MANONMANIAM SUNDARANAR UNIVERSITY
ABISHEKAPATTI,TIRUNELVELI-627012,TAMILNADU,INDIA

Master of Science – Environment Science

(with effect from the academic year 2021-2022)

VISION AND MISSION OF THE UNIVERSITY

VISION

" To provide quality education to reach the unreached "

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

Vision of the Programme :

- 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".

Mission of the Programme :

- To provide environmental education and awareness to the students, youth and public and train them to conserve the mother Nature

Evaluation , Scheme

Duration:2 Years

M.Sc. Environment Science or Master of Science in Environment Science is a postgraduate Environmental Science course. Environmental Science is an interdisciplinary academic field that integrates chemistry and biological sciences, (including but not limited to Ecology, Chemistry, Biology, and Geology) to the study of the environment, and the solution of environmental problems. Environmental science provides an integrated, quantitative, and interdisciplinary approach to the study of environmental systems. The duration of M.Sc. in

Environment Science is mostly of two academic years. The syllabus for the course is divided into four semesters.

M.Sc. Environment Science Eligibility

- Aspiring students should have passed Bachelor's Degree from any recognised University or its equivalent examination with any of the following subjects like Environmental Sciences, Chemistry, Botany, Zoology, Microbiology, Biotechnology, Geology, Life Sciences, Home Science Relevant courses in B.E. and B. Tech-Environmental Engineering, Agriculture, Biotechnology, secured minimum 55% marks (45% in case of SC/ST candidates) in the above-mentioned examination.
- Candidates who have appeared or who are likely to appear for the qualifying examination i.e. B.Sc. or equivalent but whose results have not been as yet declared can also appear for this entrance test provided, they have offered the mentioned subjects at the said examination.

Common Course Structure for M.Sc. Environmental Science
(with effect from the academic year 2021-22 onwards)

Sem. (1)	Sub. No. (2)	Subject Status (3)	Subject Title (4)	Contact Hrs./ Week (5)	Credits (6)
I	1	Core - 1	Fundamentals of Ecology and Ecosystem	6	4
	2	Core - 2	Biodiversity Types, Concept and Conservation	6	4
	3	Core - 3	Environmental Biology	5	4
	4	Core - 4	Statistical and Research Methods	5	4
	5	Core - 5 Practical - 1	Ecology & Biodiversity	4	2
	6	Core - 6 Practical – 2	Environmental Biology	4	2
			Subtotal	**30**	**20**
II	7	Core - 7	Environmental microbiology	5	4
	8	Core - 8	Environmental chemistry	5	4
	9	Core - 9	Solid Waste and Management	4	4
	10	Core - 10	Environmental Toxicology	4	4
	11	Core - 11	Field Work	4+	3
	12	Core - 12 Practical - 3	Environmental microbiology & toxicology	4	2
	13	Core - 13 Practical - 4	Environmental chemistry & solid waste management	4	2
			Subtotal	**30**	**23**

Sem. (1)	Sub. No. (2)	Subject Status (3)	Subject Title (4)	Contact Hrs./ Week (5)	Credits (6)
III	14	Core - 14	Pollution: assessment, instrumentation and control Technologies	6	4
	15	Core - 15	Environmental Biotechnology	6	4
	16	Core - 16	Environmental management and impact assessment	5	4
	17	Core - 17	Research Methodology	5	4
	18	Core - 18 Practical - 5	Practical- Pollution: assessment, instrumentation and control Technologies	4	2
	19	Core - 19 Practical - 6	Practical- Environmental Biotechnology	4	2
			Subtotal	**30**	**20**
IV	20	Core - 20	Natural disaster management	4	4
	21	Core - 21	Forest and Wildlife Ecology	4	4
	22	Core - 22	Remote sensing and Geographical Information	4	4
	23	Core - 23 Practical - 7	Practical- Natural disaster management and Forest and Wildlife Ecology	4	2
	24	Core - 24 Practical - 8	Practical- Remote sensing and Geographical Information	4	2
	25	Elective - 1	Field Work / Study Tour	3+	3
	26	Core - 25	Project	7+	8
			Subtotal	**30**	**27**
			Total	**120**	**90**

+ Extra hours for the Project

For the Project, flexible credits are b/w 5 – 8 & Hours per week are b/w 10 - 16.

Total number of credits ≥ 90 : 90

Total number of Core Courses	:	25 (15 T + 8 P + 1 Prj. + 1 FW.)
Total number of Elective Courses / F.W. / S.T.	:	1
Total hours	:	120

FIRST SEMESTER

Core – 1: Fundamentals of Ecology and Ecosystem

a. Objectives:

1. Improve ecological literacy by learning the basic principles and concepts of the field of ecology
2. Improve scientific literacy by learning how ecologists construct knowledge

b. Pre-requisite for the study of the course:

The pre-requisite for studying the course Ecology and Ecosystem is a basic knowledge of our environment, constituent of our environment, Ecological factors affecting our environment.

c. Outcome of the study:

The student completed this course will have a full-fledged knowledge on the idea of biosphere, atmosphere, lithosphere, components of Ecosystem, Ecosystem stability and homeostasis, population characteristics, Ecological Niche, Ecological succession and the relation between Man and Environment.

d. Course outline:

Unit I: Introduction to Ecology -Definition, subdivision and scope, Basic concepts in ecology, Autecology and Synecology, Level of organization in Ecology, Environmental heterogenicity, Applied ecology, Environmental complexes, Interaction of ecological factors.

Unit II: Ecological factors-Light, temperature, precipitation (rainfall), humidity. Atmosphere: gases and wind, atmospheric gases, wind factor and fire factor, topographic and edaphic factors. Different environmental laws and limiting factors (Liebig's law of minimum, Shelford's law of Tolerance, Combined concept of limiting Factors). Biotic community, Interdependence in a community and community metabolism, Community ecology: structure, composition and development of community, species diversity in communities, Ecotones, Concept of edge effect, Ecological niche, Gause's Principle.

Unit III: Ecosystem-Introduction, kinds of ecosystem, structure and functions, abiotic and biotic component, Ecological energetics, Energy flow models, Food chain and

Food web, Concepts of productivity and standing crops, Ecological Pyramids-types, Ecological succession, Ecological indicators, Ecological efficiencies, Biogeochemical cycles in ecosystems.

Unit IV: Population ecology-Population characteristics; density, natality, mortality, biotic potential, survivorship curves, age distribution, growth curves and models, r &k selection. Population interaction, Prey-Predator Relationship, Ecological Model.

