energy audit, energy conservation-principles and approaches – green buildings – energy policies – international and national norms.

References

1. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
2. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
3. Murphy, W. R., Energy Management, Elsevier, 2007.
4. Smith, C. B., Energy Management Principles, Pergamum, 2007
5. Environment pollution control Engineering by C S Rao, New Age International, 2006, reprint 2015, 2nd edition.
6. Environmental studies, by Benny Joseph, Tata McGraw Hill, 2008, 2nd edition.
7. Bharucha, E., Textbook of Environmental Studies, Universities Press (2005).
8. Chapman, J.L. and Reiss, M.J., Ecology-Principles and Application, Cambridge University Press (LPE) (1999).
9. Joseph, B., Environmental Studies, Tata McGraw-Hill (2006).
10. Eastop, T.P. and Croft, D.R. Energy Efficiency for Engineers and Technologists, Longman and Harow (2006).
11. Miller, G.T., Environmental Science- Working with Earth, Thomson (2006).
12. Wright, R.T., Environmental Science-Towards a sustainable Future, Prentice Hall (2008) 9thed.
13. O'Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	L	M	M	H	M	L	M	L	L	M
CO2	H	H	M	M	L	L	H	M	M	L	M	L	H
CO3	H	H	L	L	M	M	H	L	H	L	M	M	M
CO4	H	H	M	H	H	L	H	L	M	M	L	M	H
CO5	M	M	L	H	H	M	H	L	L	M	L	L	H
CO6	H	H	M	L	M	L	H	L	L	M	L	M	M

L/M/H L – Low; M – Medium; H - High

Skill based core (Mandatory)

ENVIRONMENTAL ANALYSES AND TECHNIQUES

L	T	P*	C
2	-	0	2

Objectives

1. To provide detailed methodologies for the analytical techniques commonly used for different kinds of environmental samples.
2. To know the principle involved in the quality control of the analysis

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Learn the techniques of analysis of water quality	K1
CO2	Understand the principle and estimation of heavy metals and sample collection methods	K2
CO3	Apply the principles and techniques for soil quality analysis	K3
CO4	Create knowledge in conversion of biomass into fuels	K6
CO5	Understand about air pollutant analysis	K2
CO6	Learn about radioactivity measurement	K1

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Pre-requisite for the study of the course:

The pre-requisite for studying the course on Environmental analyses and techniques is basic knowledge about technological analysis in Environmental Science and fundamental knowledge of environmental parameters.

Outcome of the study:

The student completed this course can expect to have a well-versed knowledge on air pollution analysis, estimation of heavy metals, modelling techniques,Radioactivity Measurement.

Unit – I **6Hrs (6L+0P)**

Detection of color, turbidity, pH, EC and temperature, oil and grease in water and waste water. Analysis of Dissolved oxygen, BOD, COD, Alkalinity, Hardness, TS, TDS, TSS and other solids, Ammonical Nitrogen, Organic Nitrogen, Sulphite, Fluoride, Potassium, Sodium, Chloride, Phosphorous, silica and phenolic in waste water – Theory and Practical.

Unit-II **6Hrs (6L+0P)**

Theory and practical of estimation of Zinc, Mercury, Lead, Copper, Chromium, Cadmium, Magnesium, Iron and Manganese in waste water samples.Sample preparation and estimation of Organo Chloride, Organo Phosphates, carbonates and pyrethroids in water and soil samples.

Unit–III **6Hrs (6L+0P)**

Preparation and Estimation of bulk density, specific gravity, moisture, water holding capacity, alkalinity, Sulphate, Calcium, Nitrogen, Phosphorous, Organic Carbon and heavy metals in soil samples.

Unit – IV **6Hrs (6L+0P)**

Experiments related to air pollution analysis – Analysis of ambient air quality, ambient and stack sampling, Particulate and gaseous pollutants, meteorological parameters, atmospheric stability, wind profile and stack plume patterns, modelling techniques.

Unit – V **6 Hrs(6L+0P)**

Radioactivity Measurement – Radioactive Decay, Isotopes, Instruments used for measurement of radiation intensities, Radiochemical separation for the determination of Radium in environmental matrix. Detection of Alpha, Beta and Gamma radio activity in selected matrices.

References

1. G. D. Christian, Analytical Chemistry, 6th Ed, John Wiley & Sons, 2007.
2. H. A. Strobel and W. R. Heineman, Chemical instrumentation: a systematic approach,Wiley, 1989.

3. H. H. Willard, Instrumental methods of analysis, Van Nostrand, 1981.
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7. Ed Metcalfe, Atomic absorption and emission spectroscopy, J. Wiley, 1987.
8. Course-3: Analytical Methods in Environmental Sciences (4 Cr)

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	M	M	L	H	M	H	H	M	M	H	L	M
CO2	H	M	M	L	H	M	H	H	M	M	H	L	M
CO3	H	M	M	L	H	M	H	H	M	M	H	L	M
CO4	H	M	M	L	H	M	H	H	M	M	H	L	M
CO5	H	M	M	L	H	M	H	H	M	M	H	L	M

Elective papers

Elective Paper 1: Contemporary Environmental issues

Course code:

L	T	P	C
3	-	-	3

Course Objectives

- To provide an overview of the most pressing environmental problems at global level
- To understand the causes and the consequences of the environmental issues.
- To develop ideas and solutions to tackle the environmental problems.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6

CO1	Analysis the global and national level environmental related issues.	K4
CO2	Developing knowledge in need of Conservation of water, soil and forest resources	K3
CO3	Remember the various wild life conservation projects	K1
CO4	Evaluate about epidemiological issues in worldwide	K5

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Global Environmental Issues: 10hrs (10L+0P)

Biodiversity loss, Climate change, Ozone layer depletion.Sea level rise.International efforts for environmental protection.

National Action Plan on Climate Change (Eight National missions – National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a 'Green India', National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change).

UNIT II 6hrs (5L+0P)

Current Environmental Issues in India: Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States.

UNIT III 8 hrs (8L+0P)

Conservation of water, soil and forest: Water conservation-development of watersheds, Rain water harvesting and ground water recharge.

National river conservation plan – NamamiGange and Yamuna Action Plan.

Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India.Soil erosion, reclamation of degraded land, desertification and its control.

Climate change - adaptability, energy security, food security and sustainability.

Forest Conservation – Chipko movement, Appiko movement, Silent Valley movement and Gandhamardhan movement. People Biodiversity register.

UNIT IV 8 hrs (8L+0P)

Wild life conservation projects: Project tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision.

Carbon sequestration and carbon credits.Waste Management – Swachha Bharat Abhiyan.Sustainable Habitat: Green Building, GRIHA Rating Norms.Vehicular emission norms in India.

UNIT V **8hrs (8L+0P)**

Epidemiological Issues: Fluorosis, Arsenocosis, Goitre, Dengue. Environmental Disasters: Minnamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011.

Reference

1. Asthana D.K. and M. Asthana, 2001 Environment Problems and Solutions, (2nd Edn.), S.Chand& Co. Ltd., New Delhi.
2. Shantakumar, S. 2005 Introduction to Environmental Law, (2nd Edn.), Wadhwa& Company, Nagpur,
3. Rangarajan. M. 2006 Environmental Issues in India Pearson India. New Delhi.
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6. Hill, M. 2004. Understanding Environmental Pollution: A Primer. Cambridge: Cambridge University Press.
7. Shafi. S. M. 2005 Environmental Pollution.Atlantic Publishers and Distributors, New Delhi. 456 pages
8. Schmitz, O. J. 2017 The New Ecology Rethinking a Science for the Anthropocene. Princeton University Press. 256 pp

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	H	H	M	H	H	M	L	M	M	M
CO2	M	H	M	H	M	L	H	H	M	L	M	L	M
CO3	L	H	M	H	L	H	H	H	M	M	H	L	M
CO4	L	L	M	M	H	L	H	H	M	M	M	L	M

L/M/H L – Low; M – Medium; H - High

Elective paper 2: BIO MONITORING AND ECOLOGICAL ASSESSMENT

Course code:

L	T	P	C
3	-	-	3

Course Objectives

- Acquire knowledge in physicochemical and biological changes in ecosystems
- Enable the students to assess the habitat conditions based on biological indicators
- Learn the general methods of biological indication of ecosystem health.
- Apply knowledge in the construction and application of biomonitoring systems.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Recognize the importance of a multidisciplinary team approach to exposure assessment and biological monitoring of environment.	K1
CO2	Understand the presence of bioindicators are the qualitative and quantitative indication of the environment	K2
CO3	Explain the bioindicators, biomarkers, aquatic macrophytes are bioindicators	K3
CO4	Evaluate the practical advantages and limitations of biological monitoring as practiced in industrial hygiene and public health	K5
CO5	Discuss the principles and concept of ecological monitoring	K

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **7Hrs (7L+0P)**

Definitions, strategies and principles for bioindication/biomonitoring of the environment.Causes of biological changes.Advantages of bioindicators over other types of indicators of the environment.

UNIT II **10Hrs (10L+0P)**

Types of bioindicators.Specific bioindicators.Biomarkers.Qualitative and quantitative indication of the environment.Saprobic system.Microbial indicators.Algae as

ecological bioindicators.Lichens as indicators of air pollution.Bryophytes as bioindicators.Plants as bioindicators.

UNIT III **6Hrs (6L+0P)**

Ecological indices.Changes in plants indicating environment - invasive Plant communities - Agri-environmental indicators.Forests type and quality as indicators.

UNIT IV **6 Hrs (7L+0P)**

Aquatic macrophytes as bioindicators.Plankton communities as indicators of water quality.Macroinvertebrates as indicators of water quality.Fish as bioindicators.Insects as indicators of terrestrial ecosystems.Terrestrial vertebrates as bioindicators.

UNIT V **7Hrs (7L+0P)**

Overview of Ecological Monitoring: Principle - concepts – need and significance. Techniques applied Visual – instrumental; Global environmental monitoring system of UNEP – functions. World conservation monitoring Centre.

