Department of Studies and Research in Environmental Science

Course Structure & Syllabus

Choice Based Credit System (CBCS)

Eligibility Criteria: General candidates who have passed a B.Sc degree of this university in any branch of science with 45 aggregate % in core/cognate subjects and SC/ST candidates with 40 % aggregate in core/cognate subjects shall be eligible for admission to M.Sc. degree course in Environmental Science.

Course Structure

I Semester

S. No.	Paper	Title of the paper	Instruction Hrs per Week	No. of Credits	Duration of the Exam.	Marks		
						Internal Assessment	Semester End Examn.	Total Marks
1	CPT-1.1	**Environmental Biology**	4	4	3 Hrs	20	80	100
2	CPT-1.2	**Environmental Chemistry**	4	4	3 Hrs	20	80	100
3	CPT-1.3	**Environmental Geoscience**	4	4	3 Hrs	20	80	100
4	SPT-1.4 A	**Energy and Environment**	4	4	3 Hrs	20	80	100
	SPT-1.4.B	**Natural Resources**	4	4	3 Hrs	20	80	100
5	CPP-1.5	**Practical's based on Environmental Biology**	4	2	3 Hrs	10	40	50
6	CPP-1.6	**Practical's based on Environmental Chemistry**	4	2	3 Hrs	10	40	50
7	CPP-1.7	**Practical's based on Environmental Geosciences**	4	2	3 Hrs	10	40	50
8	SPP – 1.8 A	**Practical's based on Energy and Environment**	4	2	3 Hrs	10	40	50
	SPP – 1.8 B	**Practical's based on Natural Resources**	4	2	3 Hrs	10	40	50
		Total	32	24		120	480	600

Note: CPT: Core paper theory CPP: Core paper practical

SPT: Special paper theory SPP: Special paper practical

II Semester

S. No.	Paper	Title of the paper	Instruction Hrs per Week	No. of Credits	Duration of the Exam.	Marks		
						Internal Assessment	Semester End Examn.	Total Marks
1	CPT- 2.1	**Environmental Pollution, Monitoring and Control**	4	4	3 Hrs	20	80	100
2	CPT- 2.2	**Solid Waste Management**	4	4	3 Hrs	20	80	100
3	SPT- 2.3 A	**Environment and Conservation**	4	4	3 Hrs	20	80	100
	SPT- 2.3 B	**Environmental Toxicology**	4	4	3 Hrs	20	80	100
4	OEPT – 2.4	***To be offered by Other Departments of the faculty***	4	4	3 Hrs	20	80	100
5	CPP-2.5	**Practical's based on Environmental Pollution, Monitoring and Control**	4	2	3 Hrs	10	40	50
6	CPP-2.6	**Practical's based on Solid Waste Management**	4	2	3 Hrs	10	40	50
7	SPP-2.7 A	**Practical's based on Environment and Conservation**	4	2	3 Hrs	10	40	50
	SPP-2.7 B	**Practical's based on Environmental Toxicology**	4	2	3 Hrs	10	40	50
8	OEPP 2.8	***To be offered by Other Departments of the faculty***	4	2	3 Hrs	10	40	50
		Total	32	24		120	480	600

Note: CPT: Core paper theory CPP: Core paper practical
SPT: Special paper theory SPP: Special paper practical
OEPT: Open Elective Paper Theory OEPP: Open Elective Paper practical

III Semester

S. No.	Paper	Title of the paper	Instruction Hrs per Week	No. of Credits	Duration of the Exam.	Marks		
						Internal Assessment	Semester End Examn.	Total Marks
1	CPT- 3.1	**Environmental Systems Analysis, Remote Sensing & GIS**	4	4	3 Hrs	20	80	100
2	CPT- 3.2	**Water and Wastewater Management**	4	4	3 Hrs	20	80	100
3	SPT- 3.3 A	**Environmental Microbiology**	4	4	3 Hrs	20	80	100
	SPT- 3.3.B	**Environmental Impact Assessment, Policy and Laws**	4	4	3 Hrs	20	80	100
4	OEPT – 3.4	***To be offered by Other Departments of the faculty***	4	4	3 Hrs	20	80	100
5	CPP-3.5	**Practical's based on Environmental Systems Analysis, Remote Sensing & GIS**	4	2	3 Hrs	10	40	50
6	CPP-3.6	**Practical's based on Water and Wastewater Management**	4	2	3 Hrs	10	40	50
7	SPP-3.7 A	**Practical's based on Environmental Microbiology**	4	2	3 Hrs	10	40	50
	SPP-3.7 B	**Practical's based on Environmental Impact Assessment, Policy and Laws**	4	2	3 Hrs	10	40	50
8	OEPP-3.8	***To be offered by Other Departments of the faculty***	4	2	3 Hrs	10	40	50
		Total	32	24		120	480	600

Note: CPT: Core paper theory CPP: Core paper practical
SPT: Special paper theory SPP: Special paper practical
OEPT: Open elective paper theory OEPP: Open elective paper practical

IV Semester

S. No.	Paper	Title of the paper	Instruction Hrs per Week	No. of Credits	Duration of the Exam.	Marks		
						Internal Assessment	Semester End Examn.	Total Marks
1	CPT- 4.1	**Environmental Disaster Management**	4	4	3 Hrs	20	80	100
2	CPT- 4.2	**Environmental Research Methodology, Statistics and Computer Applications**	4	4	3 Hrs	20	80	100
3	SPT- 4.3 A	**Environmental Education and Awareness**	4	4	3 Hrs	20	80	100
	SPT - 4.3 B	**Environmental Biotechnology**	4	4	3 Hrs	20	80	100
4	CPD 4.4	**Project Dissertation**	4	4		20	80	100
5	CPP-4.5	**Practical's based on Environmental Disaster Management**	4	2		10	40	50
6	CPP-4.6	**Practical's based on Environmental Research Methodology, Statistics and Computer Applications**	4	2		10	40	50
7	SPP- 4.6 A	**Practical's based on Environmental Education and Awareness**	4	2		10	40	50
	SPP- 4.6 B	**Practical's based on Environmental Biotechnology**	4	2		10	40	50
8	CPPP 4.8	**Practical's based on Project Dissertation**	4	2		10	40	50
		Total	32	24		120	480	600

Note: CPT: Core paper theory CPP: Core paper practical
SPT: Special paper theory SPP: Special paper practical
OET: Open Elective Theory OEP: Open Elective practical
CPD: Core paper Dissertation CPPP: Core paper project practicals