REFERENCES

1. Begon, M., Townsend, C.R. and Herper, J.L. (2005). Ecology: From Individuals to Ecosystems, 4thEdition, John Wiley & Sons.
2. Botkin, D. and Edward, K. (1997). Environmental Sciences, John wiley& Sons, New York.
3. Chapman, J. L. and Reiss, M. J. (1998). Ecology: Principles and Applications.Cambridge University Press, UK.
4. Cunningham, W. P. and Cunningham, M. A. (2004). Principles of Environment Science. Enquiry andApplications. 2nd Edition. Tata McGraw Hill, New Delhi.
5. Dash, M.C. and Dash, S.P. (2009). Fundamentals of Ecology. McGraw Hill Education.
6. Odum, E.P. (2005). Fundamentals of Ecology, 5thEdition, Cengage Learning Publication.
7. Raven, P. H., Berg, L.R. and Hassenzahl, D.M. (2008). Environment. 6th Edition. John Wiley & Sons., USA.
8. Sharma, P.D. (2000). Ecology & Environment, 7thEdition, Rastogi Publications, Meerut.
9. Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India. 2006.
10. Smith, T.M. and Smith, R.L. (2015). Elements of Ecology. 9thEdition, Pearson Benjamin Cummings, USA.

e. Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember facts on ecology, and ecological dynamics	K1
CO2	Understand to correlate ecological dynamics and regulation of vital processes on earth as biogeochemical cycles	K2
CO3	Relate ecosystem services, ecological resilience, ecological economics, and landscape ecology	K3
CO4	Device experiments to appreciate concepts of Ecology	K4
CO5	Evaluate the forces impacting ecosystems viz., climate change, stress, population,	K5

	consumerism, globalization, land use change	
CO6	Create habitat inventory of streams, river and freshwater wetlands	K6

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

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
CO1	H	H	H	H	H	H	H	H	H	H
CO2	H	H	H	H	H	H	H	H	H	H
CO3	H	H	H	H	H	H	H	H	H	H
CO4	H	H	H	H	H	H	H	H	H	H
CO5	H	H	H	H	H	H	H	H	H	H
CO6	H	H	H	H	H	H H H	H H			

L/M/H L – Low; M – Medium; H - High

Core – 2

Biodiversity Types, Concept and Conservation

a. Course Objectives:

1. To understand the concept of the biodiversity.
2. To create the awareness on the importance and conservation of the biodiversity

b. Course Prerequisites:

The pre-requisite for studying the course on Biochemistry and Biochemical techniques is a basic knowledge on Ecosystem, ecology, ecological pyramids, types of forests- biotic and abiotic factors constituting it.

c. Course outline:

Unit I : Biodiversity concept, Biodiversity-components, Biodiversity-Types, Biodiversity-importance, ecological importance, economical importance, key stone umbrella and flagship species, Economic value of biodiversity, ecotone and niche.

Unit II: Biodiversity- values, Biodiversity status: National status and Global status, hotspot; threatened species, IUCN Red list, endangered species, vulnerable species, rare species, extinct species and endemic species. Climate change, induced losses. Common flora and fauna in India- Aquatic: phytoplankton, Zooplankton and macrophyes. Terrestrial: Forests; Endangered and threatened species.

Unit III: Concepts, distribution and importance of megadiversity zones, Biodiversity hotspots, National and global red data lists, Categories of species and their management, Restoration of biodiversity, Acceleration of ecological succession, Reintroduction of biota.

Unit IV: IPRs, national and international programs for biodiversity conservation. Wildlife values and eco-tourism, wildlife distribution in India, problem in wildlife protection, role of WWF, WCU, CITES, TRAFFIC, Wildlife Protection Act 1972.

Unit V: Importance of Biodiversity conservation, Different approaches for Biodiversity conservation-In-situ conservation: sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots. Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; In-vitro Conservation: germplasm and gene Bank; tissue culture: pollen and spore bank, DNA bank.

1. Sustaining Life: How Human Health Depends on Biodiversity Eric Chivian Aaron Bernstein

2. (2008)
3. Shahid Naeem, Daniel E. Bunker, Andy Hector and Michel Loreau (2009)Biodiversity, ecosystem
4. fuctioning and human well being: An ecological and economic perspective
5. S.K. Agarwal et al (1996) Biodiversity and Environment, APH, Dehra Dun.
6. S.S. Negi (1993) Biodiversity and its Conservation in India, Indus Publications, New Delhi.
7. W.W. Collins and C.O. Qualset (1998) Biodiversity in Agro-ecosystem, CRC, Boston.
8. V.K. Krishnamurthy (2003) Text Book of Biodiversity, Science Publisher, Chennai.
9. P.S. Ramakrishnan (2000) Mountain Biodiversity, Land Use Dynamics and Traditional Ecological
10. Knowledge, Oxford and IBH, New Delhi
11. Global Biodiversity strategy: WRI, IUCN & UNEP
12. Ecotourism and Sustainable Development: Singh; Abhijeet Pub

d. Course Outcomes(Cos):

At the end of the course, the student will be able to

CO1: Observe how different global impacts can interact to affect ecosystems.

CO2: Describe ecological networks and what they can tell us along with their conservation.

CO3: Discover the main reasons for decline and threats to biodiversity worldwide.

CO4: Analyse how different global impacts can interact to affect ecosystems.

CO5: Editorialize on a topical aspect of biodiversity and/or conservation.

CO6: Hypothesize ways in which we could mitigate global impacts on ecosystems.

e. Mapping of Cos to POs and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	H	H	M	H	H	M	M	M	M	H	K1
CO2	H	H	M	H	H	M	M	H	H	H	K2
CO3	H	M	H	H	H	H	H	M	H	H	K3
CO4	H	H	M	H	H	H	H	H	M	H	K4
CO5	H	H	M	H	H	H	H	M	M	H	K5
CO6	H	H	M	H	H	H	H	H	M	H	K6

Core – 3
Environmental Biology

a. Course Objectives:

Upon completing this course, students will be able to:

1. Explain core concepts in ecology and summarize our ecological understanding of environmental problems
2. List environmental problems that are the result of unsustainable human behaviour and explain the root causes of environmental problems

b. Course Prerequisites:

The pre-requisite for studying the course on Environmental biology is a basic knowledge on biology, conservation and ecology of plants, birds and mammals, insects, fungi and microbes.

c. Course outline

Unit I: Fundamentals of Ecology, Definition, Subdivisions. Ecosystems: concept of ecosystems, energy flow in ecosystems, Nutritional Flux. Development and evolution of the ecosystems. Biogeochemical cycles, Food-chains, ecotone, edge effects, ecological niche, and ecosystem stability.

Unit II: Environmental Microbiology: Microbes – classification and their applications in the environmental sciences. Cultivation and growth of microorganisms. Microorganisms and their association with man, animals and plants. Microbes as anti-microbial agents, Extremophilic microorganisms, Microbial metabolism.

Unit III: Biomes and Habitat Diversity: Classification of biomes, major biotic elements of each biome and their characteristics. Biological diversity of India: Definition and nature, India's biogeographically history, physiography, climate and its impact on biodiversity. Indian forest and vegetation types and diversity of flora and fauna. Population and Community Ecology.

Unit IV: Wetlands Forests and Semi-arid Habitats of India: Definition and types of wetlands, important wetlands of India and their conservation issues. Forests and semi-arid habitats

of India: their distribution in India, ecological status of forests and arid lands, and their
conservation.

Unit V: Endangered, Endemic and Extinct Species of India: Threatened species categories of
IUCN, threatened species of plants and animals in India and their reasons, Red data books. Environmental biotechnology. Role of biotechnology in conservation of species, *insitu*
and *ex-situ* conservation.