References

1. Nalini, K.S. 1993 Environmental Resources and Management, Anmol Publishers.
2. Nautiyal, S and A. K. Kaul 1999 Forest Biodiversity and its Conservation Practices in India. Oriental Enterprises, Dehradun, India.
3. Negi, S. S 1993 Biodiversity and its Conservation in India. Indus Publications, New Delhi.
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5. Ahuja. S 2013 Monitoring water quality: Pollution assessment, Analysis and Remediation. Elsevier publication. 390 pages.
6. Conti M. E. 2008 Biological Monitoring: Theory and Applications (The Sustainable World). WIT Press. 256 pages
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8. Shigesada N and K. Kawasaki, 1997, Biological Invasions: Theory and Practice, Oxford University Press, Oxford.
9. Subramanian K. S. and G.V. Iyengar 1997 Environmental Biomonitoring: Exposure Assessment and Specimen Banking. American Chemical Society. 298 pages

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	L	M	M	H	M	L	M	L	L	M
CO2	H	H	M	M	L	L	H	M	M	L	M	L	H
CO3	H	H	L	L	M	M	H	L	H	L	M	M	M
CO4	H	H	M	M	L	L	H	M	M	M	H	M	H
CO5	H	M	L	M	H	M	H	H	L	M	L	L	H

L/M/H L – Low; M – Medium; H - High

Elective paper

3. ECOTOURISM

Course code:

L	T	P	C
3	-	-	3

General Objectives

- This course introduces the students to the economic, cultural and environmental impacts of ecotourism.
- Toaware of the different ecotourist spots and its activities.
- To understand ecotourism as a significant aspect of tourism in future.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	describe the key terminology, principles, concepts and types ecotourism	K1
CO2	identify the ecotourism spots and maintenance for sustainable tourism and recreation and critically discuss the ecological centres	K2
CO3	Learn about types, development and conservation of ecotourism	K3
CO4	Appraiseeconomic impacts of ecotourism and review of scope and management of ecotourism.	K4
CO5	Remember the significance of ecotourism and national parks.	K5

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I:Introduction to Ecotourism **6hrs (6L+0P)**

Concepts of Tourism – Types of Tourism – Religious – Cultural – Heritage – Monumental – Adventure – Mass – Sustainable – Consumptive and Non-Consumptive Tourism. Ecotourism - Concepts, History and Origin, Objectives and Benefits.Factors affecting Ecotourism.

UNIT II: Ecotourism Spots **6hrs (6L+0P)**

Places of interests of Ecotourism – Eco-circuit of the Eastern and Western Ghats, Himalayas, Coastal regions (India) – Infrastructural Facilities.Maintenance of Ecological Centers – Important Biosphere Reserves.Target group of Ecotourism.

UNIT III: Ecotourism, Types and Conservation **10hrs (10L+0P)**

Types of Ecotourism - Rain forest – Mountain, Polar, Islands and Coasts – Wilderness –Total Quality Management (TQM) of Ecotourism Resorts, Knowledge, skills, attitude and commitment of ecotourism service providers. Biodiversity Conservation and Sustainable Ecotourism, Community Based Tourism for Conservation and Development. Conservation – Insitu and Exsitu (Sanctuaries, National Parks, Gene Banks, Seed Banks, Ova Bank)

UNIT IV: Impact of Ecotourism **12hrs (12L+0P)**

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-Role of ethics in ecotourism - Advantages and Disadvantages of Ecotourism- Ecobranding and Eco-labeling of Ecotourism Products - Marketing of Ecotourism, Ecotourism and Sustainable Development - Management Issues in Ecotourism, Ecotourism-based/related employment, Scope and areas of employment.

UNIT V: Significance of Ecotourism **8hrs (8L+0P)**

Parambikulam Tiger Reserve, Kaziranga National Park, Ecotourism spots in Tamil Nadu (Ooty, Kodaikanal, Yelagiri, Yerkaud, Pachamalai).Gulf of Mannar, Point Calimere, Vedanthangal Bird Sanctuary. A World Heritage Site in Assam,TheKabini River, Jog falls, Snow fall mountains in Kulumanali, Ganktok.

References

1. The Encyclopedia of Ecotourism, Weaver, D. B. (2001), CABI.
2. Encyclopedia of Ecotourism, Volume I, II and III, Sinha, P.C (2003), Anmol Publications Pvt. Ltd.,
3. Ecotourism and sustainable Development, N. Mukherjee (2008). Cybetech Publications

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5. Ecotourism. An Introduction, Fennell A David. (2003), Routledge, London and New York.
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12. Ecotourism: a guide for planners and managers, Lindberg, K. and D.E.
13. Hawkins. (eds). (1993), North Benninton: The Ecotourism Society.
14. Ecotourism, Page, S.J. and R.K. Dowling. (2002). New York: Prentice Hall.
15. Ecotourism, Weaver, D. (2001). Milton: John Wiley & Sons

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	L	M	M	H	M	L	M	L	L	M
CO2	H	H	M	M	L	L	H	M	M	L	M	L	H
CO3	H	H	L	L	M	M	H	L	H	L	M	M	M
CO4	H	H	M	H	H	L	H	L	M	M	L	M	H
CO5	H	H	L	H	H	M	H	L	L	M	L	L	H

L/M/H L – Low; M – Medium; H – High

SEMESTER-II

CORE 4: ENVIRONMENTAL POLLUTION AND CONTROL

Course code:

L	T	P	C
4	-	4	4

Objectives of the study

- To understand about the sources, and types of pollution
- To understand the measurement of water quality parameters
- To understand the control methods of pollution

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Describe the sources and effects of water and soil pollution and study the environmental impact of fertilizers, pesticides, use and throw plastics and hospital wastes.	K1
CO2	Explain the sources and effects of air pollution, thermal, radioactive and noise pollution	K2
CO3	Experiment the various air, water, and soil pollutants using instrumental, chemical and microbiological methods	K3
CO4	Practical knowledge for the determination of different water parameters, and air pollutants.	K4
CO5	Learn measurement of noise level of different areas and Survey of air pollution control equipments.	K5

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Air Pollution **15hrs (9L+6P)**

Sources and types of Pollutants - Criteria air pollutants. Sampling and monitoring of air pollutants (gaseous and particulates); Principles and instruments for measurements of (i) ambient air pollutants concentration and (ii) stack emissions. Indian National Ambient Air Quality Standards.Impact of air pollutants Acid rain. Dispersion of air pollutants - Mixing height/depth, lapse rates, Gaussian plume model, line source model and area source model. Control devices for particulate matter: Principle and

working of: settling chamber, centrifugal collectors, wet collectors, fabric filters and electrostatic precipitator. Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion. Indoor air pollution, Vehicular emissions and Urban air quality.

UNIT II: Noise Pollution 8 hrs (5L+3P)

Sources, weighting networks, measurement of noise indices (L_{eq}, L_{10}, L_{90}, L_{50}, LDN, TNI).Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods. Vibrations and their measurements.Impact of noise and vibrations on human health.

UNIT III: Water Pollution 12hrs (9L+3P)

Types and sources of water pollution.Impact on humans, plants and animals. Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Microbiological analysis – MPN. Indian standards for drinking water (IS:10500, 2012). Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Wastewater Treatment: Primary, Secondary and Advanced treatment methods. Common effluent treatment plant.

UNIT IV: Soil Pollution 12hrs (6L+6P)

Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components).Analysis of soil quality. Soil Pollution control. Industrial effluents and their interactions with soil components.Soil micro-organisms and their functions - degradation of pesticides and synthetic fertilizers.

UNIT V: Thermal, Marine Pollution and Radioactive pollution 8 hrs (5L+3P)

Sources of Thermal Pollution, Heat Islands, causes and consequences.Sources and impact of Marine Pollution.Methods of Abatement of Marine Pollution.Coastal management. Radioactive pollution – sources, biological effects of ionizing

Reference

1. Krishnan Kannan, K., 1997. Fundamentals of Environmental Pollution, S. Chand Company, New Delhi.
2. Sharma, B. K., Kaur, H., 2000. Environmental Chemistry, Goel Publishing House, Meerut, India.
3. Dara, S.S., 2000. A text book of environmental chemistry and pollution control. S. Chand Company, New Delhi.

4. Sharma, P. D., 1993. Environmental Biology and Toxicology, Rastogi Publications, New Delhi.
5. A.G.Murugesan and C.Rajakumari, Environmental Science and Biotechnology – Theory and Techniques, MJP Publishers.
6. APHA. 1975. Standard methods for the examination of waste water. AWWA, New York.

MAJOR PRACTICAL - III

ENVIRONMENTAL POLLUTION AND CONTROL – PRACTICALS

L	T	P*	C
-	-	4	2

1. Determination of TS, TDS & TSS in industrial effluents / sewage
2. Estimation of COD
3. Estimation of Sulphate in industrial effluents
4. Estimation of Phosphate in water
5. Estimation of chloride in water
6. Determination of total hardness and Ca& Mg hardness,
7. Microbiology of Air: by exposure plate method;
8. Air quality analysis using high volume air sampler
9. Determination of organic carbon, from soil samples
10. Soil sampling, description of the soil horizon, determination of soil pH, conductivity and salinityfrom soil samples
11. Demonstration of noise pollution monitoring equipment

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	L	H	H	L	H	H	H	L	M	M	H
CO2	H	H	H	H	H	L	H	H	H	M	M	M	H
CO3	H	H	M	M	H	L	H	H	H	L	M	M	H
CO4	H	H	M	H	H	L	H	H	M	M	L	M	H
CO5	H	H	M	H	H	L	H	H	M	M	L	L	H

L/M/H L – Low; M – Medium; H - High

Core 5: ENVIRONMENTAL DISASTER MANAGEMENT

Course code

L	T	P	C
4	-	4	4

Course Objectives

1. To improve the scientific knowledge among students about various natural and man-made disasters
2. To train the student to involve them to cope with different disaster management activities like preparedness, prevention and thereby to reduce disasters effect.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Learn types of environmental hazards and disasters and its profile in India	K1
CO2	Analyses the causes and impacts of disasters on environment	K4
CO3	Focus the various national agencies that play a major role in disaster management	K4
CO4	Evaluate risk reduction approaches of disasters with safety issues in mitigating industrial disasters.	K5
CO5	The knowledge gained will enable the students to volunteer themselves in disaster management programs thus helping affected community.	K6
CO6	Develop understanding about different environmental disasters management practices and preparedness.	K3

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I Introduction Principles and Practices 9Hrs(7L+5P)

Introduction, Meaning and Fundamentals of Disasters, disaster impacts, Humanity and Development, Disruption of Development by Disasters, Loss of Resources, Environmental Disasters and Environmental stress.