Internal Assessment Marks allotment basis

1st Test for 10 marks	
2st Test for 10 marks: Average of two tests for marks	: 10
Seminar (Environmental perspectives, Journal club and Environmental Hotspots)	: 05
Extra activities (Awareness programmes for general public, extension activities etc…)	: 05
	Total : 20

SYLLABUS

Note: All the CPT/SPT/OEPT courses consists of four units each and each unit should be taught for a maximum of 16 hours

I SEMESTER

CPT 1.1 ENVIRONMENTAL BIOLOGY

Unit 1

Principal and Scope of environmental biology: Fundamental Concepts and Principles; structure and function, food chain and food wave. Classification of ecosystem: Fresh water, marine, estuarine and terrestrial ecosystems. Primary and secondary production – definition, measurement of productivity in terrestrial and aquatic pathways in ecosystem; Basic laws of energy flow; energy flow models

Unit 2

Community concept: types of community, succession process, competition and coexistence, types of interactions: predation, parasitism, antibiosis, commensalism, cooperation and mutualism, population growth. Classification of biomes, major biotic elements of each biome and their characteristics

Unit 3

Forest ecology: Definition and Characteristics, forest influence on climatic regulations, flood and soil erosion control and wild habitat protection, maintaining hydrology, nutrient cycling and moisture conservation, effect of fire on forest ecosystem – soil, moisture, nutrient content, micro and macro fauna.

Marine environment: Biota in different types of zones, its diversity-plankton, nekton, benthos, their adaptations and productivity, Indian marine territory, Exclusive Economic Zones (EEZ)

Unit 4

Energy flow in an ecosystem: Flow and energy fixation, construction of ecological pyramids.

Biogeochemical cycles: Hydrological cycles, carbon cycle, oxygen cycle, nitrogen cycle, sulfur cycle, phosphorus cycle-its importance and applications.

Succession: Primary succession, secondary succession and ecological climax, impacts of development of ecosystem, population, community ecology, predator and prey relationship.

References:

1. An Introduction to Ecology and Environmental Science - Prabu
2. Ecology and Environmental Biology-Saha
3. Aquatic Ecosystems – Findlay
4. Fundamental Ecology – Odum
5. Elements of Environmental Science – PK Gaur

6. Environmental Biology - Mike Calver, Alan Lymbery, Jennifer McComb and Mike Bamford
7. Environmental Biology - Arvind Kumar

CPT 1.2 ENVIRONMENTAL CHEMISTRY

Unit 1

Fundamentals of Environmental Chemistry: Stoichiometry, Gibbs energy, chemical potential, chemical equilibria, acid-base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides.

Unit 2

Soil Chemistry: Inorganic and organic components of soil, chemical properties of soil-saline. Acidic and alkaline soils, micro and macro nutrients of soil, nitrogen, phosphorus and Potassium Pathways in the soil.

Unit 3

Chemical composition of Air and Water: Classification of elements, chemical speciation, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matters. Thermochemical and photochemical reactions in the atmosphere. Toxic chemicals in the environment. Properties of water, water pollutants - sources & types, heavy metals, metalloids, types of reactions in various water bodies including marine environment.

Unit 4

Environmental Instrumentation: Spectrometry, UV-Vis and IR spectrophotometer and AAS, flame spectrometry and fluorimetry; Chromatographic techniques: Paper, Thin Layer, Gas and Gas – Liquid Chromatography, HPLC, X-ray fluorescence, x-ray diffraction, Electrophoresis, NMR and Mass Spectrometry.

References:

1. A Text book of Environmental Science - Prabhat Patnaik
2. A Textbook of Environmental Sciences - Purohit
3. Elements of Environmental Chemistry – J. Hussain
4. Environmental Instrumentation and Analysis Handbook – R.D. Down and J.H. Lehr
5. Environmental Analysis and Instrumentation - N. Rajvaidya and D. K. Markande
6. Environmental Monitoring and Analysis - Dr. Aradhana Salpekar

CPT 1.3 ENVIRONMENTAL GEOSCIENCES

Unit 1

Principles: Scope and necessity, origin of the earth, earth systems and its interaction – lithosphere, atmosphere, hydrosphere and biosphere, Interior of the Earth, earth's materials – minerals and their definition. Distribution and abundance of elements in the earth's crust. The earth systems and biosphere: Structure and composition of lithosphere, hydrosphere, atmosphere and biosphere. Geographical classification and zones of Environment. Energy budget of the earth

Unit 2

Elements: Concepts of major, trace and REE. Classification of trace elements, mobility of trace elements and geochemical cycles. Biochemical factors in environmental health. Human use, trace elements and health. Possible effects of imbalance of some trace elements. Diseases induced by human use of land.

Unit 3

Water Resources and Environment: Global water balance. Ice sheets and fluctuations of sea levels. Origin and composition of seawater. Hydrological cycle. Factors influencing the surface water. Types of water resources. Human use of surface ground waters.

Unit 4

Climate: General relationship between landscapes, biomes and climate. Climate of India. Indian Monsoon, Elnino, droughts, Tropical cyclones and westerly disturbances. Earthquake and Tsunamis, Volcanoes, Landslides

References:

1. A TB of Geology-S.Rao
2. Environmental Science -Santra
3. A Text book of Environmental Science -Prabhat Patnaik
4. A Textbook of Environmental Sciences-Purohit

SPT 1.4 A - ENERGY AND ENVIRONMENT

Unit 1

Energy resources and their exploitation: Sun as source of energy - nature of its radiation, Conventional energy sources: coal, oil, and nature gas, non-conventional energy sources: hydroelectric power, tidal, wind, geothermal energy, solar collectors, photovoltaics, solar ponds, nuclear-fission and fusion, magneto-hydrodynamic power (MHD), Energy use pattern in different parts of the world and its impact on the environment. CO_2 emission in atmosphere.

Unit 2

Bio catalysis and nonconventional energy: Biocatalysis, green chemistry in industries, fuel cell and electric vehicles, solar energy and hydrogen production, energy from alternate sources; Solar photovoltaic technology. Biofuel production (bio-ethanol and biodiesel), Biomass, prevention/minimization of hazardous/toxic products. Agricultural related practices and food processing, Production of biodegradable materials, concept of green building, and pollution free engineering processes.