References :
1. Microbes, Man and Animals : The Natural History of Microbial Interactions : Linton, A. H. and Burns, R.G. (1982) john Wiley and Sons.
2. Elements of Microbiology : Pelczar, M.J. and Chan ECS, 1981 McGraw Hill.
3. General Microbiology : Stainer, R.Y.., Adelberg, E.A. and Ingraham, J.L. 1977. Macmillan Press.
4. Microbial Methods for Environmental Biotechnology : Grainer, J.M. and Lynch, J.M. 1984. Academic Press.
5. Microbiological Methods for Environmental Scientists and Enginners : Gaudy, A.F. and Guady, E.T. 1980, McGraw Hill.

d. Course Outcomes(Cos):

At the end of the course, the student will be able to

CO1: Analyze the different parameters of soil and water

CO2: Understand the current environmental issues

CO3: Classify the various ecosystems and animal interactions

CO4: Identify planktons and equipment used in ecology

CO5: Create love towards nature.

a. Mapping of Cos to POs and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	H	H	M	H	H	M	M	M	M	H	K1
CO2	H	H	M	H	H	M	M	H	H	H	K2
CO3	H	M	H	H	H	H	H	M	H	H	K3
CO4	H	H	M	H	H	H	H	H	M	H	K4
CO5	H	H	M	H	H	H	H	M	M	H	K5
CO6	H	H	M	H	H	H	H	H	M	H	K6

Core-4
Statistical and Research Methods

a. Course Objectives:

Upon completing this course, students will be able to:

1. Formulate research questions.
2. design research and the various types of research designs
3. Carry out quantitative and qualitative research

b. Course Prerequisites:

The pre-requisite for studying the course on statistical and research methods is a basic in computer analysis of data sets, designing and evaluating research designs and techniques, and having the skills to understand primary research in scientific literature.

c. Course outline:

Unit I: Sampling, Data collection and recording. Central tendency – concept; arithmetic mean, mode, median for ungrouped and grouped data.

Unit II: Measures of dispersion: absolute and relative measures; range, standard deviation (grouped and ungrouped data), variance, quartile deviation, coefficient of variability. Skewness, Kurtosis. Probability - normal, poisson and binomial.

Unit III: Statistical Methods: Hypothesis testing, significance and correlation. Correlation. Linear models and regressions. Pearson and other correlation coefficients. Multiple regressions. Distribution- Normal, t and chi square test.

Unit IV: Difference among means: F-test: 1 way ANOVA; F-test: 2 ways ANOVA. Computer applications in environmental modeling. Computer-based modeling: Linear, regression, validation and forecasting. Computer-based modeling for population and population studies.

Unit V: Matrices, simultaneous linear equations; tests of hypothesis and significance. Time series analysis - moving averages (3 and 5 unit cycles). Current development in the subject

References :

1. Zar, Jerrold H. (1998). Biostatistical Analysis. Prentice Hall, N.J.
2. Sokal, Robert and James Rohlf (1997). Biometry, Freeman Press, N.Y.
3. Walpole, R. and R. Myers (1993). Statistics for Engineers and Scientists, 5th edn. MacMillan, N.Y.

4. Wayne, R. Ott (1995). Environmental Statistics and Data Analysis, CRC Press.
5. Manly (2001) Statistics for environmental science and management, Chapman and Hall / CRC.
6. Ramsay and Schafer (1997). The Statistical Sleuth, Duxbury Press.

d. Course outcomes

At the end of the course, the student will be able to

CO1: Distinguish between empirical research and other approaches to gaining knowledge

CO2: Recognize the main characteristics of qualitative and quantitative research design.

CO3: Formulate a research question and applicable designs to address that question

CO4: Appropriately apply inferential statistical procedures, e.g., t-test, correlation, ANOVA, to test research hypotheses

CO5: Explain the role of measurement in research and demonstrate understanding of the concepts of validity and reliability of data collection instruments

e. Mapping of Cos to POs and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	M	M	M	M	M	M	M	M	M	M	K1
CO2	M	M	M	M	M	M	M	M	M	M	K2
CO3	M	M	M	M	M	M	M	M	M	M	K3
CO4	M	M	M	M	M	M	M	M	M	M	K4
CO5	M	M	M	M	M	M	M	M	M	M	K5
CO6	M	M	M	M	M	M	M	M	M	M	K6

Core -5
Practical-1

Ecology & Biodiversity

1. Determination of Importance value index of species in a plant community.
2. To compare two plant communities
3. Quantitative measurement of plankton in fresh and marine water samples.
4. Determination of primary productivity by light and dark bottle method.

5. Indicate distribution range of a plant and animal species identified as endangered on an Indian map.
6. Identification and description of plant species.
7. To plot biosphere reserve on a map of India.
8. Prepare a document of endemic and exotic species of plants and animals for a selected PAN.

Core -6
Practical- 2

Environmental Biology

1. Identification of fauna and flora of terrestrial, freshwater and marine ecosystems.
2. Identification of phytoplankton and zooplankton (either freshwater or marine).
3. Qualitative estimation of phytoplankton by Lacky's Drop Method and Zooplankton by Sedgwick-Rafter Cell method.
4. Estimation of primary productivity – Light and dark bottle method – effects of depth and light.
5. Community study: quadrat method; flora and fauna study by frequency, density and abundance – line transect method.

II Semester
Core – 7
ENVIRONMENTAL MICROBIOLOGY

a. Course objectives
    1. Understand the role of microorganisms as agents of environmental change
    2. .Recognize microorganisms as indicators of alteration of an ecosystem
    3. Understand microbial processes aimed to solve environmental problems
b. Course prerequisites
    The pre-requisite for studying the course on Environmental microbiology is a general knowledge on basic biology, bacteria and other microorganisms and their role in the environment.
c. Course outline
    Unit-I: General and Aquatic Microbiology: **C**lassification, characteristics, occurrence and distribution of microorganisms. Microbial cultivation and growth. Microbial mats, Bio-films, Role of Microorganisms in Wastewater and Water Treatment; Bioassay tests for toxicity evaluation, Pathogens and Indicator microorganisms; Eutrophication of water bodies.

    Unit-II: Soil microbiology: General characteristics and activities of microorganisms in surface soil, Mineralization and Immobilization of soil nutrients, Microbial degradation of cellulose, hemicelluloses and lignin. Microbes in Agriculture-Biological nitrogen fixation, bio-fertilizers, Mycorrhiza and their environmental significance. Microbe mediated C, N and S transformations.

    Unit-III: Food microbiology**:** Food borne infections: bacterial (Clostridium, Salmonella, Shigella, Staphylococcus), Mycotoxins in food with reference to Aspergillus species. Genetically modified foods. Microbes in food production. Applications of microbial enzymes in food industry.

Unit-IV: Bio-indicators: Plankton community as indicators of water pollution; use of diversity index in evaluation of water quality. Determination of microbiological quality of recreational and potable waters, indicator organisms, coliforms and E.coli, fecal streptococci, clostridia, and heterotrophic plate counts etc. lichens as air pollution indictors.
Biosensor Components, advantages and limitations, biocatalyst based, ion-affinity based and microorganism based biosensors; Applications of biosensors in environmental monitoring.

Unit V: Applied Environmental Microbiology: Bioremediation: principle and mechanisms, types and environmental applications. Specific Processes: Biodegradation of pesticides and hydrocarbons, Bio-hydrometallurgy, Microbial Enhanced Oil Recovery, Biodegradable Plastics, Biosurfactants. Release of genetically engineered microbes and environmental risk.