UNIT II Types of Environmental hazards & Disasters 9Hrs (7L+5P)

Natural Hazards- Planetary Hazards - disasters Volcanoes - Eruption, Volcanic Hazards, Earthquakes, Causes of Earthquakes, Hazardous effects, Earthquake Hazards in India, Landslides, Landslide hazard, Lightning, Hailstorms, Tropical cyclones & Local storms, - Floods, Droughts, Cold waves, Heat waves, Tsunami - hazards Chemical hazards/ disasters, Release of toxic chemicals, nuclear explosion, Sedimentation processes Biological hazards/ disasters - Population Explosion

UNIT III Disaster Prediction and Regional Forecasting 9Hrs(7L+5P)

Prediction, Forecasting and Managing - Principles - Nationwide HPC Grid Integrating / Interfacing HPC and Satellite Resources - Sharing of spatial and non-spatial data -. Decision Support Centre (DSC) National Emergency Operation Centre (NEOC) - Virtual Private Network (VPN) National Emergency Communication Network - (NECN) Early Warning Systems (EWS) for Hazards.

UNIT -IV Disaster Management- preparedness 9Hrs (9L+5P)

Emerging approaches in Disaster Management- Pre- disaster stage (preparedness) - Preparing hazard zonation maps, Predictability/ forcasting& warning, Preparing disaster preparedness plan, Land use zoning, Disaster resistant house construction, Population reduction in vulnerable areas, Awareness. Emergency Stage - Rescue training for search & operation at national & regional level, Assessment surveys. Post Disaster stage-Rehabilitation.

UNIT V Disaster Management mitigation & awareness9Hrs (9L+5P)

Education on disasters, Community involvement, Monitoring Management-. Stakeholders' Roles and Responsibilities, Categories of stakeholders - Governmental agencies - Non Governmental agencies -Disaster education. disaster recovery, mitigation and preparedness, Disaster Associated Health Issues - programme planning and management.

References

1. R.B.Singh (Ed) Environmental Geography, Heritage Publishers New Delhi,1990
2. Savinder Singh, Environmental Geography, PrayagPustakBhawan, 1997\
3. H.K. Gupta (Ed) Disaster Management, Universities Press, India, 2003
4. R.K. Bhandani An overview on Natural &Man-made Disaster & their Reduction, CSIR, New Delhi
5. M.C. Gupta Manuals on Natural Disaster management in India, National Centre for Disaster Management, IIPA, New Delhi, 2001.
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8. Mohammed I., El-Sabh, SrinivasanVenkatesh, CinnaLomnits, Tad S. Murty, (Editor), 2001,Earthquakes and Atmospheric Hazards: Preparedness Studies, Springer, 208 p.
9. Bill MacGuire, Ian Mason, Christopher Kilburn, 2002, Natural Hazards and Environmental Change, A Hodder Arnold Publication; Reissue edition, 202 p.
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MAJOR PRACTICAL – IV

ENVIRONMENTAL DISASTER MANAGEMENT

L	T	P	C
-	-	4	2

1. Study of Recent Disasters (at local, state and national level)
2. Preparation of Disaster Risk Management Plan of an Area or Sector
3. Disaster assessment and monitoring using multi-temporal RS data
4. Field study/ visit
5. Case studies.

Mapping of COs to POs and PSOs

	ENVIRONMENTAL DISASTER MANAGEMENT												
	Correlation level with POs					**Correlation level with PSOs**							
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**
CO1	H	M	M	H	M	L	H	M	H	M	L	H	H
CO2	H	L	M	H	H	L	M	M	H	H	M	H	H
CO3	H	L	L	M	L	L	M	M	H	H	H	L	H
CO4	H	M	M	H	M	L	M	H	H	M	M	L	H
CO5	H	M	L	L	L	L	M	H	M	M	L	L	H
CO6	H	M	M	M	H	L	H	L	L	M	M	L	H

L/M/H L – Low; M – Medium; H - High

Core 6: Statistics for Environmental Sciences

Course code

L	T	P	C

4	**-**	**-**	**4**

Course Objectives:

- To help them understand the statistical techniques within biological and ecological context
- To train them how to create well-written reports, containing relevant information

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Understand the basic concepts of statistics	K2
CO2	Write and collect the information and draw scientific inference from ecology and environment related data	K6
CO3	Analyze, model and quantify in environmental regression models	K4
CO4	Understand the basic concepts of Big data analytics like ANOVA, t-test, f-test etc	K2
CO5	Evaluate and execute a well-planned field research	K5
CO6	Apply Probability and probability distribution using different statistical calculations.	K3

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Introduction to Statistics **12hrs (12L+0P)**

Definition and Application of Statistics, Qualitative Data, Quantitative Data, Frequency Distribution, Cumulative Frequency, Diagrammatical Representation of Statistical Data (Bar,

Pie), Graphical Representation of Frequency Distribution (Histogram, Frequency Polygon, Cumulative Frequency Curves).

Attributes and Variables: types of variables, scales of measurement, measurement of Central tendency and Dispersion, Standard error, Moments – measure of Skewness and Kurtosis, Distributions - Normal, log-normal, Binomial, Poisson, t, 2 and F-distribution.

UNIT II Descriptive Statistics **8hrs (8L+0P)**

Measure of Central Tendency: Mean, Median, Mode, Geometric Mean (Merits and Demerits), Measure of Dispersion: Range, Standard Deviation, Variance, (Merits and Demerits), Co-Efficient of Variation.

UNIT III Probability **8hrs (8L+0P)**

Basic concept of probability theory, Sampling theory, Trial, event, sure event, random event, Sample space, Definition of probability, mutually exclusive events, Independent event, Laws of Probability - simple problems, Normal probability curve.

UNIT IV: Hypothesis Testing, correlation and Regression **12hrs (12L+0P)**

Hypothesis: Types of Hypothesis, Level of Significance, Type I and Type II Error, Standard Error, Degrees of Freedom, Chi Square Test, Student's t Test: One Sample t Test, Paired t Test. tests of hypothesis (t-test, 2-test ANOVA: one-way and two-way); significance and confidence limits. Correlation- Definition, Types of Correlation, Karl Pearson's Coefficient Of Correlation, Simple Linear Regression, One Way ANOVA and Two way ANOVA.

UNIT V:Environmental Modelling **12hrs (12L+0P)**

Approaches to development of environmental models; linear, simple and multiple regression models, validation and forecasting. Models of population growth and interactions: Lotka-Voltera model, Leslie's matrix model.Scientific Report Writing - Theory behind scientific communication – Importance, target audience - Insight on parts of a Scientific Report – with regard to creating abstracts, documenting theories, models, and accurately interpreting results.

References

1. Fundamentals of Mathematical Statistics: S.C. Gupta And V. K. Kapoor
2. Fundamentals of Statistics: S.C. Gupta
3. Fundamentals of Biostatistics: Veer BalaRastogi

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	L	H	L	M	L	M	M	M	H	M	M	H
CO2	H	M	H	H	H	L	H	M	M	L	M	L	H
CO3	H	L	H	M	H	M	H	L	H	L	M	M	H
CO4	H	M	H	M	H	L	H	L	M	M	L	M	H
CO5	H	M	H	H	H	M	H	L	L	M	L	L	H
CO6	H	M	H	H	H	L	H	H	M	M	M	M	H

L/M/H L – Low; M – Medium; H - High

ELECTIVE PAPER

1. RESTORATION ECOLOGY

Course code

L	T	P	C
3	-	-	3

Course Objective:

1. To understand the ecological concepts relevant for restoring ecosystems and critically think about the scientific/logistic challenges of applying these concepts into a restoration plan.
2. Students will describe the role of key ecological concepts in restoration

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Provide you withan understanding of the process of assisting in the recovery of damaged, degraded or destroyed ecosystems.	K2
CO2	Describe the major ecological principles underlying the successful restoration of natural resources including concepts of disturbance and succession	K1
CO3	Use ecological and management principles and select appropriate methods and tools for designing and conducting restoration projects for sustainable development	K6
CO4	Know the National restoration goals, Policy and Program	K1
CO5	Explain the importance of integrated aquatic ecosystem restoration like wild life and water resources	K3

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **9Hrs (9L+0P)**

Restoration Ecology - Definition, principles, concepts and strategies. (long term vs. short term) role of ecological principles in restoration, role of pioneer species in restoration and holistic approach in restoration.