Unit 3

Energy Use: Relationship among energy, environment and economical level of development. Resources of energy and energy use pattern in different parts of the world. Indian energy scenario and its impact on the environment.

Unit 4

Energy Conservation and Energy Economics: Energy efficiency at national level, improving energy efficiency, energy analysis, concept of exergy (theoretical treatment), capital recovery factor, levelised annual cost, economic analysis of wind electric generation and thermal power systems.

References:

1. Energy Security and Environmental Sustainability - Surya Narain Yadav
2. Energy and Environment: Technological Challenges for the Future - Y.H. Mori and K. Ohnishi Non-conventional Energy Sources - G.D. Rai
3. Energy Explained: v. 1&2: Conventional Energy and Alternative - Vikram Janardhan and Bob Fesmire
4. Non-Conventional Energy System - S.K. Agarwal
5. An Introduction to Environmental Energy Resources - Manjunatha

SPT 1.4 B - NATURAL RESOURCES

Unit 1

Principles: Classification, concepts and approaches of natural resource conservation. Natural resources of India. Resources and reserves. Mineral and population. Oceans as new areas for exploration of mineral resources

Unit 2

Mineral and Water Resources: Concept and classification, integrated water resource management, participatory watershed development in water harvesting, lakes and river conservation programmes. Wetland management Coastal zone management. Implications of National River linking programme on environment. Minerals, nutrients and biological resources of soil. Soil loss, soil erosion, Role of organic matter and its maintenance, diagnosis of nutrient deficiencies. Wasteland development – concept scope, issues and strategies

Unit 3

Forest resource: Flora and fauna, microbes, medicinal and herbal resources. Relevance, threats and need for conservation of forest resources. Forest management – meaning and objectives. Forest – land use changes in India – future demand of forestlands. Community forest management, Social forestry, agro-forestry, protected area management –Eco-development committee & Eco-tourism. Gene pool management

Unit 4

Sustainable development: Urban planning and environmental management, Understanding the resource ecology and life-supporting capacity of resources. Economic models: Green building concept- green technology concept.

References:

1. Natural Resources - Christian Lannerberth
2. Environmental Science - Santra
3. A Text book of Environmental Science - Prabhat Patnaik
4. A Textbook of Environmental Sciences- Purohit
5. Natural Resources: Exploration and Development - Satish Tiwari
6. Natural resources - S. B. Ghosh
7. Target 3 Billion: Innovative Solutions towards Sustainable Development - APJ Abdul Kalam and Srijan Pal Singh
8. Sustainable Development (Encyclopaedia of Sustainable Development) - P. C. Sinha
9. Urban Environmental Management - Shahab Fazal

CPP 1.5 PRACTICALS BASED ON ENVIRONMENTAL BIOLOGY

1. Vegetation studies by line, quadrate and belt transect methods.
2. Calculation of Biodiversity Index.
3. Field Visit to Aquatic, Forest and other ecosystems for identification of biota.
4. Construction of Ecological pyramids of different ecosystems.
5. Productivity of aquatic ecosystem by plankton study.
6. Study of wetland flora and fauna.

References:

1. Environmental Biology - Mike Calver, Alan Lymbery, Jennifer McComb and Mike Bamford
2. Environmental Biology - Arvind Kumar
3. An Introduction to Ecology and Environmental Science - Prabu
4. Ecology and Environmental Biology-Saha

CPP 1.6 PRACTICALS BASED ON ENVIRONMENTAL CHEMISTRY

1. Analysis of Soil and Water: Physical properties, chemical properties, nutrients, bacterial parameters.
2. Alkalinity of soil.
3. Total hardness of water. on
4. Estimation of halides in water samples.
5. Estimation of sulphates in water samples.
6. Estimation of carbon di-oxide in water samples.

References:

1. A Text book of Environmental Science - Prabhat Patnaik
2. A Textbook of Environmental Sciences - Purohit
3. Elements of Environmental Chemistry – J. Hussain

CPP 1.7 PRACTICALS BASED ON ENVIRONMENTAL GEOSCIENCES

1. Studies of models of various rock types.
2. Study of geological maps.
3. BOD and COD.
4. Study of various ground water sources and its quality.
5. Wind rose.
6. Study of various meteorological parameters and climate.

References:

1. A TB of Geology-S.Rao
2. Environmental Science -Santra
3. A Text book of Environmental Science -Prabhat Patnaik

SPP 1.8 A - PRACTICALS BASED ON ENERGY AND ENVIRONMENT

1. Study of solar cells.
2. Conversion of biomass to alcohol.
3. Case studies on energy efficiency analysis.
4. Study of various agro wastes as substrates for biofuel production.
5. Biological degradation of recalcitrant biomass.
6. Case studies on energy use patterns across the globe.

References:

1. Energy and Environment: Technological Challenges for the Future - Y.H. Mori and K. Ohnishi
2. Non-conventional Energy Sources - G.D. Rai
3. Energy Explained: v. 1&2: Conventional Energy and Alternative - Vikram Janardhan and Bob Fesmire
4. Non-Conventional Energy System - S.K. Agarwal

SPP 1.8 B - PRACTICALS BASED ON NATURAL RESOURCES

1. Estimation of minerals from various sources.
2. Quantification of soil nutrients (NPK, Na, Ca).
3. Visit to forest ecosystem and studies on vegetation mapping.
4. Studies on Gene pool of forest ecosystems using curated databases.
5. Case studies on river linking and its implications.

References:

1. Natural Resources - Christian Lannerberth
2. Environmental Science - Santra
3. A Text book of Environmental Science - Prabhat Patnaik

II SEMESTER

CPT 2.1 ENVIRONMENTAL POLLUTION, MONITORING AND CONTROL

Unit 1

Air pollution: Definition, sources and classification of air pollutants. Transport and diffusion of pollutants, effect of air pollution on man and climate. Ambient air quality standards and air pollution indices. Air sampling and monitoring techniques - settle able and suspended particulate matter - dust fall jar and impingement method, high volume air sampler

Unit 2

Noise Pollution: Definition, sources and terminology; types of noise; Measurement of noise; Noise indices, noise exposure level and impact on Human beings and climate. Noise control and abatement measures.