REFERENCES

1. Gaudy, A.F. & E.T. (1980). Microbiological Methods for Environmental Scientists and Engineers, McGraw Hill.
2. Grainer, J.M. & Lynch, J.M. (1984). Microbial Methods for Environmental Biotechnology: Academic Press.
3. Madigan, M.T. &Martinko,J.M. (2006). Brock Biology of Microorganisms. Pearson Prentice Hall.
4. Maier, R.M., Pepper, I.L. &Gerba, C.P. (2000). Environmental Microbiology, Academic Press.
5. Parihar, P. &Parihar, L. (2008). Advances in Applied Microbiology. 1stEd., Agrobios (India).
6. Pelezar, M.J. Jr., Chan, E.C.S and Kreig, N.R (1993). Microbiology, Tata McGraw Hill, Delhi.
7. Purohit, S.S. (2010). Microbiology Fundamentals and Applications, 6th Ed., Agrobios.
8. Stainer, R.Y., Adelberg, E.A. & Ingraham, J.L. (1977). General Microbiology, Macmillan Press.
9. Environmental Microbiology - Alan H. Varnam and Malcolm G. Evans.
10. Environmental Microbiology - Annette Bolger.
11. Environmental Microbiology - Purnima Sethi and V.S. Kulkarni

d. Course outcome:
At the end of the course, the student will be able to

CO1: Learn the major principles of environmental microbiology and the relationship of microbes to environmental processes and other living organisms.

CO2: Demonstrate proper scientific procedure to identify various type of environmental microbes.

CO3: practice critical thinking skills and apply them to both material presented in lecture and the analysis of data generated in the laboratory

CO4: Apply knowledge of the biology and distribution of certain species of microorganisms, principally bacteria, in order to use them as bio indicators of

contamination and other environmental impacts

CO5: Obtain information, design experiments and interpret results

CO6: Recognize and use the properties of microorganisms, principally bacteria, to remedy problems of contamination and other environmental impacts.

e. Mapping of Cos to POs and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	H	L	H	M	M	L	M	L	L	H	K2
CO2	L	H	M	M	L	M	L	M	L	H	K1
CO3	M	M	H	M	M	M	M	M	L	H	K4
CO4	L	L	M	H	L	L	M	L	M	H	K5
CO5	L	L	H	H	H	L	L	M	M	H	K3

Core – 8
ENVIRONMENTAL CHEMISTRY

a. Course Objectives:

1. To educate the students on Atmosphere and Water quality analysis and water pollution.
2. To impart the understanding on Particles in the atmosphere and Origin of Hazardous wastes

b. Course Prerequisites:

The pre-requisite for studying the course on Environmental Chemistry is a basic knowledge on the atmosphere, pollution, pollution types and its sources.

c. Course Outcomes(Cos):

At the end of the course, the student will be able to

CO1: Remember the basics of environment

CO2: Understand the chemical analysis techniques in environment

CO3: Apply the instrument techniques in pollution mitigation

CO4: Analyze the pollution and causes of pollution

CO5: Evaluate a mechanism to prevent pollution

CO6: Create a newer techniques for pollution prevention

d. Course Outline:

Unit I: Chemistry of water and aquatic system -Stiochiometry, Gibb's energy, chemical potential, chemical equilibria, acid base reactions, solubility product, solubility of gases in water. The carbonate system; Chemistry of water, Properties of water and their significance, types, sources and consequences of water pollution, Physico chemical and bacteriological sampling and analysis of water quality. Water quality standards. Concept of DO, BOD, COD,

sedimentation, coagulation, filtration, Redox potential, alkalinity, acidity, calcium and other metals in water, organic pollutants in sewage, soaps, oil and detergents, radionuclide in water.

Unit II: Atmospheric chemistry-Particles, ions and radicals in the atmosphere. Natural and anthropogenic sources of pollution. Primary and Secondary pollutants. Transport and diffusion of pollutants. Oxygen and ozone chemistry. Chemistry of air pollutants, Photochemical smog. Methods of monitoring and control of air pollution- SO2, NOx, CO, SPM. Effects of pollutants on human beings, plants, animals and materials. Air quality Standards

Unit III: Soil and sediment geochemistry-Inorganic and organic components of soil, Weathering of rocks, rock forming minerals, Soil properties, acid-base and ion-exchange reaction in soil, Macro and micronutrients in soil, Nitrogen pathways and NPK in soils, Interior of the earth- minerals and rocks- earth processes- plate tectonics- sea floor spreading, mountain building, rock deformation.

UNIT IV: Toxic chemicals in the environment- Organic compounds: Hydrocarbons, Chemistry of hydrocarbons, phenols, chlorofluorocarbons, pesticides, chemical fertilizers, environmental effects, effects on macro and microorganisms. Gasoline lubricants and greases, Pesticides**:** Classification, degradation, analysis, pollution due to pesticides and heavy metals

REFERENCES

1. De, A.K. (2001).Environmental Chemistry. Wiley Eastern Ltd, New Delhi
2. Field, F.W. & Haines, P.J. (2000). Environmental Analytical Chemistry, Blackwell Science Ltd. USA.
3. Karikalan, V.L. (2002). Environmental Engineering. DhanpatiRai& Co. (P) Ltd., Delhi.
4. Manahan, S.E. (1991). Environmental Chemistry. Lewis Publishers, Chelsea, Michigan.
5. O' Neill, P. (1993). Environmental Chemistry. Chapman and Hall, London.
6. Rao, C.S. (1991). Environmental Pollution Control Engineering. Wiley Eastern, New Delhi.
7. Sharma, B.K. and Kaur H. (1998). Environmental Chemistry. Goel Publishing House, Meerut.
8. Sodhi, G.S. (2002). Fundamental concepts of Environmental Chemistry, Narosa Publishing House, New Delhi.

e. Mapping of Cos to POs and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	H	M	L	M	L	L	M	L	L	H	K1
CO2	M	H	L	M	L	L	M	L	M	H	K2
CO3	M	L	H	L	M	L	L	L	M	H	K3
CO4	M	L	M	H	M	L	L	L	L	H	K4
CO5	M	H	M	L	H	L	L	L	L	H	K5
CO6	H	H	H	H	H	L	M	L	M	H	K6

Core 9

SOLID WASTE AND MANAGEMENT

a. Course objectives

1. To sensitize the learners about the problem of waste generation and its impact on environment and human health.
2. To familiarize the learners to existing legislation, knowledge and practices regarding Waste Management in the country.
3. To prepare the learners with the ability to manage the solid waste effectively.

b. Course prerequisites

The pre-requisite for studying the course on solid wastemanagement is a basic knowledge on solid waste from different industrial and municipal wastes and the required amount of treatment for safe disposal/recycling.

c. Course outline

UNIT I: Sources, generation, classfication & composition of solid wastes. Solid waste management methods - Sanitary land filling, Recycling, Composting, Vermi composting, Incineration, energy recovery from organic waste.

UNIT II: Solid Waste Management Plan, Waste minimization technologies, Hazardous Waste Management, Sources & Classification, physicochemical properties, Hazardous Waste Control & Treatment.

Unit III: Methods of disposal – Dumping, Sanitary Landfill, Incineration, Pyrolysis, Composting, Ocean Dumping. Leachate Management for MSW landfills

UNIT IV: Applied Uses of Solid Waste: Biogas production, Composting and Vermicomposting. International cooperation in municipal solid waste management.