UNIT II **9Hrs(9L+0P)**

Restoration of natural resources; restoration of river corridor, water resources and mine spoils. Approaches to Flood Plain Management, Concepts and Programs related to Restoration and Management of Lakes, Rivers and streams, Riverine - Riparian ecosystem and Wetlands, Fluvial restoration

UNIT III **9Hrs (9L+0P)**

Planning and evaluating aquatic ecosystem restoration — Project planning, selecting assessment criteria and synthesizing data. Introduction to watershed, concept and significance.Physical and hydrological characteristics of watershed. Drain - line treatment; Area treatment - Goals, features and watershed as unit of sustainable development

UNIT IV **9Hrs(9L+0P)**

Integrated Aquatic Ecosystem Restoration- Introduction, Institutional barriers to Integrated Aquatic Restoration, Importance of Integrated restoration to wildlife, Appropriate scale for restoration, Impact of human activities on water resources, climate change threats to water quality, Shifts in freshwater ecosystems

UNIT V **9Hrs(9L+0P)**

National restoration goals, Policy and Program.redesigning for restoration Integrated Water Resource Management (IWRM). Government agencies and NGOs in conservation and restoration; environmental education and its role in conservation and restoration. Finish Biotic Restoration Landscape ecology and restoration Finish monitoring and adaptive management

References

1. John CairnS Jr., 1992. Restoration of Aquatic Ecosystems - Science, Technology and Public Policy. National Academy Press. Washington D.C.
2. Adamus, P.R., Clairain, E. J., Smith R.D., Young R. E., 1987. Wetland Evaluation Technique (WET). Vol II. Methodology Operational Draft. U.S. Army corps of Engineers waterways Experiment Station, Vicksburg, Miss.
3. Barker, LA and E. B. Swain, 1989. Review of lake management in Minne-sota. Lake Reservoir Manage. 5:1-10.

4. Young, T. P. 2000. Restoration ecology and conservation biology. Biological Conservation 92: 73.83.
5. Hobbs, R. J. and Harris, J. A 2001. Restoration ecology: repairing the Earth's ecosystems in the new millennium. Restoration Ecology 9: 239-246.

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**							
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**
CO1	H	M	H	M	H	M	H	H	M	M	M	L	H
CO2	H	M	M	L	H	L	M	M	M	M	L	L	M
CO3	H	H	H	M	H	L	M	M	L	M	M	L	M
CO4	H	M	H	M	H	L	M	M	L	M	M	L	M
CO5	H	M	M	M	H	L	M	M	L	M	M	L	M

L/M/H L – Low; M – Medium; H - High

Elective paper

2. ENVIRONMENT AND HUMAN HEALTH

Course code:

L	**T**	**P**	**C**
3	**-**	**-**	**3**

Course Objectives

- To understand the water contamination and water quality standards
- To develop the knowledge about communicable diseases
- To know the toxic effects of heavy metals and pesticides on human health

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Create awareness of drinking water quality standards	K6
CO2	Know about the occupational health issues and their importance	K2
CO3	Recognize harmful substances which can pollute the immediate environment (air, water and soil) and cause health problems for people	K1

CO4	Evaluate the cultural factors in health and disease	K5
CO5	Recognize, assess and evaluate occupational health hazards	K1
CO6	Develop skills in ventilation and safe disposal of solid and biomedical wastes	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **8 hrs (8L+0P)**

Introduction – Need for protected water – Contamination of water – Sewage, Industrial effluents– Small scale purification of drinking water at home level – Water quality standards

UNIT II **8 hrs (8L+0P)**

Epidemiology of communicable diseases- Hepatitis, Cholera, Diarrhoeal diseases, Typhoid, Amoebiasis , Malaria , Plague , Causative agents – Mode of Transmission – Clinical features – Prevention and control

UNIT III **10 hrs (10L+0P)**

Heavy metals and health hazards – Aluminium, Arsenic, Cadmium, Chromium, Lead, Mercury – Pesticides and health hazards – Sources for human beings – Prevention – Occupational Diseases – Beedi rolling and health

UNIT IV **8 hrs (8L+0P)**

Air pollutants and human health – Prevention of Air Pollution associated diseases – Noise pollution and human health - Global warming and human health – Health hazards due to use and throw plastics

UNIT V **8 hrs (8L+0P)**

Ideal Housing – Ventilation – Safe disposal of solid wastes and biomedical wastes – Cultural factors in health and disease – Use of Mobile phone and human health - Health education and communication.

References

1. K. Park, (1987) Preventive and Social medicine – M/s. BanarsBhanot publication publishers, Jabalpur, India
2. Krishnan Kannan (1997), Fundamentals of environmental pollution, S.Chand Company, India
3. Rangwala (1987) Fundamentals of water supply and sanitary engineering, Charotar Publishing House, Anand, India
4. ManolTiwari et al., (2007). Environmental Studies, I.K. International Publishing House Pvt. Ltd
5. Daniel S. Blumenthal., (1985). Introduction to Environmental Health. Springer Publishing Company, New York

6. V.P. Desai. (1997). Way to Environment and our health. SonaliPingley Publishers, Mumbai.

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**
CO1	H	H	M	L	H	L	H	H	H	H	M	H	H
CO2	L	H	M	M	H	L	H	H	H	H	M	H	H
CO3	L	H	M	M	H	L	H	H	H	H	M	H	H
CO4	L	H	M	M	H	L	H	H	H	H	M	H	H
CO5	L	H	M	M	H	L	H	H	H	H	M	H	H
CO6	M	H	M	M	H	L	H	H	H	H	M	H	H

L/M/H L – Low; M – Medium; H - High

Elective paper

3. ENVIRONMENTAL EDUCATION AND COMMUNICATION

Course code

L	T	P	C
3	-	-	3

Course Objectives

1. To understand the concept and significance of Environmental Education.
2. To understand the nature and scope of environmental education with regard to Indian policies.
3. To acquire knowledge of environmental issues and policies in India
4. To understand the curriculum and methods in environmental education
5. Demonstrate an understanding of critical and cultural approaches to environmental communication.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1:	Understand the concept and significance of Environmental Education	K1
CO2:	Associate the nature and scope of environmental education	K2

	with regard to Indian policies.	
CO3:	Simulate critical thinking skills in relation to environmental affairs	K3
CO4:	Connect many disciplines and fields that intersect with environmental concerns.	K4
CO5:	Defend intrinsic values of ecological processes and communities.	K5
CO6:	Create and communicate science effectively, with appropriate use of scientific terminology.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **9Hrs (9L+0P)**

Introduction to Environmental Education: Meaning, definition, characteristics and scope of Environmental Education – Importance of and guiding principles of Environmental Education - incorporating E.E at various levels- Primary, Secondary and Higher Secondary levels. Education about environment: Factors of degradation of environment – adverse socio – economic impacts of degradation of environment.

UNIT-II **9Hrs(9L+0P)**

Environmental pollution and its consequences – Air pollution, water pollution, land pollution, nuclear pollution, Ozone depletions - Urbanization and its impacts on environment - Deforestation and its impacts on environment - Factors responsible for flora and fauna extinction – Measures to conserve flora and fauna – Ways of protecting, Management of Environment, Preserving and Restoring of environment.

UNIT III **9Hrs(9L+0P)**

Environmental movements in India: Silent Valley movement, Chipko movement, Narmada Bachao, Andolon, National Test Range at Baliupal, Orissa –conditions for achieving the goals of sustainable development – Strategies for sustainable development in India. International Efforts for Environmental Protection: The Stockholm conference 1972 – The Rio Summit 1992 – the Rio Declaration at the earth charter – Major achievement of the Rio Summit – Main features of the Rio Declaration – Kyoto conference and part on Global Warming 1997 – present developments.

UNIT IV **9Hrs(9L+0P)**

Environment research programme: Environmental Management – Data base Management for Environmental appraisal, Monitoring and warning system. Society, culture and environment: Meaning – Changes of Values, cultural values, aesthetic values, man and environment, the nature of scientific conclusions, the state of public knowledge of ecology, rights and responsibilities in ecology understanding.

UNIT V **9Hrs (9L+0P)**

Definition, Nature and Scope, Need of Environmental Communication - Public Participation in Environmental Decisions - Ecology and Society need of public Education through media. Relevance of eco-education and mass media - Rethinking of eco-education through media impact of Environment on Human development - Human behaviour and Environmental Education through media - Sustainable development and New Communication media Environmental issues and local media.

References

1. Sharma, R. A. (2008). Environmental Education. Meerut: R.Lall Books Depot.
2. Sharma, B. L., &Maheswari, B. K. (2008). Education for Environmental and Human value. Meerut: R.Lall Books
3. Singh,YK (2009) Teaching of environmental science. New Delhi: APH Publishing Corporation.
4. Sharma, V. S. (2005). Environmental education. New Delhi: Anmol publication.
5. Reddy, P. K.,& Reddy, N. D. (2001). Environmental Education. Hyderabad: Neelkamal publications.
6. Agarwal, S.P. and Aggarwal, J.C. (1996) Environmental Protection, Education and Development. New Delhi: New Concepts.
7. Mahesh Rangarajan, Editor, 2009. Environmental Issues in India: A reader. Pearson Education India
8. Kelu.P (2000) Environmental Education – A conceptual Analysis Calicut: Calicut University
9. Robert Cox and Phaedra C. Pezzullo (2016) Environmental Communication and the Public Sphere (4th ed.). Los Angeles: Sage Publications.
10. Anders Hansen and Robert Cox, (2015) TheRoutledge Handbook of Environment and Communication. London: Routledge.

Mapping of COs to POs and PSOs

	Correlation level with POs	Correlation level with PSOs

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	M	H	H	H	M	H	M	M	H	M	M	M
CO2	M	M	H	H	H	M	H	M	M	H	M	M	M
CO3	M	M	H	H	H	M	H	M	M	H	M	M	M
CO4	M	M	H	H	H	M	H	M	M	H	M	M	M
CO5	M	M	H	H	H	M	H	M	M	H	M	M	M
CO6	M	M	H	H	H	M	H	M	M	H	M	M	M

L/M/H L – Low; M – Medium; H - High

Supportive course (Mandatory)

ENVIRONMENTAL TOXICOLOGY

Course code:

L	T	P	C
3	-	-	3

Course objectives

- To impart the knowledge of principles and scope of toxicology.
- To gain the knowledge about the factors influence the toxicity

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Gain knowledge on various environmental toxicants, concepts of LC50, LD50 and ED50	K1
CO2	Understand the entry of toxicants, and behaviour of toxicants in the environment	K2
CO3	Apply the relationship of dose-response in toxicity	K3
CO4	Gain knowledge on the exposure routes of toxicants, toxicological test methods, and determination of toxic levels of contaminants	K4
CO5	Discuss the level of toxicity in various organs	K5
CO6	Practise the toxicity of substances in animal model in research aspects	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Basic concepts of Toxicology **10 hrs (10L+0P)**

Principles of Toxicology - Scope of Toxicology - Dose response relationship, concept of LC50, LD50 and ED50 - Types of toxic substances: Degradable and non-degradable - Acute and chronic toxicity – Synergism and Antagonism - Sigmoid relationships - Chemical and biological factors influencing toxicity

UNIT II: Toxicants in the Environment **8 hrs (8L+0P)**

Toxic substances in the environment, their sources and entry routes – exposure of toxicants by air, water, soil and diet.Bioaccumulation, biomagnifications and biotransformation of toxic materials in food chain.

