



## Department of Studies and Research in Environmental Science

### Course Structure & Revised Syllabus Choice Based Credit System (CBCS)

**Eligibility Criteria:** General candidates who have passed a B.Sc degree in any branch of science of this University or any UGC recognized higher education institution 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.

Further, candidates who have passed Bachelor of Science in Agriculture and other allied subjects (B.Sc Ag AgriMarketing, Agriculture Engineering, Agribiotechnology), Bachelor of Forestry Science (B.FSc), Bachelor of Horticulture (B.Sc. Horti), Bachelor of Science in Agricultural Biotechnology (B.Sc AgBiotech), Bachelor of Technology in Agricultural Biotechnology, Agriculture Engineering (B.Tech AgBio, Agri Eng), Bachelor of Technology in Food Science (B.Tech Food Science) Bachelor of Fisheries Science (B.Fsc) Bachelor of Home Sciences (BHSc), Bachelor of Technology in Environmental Engineering (B.Tech Env Eng), Bachelor of Engineering in Environmental Engineering (B.E in Env Eng) with 45 % aggregate in core/cognate subjects and SC/ST candidates with 40 % aggregate in core/cognate subjects from any UGC recognized higher education institution shall also be eligible for admission to M.Sc. degree course in Environmental Science of Tumkur University.

**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	<b>Environmental Biology</b>	4	4	3 Hrs	20	80	100
2	CPT-1.2	<b>Environmental Chemistry</b>	4	4	3 Hrs	20	80	100
3	CPT-1.3	<b>Environmental Geoscience</b>	4	4	3 Hrs	20	80	100
4	SPT-1.4 A	<b>Energy and Environment</b>	4	4	3 Hrs	20	80	100
	SPT-1.4.B	<b>Natural Resources</b>	4	4	3 Hrs	20	80	100
5	CPP-1.5	<b>Practical's based on Environmental Biology</b>	4	2	3 Hrs	10	40	50
6	CPP-1.6	<b>Practical's based on Environmental Chemistry</b>	4	2	3 Hrs	10	40	50
7	CPP-1.7	<b>Practical's based on Environmental Geosciences</b>	4	2	3 Hrs	10	40	50
8	SPP – 1.8 A	<b>Practical's based on Energy and Environment</b>	4	2	3 Hrs	10	40	50
	SPP – 1.8 B	<b>Practical's based on Natural Resources</b>	4	2	3 Hrs	10	40	50
<b>Total</b>			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	<b>Environmental Pollution, Monitoring and Control</b>	4	4	3 Hrs	20	80	100
2	CPT- 2.2	<b>Solid Waste Management</b>	4	4	3 Hrs	20	80	100
3	SPT- 2.3 A	<b>Environment and Conservation</b>	4	4	3 Hrs	20	80	100
	SPT- 2.3 B	<b>Environmental Toxicology</b>	4	4	3 Hrs	20	80	100
4	OEPT – 2.4	<i>To be offered by Other Departments of the faculty</i>	4	4	3 Hrs	20	80	100
5	CPP-2.5	<b>Practical's based on Environmental Pollution, Monitoring and Control</b>	4	2	3 Hrs	10	40	50
6	CPP-2.6	<b>Practical's based on Solid Waste Management</b>	4	2	3 Hrs	10	40	50
7	SPP-2.7 A	<b>Practical's based on Environment and Conservation</b>	4	2	3 Hrs	10	40	50
	SPP-2.7 B	<b>Practical's based on Environmental Toxicology</b>	4	2	3 Hrs	10	40	50
8	OEPP 2.8	<i>To be offered by Other Departments of the faculty</i>	4	2	3 Hrs	10	40	50
		<b>Total</b>	32	24		120	480	600

Note: CPT: Core paper theory  
 SPT: Special paper theory  
 OEPT: Open Elective Paper Theory

CPP: Core paper practical  
 SPP: Special paper practical  
 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	<b>Environmental Systems Analysis, Remote Sensing &amp; GIS</b>	4	4	3 Hrs	20	80	100
2	CPT- 3.2	<b>Water and Wastewater Management</b>	4	4	3 Hrs	20	80	100
3	SPT- 3.3 A	<b>Environmental Microbiology</b>	4	4	3 Hrs	20	80	100
	SPT- 3.3.B	<b>Environmental Impact Assessment, Policy and Laws</b>	4	4	3 Hrs	20	80	100
4	OEPT – 3.4	<i>To be offered by Other Departments of the faculty</i>	4	4	3 Hrs	20	80	100
5	CPP-3.5	<b>Practical's based on Environmental Systems Analysis, Remote Sensing &amp; GIS</b>	4	2	3 Hrs	10	40	50
6	CPP-3.6	<b>Practical's based on Water and Wastewater Management</b>	4	2	3 Hrs	10	40	50
7	SPP-3.7 A	<b>Practical's based on Environmental Microbiology</b>	4	2	3 Hrs	10	40	50
	SPP-3.7 B	<b>Practical's based on Environmental Impact Assessment, Policy and Laws</b>	4	2	3 Hrs	10	40	50
8	OEPP-3.8	<i>To be offered by Other Departments of the faculty</i>	4	2	3 Hrs	10	40	50
		Total	32	24		120	480	600