Unit V: Integrated Waste Management. Municipal Solid Waste Management & Handling Rules,2000

References:

1. Solid Waste Management CPCB. New Delhi.
2. Ecotechnology for pollution control & environmental manage
3. ment - By R.K. Trivedi & Arvind Kr.
4. Basic Environmental Technology - J.A. Nathanson
5. AareneVesilind .P, Worrell.W&Reinhart.D(2002),Solid Waste Engineering, Cengage Learning India Pvt. Ltd .
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9. Ramachandra.T.V (2006),Management of Municipal Solid Waste, Capital Publishing Company
10. Tchobanoglous G and Kreith. F(2002), Handbook of Solid Waste Management, Second Edition, McGraw- Hill Companies.

11. Tchobanoglous G, Rowe.R.D and Peavy. S.H (1985), Environmental Engineering, International Edition, McGraw –Hill Book Co. Singapore

d. Course outcome

CO1: Examine the characters of solid wastes and its control

CO2: Estimate the environmental quality based on ambient environmental quality standards and learn about solid waste management

CO3: Practice solid waste control systems to control pollution.

CO4: Appraise the involvement of microorganisms and activated carbon in filtration technique to control pollution

CO5: Develop knowledge in control technologies for solid waste disposal

CO6: Focus the pollution control techniques in various industries

e. Mapping of COs to Pos and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	H	L	H	M	M	L	L	L	L	H	K1
CO2	L	H	M	L	L	L	L	L	L	H	K2
CO3	M	H	H	M	M	L	L	L	L	H	K3
CO4	L	L	M	H	L	L	L	L	L	H	K5
CO5	L	L	M	M	H	L	L	L	L	H	K6
CO6	H	H	H	H	H	L	L	L	L	H	K4

Core 10
ENVIRONMENTAL TOXICOLOGY

Objectives

1. Understand the sources, effects and control of various environmental pollution
2. Learn about the impact of pollutants and their toxic effect on environment
3. Study various toxicological bioassay test and toxicity effects on various organs

Course – Prerequisites:

The pre-requisite for studying the course on Environmental pollution and toxicology is a basic knowledge on water pollution, soil pollution, air pollution, radioactive pollution, thermal pollution, noise pollution and various toxicity and toxicological assays.

Course Outcomes (COs)

At the end of the course, the student will be able to -

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.

CO2: Explain the sources and effects of air pollution, thermal an noise pollution

CO3: Estimate the air and water pollutants using instrumental and chemical methods

CO4: Develop the knowledge about routes of exposure of toxicants, toxicological testing methods and dose response relationship.

CO5: Appraise the interaction between environmental toxicants and organisms, and how this cause impacts on populations and ecosystems.

Course outline

UNIT I: Toxic chemicals in the environment - air, water & their effects, Pesticides in water, Biochemicals aspects of arsenic, cadmium, lead mercury, carbon monoxide, ozone and PAN pesticide.

Unit II: Toxic agents: Pesticides, metals, solvents and vapours, radiation and radioactive materials, chemical carcinogens, food additives and contaminants, air, water and soil pollutants.

UNIT III: Mode of entry of toxic substance, biotransformation of xenobiotics detoxification, Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, Environmental carcinogenicity testing.

Unit IV: Insecticides, MIC effects. Concept of major, trace and Rare Earth Element (REE)- possible effects of imbalance of some trace elements.

Unit V: Biogeochemical factors in environmental health,. Epidemiological issues goiter, fluorosis, arsenic poisoning

References

1. Environmental chemistry - Sodhi
2. Principals of Environmental chemistry - Manhan
3. Environmental hazards & human health R.B. PhilipMehta, C.S. (1991)
4. Environmental Protection & the Law. Ashish Pub., Delhi.
5. Environmental hazards & human health R.B. Philip
6. Toxicology - principles & applications - Niesink & Jon devries
7. Parasitology - Chatterjee
8. Preventive & Social medicines – Perk

Mapping of COs to POs and PSOs

CO	Correlation level		Cognitive level
	PO	PSO	

	1	2	3	4	5	1	2	3	4	5	
CO1	H	M	M	M	L	L	H	M	L	H	K1
CO2	M	H	M	M	L	L	M	M	L	H	K2
CO3	L	M	H	M	M	L	H	H	M	H	K4
CO4	L	L	M	H	L	M	M	H	L	H	K3
CO5	L	L	H	M	H	L	H	M	M	H	K5

Core 11
Field Work
Core 12
Practical -3
Environmental microbiology & toxicology

1. Laboratory safety.
2. Basic microbial techniques
3. Isolation of microorganisms from air, water and soil.
4. Microbial staining, observation and micrometry; presence of pathogen in waste water.
5. Isolation of microorganisms of environmental interest.
6. Analysis of soil microflora by dilution plate method, study of rhizospheric and rhizoplane microbes.
7. Study of anatomical changes in plants to detect effect of pollution.
8. Determination of chloroplasts per unit area, estimation of chlorophyll content and stomatal conductance.

Core-13
Practical- 4
Environmental chemistry & solid waste management

1. Sampling methods of soil and solid waste
2. Physico-chemical characterization water and waste water,
3. Physico-chemical characterization soil and sediment.
4. Air quality assessment
5. Solid waste characteristics.
6. Analysis of Moisture content
7. Analysis of Organic Matter
8. Analysis of Organic Carbon
9. Preparation of Compost
10. Biological analysis of Municipal Solid waste

Core-14.
Pollution: assessment, instrumentation and control
Technologies
Objectives

1. To provide general understanding of quality of air and impact on local and global effects of air pollution on human, materials, properties and vegetation.
2. To study the fate and transport of air pollutants and its measurement techniques.

3. To discuss the various types of air pollution control equipment and their design principles and limitation.

Course – Prerequisites:

The pre-requisite for studying the course on Environmental pollution and control is a basic knowledge on major problems of pollution of the atmosphere, water, the land surface and the food chain.

Course Outcomes (COs)

At the end of the course, the student will be able to -

CO1: Classify and identify the sources of air pollutants and predict the effects of air pollutant on human health and environment

CO2: Apply and relate the significance of various air pollution dispersion models

CO3: Analyze the air quality and relate with air pollution regulation

CO4: Design various air pollution control equipment and evaluate its use.

Course outline

Unit-I: Waste water management

Primary treatment methods– screening, grit removal, primary sedimentation, secondary treatment methods, Activated sludge process, Trickling filters, Rotating biological contactors, Oxidation ponds and Lagoons. Advance waste water treatment, removal of nutrients and solids. Wastewaters reuse and sludge disposal, MINAS

Unit-II: Air Pollution control

Control methods for particulates-gravitational settling chambers, Centrifugal collectors, Wet collectors, Fabric filters, electro static precipitators. Control methods for gaseous pollutants-adsorption, absorption, condensation, combustion. High Volume Air Sampler, Major air pollutants in India.

Unit-III: Noise Pollution Control

Basics of sound, Sound propagation, Measurement of noise and indices, Effect of meteorological parameters on noise propagation. Noise control and abatement measures, Noise exposure levels and standards, Impact of noise on human health.

Unit-IV: Solid and Hazardous Waste Management

Sources, Chemical composition and Classification of solid wastes, Solid waste management options: Sanitary Landfill, Recycling, Composting, Incineration, Energy recovery options from organic wastes. Hospital waste management; Fly ash management, Municipal Solid waste. Classification of Hazardous wastes, Physico-chemical, Hazardous waste control and treatment, Different methods of disposal and management of hazardous wastes.