UNIT III: Dose-Response Relationships **8 hrs (8L+0P)**

Graded response - Quantal response, Time action curves - Threshold limit value (TLV) - Margin of safety - Toxicity curves.Physiological and metabolic effects on flora and fauna.

UNIT IV: Toxicity Testing **6 hrs (6L+0P)**

Methods used to assess toxicity, Bioassay – types, characteristics, significance and Limitations. Bioassay methods using plant, animal and microbial models - Teratogenicity, carcinogenicity and mutagenicity

UNIT V: Organ toxicity **12 hrs (12L+0P)**

Hepatotoxicity: Common examples of hepatotoxicants, Nepherotoxicity: Common examples of nepherotoxicants, Pulmonary toxicity: Common examples of pulmonary toxicants, Neurotoxicity: Common examples of neurotoxicants.

References

1. Casseret LJ and Doull J (1982) Toxicology. The Basic Science of Poisons. Macmillan Publishers, New York.
2. Curtis D. Klaassen, John B. Watkins (2015) Casarett&Doull's Essentials of Toxicology, Third Edition, McGraw Hill Professional.
3. David Woolley, Adam Woolley (2008) A Guide to Practical Toxicology: Evaluation, Prediction, and Risk, Second Edition, CRC Press, USA.
4. Donald W. Sparling (2017) Basics of Ecotoxicology, CRC Press/Taylor & Francis Group, USA.
5. Kaiden Higgins (2017) Environmental Toxicology, Larsen and Keller Education, USA.

6. Shaw I and Chadwick J (1998) Principles of Environmental Toxicology, CRC Press, USA.
7. Stephen M. Roberts, Robert C. James, Phillip L. Williams (2015) Principles of Toxicology: Environmental and Industrial Applications, John Wiley & Sons, New Jersey, USA.
8. William Hughes (1996) Essentials of Environmental Toxicology, Taylor & Francis, USA.

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**							
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**
CO1	M	H	M	M	H	L	M	L	H	M	M	L	H
CO2	H	H	M	M	H	M	M	L	H	M	M	L	H
CO3	M	H	M	M	H	L	M	L	H	M	M	L	H
CO4	H	H	L	M	H	L	M	L	H	M	M	L	H
CO5	M	H	M	M	H	M	M	L	H	M	M	L	H
CO6	M	H	L	M	H	M	M	L	H	M	M	L	H

L/M/H L – Low; M – Medium; H - High

SEMESTER-III

Core 7: INSTRUMENTATION AND RESEARCH METHODOLOGY

Course Code:

L	T	P	C
4	-	4	4

Course Objective:

- Understand and Study about various Instrumentation methods and their working.
- To develop the knowledge about scientific research, formulating thesis and report writing

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Evaluate, Construct and execute a scientific project, write scientific reports, develop research and communication skills	K4 & K6
CO2	Learn principles and working of spectroscopic instruments	K1
CO3	Understand principles, working and applications microscopic and centrifuge techniques used in scientific research	K2
CO4	Create knowledge in extraction of various plant and other products using chromatographic and electrophoresis techniques	K6
CO5	Skill developed in the field of environmental instrumentation and analyses	K4
CO6	Application of knowledge in setting up and conducting experiments	K3

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **12 hrs (9L+3P)**

Spectroscopy: Absorption Spectroscopy: Quantitative aspects, photometer and spectrophotometer designs. Molecular UV and UV absorption Spectroscopy, Photo acoustic spectroscopy.Molecular fluorescence, phosphorescence and chemiluminescence spectroscopy.Atomic spectroscopy, Raman spectroscopy and their applications, NMR - application to Proton and other isotopes, environmental

effects, ESR. X-ray spectroscopy, fluorescence, absorption, diffraction. Mass spectroscopy

UNIT II **12 hrs (9L+3P)**

Microscope: Microscopy- Bright field, Dark field, Phase contrast microscope, Confocal microscopy. Electron microscope: Scanning Electron microscope and Transmission Electron microscope, STM, AFM, HR-TEM.

Centrifuge techniques: Basic principles of sedimentation, the sedimentation coefficient. Types of centrifuges.Preparative and analytical ultra-centrifuge.Types of rotors.Clearing Factor.

UNIT III **12 hrs (6L+6P)**

Chromatography: Plate theory, qualitative and quantitative analysis, adsorption chromatography, partition chromatography, thin layer chromatography, Paper chromatography, column chromatography, Computerized system; Gas-liquid chromatography, Gas solid type, HPLC, Partition Chromatography, Ion-exchange chromatography, Size exclusion chromatography

Electrophoresis: General principles, supporting materials. AGE, SDS-PAGE, Isoelectrofocusing, Western, Southern and Northern blotting and PCR.

UNIT IV **10 hrs (7L+3P)**

Introduction to Research: Meaning of research; Types of research- Exploratory research, Conclusive research; The process of research, Scientific Research: Methods of scientific research-Preparation of review article-editing research paper-collection of literature-references-bibliography and thesis writing.

UNIT V **12 hrs (9L+3P)**

Formulating the research hypothesis- Types of Research hypothesis; Writing a research proposal- Contents of a research proposal and types of research proposals.

Research Design: Meaning of Research Designs; Nature and Classification of Research Designs; Exploratory Research Designs: Secondary Resource analysis, Case study Method, Expert opinion survey, Focus group discussions; Descriptive Research Designs: Cross-sectional studies and Longitudinal studies; Experimental Designs, Errors affecting Research Design.

References

1. Chatwal, G. and Anand,S. 1989. Instrumentation Methods of Chemical Analysis. Himalays Publishing House, Delhi.
2. Robinson, J.W. (ed).1991, Practical Handbook of Spectroscopy CRC Press, Boston.

3. Webster, J.C. (ed). 2005. Bioinstrumentation. John Wiley & Sons Inc., Singapore.
4. Gurumani, N. 2006. Research methodology for Biological Sciences, MJP Publishers, Chennai.
5. Palanichamy, S. Shunmugavelu, M. 2006. Research methods in Biological Sciences. Sarojini for palani paramount Publication. Anna Nagar Palani.
6. Cannel. J.P. 1998. Natural Products Isolation, Humana Press New Jersey.
7. Harbone J. B. 2003. Phytochemical methods, (5th Edition) Chapman &Hall, London.
8. Keith Wilson, 2000. A practical guide to clinical biochemistry.
9. Willard Merrit Instrumental methods of analysis 7th Edition

MAJOR PRACTICAL – V

INSTRUMENTATION AND RESEARCH METHODOLOGY

L	T	P*	C
-	-	4	2

1. Preparation of research article
2. UV-Spectrophotometer
3. Thin Layer chromatography
4. Paper chromatography
5. Column chromatography
6. Principles and operation of microscope types with illustration
7. PAGE of protein extracted from plant leaf
8. Agarose gel electrophoresis of DNA sample isolated from plant
9. Research Communication and scientific documentation: structure of a scientific paper, thesis, dissertation, research article.

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**							
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**
CO1	M	M	L	H	H	L	H	M	M	H	H	M	H
CO2	H	H	H	H	H	L	H	M	M	H	H	M	H
CO3	M	M	M	M	H	M	H	M	M	H	H	M	H
CO4	H	H	H	H	H	M	H	M	M	H	H	M	H
CO5	H	H	H	H	H	H	H	M	M	H	H	M	H
CO6	H	H	H	H	H	H	H	M	M	H	H	M	H

L/M/H L – Low; M – Medium; H - High

CORE 8: REMOTE SENSING, GIS AND ENVIRONMENTAL MODELLING

Course code

L	T	P	C
4	-	4	4

Course Objectives

- The understand the working and application of remote sensing and GIS
- This course introduces the students to various computer-based and statistical methods used for study and management of natural resources and the environment.
- The students are expected to learn about remote-sensing techniques, physical principles, sampling, statistics and image-analysis methods.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	To learn how sensors collect spatial geographic data	K1
CO2	To generate geographical information by processing digital data by remote sensing and assess its environmental applications.	K2
CO3	To apply RS, GIS and GPS tools in various dimensions of the environment.	K3
CO4	Analysis mathematical and statistical concepts required for model development. □	K4
CO5	Building a foundation for understanding Remote Sensing and Geographic Information System (RS-GIS) as a powerful tool for geospatial analysis.	K6

K1- Remember; K2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **8 hrs (5L+3P)**

Remote Sensing: definitions and principles; electromagnetic (EME) spectrum; interaction of EMR with Earth's surface; spectral signature; satellites and sensors; aerial photography and image interpretation.

UNIT II **12hrs (6L+6P)**

Geographical Information Systems: definitions and components; spatial and non-spatial data raster and vector data; database generation; database management system; land use/ land cover mapping; overview of GIS software packages; GPS survey, data import, processing, and mapping.

UNIT III **8 hrs(5L+3P)**

Applications and case studies of remote sensing and GIS in geosciences, water resource management, land use planning, forest resources, agriculture, marine and atmospheric studies.