Unit 3

Aquatic and Soil Pollution: Definition, sources and classification of aquatic pollutants. Consequences of pollution on surface, subsurface and mariner water sources. Soil Pollution – definition, sources and classification of soil pollutants and their impact on soil and plants. Bacteriological sampling and analysis of soil quality

Unit 4

Radioactive Pollution: Definition, radioactivity, radionuclides, radiation emissions, sources, radioactive decay and buildup. Biological effects of radiation and ecosystem. Radiation exposure standards, radioactive pollution and pollution control measures. Biological dosimetry.

References:

1. Air Environment and Pollution -Purohit
2. Environment and Water Pollution cause Effect and Control- Noor
3. Environmental Law and Pollution Control -P.N.Prasad
4. Environmental Pollution - R.K. Khitoliya
5. Environmental Pollution by -V.K. Prabhakar
6. Environmental Pollution: Causes, Mit... And Recycling by -P. C. Trivedi
7. Environmental Pollution – Narayanan

CPT 2.2 SOLID WASTE MANAGEMENT

Unit 1

Solid wastes: Definition, types, sources, characteristics, and impact on environmental health. Waste generation rates. Concepts of waste reduction, recycling and reuse. Collection, segregation and transport of solid wastes. Handling and segregation of wastes at source. Collection and storage of municipal solid wastes

Unit 2

Solid waste processing technologies: Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery. Composting, vermicomposting and incineration of solid wastes. Disposal in landfills - site selection, design, and operation of sanitary landfills, secure landfills & landfill bioreactors, leachate & landfill gas management, landfill closure & post-closure environmental monitoring and landfill remediation.

Unit 3

Hazardous wastes: Definition, sources and characteristics. Hazardous waste categorization, generation, collection, transport, treatment and disposal. Legislation on management and handling of municipal solid wastes and hazardous wastes.

Unit 4

Hospital Waste Management: Characterization, types & quantity, segregation, treatment & disposal and preventive measures

References:

1. Solid Waste Management - V.K. Prabhakar
2. Solid Waste Management - Hari Mohan Singh
3. Solid Waste Management: A Local Challenge with Global Impacts – U.S Environmental Protection Agency
4. Solid Waste Management - Simeon Dulo

SPT 2.3 A - ENVIRONMENT AND CONSERVATION

Unit 1

Biodiversity concepts and patterns: Microbial diversity, plant diversity, Agro-biodiversity, soil biodiversity and economic value of biodiversity biodiversity. Levels of Biodiversity - Community diversity (alpha, beta and gamma biodiversity), Gradients of Biodiversity (latitudinal, insular)

Unit 2

Ecosystems diversity: Biomes, mangroves, coral reefs, wetlands and terrestrial diversity (equilibrium mix of *G* and W.). Species diversity - richness and evenness, loss of species, magnitude of biodiversity. Direct and indirect benefits, Bioprospecting (molecular techniques like RAPD, RFLP, AFLP, DNA sequencing etc). Genetic diversity - sub species, breeds, race, varieties and forms. Variation in genes and alleles at DNA sequence levels (selected case studies). Microbial diversity and useful prokaryotic genes.

Unit 3

Threats to Biodiversity: Habitat loss and fragmentation, disturbance and pollution; introduction of exotic species; extinction of species. IUCN categorized-endangered, threatened, vulnerable species. Red data book and related documentation. Human intervention and biodiversity loss.

Unit 4

Methods of conservation: In situ (Biosphere reserves, National Parks, Sancturies, Sacred groves etc) & *ex situ* (Botanical gardens, Zoological gardens, Gene banks, Pollen, seed and seedling banks, tissue culture and DNA banks etc) and modes of conservation. Benefits of

conservation - biodiversity as a source of food and improved varieties, source of drugs and medicines, Aesthetics and cultural benefits. Biodiversity conservation laws.

References:

1. Biodiversity and Conservation - P. C. Joshi
2. Biodiversity and Conservation - M. P. Singh and Aravind Kumar
3. Biodiversity Conservation - Ghosh Asish
4. Systematic Conservation Planning (Ecology, Biodiversity and Conservation) - Chris Margules and Sahotra Sarka
5. A Text book of Environmental Science -Prabhat Patnaik
6. A Textbook of Environmental Sciences-Purohit

SPT 2.3 B - ENVIRONMENTAL TOXICOLOGY

Unit 1

Toxicology: Definition and scope, acute and chronic toxicity, selective toxicity, does sysnergism and antagonism. Toxic chemicals in the environment and biochemical aspects of As Cd, Pb, Hg, CO, O_3, PAN, pesticides and carcinogens in air.

Unit 2

Does-Response relationships: Graded response, quantal response, time action curves threshold limit value (TLV), margin of safety, toxicity curves; cumulative toxicity and LD50 & CTF.

Unit 3

Toxicity testing: Bioassay – Definition, purpose, criteria for selection of test organism methodology, estimation of LC50, limitation and importance of bioassay, acute toxicity (single), Sub acute toxicity, chronic toxicity, teratogenicity, carcinogenicity and mutagenicity.

Unit 4

Bio-transformation, bio-accumulation and bio-magnification: Principles, receptor sites absorption and storage of xenobiotics, types of bio- transformations, toxico-genomics and pharmacogenomics. Influence of ecological factors on the effects of toxicity, concept of green chemistry. Pollution of the ecosphere by industries, global dispersion of toxic substance, dispersion and circulating mechanisms of pollutants, degradable and non-degradable toxic substances and food chain.

References:

1. Environmental Toxicology set of 3 volumes- Peter Gomes
2. Aquatic Environment and Toxicology-Pawan Kumar Bhart
3. Toxicology: Principles and Methods-Second Revised Edition - M A Subramanian
4. Toxicology: A Manual for Students and Practitioners. - Edwin Welles Dwigh
5. Toxicology: The Nature, Effects and Detection of Poisons, with the Diagnosis and Treatment of Poisoning - Cassius M Riley
6. Toxicology - Vijayan Kannampilly

CPP 2.5 PRACTICALS BASED ON ENVIRONMENTAL POLLUTION, MONITORING AND CONTROL

1. Visit to various sites of pollution and collection of samples.
2. Quantification of chromium from tannery effluents.
3. Physico-chemical properties of polluted soils.
4. Physico-chemical properties of polluted ware.
5. Bacteriological sampling and analysis of soil quality.
6. Surveillance and quality of analysis of potable water.
7. Radioactive decay.