REFERENCES

1. Dara, S.S. (1995). A Text Book of Environmental Chemistry and Pollution Control, S. Chand, and Co. Ltd., New Delhi.

2. De, A.K. (1990). Environmental Chemistry, 2ndedition. Wiley Eastern Ltd. New Delhi.

3. Gilbert M. (2007). An Introduction to Environmental Engineering and Science, Prentice Hall, New Delhi.

4. Harrison, R.M. (2014). Pollution: Causes, Effects and Control. 5th Edition, RCS Publishing.

5. Krishnan Kannan Ed.(1994). Fundamentals of EnvironmentalPollution, S. Chand & Company Ltd., Ramnagar, New Delhi.
6. Manahan S.E. (2000). Fundamentals of Environmental Chemistry, Boca Raton: CRC Press.
7. Metcalf & Eddy, (1995). Waste Water Engineering, Tata Mc-Graw Hill Publishers, 3rdEdition.
8. Rao, C.S. (2001). Environmental Pollution Control Engineering, New Age International Publication, New Delhi
9. Spellman, F.R. (2017). The Science of Environmental Pollution. Taylor & Francis, CRC Press.
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Mapping of COs to POs and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	H	M	M	M	L	L	H	M	L	H	K1
CO2	M	H	M	M	L	L	M	M	L	H	K2
CO3	L	M	H	M	M	L	H	H	M	H	K4
CO4	L	L	M	H	L	M	M	H	L	H	K3
CO5	L	L	H	M	H	L	H	M	M	H	K5

Core 15 .Environmental Biotechnology

Objectives

1. To know the possibilities of environmental application presented by the biotechnology of higher organisms.
2. To emphasize the knowledge of the different types of biotechnological processes that exists in the field of environmental applications.
3. To make known the wide range of professional activities linked to biotechnological knowledge and to provide the foundations of the intimate interrelation between this scientific field and the sustainable development of human society.

Course prerequisites

The pre-requisite for studying the course on Environmental biotechnology is a basic knowledge on microbiological and ecological foundations that explain the participation of microorganisms in ecosystems and the great power that exists in their biotechnological use.

Course Outcomes (COs)

At the end of the course, the student will be able to -

CO1: Understand and assimilate the specific concepts and terminology of environmental biotechnology.

CO2: Find and manage information from a variety of sources

CO3: Analyze properties of microorganisms with potential application to environmental biotechnology processes.

CO4: Describe the scientific basis for environmental biotechnology

CO5: Study bioreactors for environmental application.

Course outline

Unit I: Basic techniques in genetic engineering

Brief account of the structure and functions of DNA and RNA, Restriction Endonucleases, DNA Ligase, Southern blotting and hybridization, Recombinant DNA Technology, Gene identification and isolation; Genomic library, use of reverse-transcriptase, cDNA library, Environmental Genomics/Metagenomics.

Unit II: Cloning

Cloning Vectors, (Plasmid, Cosmic, Phasmid, Bacterial Artificial Chromosome, Yeast Artificial Chromosome), Introduction of genes into new hosts using plasmid and phage vector. Gene transfer methods in bacteria and plants, PCR, Chemical synthesis of DNA, DNA ligation, Genetically Modified Organism (GMOs) and their impact on the environment. Xenobiotics compound: persistence and biomagnification

Unit III: Fermentation technology

Basics of Bioreactor, Use of natural and genetically engineered micro-organisms from extreme environment like thermophiles, alkalophiles, acidophiles and halophiles in industrial applications. Production of enzymes like cellulase, proteases amylases and acetic acid production, Renewable and alternative sources of energy; production of bio-hydrogen, biodiesel, bioethanol etc.

Unit IV: Biofertilizers and biopesticides

Biofertilizers application and future prospects, Biopesticides, Properties of *Bacillus thuringiensis,* Symbiotic Nitrogen fixation, Biochemistry of nitrogenase, Genetics of nitrogen fixation, regulation of *nif*gene expression, Plant-Incorporated Protectants (PIPs). Bioremediation of agricultural and industrial waste containing heavy metals and dyes using microbes.

REFERENCES

1. Alexander, M. (1999). Biodegradation and Bioremediation, 2nd edition, Academic Press.

2. Brown T. A. (2012) Gene Cloning and DNA Analysis: An Introduction 6th Edition, Wiley.

3. Fulekar, M.H. (2010). Environmental Biotechnology - Theory and Application –: CRC Press. Science Publisher, USA.

4. Gupta, P.K. (2010). Elements of Biotechnology. 2nd edition. Rastogi Publications.

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6. Manahan, S.E. (1997). Environmental Science and Technology. Boca Raton. FL: Lewis Publishers, New York.

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9. Thakur, I.S. (2006). Environmental Biotechnology: Basic Concepts and Applications. I.K International Publishing House Pvt Ltd.
10. Wainwright, M. (1999).

Mapping of COs to POs and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	H	M	M	M	M	M	H	M	M	H	K1
CO2	M	H	M	M	M	M	M	M	M	H	K2
CO3	M	M	H	M	M	M	H	H	M	H	K4
CO4	M	M	M	H	M	M	M	H	M	H	K3
CO5	M	M	H	M	H	M	H	M	M	H	K5

Core 16. Environmental management and impact assessment

Course Objectives

1. to introduce students to environmental impact assessment and to provide theoretical and practical education in this field.
2. to focus is on the rationale and methodology of integrated environmental impact assessment (EIA)

Course Prerequisites:
The pre-requisite for studying the course on Environmental management and impact assessment is a basic knowledge on relevant bio-physical, social, cultural, economic and human health aspects of development proposals, programs and policies.

Course Outcomes(Cos):

At the end of the course, the student will be able to

CO1: Critically examine assumptions inherent in impact assessment..

CO2: Understand the historical evolution of impact assessment in selected parts of the world.

CO3: Examine a range of environmental impact assessments.

CO4: Identify and explore impact assessment fields and approaches..

CO5: Develop their own perspectives on impact assessment and to be able to relate this to other subject areas and to their wider understanding..

Course outline

Unit I

Origin, aims and needs of EIA, EIA guidelines 1994, EIA notification and amendments; Environmental Impact Assessment (EIA) as a tool in environmental management, EMS, ISO

14001. Baseline information and predictions (Land, water, atmosphere, energy etc.), Restoration and rehabilitation technologies.

Unit II

Types of Projects requiring Environmental Clearance, Types of EIA, Project screening, Scoping, Base-line study, Impact identification, Prediction and assessment of impacts, Mitigation measures. Public participation, review and decision making, Generic structure of EIA Document, Composition of EAC, SEAC, Benefits and future of EIA.

Unit III

Introduction, concepts, steps, methodology. Environmental Auditing: Procedure, Matrix methods and Batelle method of auditing, National Environmental Policies and guidelines for environmental audit in India, Environmental impact statement

Unit IV

Environmental Impact Assessment of major developmental projects – river valley projects, mining projects, thermal power plants, transport (rail, road highway), oil refineries and petrochemicals.

Unit V

Prediction and assessment of impacts on the biological, cultural and socio- economic environments

REFERENCES

1. Glasson, J. Therivel, R. and Chadwick, A. (2006). Introduction to Environmental Impact Assessment. Routledge, London.

2. Jain, R.K., Urban L.V. and Stacey, G.S. (1981). Environmental Impact Analysis: A New Dimension in Decision Making. Van Nostrand Reinhold Company, New York.