UNIT IV **8 hrs(5L+3P)**

Environmental modelling: Scope and definition - Basics of Model Formulation - Basic Mathematical Formulation - Modelling approaches– deterministic, stochastic and the physical approach- Applications of environmental models- the model building process.

UNIT V **12 Hrs(6L+6P)**

Mathematical Modelling: General theory of mathematical modelling. Integration of basic processes (evaporation, snow-melt, runoff, soil water dynamics, groundwater flow) in mathematical models. Model calibration, parameter optimisation, validation. Water quality modelling- surface water quality modelling and Ground water quality modelling, air quality modelling (the box model, the Gaussian plume model point sources, line sources, area sources- Gaussian puff model).

References

1. Lillesand,T.M., Kiefer, R.W. and J.W.Chipman. “Remote Sensing and Image Interpretation” 5th Edition, John Willey and Sons Asia Pvt. Ltd., New Delhi, 2004.
2. Anji Reddy, M. “Textbook of Remote Sensing and Geographical Information System” 2nd edition. BS Publications, Hyderabad, 2001.
3. Lo. C.P.andA.K.W.Yeung, “Concepts and Techniques of Geographic Information Systems”,Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
4. Peter A.Burrough, Rachael A. McDonnell, “Principles of GIS”, Oxford University Press, 2000.
5. Ian Heywood “An Introduction to GIS”, Pearson Education Asia, 2000

Major Practical – VI

Remote sensing, GIS and Environmental Modelling

L	T	P*	C
-	-	4	2

1. Remote sensing imageries – processing
2. Geometric rectification
3. Classification of remote sensing data
4. Remote sensing application – wetland identification
5. Mapping stream s and river habitats
6. River basin inventory using ground data and remote sensing data
7. Vegetation analysis - past and present
8. Forest type analysis using remote sensing.
9. False image analysis
10. Disaster images and analysis.

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	M	H	M	H	L	M	M	M	H	H	L	H
CO2	H	M	H	M	H	L	M	M	M	H	H	L	H
CO3	H	M	H	M	H	L	M	M	M	H	H	L	H
CO4	H	M	H	M	H	L	M	M	M	H	H	L	H
CO5	H	M	H	M	H	L	M	M	M	H	H	L	H

L/M/H L – Low; M – Medium; H - High

CORE 9: ENVIRONMENTAL GEOSCIENCES

Course code:

L	T	P	C
4	-	-	4

Course Objective:

- Understand the origin of earth, rock and soil characters
- Understand the climates of India, weathering
- Study about geological process, and natural hazards

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Have a basic understanding on the Earth formation and its structural components.	K1
CO2	Identify and classify common rocks and minerals	K3
CO3	Understanding the Earth system of interacting rock, water, air and life and how these elements have shaped Earth's surface	K2
CO4	Have the skill to identify the geologic features of the earth and use them to understand the geologic history of a region.	K2
CO5	Understand the climatic patterns and weathering reactions in India	K1
CO6	Make Prediction of natural hazards like earth quakes, tsunami and volcanic eruptions and mitigation of their impacts.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **10hrs (10L+0P)**

Origin of earth - Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere.Concept of minerals and rocks.Formation of igneous and metamorphic rocks. Controls on formation of landforms - tectonic including plate tectonic and climatic. Concept of steady state and equilibrium, Energy budget of the earth.Earth's thermal environment and seasons.Coriolis force, pressure gradient force, frictional force, geo-strophic wind field, gradient wind.

UNIT II **10 hrs (10L+0P)**

Climates of India, western disturbances, Indian monsoon, droughts, El Nino, La Nina.Concept of residence time and rates of natural cycles.Geophysical fields.

Weathering including weathering reactions, erosion, transportation and deposition of sediments. Soil forming minerals and process of soil formation, Identification and characterization of clay minerals, Soil physical and chemical properties, soil types and climate control on soil formation, Cation exchange capacity and mineralogical controls.

UNIT III **8 hrs (8L+0P)**

Geochemical classification of elements, abundance of elements in bulk earth, crust, hydrosphere and biosphere.Partitioning of elements during surficial geologic processes, Geochemical recycling of elements.Paleoclimate.

UNIT IV **10 hrs (10L+0P)**

Distribution of water in earth, hydrology and hydrogeology, major basins and groundwater provinces of India, Darcy's law and its validity, groundwater fluctuations, hydraulic conductivity, groundwater tracers, land subsidence, effects of excessive use of groundwater, groundwater quality. Pollution of groundwater resources, Ghyben-Herzberg relation between fresh-saline water.

Natural resource exploration and exploitation and related environmental concerns.Historical perspective and conservation of non-renewable resources.

UNIT V **6 hrs (6L+0P)**

Natural Hazards: Catastrophic geological hazards - floods, landslides, earthquakes, volcanism, avalanche, tsunami and cloud bursts. Prediction of hazards and mitigation of their impacts.

References

1. Engineering and General Geology by Parbin Singh, Eight Edition, S K Kataria& Sons
2. A. Text book of Geology by Mahapatra, CBS Publishers
3. Fundamentals of Historical Geology and Stratigraphy of India by Ravindra Kumar, New Age International
4. Engineering Geology by Duggal, S.K, Pandey, H.K and Rawal, N, McGraw Hill Education, 2014
5. Oliver. H. Heintzelman, Richard, M. Highsmith, J.R. 1965,1971 'World Regional Geography' Printice Hall of India (P)ltd., NewDelhi
6. Cole, J. 1996 'A geography of the world's major regions', Rout ledge, London
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8. Gourou P. 1980 ' TheTrophical World' Longman, London.

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**							
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**
CO1	H	M	M	H	H	M	H	M	M	H	H	H	H
CO2	H	M	L	H	H	M	H	M	M	H	H	H	H
CO3	H	L	L	H	H	M	H	M	M	H	H	H	H
CO4	H	M	M	H	H	M	H	M	M	H	H	H	H
CO5	H	L	L	H	H	M	H	M	M	H	H	H	H

L/M/H L – Low; M – Medium; H - High

CORE 10: HAZARDOUS WASTE AND SOLID WASTE RECYCLING TECHNIQUES

Course code:

L	T	P	C
4	-	-	4

Course Objective:

- Study about solid waste, Industrial waste, Marine waste and biological Processing waste recovery studies.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Analysis the characters, impacts, treatment and disposal methods of hazardous waste	K3
CO2	Evaluate the management of solid and liquid wastes from municipal and industrial sources. .	K5
CO3	Apply the principles of remedial measures of recycling, reuse and recovery from the wastes.	K3
CO4	Understand and describe the principle and mechanistic role of microbes in the degradation of various pollutants.	K2
CO5	Formulate the integrated waste management	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **8 hrs (8L+0P)**

Hazardous waste – Types, characteristics and health impacts. Hazardous waste management: Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal.

UNIT II **8 hrs(8L+0P)**

Solid Waste - types and sources. Solid waste characteristics, generation rates, solid waste components, proximate and ultimate analyses of solid wastes. Solid waste collection and transportation: container systems - hauled and stationary, layout of collection routes, transfer stations and transportation.

UNIT III **12hrs(12L+0P)**

Solid waste processing and recovery – Recycling, recovery of materials for recycling and direct manufacture of solid waste products.Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and vermicomposting, biomethanation of solid waste.Disposal of solid wastes – sanitary land filling and its management, incineration of solid waste.

UNIT IV **12hrs (12L+0P)**

Integrated waste management: Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management: Life cycle assessment: Cradle to grave approach; lifecycle inventory of solid waste; role of LCA in waste management; advantage and limitation of LCA; case study on LCA of a product.

UNIT V **9 hrs (9L+0P)**

E-waste: classification, methods of handling and disposal .Fly ash: sources, composition and utilisation. Plastic waste: sources, consequences and management.

References

1. Asnani, P. U. 2006. Solid waste management. India Infrastructure Report 570.
2. Bagchi, A. 2004. Design of Landfills and Integrated Solid Waste Management. John Wiley & Sons.
3. Blackman, W.C. 2001. Basic Hazardous Waste Management. CRC Press.
4. McDougall, F. R., White, P. R., Franke, M., &Hindle, P. 2008. Integrated Solid WasteManagement: A Life Cycle Inventory. John Wiley & Sons.
5. EPA. 1999. Guide for Industrial Waste Management. Washington D.C.
6. White, P.R., Franke, M. &Hindle P. 1995. Integrated Solid waste Management: A Lifecycle Inventory. Blackie Academic & Professionals.
7. Zhu, D., Asnani, P.U., Zurbrugg, C., Anapolsky, S. & Mani, S. 2008. Improving Municipal Solid waste Management in India. The World Bank, Washington D.C.

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**							
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**
CO1	M	H	H	H	H	H	H	L	H	M	L	M	H
CO2	M	H	H	H	H	H	H	L	H	M	M	M	H
CO3	M	H	H	H	H	H	H	M	H	M	L	M	H
CO4	M	H	H	H	H	H	H	M	H	H	L	H	H

CO5	M	H	H	H	H	M	H	L	H	M	L	H	H

L/M/H L – Low; M – Medium; H - High

ELECTIVE PAPER

Elective paper 1

VERMI AND MUSHROOM CULTURE

L	T	P	C
3	-	-	3

Objective:

This course will give an idea about the application of biological science, particularly plant science in business generations and self-employment. This focuses on the Vermicompost and Mushroom cultivation, its marketing and also in Agriculture depended economy and its impact on society.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Have a basic understanding on the vermi composting	K1
CO2	Identify and classify common earthworms	K2
CO3	Understanding the vermi techniques	K2
CO4	Have the skill to identify the mushrooms	K2
CO5	Understand the climatic patterns and weathering conditions for mushroom cultivation	K1
CO6	Create techniques regarding the mushroom cultivation	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Unit I **8 hrs (8L+0P)**

Vermi composting - Definition, introduction and scope: Ecological classification: Humus feeders, Humus formers leaf, mold, top soil and sub soil types. Physical, chemical and biological changes brought by earthworm in soil-burrows- drilosphere - earthworm casts.