References:

1. Air Environment and Pollution -Purohit
2. Environment and Water Pollution cause Effect and Control- Noor
3. Environmental Law and Pollution Control -P.N.Prasad

CPP 2.6 PRACTICALS BASED SOLID WASTE MANAGEMENT

1. Physico-chemical analysis of solid wastes.
2. Estimation of sulphates from solid wastes.
3. Estimation of fluorides from solid wastes.
4. Waste Sampling techniques.
5. Case studies on best practices of solid waste management.
6. Visit to a solid waste processing unit.

References:

1. Solid Waste Management - V.K. Prabhakar
2. Solid Waste Management - Hari Mohan Singh
3. Solid Waste Management: A Local Challenge with Global Impacts – U.S Environmental Protection Agency

SPP 2.7 A - ENVIRONMENT AND CONSERVATION

1. Visit to ridge and shola forest and measurement of species diversity.
2. Genetic analysis of species diversity by BLAST.
3. Distribution range of plant and animal species identified as endangered.
4. Case studies on successful conservation measures.
5. Micro propagation of endangered plant species.
6. Visit to Conservation sites and field reports.

References:

1. Biodiversity and Conservation - P. C. Joshi
2. Biodiversity and Conservation - M. P. Singh and Arvind Kumar
3. Biodiversity Conservation - Ghosh Asish

SPP 2.7 B - ENVIRONMENTAL TOXICOLOGY

1. Estimation of metals in soil, plants and animal tissue.
2. Estimation of reducing sugars in toxic waste.
3. Estimation of protein from toxic waste.
4. Case studies on environmental effects of pesticides.
5. Modeling of pollutant dispersion.
6. Toxico-genomic and pharmaco-genomic evaluation of pollutants.

References:

1. Environmental Toxicology set of 3 volumes- Peter Gomes
2. Aquatic Environment and Toxicology-Pawan Kumar Bhart
3. Toxicology: Principles and Methods-Second Revised Edition - M A Subramanian

III SEMESTER

CPT 3.1 ENVIRONMENTAL SYSTEMS ANALYSIS, REMOTE SENSING AND GIS

Unit 1

Environmental systems – an introduction: An overview of mathematical models applied to various environmental issues, need, scope and objectives of environmental modeling. Role of mathematical models in environmental quality management. Model classification – Brief review of different states involved in model building. Calibration and verification of model, limitations in modeling.

Unit 2

Fundamentals of Remote sensing: Remote Sensing – history & development, definition, concept and principles, energy resources, radiation principles, electromagnetic radiation, interaction between matter and electromagnetic radiation, Sensors - types of sensors, concept of resolution – spatial, spectral, temporal, radiometric, basic concept and principles of thermal , microwave and hyper spectral sensing. Spectral reflectance and their characteristics of earth surface features,

Unit 3

Platforms: Products used in remote sensing, images, scale, mosaics, time and seasons of orbital cycles. Aerial photographs, photographic systems and satellite data products. Photogrammetry – basic principles, types, steps and elements of image interpretation, visual interpretation. Interpretation equipment's - digital image processing, image rectification, enhancement, classification, data merging and image processing software.

Satellites and their characteristics – geo-stationary and sun-synchronous, Indian space programme.

Unit 4

Introduction to GIS: GIS and their uses for environmental monitoring. Remote sensing data products and their procurement, GIS and spatial distribution of environmental data, data integration and analysis, data based structure, satellite data analysis, GIS software. Remote sensing and GIS applications - management and monitoring of environment, conservation of resources and coastal zone management.

References:

1. Environmental Modeling with GIS and Remote Sensing-Skidmore
2. Dynamic Modeling of Environmental Systems (Modeling Dynamic Systems)- Michael Deaton and James J. Winebrake
3. Geographic Information Systems and Environmental Modeling by Clarke Keith C., Parks Bradley O. and Crane Michael P
4. Remote Sensing and GIS - Atiqur Rahman
5. Basics of Remote Sensing and GIS - Dr. S. Kuma
6. Fundamentals of Remote Sensing - George Dr. Joseph
7. Datums and Map Projections for Remote Sensing GIS and Surveying - Jonathan C. Iliffe

CPT 3.2 WATER AND WASTEWATER MANAGEMENT

Unit 1

Hydrology: Sources of water and its characteristics, distribution of water on earth. physical and chemical properties of water. Various types of water demand. Per capita demand, water quality standards for various uses. Water harvesting and water shed management.

Unit 2

Ground water hydrology: Occurrence of groundwater, ground water zones and groundwater System. Porosity, permeability and types of Aquifers. The water table, changes in water quality and saltwater intrusion.

Unit 3

Water purification: Screening – coarse screen, medium screen, fine screen. Treatment system – sedimentation and coagulation. Filtration – rapid sand filter, slow sand filter, advantages and disadvantages. Disinfections – Methods of disinfections, chlorination, water softening process. Corrosion and scale prevention, taste and odor removal. Impurities in drinking water. Advances in water purification technologies – Nanotechnology and Nano-biotechnology.

Unit 4

Waste water treatment: Characteristics of waste water. Primary treatment – sedimentation and flocculation, equalization, neutralization. Secondary treatment – aerated lagoons, trickling Filters, activated sludge process, oxidation pond, aerobic and anaerobic decomposition of sewage. A note on reverse osmosis. Tertiary treatment and sludge drying beds.

References:

1. Basic Water Treatment: 3- George Smethurst and Paul Clement
2. Ground and Surface Water Hydrology- Larry W. Mays
3. Fundamentals of Ground Water- Franklin W. Schwartz and Hubao Zhang
4. Ground-Water Microbiology and Geochemistry - Francis H. Chapelle
5. Water Purification - Charles Gilman Currier
6. Water Purification - Joseph Wilton Ellms
7. Waste Water Treatment: Distribution and Management - Sheela Sanghvi
8. Sewage Treatment & Disposal and Waste Water Engineering - P.N. Modi
9. Low Cost Waste Water Treatment Technologies - Noor M
10. Fundamentals of Environmental Engineering-D.D.Reible

SPT 3.3 A - ENVIRONMENTAL MICROBIOLOGY

Unit 1

Introduction: Prokaryotes versus eukaryotes - eukaryotic and prokaryotic cell structure, three domains of life. General characters of a) Protozoa b) algae, c) fungi, d) bacteria and e) virus. General concepts of microbial taxonomy, morphological, physiological, biochemical, genetic and molecular characterization, classification and identification schemes.

Unit 2

Effects and microbial adaptations to environmental conditions: Temperature, oxygen, desiccation, extreme cold, ionic effect, osmotic pressures, radiant energy, hydrostatic pressures.