3. Kreske, D.L. (1996). Environmental Impact Statemement: A practical guide for agencies, citizens and consultants. John Wiley and Sons Inc., New York.

4. Kulkarni, V.S., Kaul, S.N. and Trivedi, R.K. (2002). A Handbook of Environmental Impact Assessment. Scientific Publishers, India.

5. Petts, J. (2005). Handbook of Environmental Impact Assessment-Volume 1 and 2.Blackwell Publishers, UK.

6. Reddy, M.A. (2010). Textbook of Environmental Science & Technology, BS Publications.

7. Singh, P.P. and Sharma, S. (2004). Environment and Pollution Education. Deep and Deep Publication Pvt. Ltd, New Delhi.

PRACTICAL-III

Environmental Management

A. To record the following parameters by weather monitoring station

(Two exercise to be given)

1. Atmospheric Pressure 2. Rain fall 3. Ambient Temperature
4. Wind Speed and Direction 5. Wind Chill and Temperature
6. Humidity and Dew point

B. Analysis of Heavy metals in given samples by Atomic Absorption Spectrophotometer.

1. Al 2.Cd 3. Cr 4. Cu 5. Fe 6. Hg 7. Ni 8. Pb

C. Waste Water Analysis

Experiment related to physicochemical properties of waste water

D. Soil Analysis

Sampling and Collection of soil sample, Determination of physical and chemical properties of soil: CEC, pH, moisture content, Soil water holding capacity, organic matter content, Nitrogen, Phosphate phosphorus, Calcium Carbonate content

E. Measurement of noise in industrial, residential and commercial zones within the university premises.

F. Field visit to river/lake and/or wastewater treatment plants.

Mapping of Cos to POs and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	H	H	M	H	H	M	M	M	M	H	K1
CO2	H	H	M	H	H	M	M	H	H	H	K2
CO3	H	M	H	H	H	H	H	M	H	H	K3
CO4	H	H	M	H	H	H	H	H	M	H	K4
CO5	H	H	M	H	H	H	H	M	M	H	K5
CO6	H	H	M	H	H	H	H	H	M	H	K6

Core-18: Research Methodology

Course objectives

1. To understand a general definition of research design.
2. To identify the overall process of designing a research study from its inception to its report.
3. To identify a research problem stated in a study.
4. To understand the link between quantitative research questions and data collection and how research questions are operationalized in educational practice.

Course prerequisites

The pre-requisite for studying the course on research methodology is a basic knowledge on some basic concepts of research and its methodologies.

Course Outcomes(Cos):

At the end of the course, the student will be able to

CO1: Demonstrate the ability to choose methods appropriate to research aims and objectives

CO2: Understand the limitations of particular research methods

CO3: Develop skills in qualitative and quantitative data analysis and presentation

CO4: Develop advanced critical thinking skills

CO5: Demonstrate enhanced writing skills

Course outline

Unit I

Introduction: Sampling, data collection and recording. Central tendency – concept, arithmetic mean, mode, median for ungrouped and grouped data. Measures of dispersion - absolute and relative measures, range, standard deviation (grouped and ungrouped data), variance, quartile deviation, co-efficient of variability. Probability - normal and binomial

Unit II

Statistical Methods: Hypothesis testing, significance and correlation. Correlation - linear models and regressions. Pearson and other correlation coefficients. Multiple regressions, Distribution- Normal, t and chi square test Difference among means: F-test: 1 way ANOVA, F-test: 2 ways ANOVA.

Unit III

Research Writing: Overall outline and structure of the article/manuscript. Description, value, and development of points/outlines before writing. Screening of Material for inclusion within the structure of the manuscript. Importance of authors & their sequence, importance of clear title, abstract and summary. Introduction, methods, results and discussion.

Unit IV

Writing Style - Active or passive, Punctuation, use of commas, apostrophe, semicolon and colon. Avoiding duplication and repetition. Importance of revisions and references. Plagiarism - paraphrasing and copy write violation. Consequences of plagiarism. Why not to fudge, tinker, fabricate or falsify data.

Unit V

Computer applications in environmental modeling: Computer-based modeling: Linear, regression, validation and forecasting. Computer-based modeling for population and population studies.

References:

1. Biostatistics: A Guide to Design, Analysis and Discovery, 2nd Edition
2. Environmental Statistics (Handbook of Statistics) - Ganapati P. Patil and C. Radhakrishna Rao

3. Environmental Statistics - Books LLC
4. Scientific Writing: A Reader and Writer's Guide - Lebrun, Jean-Luc
5. Scientific Writing - Hall Marian Rose
6. From Research to Manuscript: A Guide to Scientific Writing- Michael J. Katz
7. Computing Research for Sustainability - Committee on Computing Research for Environmental and Societal Sustainability, Computer Science and Telecommunications Board, Division on Engineering and Physical Sciences and National Research Council
8. Statistics for Environmental Science and Management-Manjunatha

a. Mapping of Cos to POs and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	M	M	M	M	M	M	M	M	M	M	K1
CO2	M	M	M	M	M	M	M	M	M	M	K2
CO3	M	M	M	M	H	M	M	M	M	M	K3
CO4	M	M	M	M	M	M	M	M	M	M	K4
CO5	M	M	M	M	M	M	M	M	M	M	K5
CO6	M	M	M	M	M	M	M	M	M	M	K6

Core – 20 Natural Disaster Management

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.

Pre-requisite for the study of the course:

The pre-requisite for studying the course on Environmental Disaster Management to have knowledge in disaster plans, warning systems to save environment.

a. Outcome of the study: Course Outcomes(Cos):

At the end of the course, the student will be able to

CO1: Remember Meaning and Fundamentals of Disasters

CO2: Understand the impact of the different Disasters

CO3: Apply the knowledge for predication of Disasters

CO4: Analyse the causes the different Disasters.

CO5: Evaluate the protocol and create the awareness.

CO6: Anticipate the cautions and prevent measures

Course outline

Unit-I Introduction to Hazards

Hazard Classification – Natural hazards and Technological hazards, Effects of hazards, Vulnerability and susceptibility of hazards, Assessing hazards and risks, Hazard prediction and warning, A brief introduction to biological hazards- Biological warfare, Anthrax.

Unit–II Earthquakes and Landslides and Volcanoes

Earthquakes - Types and Distribution of earthquakes, Prediction and control of earthquakes, Tsunami, mass movements; types, affecting factors, prediction, prevention & control and effect of mass movements. Volcanoes-Distribution, types, eruption processes, Factors, Products.

Unit-III Water related hazards

Different kinds of floods, Factors leading to floods, Factors affecting floods, Floods and their associated hazards, Flood control measures, Prediction of floods. Factors leading to drought, drought consequences, strategies for drought mitigation, Desertification – Factors causing desertification, famine, El Nino and their effects.

Unit- IV Weather related Hazards

Effects of cyclones, genesis of a cyclone, Behavior of a cyclone and their forecast, Factors affecting cyclone hazards, Structure of a tropical cyclone, Size of tropical cyclones, Cyclone risk and mitigation strategies, Storm surge, Hurricane, cyclones and tornadoes, thunderstorms, lightening.