Unit II **8 hrs (8L+0P)**

Optimal conditions for vermiculture-temperature, moisture, pH, soil type, organic matter, protection from sunlight, rain, predators-food preference. Basic components for vermi culture-culture practices- Home- School-Industries-Vermi wash.

Unit III **8 hrs (8L+0P)**

Composting- vermi composting-Required conditions-Requirements-Methods-Hep-Pot-Tray-changes during Vermi compost-Advantages-Cost-Benefit analysis of vermi composting-Role of Earthworms in soil fertility–Use of Vermicompost for crop production –Use of earthworms in land improvement and land reclamation, Economics of Vermicompost and vermiwash production.

Unit IV **8 hrs (8L+0P)**

Introduction and Importance of mushrooms; History of mushrooms cultivation; resent status of mushroom industry in India cultivable edible mushrooms; Biology of mushrooms: food value of edible mushrooms; uses of mushrooms; Poisonous mushrooms and Medicinal mushrooms.

Unit V **8 hrs (8L+0P)**

Mushrooms farm structure; design and layout; Spawn principles and techniques of spawn production; Principle and techniques of compost and composting; Cultivation techniques of white button mushroom, oyster mushroom;Management of fungal bacterial and viral diseases in mushroom; Competitors, pests and nematodes in mushrooms; Post harvesting techniques and Economics of mushroom cultivation.

References

1. Sultan Ahmed Ismail, 2005, The Earthworm Book, second revised Edition, Mother India Press, Goa.
2. Edwards C.A. and Bohlen, P.J 1996, Ecology of earthworms – 3rd Edition, Chapman and Hall.
3. Jsmail, S.A., 1970, Vermicology, The Biology of earth worms, Orient Longman, London.
4. Lee, K.E., 1985. Earthworms – Their ecology and relationship with soil and land use, Academic Press, Sydney

5. Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	L	L	L	L	L	L	L	L	L	L	L	L	L
CO2	L	L	L	L	L	L	L	L	L	L	L	L	L
CO3	L	L	L	L	L	L	L	L	L	L	L	L	L

L/M/H L – Low; M – Medium; H - High

Elective paper 2

ENVIRONMENTAL CHEMISTRY

L	T	P	C
3	-	-	3

Course Objectives:

The main objectives of this course are to:

1. Impart knowledge on the fundamentals of chemical process
2. Understand the environmental problems
3. Study for solving various environmental issues

Course outcomes

On the successful completion of the course, student will be able to:

	Course outcomes	Cognitive level
1	Have a basic understanding on the fundamental concepts of chemistry - atoms, bonding a chemical molecules	K2
2	Understand the sources, classification and formation of chemical pollutants and their impact on environment	K2
3	Have detailed knowledge on various physico-chemical parameters, chemical reactions and removal/reduction of air, soil and water pollutants from the environment	K2
4	Have the skill to design a field research on environmental problems for sustainable maintenance of the functional ecosystem	K3
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create		

UNIT – I **6 hrs (6L+0P)**

Stochiometry, Gibb's energy, Chemical potential, chemical equilibria, acid-base reactions. Solubility product, solubility of gases in water, the carbonate system,unsaturated and saturated hydrocarbons, Radio nuclides.

UNIT – II **6 hrs (6L+0P)**

Atomic structure, electronic configuration, types of chemical bonds, mole, molarity and normality – concepts of pH and pE – Electrochemistry, Nernst equation

UNIT – III **8 hrs (8L+0P)**

Classification of elements, chemical speciation, Particles, ions and radicals in theatmosphere. Chemical processes for formation of inorganic and organic particulate

matter – principles of photochemistry – fluorescence – phosphorescence - Thermochemical and photochemical reactions in the atmosphere.

Unit IV **8 hrs (8L+0P)**

First law of thermodynamics, enthalphy, adiabatic transformations, second law ofthermodynamics, Carnot's cycle, entropy, Gibb's free energy, chemical potential, phase equilibria, Gibb's Donnan equilibrium, third law of thermodynamics, enzymes catalysis,Michaelis/ Menten equation – exo and endothermic reactions – spontaneous and non spontaneous reactions

UNIT – V **8hrs (8L+0P)**

Oxygen and ozone chemistry, Chemistry of air pollutants, Photochemical Smog,Chemistry of water, concept of D.O., B.O.D., and C.O.D, wastewater treatment - redox potential – Organic compounds -hydrocarbons, functional groups, nucleophiles and electrophiles. Surface and interface chemistry - Adsorption, absorption, catalysis, colloids, surfactants, examples, types of adsorption, desorption. Synthetic Polymers: biological decomposition, polymer decay, ecological consideration - Inorganic and organic components of soil, nitrogen pathways and NPK in soils.

References

1. Fundamental Concepts of Environmental Chemistry, Sodhi, G.S. (2009),Alpha Science International Ltd.
2. Environmental Chemistry, (5th Ed.), De, A. K. (2002), New Age International (P) Ltd.
3. Fundamentals of Environmental Chemistry, 3rd Edition, Manahan, E. S. (2011). CRC Press.
4. Photochemistry &Spectroscopy, Simons, J. P. (1971), Wiley Interscience.
5. Fundamentals of Photochemistry, Rohatgi-Mukherjee, K. K. (2006), New Age International (P) Ltd.
6. Elements of Environmental Chemistry, Jadhav, H. V. (1992), Himalya Publication House.
7. Environmental Chemistry, Sharma, B. K. and H. Kaur, H. (1994), Goel Publishing House
8. Environmental Chemistry, Moore, J. W. and Moore, E. A. (1976), Academic PressInc.
9. Environmental Chemistry A global perspective, (4th Ed.), Van Loon, G. W. and Duffy, S. J. (2017), Oxford University Press.

10. Chemistry of Atmospheres: An Introduction to the Chemistry of the Atmospheres of Earth, the Planets, and their Satellites (3rd Ed.), Wayne, R. P., (2000), Oxford University Press.
11. Basic Concepts of Environmental Chemistry (2nd edition), Connell, D.W. (2005), CRCPress.
12. Textbook of Environmental Chemistry, Pani, B. (2007), IK International Publishing House.
13. Elements of Environmental Chemistry (2nd edition), Hites, R.A. (2012), Wiley & Sons.
14. Standard Methods for the Examination of Water and Waste Water, (23rdEd.), APHA, (2005), Washington, D.C.
15. Fundamentals of Soil Science, (8th Ed.), Futh, H. D. (2016), Wiley India.

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	H	M	H	M	H	H	M	M	H	L	H
CO2	M	H	H	M	H	M	H	H	M	M	H	L	H
CO3	M	H	H	M	H	M	H	H	M	M	H	L	H
CO4	M	H	H	M	H	M	H	H	M	M	H	L	H

H-High; M-Medium; L-Low

Elective paper

3. NON-CONVENTIONAL ENERGY TECHNOLOGY

Course code:

L	T	P*	C
3	-	-	3

Course Objectives:

- To understand Measurement of Energy, Feed stock materials- Reactors, Solar energy conversion technologies and Distribution of geothermal resources were studied.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Understand the need of energy conversion and the various	K1

	methods of energy storage	
CO2	Estimate the renewable energy, Utilization of it, Principles involved in green energy collection and conversion of it to electricity generation.	K2
CO3	Apply the concepts involved in wind energy conversion system by studying its components, types and performance.	K3
CO4	Illustrate ocean energy and explain the operational methods of their utilization.	K4
CO5	Estimate the Geothermal &Tidal energy, its mechanism of production and its applications.	K5
CO6	Integrate the concepts of Direct Energy Conversion systems & their applications.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT- I **6Hrs (6L+0P)**

Introduction- Energy- Measurement of Energy- Energy resources- Types of renewable and non- renewable energy resources- Advantages of Renewable energy resources- Resources available in India- World Energy Demand.

UNIT-II **9Hrs (9L+0P)**

Biofuels- Classes of Biofuels- Biomass energy- Sources of Biomass for fuel conversion- Advantages and Disadvantages of biomass as a source of energy – Biochemical- Thermo chemical Conversion-Bioethanol production- Bioethanol Vs Petrol- Outlook of bioethanol fuel Market worldwide- Biodiesel production- Global Scenario- Conversion Technologies.

UNIT-III **6Hrs (6L+0P)**

Biogas production- Feed stock materials- Reactors- Mechanism of methane formation- Factors affecting methane formation- Biogas production from alternate feed stocks- Biohydrogen production- Methods- Hydrogenase enzyme- Invitro production of hydrogen- Hydrogen Fuel Cells- Mechanism- Application.

UNIT-IV **9Hrs (9L+0P)**

Solar energy conversion technologies- Solar photovoltaic conversion- Application and costs of solar energy technology- Solar collector modeling- Solar collector related studies- Applications of photovoltaic electricity- Solar air and water heaters- Solar drying- Wind energy conversion technology- Wind energy planning- Ocean thermal energy- wave/ current energy- Wind powered electricity generation with and without grid interconnection.

UNIT- V **6Hrs (6L+0P)**

Geothermal energy- Energy storage- Distribution of geothermal resources- Geothermal exploration- Geothermal utilization- Comparison of geothermal energy with other energy sources - Nuclear/ thermonuclear reactors- Environmental considerations- Energy economics- Energy education

References

1. Velusamy M.A, Thangaraj K, Baskar. K, Shubra Singh. 2016. Sustainable Power for Future-Renewable Energy. University Science Press
2. Sharma. M.R. Science, Technology and Society. 2009. University Science Press.
3. David M. Mousdale., Biofuels Biotechnology, Chemistry and sustainable development. CRC Press
4. NejatVeziroglu (1983). Alternative energy sources V. Elsevier science publishers
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6. Jogdand, S.N. (2003) Environmental biotechnology, Himalaya Publishing house
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8. Dubey R.C. and Maheswari, D. K (2005) A Textbook of Microbiology, S.Chand&Company Ltd.
9. Anjaneyalu, Y (2004) Introduction to Environmental Science, BS Publications
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11. Desai A.V. (2000) Nonconventional energy, New Age International (P) Ltd.