Microbial control: General concepts, Inhibition of growth and killing, sterilization and disinfection, antisepsis, and sanitation, desirable characteristics and mode of action physical agents (moist and dry heat, radiation and filtration), chemical agents, classes of disinfectants: Factors affecting sterilization and disinfection (moisture, organic matter, temperature, pH). Evaluation of antimicrobial activity

Unit 3

Bio-indicators: What are 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: What is a biosensor? Components, advantages and limitations, biocatalyst based, ion-affinity based and microorganism based biosensors; Applications of biosensors in environmental monitoring.

Unit 4

Quality Control and Quality Assurance: What is quality control and quality assurance? Standard operating procedures, quality assurance of pre-analytical, analytical and post analytical stages of microbiological procedures. Staff & qualifications, quality control of culture medium.

References:

1. Environmental Microbiology - Ralph Mitchell and Ji-Dong Gu
2. Environmental Microbiology: A Laboratory Manual - Ian L. Pepper and Charles P. Gerba
3. Environmental Microbiology - Alan H. Varnam and Malcolm G. Evans
4. Environmental Microbiology - Annette Bolger
5. Environmental Microbiology - Purnima Sethi and V.S. Kulkarni
6. Environmental Microbiology: Methods and Protocols - Spencer
7. Environmental Microbiology- Banwari Lal

SPT 3.3 B - ENVIRONMENTAL IMPACT ASSESMENT, POLICY AND LAWS

Unit 1

Origin and development of EIA: Assessment and Prediction of impact on Air water, noise and biological environment. Methods of impact analysis, public participation in environmental decision making, risk assessment and mitigation measures.

Unit 2

Environmental Audit: General approaches to environmental auditing, audit methods, benefits of environmental auditing. on-site and post – audit activities, statutory environmental statements.

Unit 3

Environmental Planning: Importance of planning, local, regional, state and national planning. Zoning-Physical planning. National policy, sectorial – integration, state level policy and implementation. Organizational structure at state and central governmental levels.

Unit 4

Legal control of Environmental pollution in India:

i. The Wildlife protection Act – 1972
ii. The Water prevention and control of pollution Act, 1974, amended 1988: CESS Act 1977, amended in 1991.
iii. The Forest Conservation Act, 1980, amended in1988.
iv. The Air prevention and control of pollution Act, 1981, amended in 1990.
v. The Environment protection Act. 1986.
vi. Hazardous waste management rules-1989 & amendment rules

References:

1. Environmental Dilemmas and Policy Design-Pellikaan
2. Environmental Economics and Natural Resource Management -Muralidhar Majhi
3. Environmental Management-Thakur
4. Environmental Studies and Ethics- Gouri Suresh
5. Environmental Impact Assessment - R.R. Barthwal
6. Global Environmental Policies-Ravinder Dhanai
7. Environmental Law and Pollution Control - P.N.Prasad
8. Environmental Impact Assessment: A Guide to Best Professional Practices- Charles H. Eccleston
9. Environmental Impact Assessment - Larry W. Canter

CPP 3.5 PRACTICALS BASED ON ENVIRONMENTAL SYSTEMS ANALYSIS, REMOTE SENSING AND GIS

1. Study of different stages involved in model building.
2. Image interpretation from various sources.
3. Study of Pattern Maps.
4. Case studies on remote sensing and satellite types.
5. Study of spectral reflectance and earth surface features.
6. Study of topographical features using different survey models.
7. Visit to IMD.

References:

1. Environmental Modeling with GIS and Remote Sensing-Skidmore
2. Dynamic Modeling of Environmental Systems (Modeling Dynamic Systems)- Michael Deaton and James J. Winebrake
3. Geographic Information Systems and Environmental Modeling by Clarke Keith C., Parks Bradley O. and Crane Michael P

CPP 3.6 PRACTICALS BASED ON WATER AND WASTE WATER MANAGEMENT

1. Determination of porosity and permeability of soils.
2. Physico-chemical properties of waste and treated water.
3. Biological properties of waste and treated water.
4. Evaluation of water disinfection methods.
5. Caste studies on novel and successful water treatment protocols.
6. Visit to water treatment plant.
7. Visit to rain water harvesting park.

References:

1. Basic Water Treatment: 3- George Smethurst and Paul Clement
2. Ground and Surface Water Hydrology- Larry W. Mays
3. Fundamentals of Ground Water- Franklin W. Schwartz and Hubao Zhang

SPP 3.7 A - PRACTICALS BASED ON ENVIRONMENTAL MICROBIOLOGY

1. Isolation and enumeration of microbes from environmental samples.
2. Cultural characteristics of isolated microbes.
3. Evaluation of anti-microbial chemical agents.
4. Effect of environment on microbes.
5. Determination of Bi-phasic growth curve.
6. Enrichment of purple non-sulphur bacteria.

References:

1. Environmental Microbiology - Ralph Mitchell and Ji-Dong Gu
2. Environmental Microbiology: A Laboratory Manual - Ian L. Pepper and Charles P. Gerba
3. Environmental Microbiology - Alan H. Varnam and Malcolm G. Evans

SPP 3.7 B - PRACTICALS BASED ON ENVIRONMENTAL IMPACT ASESSMENT, POLICY AND LAWS

1. Case studies on impact assessment: River valleys, mining projects.
2. General principles of environmental audit.
3. Case studies on environmental audit.
4. Case studies on effective utilization of environmental laws: oil refineries, petrochemical industry.
5. Comparative analysis of various mega building projects and its impact assessment.
6. Impact assessment of green belts.

References:

1. Environmental Dilemmas and Policy Design - Pellikaan
2. Environmental Economics and Natural Resource Management - Muralidhar Majhi
3. Environmental Management –Thakur

IV SEMESTER

CPT 4.1 ENVIRONMENTAL DISASTER MANAGEMENT

Unit 1

Environmental Hazards: Classification, Causes and Distribution.

Natural Hazards - Geological hazards, earthquakes, volcanoes, mass-movement, tsunami. Hydrological hazards - Floods, droughts, water quality, contamination, cyclones and hurricanes. Atmospheric/Climatic hazards - extreme weather events, global climatic change.

Unit 2

Man-made Hazards: Biophysical hazards - Frost hazards in agriculture, epidemics and wildfires. Technological Hazards - Nature and significance. Lessons from Bhopal and Chernobyl disasters.