REFERENCES

1. Abbott, Patrick L. 2004. Natural disasters. 4th ed. Boston, McGraw-Hill Higher Education. Alexander, David. 2000. Confronting catastrophe: new perspectives on natural disasters. New York, Oxford University Press.

2. Allison, I. S. and Palmer, D. F. 1980. Geology, the science of a changing Earth. VII Edition. McGraw-Hill Inc.

3. Cesare Emiliani 1992. Planet Earth -Cosmology, geology and the evolution of life and the environment. Cambridge University press U.K.

4. Robinson, A.G. 2002. Earthshock: hurricanes, volcanoes, earthquakes, tornadoes, and other forces of nature. Rev. Ed.New York,

5. Thames & Hudson, 2002. Smith, Keith. 2002. Environmental hazards: assessing risk and reducing disaster. 3rd ed. London, New York, Routledge.

Mapping of Cos to POs and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	L	L	M	L	H	L	L	M	L	M	K1
CO2	L	L	M	L	H	L	L	M	L	M	K2
CO3	L	L	M	L	H	L	L	M	L	M	K3
CO4	L	L	M	L	H	L	L	M	L	M	K4
CO5	L	L	M	L	H	L	L	M	L	M	K5
CO6	L	L	M	L	H	L	L	M	L	M	K6

Core – 20 Forest and Wildlife Ecology

Objectives:

1. Improve ecological literacy by learning the basic principles and concepts of the field of ecology
2. Improve scientific literacy by learning how ecologists construct knowledge

Pre-requisite for the study of the course:

The pre-requisite for studying the course Ecology and Ecosystem is a basic knowledge of our environment, constituent of our environment, Ecological factors affecting our environment.

:

a. Course Outcomes(Cos):

At the end of the course, the student will be able to

CO1: Remember the structure and function of ecosystems

CO2: Understand the speciation and ecological successions.

CO3: Apply the knowledge on ecosystems principals and their environments

CO4: Analyse the importance of the different ecosystems.

CO5: Evaluate the interconnections human and their environment.

CO6: Anticipate the human impact on environment and its conservations.

Course outline

Unit-I

Types and composition of forests of India, Structural organization of forest ecosystems, Primary production in different ecosystems and methods of measurement of primary production, Social forestry: Objectives, scope and necessity, Agroforestry, Extension forestry, *Eucalyptus* dilemma, people's participation, Roles on NGOs.

Unit-II

Silvicultural principles and practices, Impact of deforestation and shifting cultivation on forest ecosystems. Forest management: Objectives and principles, Techniques, Sustainable yield relation, Biodiversity and Forest.

Unit-III

Concept of wildlife, Role of wildlife in nature, Factors influencing wildlife management such as habitats, population, behavior, food-habits, health, etc., Common flora and fauna of India. Tools for data collection and analysis. Preservation of Breeding Stock; Artificial stocking; Habitat Improvement, Game Farming.

Unit-IV

Indian wildlife IUCN Categories, National Parks, Wildlife Sanctuaries, Biosphere Reserves and Zoos in India, Ecological basis of wild life conservation and management, Special projects for endangered species (Project tiger, Gir lion Sanctuary Project, Crocodile breeding project, sea turtle conservation).

Unit-V

International trade of wildlife, Animal cruelty: causes and prevention, Wild life and range management, Management of Fire, Role of NGO's in wildlife and forest life and range management, Role of local communities in wildlife management.

REFERENCES

1. Gibbs,J.P., Malcolm, L.H. andSterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management, 2ndEdition, Wiley-Blackwell.
2. Jain, A. K. (1989). Forests in India, Vorha Publication, Allahabad.
3. Oliver, S. O. and Daniel, D. C. (1990). Natural Resource Conservation : Management for a Sustainable future. Prentice Hall International, New Jersey.
4. Raven, P. H., Berg, L.R. and Hassenzahl, D.M. (2008). Environment. 6th Edition. John Wiley & Sons., USA.
5. Sharma, P.D. (2000). Ecology & Environment, 7thEdition, Rastogi Publications, Meerut.
6. Sondhi, S. (2012). Protected Animals of India. The Energy and Resources Institute, TERI.
7. Subramanian (2000). A Text book in Environmental Sciences: Narosa Publishing House, New Delhi.

Mapping of Cos to POs and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	H	H	M	H	H	M	M	L	M	M	K1
CO2	M	M	H	M	M	L	L	M	L	L	K2
CO3	M	M	H	M	M	L	L	M	L	L	K3
CO4	M	M	M	M	M	L	L	M	L	L	K4
CO5	M	H	M	M	M	L	L	M	L	L	K5
CO6	H	H	M	M	M	M	M	L	M	M	K6

Core – 22 Remote sensing and Geographical Information

Course objectives

1. Apply the concepts of Photogrametry and its applications such as determination of heights of objects on terrain.
2. Understand the basic concept of Remote Sensing and know about different types of satellite and sensors.
3. Illustrate Energy interactions with atmosphere and with earth surface features, Interpretation of satellite and top sheet maps
4. Understand different components of GIS and Learning about map projection and coordinate system Develop knowledge on conversion of data from analogue to digital and working with GIS software.

Course prerequisites

Knowledge of surveying, map reading and basic mathematics

Course outcomes

After completing this course the student will have acquired the ability on the following.
1. Understand the concepts of Photogrametry and compute the heights of objects

2. Understand the principles of aerial and satellite remote sensing, Able to comprehend the energy interactions with earth surface features, spectral properties of water bodies .
3. Understand the basic concept of GIS and its applications, know different types of data representation in GIS
4. Understand and Develop models for GIS spatial Analysis and will be able to know what the questions that GIS can answer are
5. Apply knowledge of GIS software and able to work with GIS software in various application fields 6. Illustrate spatial and non spatial data features in GIS and understand the map projections and coordinates systems
7. Apply knowledge of GIS and understand the integration of Remote Sensing and GIS

Course outline

Unit - I

Definition, Introduction and scope of remote sensing. Electromagnetic radiation, atmosphere window, Platforms

Unit- 2

Sensors and type of scaning systems. Basic characteristics of sensors; salient features of sensors used in LANDSAT, SPOT and Indian remote sensing satellites.

Unit - 3

Aerial photography- vantage point, cameras, Filters and types of films. Elements of visual image interpretation. Multispectral Remote sensing, Microwave Remote sensing, Photogrammetry - Introduction, Stereo- scopic vision, Projection types.

Unit - 4

Digital image and image structure, Image restroration and image and image enhancement. Image classification. Remote sensing application in Forestry, Ecology and environment, Landuse, Agriculture, soils and geology, Disaster management.

Unit- 5

GIS technology and its uses in environmental science, Hardware and software requirement for GIS. Conceptual model of spatial information, Conceptual model of non spatial information. GPS.

References :

1. Introduction to Environmental remote sensing - Curtis
2. Principles of Remote sensing - Lily and kliffer.
3. Remote sensing of the Environment – Jenson

a. Mapping of Cos to POs and PSOs

CO	Correlation level										Cognitive level
	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	
CO1	L	L	M	M	M	M	M	M	M	M	K1
CO2	L	L	M	M	M	M	M	M	M	M	K2
CO3	L	L	L	M	M	M	M	M	M	M	K3
CO4	L	L	M	M	M	M	M	H	M	M	K4
CO5	L	L	M	M	M	M	M	M	M	M	K5

CO6	M	M	M	M	M	M	M	M	M	M	K6