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	H	M	L	M	H	H	L	M	M	M	M	M
CO2	H	H	M	M	L	M	H	L	M	L	M	L	H
CO3	H	H	L	L	M	M	H	M	H	L	M	M	M
CO4	H	H	M	H	H	L	H	M	L	L	L	M	H
CO5	M	M	L	H	H	M	H	M	L	M	L	L	H
CO6	H	H	M	L	M	L	H	L	M	M	L	M	M

L/M/H L – Low; M – Medium; H – High

Supportive Online Course from Swayam, MOOC NPTEL etc.https://nptel.ac.in/

MINI PROJECT

SEMESTER-IV

CORE 10: POLLUTION CONTROL ENGINEERING AND BIOREMEDIATION

Course code:

L	T	P	C
4	-	3	4

Course Objective

- Study about pollution control and oxidation process.
- Understand the filtration process.
- Understand the bioremediation of metal compounds and their characters.
- Study about phytoremediation.
- Study about application of GEMS in bioremediation

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Have a full-fledged knowledge on the principles and mechanism of pollution control techniques and the engineering principles behind.	K1
CO2	Understand and describe the type of microorganisms in the environment and the role of microorganisms in the cycling of nutrients in an ecosystem.	K2
CO3	Apply the concept of bioremediation, Nanotechnology for bioremediation	K3
CO4	Explain the importance of plants and microbes in environmental remediation	K4
CO5	Know the ethical guidelines in use of GMOs, and different biosafety levels	K5
CO6	Study the principle and working of various bioreactors	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **8 hrs(8L+0P)**

Characteristics of major industrial effluents – primary – secondary and tertiary treatment of effluents - Ion exchange – reverse osmosis – electrodialysis – colour

removal from industrial effluents – Sludge treatment and disposal – Modelling of activated sludge process

UNIT II **12 hrs(12L+0P)**

Working principles of the following reactors - Rotating Biological Contactors, Fluidized Bed Reactor, Expanded Bed Reactor, Contact Digesters, Packed Column Reactors, UASB Reactor – Microbial removal of nitrogen and phosphorus – Nutrient removal through biomass production - Hazardous waste management – Hospital waste management – Air pollution control in industries.

UNIT III **10hrs(8L+0P)**

Metal-microbes interactions – Microbial immobilization and transformation of metals – Genetic aspects of heavy metal resistance– Pesticide biodegradation – Biotechnological applications for pesticide waste disposal – Oil degradation by microbes – Aquatic macrophytes for waste water treatment – Biotechnology in soil pollution abatement.

UNIT IV **10 hrs (10L+0P)**

Effluent irrigation in agriculture –Microalgal species for aquaculture – Mass cultivation techniques – Closed and Semi Outdoor Culture Systems – Harvesting and Drying of Algal Biomass – Bioagumentation for commercial production of algae, phytoremediation, Bioremediation through nanotechnology – Magnetotactic bacteria.

UNIT V **10hrs (10L+0P)**

Genetic concept in pollution management – Transgenic microbes for treating toxic chemicals – Environmental effects of biotechnology – Gene transfer in the environment – GEMS and biosafety – Ethics of microbial biotechnology

References

1. Pradipta Kumar Mohapatra (2007), Text book of Environmental Biotechnology, I.K. International Publishing House Pvt. Ltd
2. Jogdand. S.N. (2003) Environmental Biotechnology, Himalaya Publishing House
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14. Kaul, Nandy&Trivedy, (1989). Pollution control in Distilleries Enviromedia, India
15. A.G.Murugesan and C.Rajakumari, Environmental Science and Biotechnology – Theory and Techniques, MJP Publishers

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**							
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**
CO1	H	H	H	H	H	L	H	H	H	M	M	M	H
CO2	H	H	H	H	H	L	H	H	H	M	M	M	H
CO3	H	H	H	H	H	L	H	H	H	M	M	M	H
CO4	H	H	H	H	H	L	H	H	H	M	M	M	H
CO5	H	H	H	H	H	L	H	H	H	M	M	M	H
CO6	H	H	H	H	H	L	H	H	H	M	M	M	H

L/M/H L – Low; M – Medium; H - High

Core 11 – e-PATHASHALA

Analytical Chemistry

L	T	P*	C
4	-	-	4

Objective:

1. Understand the Volumetric analysis compounds and their characters. Study about Instrumentation methods.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Learn the basic about solution preparation and error analysis	K1
CO2	Understand the principles of analytical techniques	K2
CO3	Apply the principles and working of chromatographic techniques	K3

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Unit 1 **9Hrs (9L+P)**

General analytical - Errors in analysis in laboratory safety- Volumetric analysis – Acid base titrations- Complexometric titrations-Redox titrations.

Unit 2 **9Hrs (9L+P)**

Precipitation argentometric titration - Gravimetric analysis - Mass spectrometry - Bomb calorimetry - Potentiometry -Ph. electrode, Membrane electrode, Biochemical electrode:ISFET, MOSFET.

Unit 3 **9Hrs (9L+P)**

Conductivity meter and salinity meter - DO meter – Polarography - Anode and cathode stripping voltammetry - Cyclic voltammetry - General chromatography, distribution coefficient and its implications.

Unit 4 **9Hrs (9L+P)**

Chromatographic methods – (paper, TLC and Column chromatography) - High performance thin layer chromatography (HPTLC) - Gas chromatography (GSC/ GLC) technique and sample preparations.

Unit 5 **9Hrs (9L+P)**

Gas chromatography, Mass spectroscopy - High pressure liquid chromatography - Ion exchange chromatography - Ion molecular exclusion chromatography - Capillary electrophoresis.

References

1. Principles of Biophysical chemistry - Uppadahay –Uppadahay - and Nath.
2. Analytical Techniques - S.K. Sahani

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs							
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8

CO1	H	M	M	L	H	M	H	H	M	M	H	L	M
CO2	H	M	M	L	H	M	H	H	M	M	H	L	M
CO3	H	M	M	L	H	M	H	H	M	M	H	L	M

L/M/H L – Low; M – Medium; H - High

CORE 12: ENVIRONMENTAL ASSESSMENT, MANAGEMENT AND LEGISLATION

Course code:

L	T	P	C
4	-	-	4

Objectives of the course

- Provide comprehensive knowledge in EIA, Environmental Audit and laws.
- Increase understanding on key issues related to National as well as International Environmental Law and Policies.
- Develop practical skills to facilitate effective engagement with the Environmental Law.
- Prepare the students to be well-informed in Environmental Law so as to create awareness.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Explain the concepts about Environmental Impact Assessment, develop skills in identifying and solving problems	K4
CO2	Be able to access and analyse different case studies/examples of EIA in practice for evaluation/assessment	K5
CO3	Understand the basic laws, act, public policies, treaty related to environment.	K2
CO4	Create knowledge on study about importance of environmental audit and EIA notifications for ISO standards	K6
CO5	Apply various methods to Predict the Environmental impacts of project after deciding various environmental attributes	K3

CO6	Able to know the power and functions of government agencies for pollution control.	K1

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **12hrs (12L+0P)**

Introduction to EIA and Risk Assessment: Aims and objectives of Environmental Impact Assessment (EIA). Environmental Impact Statement (EIS) and Environmental Management Plan (EMP). EIA Guidelines.Impact Assessment Methodologies.Procedure for reviewing EIA of developmental projects.Life-cycle analysis, cost-benefit analysis.

Risk Assessment - Hazard identification, Hazard accounting, Scenarios of exposure, Risk characterization and Risk management.

UNIT II **8 hrs (8L+0P)**

Environmental Audit: Guidelines for Environmental Audit. Environmental Planning as a part of EIA and Environmental Audit. Environmental Management System Standards (ISO14000 series). EIA Notification, 2006 and amendments from time to time.Eco-labeling schemes.

UNIT III **12hrs(12L+0P)**

Environmental legislations: Overview of Environmental Laws in India: Constitutional provisions in India (Article 48A and 51A). Wildlife Protection Act, 1972 amendments 1991, Forest Conservation Act, 1980, Indian Forest Act, Revised 1982, Biological Diversity Act, 2002, Water (Prevention and Control of Pollution) Act, 1974 amended 1988 and Rules 1975, Air (Prevention and Control of Pollution) Act, 1981 amended 1987 and Rules 1982, Environmental (Protection) Act, 1986 and Rules 1986, Motor Vehicle Act, 1988.

UNIT IV **12 hrs (12L+0P)**

Environmental legislations: The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, The Plastic Waste Management Rules, 2016, The Bio-Medical Waste Management Rules, 2016, The Solid Waste Management Rules, 2016, The e-waste (Management) Rules 2016, The Construction and Demolition Waste Management Rules, 2016, The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000, The Batteries (Management and Handling) Rules, 2010 with Amendments, The Public Liability Insurance Act, 1991 and Rules 1991, Noise Pollution (Regulation and Control) Rules, 2000, Coastal

Regulation Zones (CRZ) 1991 amended from time to time. National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006.

UNIT V **12hrs(12L+0P)**

Environmental Conventions and Agreements: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. IPCC, UNEP, IGBP.

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Mapping of COs to POs and PSOs

	Correlation level with POs	**Correlation level with PSOs**

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	M	H	H	H	H	L	M	M	M	H	H	M	H
CO2	H	H	H	H	H	L	L	M	M	H	H	M	H
CO3	H	H	H	H	H	L	M	M	M	H	M	L	H
CO4	H	H	H	H	H	L	L	M	M	H	H	M	H
CO5	H	H	H	H	H	M	M	M	M	H	M	L	H
CO6	H	H	H	H	H	M	M	M	M	H	M	L	H

L/M/H L – Low; M – Medium; H - High

Industrial Internship

Project and viva-voce