Unit 3

Disasters and Hazard Management: Human and ecological impacts, risk assessment and vulnerability analysis, national preparedness and adaptation strategies, hazards policies and agencies and Land use classification. Role of GIS and remote sensing in surveillance, monitoring, risk assessment, estimation of losses and planning.

Unit 4

Prediction of natural disasters: Precaution and disaster management, Safety verses production in industry and Modeling of Hazards.

References:

1. Environmental Chemical Hazards -Manish Rathi
2. Natural and Man-Made Disasters-Sharma
3. Natural Hazards and Disasters-Hyndman
4. Environmental Disasters - K. K. Singh, Lotfi Aleya and Mahadevi Singh
5. Environmental Disaster: Causes, Impact and Remedies - Mahesh V. Joshi
6. The Chernobyl Nuclear Disaster (Environmental Disasters) - Scott Ingram
7. Perils of Progress: Environmental Disasters in the 20th Century (Connections: Key Themes in World History) - Andrew L Jenks.
8. This Borrowed Earth: Lessons from the Fifteen Worst Environmental Disasters around the World (Macmillan Science) - Bill McKibben, Robert Emmet Hernan and Graham Nash
9. Environmental Disasters, Natural Recovery and Human Responses - Roger del Moral and Lawrence R. Walker
10. The Million Death Quake: The Science of Predicting Earth's Deadliest Natural Disaster (Macmillan Science) - Roger Musson
11. Prediction and Perception of Natural Hazards (Advances in Natural and Technological Hazards Research) - Jaromir Nemec jr., J.M. Nigg and F. Siccardi
12. Remote Sensing and GIS Technologies for Monitoring and Prediction of Disasters (Environmental Science and Engineering) - Shailesh Nayak and Sisi Zlatanova

CPT 4.2 ENVIRONMENTAL RESEARCH METHODOLOGY, STATISTICS AND COMPUTER APPLICATIONS

Unit 1

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 2

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 3

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. 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 4

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

SPT 4.3 A - ENVIRONMENTAL EDUCATION AND AWARENESS

Unit 1

Introduction to environmental education: Significance and concept. Fundamentals of integration of knowledge, application to human society, peoples biodiversity register and Role of NGO in environmental awareness

Unit 2

International Environmental Laws: Evolution and development of International Environmental laws with reference to Stockholm Conference, Nairobi Declaration, Rio Conference, Rio+5 and the Rio+10, etc. Global environmental issues and International laws: to control Global warming, Ozone depletion, Acid rains, hazardous waste, CITES etc. Role of UN authorities in protection of Global Environment, Multinational authorities and agreements, future of International laws.

Unit 3

Equity Environment versus Development: Importance of critical review of plan with respect to local, regional & immediate & long term gains & Effect of Development. Comparison between a. Exploitation and safe guard for conservation, b. Rate of utilization and

regeneration, c. Natural and manmade growth, d. Survival need of mankind and protection of environment Integration of development with carrying capacity of Environment

Unit 4

Definition and concepts of sustainable development: Integration of: a. Economic, Social and Environmental sustainability, b .Biodiversity and c. Availability of natural resources in development. Critical review of drawbacks in traditional (base on economics) evaluation of development and cost benefit analysis. Introduction of ecological growth factor similar to economical growth factor for sustainable development.

References:

1. Environmental Education and Management -Dr.Avinash Chiranjeev
2. Environmental Education - Babita Verma
3. Environmental Education - Pachuri and S C & P Kumar
4. Environmental Education - Dr. Rajeev Saxena
5. Environmental Education - Archana Tomar
6. Environmental Education - Sukla Bhattacharya

SPT 4.3 B - ENVIRONMENTAL BIOTECHNOLOGY

Unit 1

Introduction: Practical aspects of genetic engineering. Microorganisms from extreme environment - use of extremophilic microorganisms in waste treatment and methane production from agro industrial wastes, production of enzymes like cellulase, proteases, amylases, alcohol and acetic acid production.

Unit 2

Applications: Microbial process involvement, vermin composting, bio fertilizer, bio pesticide production. Bio-mining - microbial leaching of low grade mineral ores, molecular probes for organisms in mines and mine tailings, Petroleum pollutant biodegradation and second generation biofuels.

Unit 3

Bioremediation: Concept, role of bioremediation in controlling various pollution problems e.g. solid water, sewage water, industrial effluents, heavy metals and radioactive substances. Phytoremediation - Abatement of different types of pollution using plants, types of phytoremediation, mechanism involved with case studies.

Unit 4

Environmental Genomics: Metagenomics and metaproteomics, ecogenomics or community genomics, the study of genetic material recovered directly from environmental samples and future applications in bioremediation.

References:

1. Environmental Biotechnology: A Bio systems Approach - Daniel Vallero
2. Environmental Biotechnology (Oxford Higher Education)- B.C. Bhattacharyya and Rintu Banerje
3. Environmental Biotechnology - Dr Alan H. Scragg
4. Environmental Biotechnology: Theory and Application - Gareth M. Evans and Judith C. Furlong

CPD 4.4 CORE PAPER DISSERTATION

CPP 4.5 PRACTICALS BASED ON ENVIRONMENTAL DISASTER MANAGEMENT

1. Preparation of environmental zonation map for landslide.
2. Preparation of hazard zonation map for earthquakes.
3. Case studies on recent natural environmental hazards: tsunami
4. Case studies on recent man-made environmental hazards: Bp oil disaster.
5. Study of various hazard prediction models.
6. Preparation of a plan for environmental hazard mitigation.

References:

1. Environmental Chemical Hazards -Manish Rathi
2. Natural and Man-Made Disasters-Sharma
3. Natural Hazards and Disasters-Hyndman

CPP 4.6 PRACTICALS BASED ON ENVIRONMENTAL RESEARCH METHODOLOGY, STATISTICS AND COMPUTER APPLICATIONS

1. Calculation of mean, median and mode.
2. Calculation of standard deviation.
3. Student Tests.
4. Correlation and regression.
5. Sample manuscript writing.
6. Study and use of various computer applications/models for environmental use.

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

SPP 4.7 A - PRACTICALS BASED ON ENVIRONMENTAL EDUCATION AND AWARENESS

1. Case studies on role of NGO'S in environmental awareness.
2. Case studies on implementation of international environmental laws I: Global warming.
3. Case studies on implementation of international environmental laws II: Ozone depletion

4. Case studies on successful implementation of sustainable development model.
5. Implications of various international laws: REDD+
6. Case studies on role of various UN agencies for environmental protection.

References:

1. Environmental Education and Management -Dr.Avinash Chiranjeev
2. Environmental Education - Babita Verma
3. Environmental Education - Pachuri and S C & P Kumar

SPP 4.7 B – PRACTICALS BASED ON ENVIRONMENTAL BIOTECHNOLOGY

1. Production of enzymes like cellulase, proteases, amylases, alcohol and acetic acid production.
2. Microbial leaching of low grade mineral ores.
3. Production of second generation biofuels.
4. Abatement of different types of pollution using plants and microbes.

References:

1. Environmental Biotechnology - Dr Alan H. Scragg
2. Environmental Biotechnology: Theory and Application - Gareth M. Evans and Judith C. Furlong

4.8 CORE PAPER PROJECT PRACTICAL

SYLLABUS OF OPEN ELECTIVE COURSES TO BE OFFERED TO STUDENTS OF OTHER DEPARTMENTS OF THE FACULTY

OEPT 2.4 GLOBAL ENVIRONMENTAL ISSUES AND HUMAN HEALTH

Unit 1

Contemporary and emerging environmental issues of local, regional and global significance I: Linkage between population, development & environment and climate change.

Unit 2

Contemporary and emerging environmental issues of local, regional and global significance II: stratospheric Ozone depletion, water resources, environmental toxicants & human health, biodiversity conservation and environmental episodic events etc.

Unit 3

Basic principle of environmental health: Physiological responses of man to relevant stresses in the environment, cases and effects of pollution. Industrial Toxicology - study of environmental dose effect relationships. Evaluation of toxicity and threshold limits. Principles and methods of occupational health. The relationship between occupation, hygiene, safety and disease.

Unit 4

Health maintenance: Survey, analysis and recommendations regarding health and safety problems in the working and living environment. Treatment of variation, with demographic, vital statistics and epidemiological data. Hazard evaluation in polluted environment with specific emphasis on radiological health.

References:

- Global Environmental Issues - Ed. Frances Harris and Frances Harris
- Global Environmental Issues - K. Jagamohan Reddy
- Global Environmental and Pollution Issues by Dr. Aaradhana Salpekar and Dr. Kadambari Sharma
- The Global Casino: An Introduction to Environmental Issues, Fourth Edition -Nick Middleton
- Global Environmental Change: The Threat to Human Health
- Occupational Health - G. French

OEPP 2.8 PRACTICALS BASED ON GLOBAL ENVIRONMENTAL ISSUES AND HUMAN HEALTH

1. Population modeling using Leslie's matrix.
2. Case studies on environmental issues and human healt: Ozone, water resources
3. Awareness studies on environmental disasters.
4. Basic Hygiene and safety standards.
5. Potable water quality assessment.
6. Study of environmental carcinogens.

References:

1. Global Environmental Issues - Ed. Frances Harris and Frances Harris
2. Global Environmental Issues - K. Jagamohan Reddy
3. Global Environmental and Pollution Issues by Dr. Aaradhana Salpekar and Dr. Kadambari Sharma

OEPT 3.4 CLIMATE CHANGE

Unit 1

Human Impacts on climate: (i) Causes and consequences of Global warming, greenhouse effect, global and regional trends in greenhouse gas emissions, sea level rise, role of oceans and forests as carbon sinks, ozone depletion- stratospheric ozone shield and Ozone hole

Unit 2

Effects: Effects on organisms including humans, effects on ecosystems and productivity, species distribution ranges, spread of diseases, extinction risk for temperature-sensitive species and UV effects

Unit 3

Tools for mitigating global warming and climate change impacts: international agreements and protocols. The role of UN Collaborative Programme on Reducing Emissions from

Deforestation and Forest Degradation (REDD) and REDD+ and Clean Development Mechanism (CDM). Methods for carbon footprint analysis. Critical analysis of IPCC assessment reports.

Unit 4

Solutions: Adaptation, mitigation with renewable energy, green building, energy efficiency and reducing consumption, the Smart Grid, distributed generation and low-tech, clean coal, nuclear power and geo-engineering.

References:

1. Global Environmental Policies-Ravinder Dhanai
2. Green Chemistry-V.K. Ahluwalia
3. Understanding the Global Warming-Mittal
4. Environment and Climate Change -M.K. Rao
5. Climate Change: Key stage 2 (101 Facts) - Snigdha Sa
6. Climate Change: Fundamental Issues & Policy Tools (Climate Change and Its Causes, Effects and Prediction) - Elise M.
7. Climate Change: Observed Impacts on Planet Earth - Trevor Letche
8. Climate Change: A Multidisciplinary Approach - William James Burroughs
9. Climate Change: Biological and Human Aspects - Jonathan Cowie
10. Climate Change: Small Guides to Big Issues - Melanie Jarman

OEPP 3.8 PRACTICALS BASED ON CLIMATE CHANGE

1. Case studies on effects of climate change I: greenhouse gas emissions, sea level rise.
2. Case studies on effects of climate change II: crop productivity, human diseases.
3. Case studies on clean development mechanisms.
4. Comparative evaluation of data from IPCC reports.
5. Case studies on successful green energy initiatives I: smart grids.
6. Case studies on successful green energy initiatives II: Hybrid vehicles.

References:

1. Global Environmental Policies-Ravinder Dhanai
2. Green Chemistry-V.K. Ahluwalia
3. Understanding the Global Warming-Mittal

THEORY QUESTION PAPER PATTERN

Max. Marks = 80

NOTE: Question no. 1 is compulsory. Answer any four questions from 2 to 6.

1. **Answer in Brief (Answer any eight)** **8 X 2 = 16**
   a.
   b.
   c.
   d.
   e.
   f.
   g.
   h.
   i.
   j.
2. **Essay type question** 16
3. **Essay type question** 16
4. **Essay type question** 16
5. **Essay type question** 16
6. **Write short notes on any four of the following** **4 X 4 =16**
   a.
   b.
   c.
   d.
   e.

PRACTICAL QUESTION PAPER PATTERN

Max. Marks = 40

1. Experiments, Spotting, Demonstration 30marks
2. Records and submissions 05 marks
3. Viva -Voce 05 marks

Note: Equal Weightage should be given to all the units while setting the question paper