Note: CPT: Core paper theory  
 SPT: Special paper theory  
 OEPT: Open elective paper theory

CPP: Core paper practical  
 SPP: Special paper practical  
 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	<b>Environmental Disaster Management</b>	4	4	3 Hrs	20	80	100
2	CPT- 4.2	<b>Environmental Research Methodology, Statistics and Computer Applications</b>	4	4	3 Hrs	20	80	100
3	SPT- 4.3 A	<b>Environmental Education and Awareness</b>	4	4	3 Hrs	20	80	100
	SPT -4.3 B	<b>Environmental Biotechnology</b>	4	4	3 Hrs	20	80	100
4	CPD 4.4	<b>Project Dissertation</b>	4	4		20	80	100
5	CPP-4.5	<b>Practical's based on Environmental Disaster Management</b>	4	2		10	40	50
6	CPP-4.6	<b>Practical's based on Environmental Research Methodology, Statistics and Computer Applications</b>	4	2		10	40	50
7	SPP- 4.6 A	<b>Practical's based on Environmental Education and Awareness</b>	4	2		10	40	50
	SPP- 4.6 B	<b>Practical's based on Environmental Biotechnology</b>	4	2		10	40	50
8	CPPP 4.8	<b>Practical's based on Project Dissertation</b>	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 practical

**Internal Assessment (Theory):**

Average of two tests: 10  
**Seminar (Environmental perspectives, Journal club and Environmental Hotspots)** : 05  
**Extra activities (Awareness programmes for general public, extension activities etc...)** : 05

Total : 20

**Internal Assessment (Practical's):** 10 based on Practical Internal Test (05) and case study report (05)

## 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**

*Principle and scope of environmental biology:* Basics of environmental biology and concepts of ecosystem. Classification of ecosystem: fresh water, marine, estuarine and terrestrial ecosystems. Indian marine territory and exclusive economic zones (EEZ). Structure and function of ecosystem: food chain and food web, productivity: primary and secondary productivity, measurement of productivity in terrestrial and aquatic pathways of ecosystem.

##### **Unit 2**

*Community concept:* Types of community, ecological succession process, competition and coexistence, types of interactions: predation, parasitism, antibiosis, commensalism, cooperation and mutualism. Classification of biomes, major biotic elements of each biome and their characteristics. Community ecology, predator and prey relationship.

##### **Unit 3**

*Energy flow in an ecosystem:* Energy flow in ecosystem, basic laws of energy flow; energy flow models flow and energy fixation, construction of ecological pyramids. Biogeochemical cycles: carbon cycle, oxygen cycle, nitrogen cycle, sulfur cycle, phosphorus cycle-it's importance and applications.

##### **Unit 4**

*Forest ecology and threats to ecosystem:* Basics of different types of forest ecosystem, forest influence on climate regulations, forest as a carbon sink, threats to forest biota: greenhouse effect, climate change, ozone depletion, forest ecosystem responses and adaptations to changes.

##### **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

## **CPT 1.2 ENVIRONMENTAL CHEMISTRY**

### **Unit 1**

*Fundamentals of Environmental Chemistry:* Definition of various terms: molarity, molality, normality, percent of stock and standard solution preparation. Stoichiometry, gibbs energy, chemical potential, chemical equilibrium, acid-base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclide's.

### **Unit 2**

*Chemistry of elements:* Ions and radicals, thermo and photochemical reactions, physical and chemical properties of water, concept of oxygen demand: BOD, COD, pH Conductivity, TDS, TSS, colloids, physico-chemical characteristics of soil, soil organic carbon, soil humus, mineralization. Acidic and alkaline soils, micro and macro nutrients of soil, nitrogen, phosphorus and potassium pathways in the soil.

### **Unit 3**

*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.

### **Unit 4**

*Pollutant chemistry:* Chemistry of various organic and hydrocarbon decay, environmental effects of surfactants, pesticides and heavy metals on micro and macro organisms, chemical processes for formation of inorganic and organic particulate matter, thermo chemical 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.

### **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**

*Basics of Geosciences: Principles, Scope and its importance, bio-geographical classification zones, origin of the earth, earth systems and its interaction, structure and composition of lithosphere, atmosphere, hydrosphere and biosphere. Concept of earth's materials and minerals. Distribution and abundance of elements in the earth's crust, energy budget of the earth. Earth Processes-plate tectonics, rock and ore formation, processes for development of oceans, land, mountains, plateaus, flood plains and deltas.*

### **Unit 2**

*Earth's climate: Climatic classification and variability, movements in atmosphere, global scale, ocean circulation pattern, El-nino and southern oscillation, La-nina, glacial cycles. General relationship between biomes and climate, climate of India, Indian Monsoon, tropical cyclones and westerly disturbances.*

### **Unit 3**

*Water Resources and management: Introduction, types of water resources, hydrological cycle, Global water Distribution and balance, origin and composition of seawater, ice sheets and ice caps fluctuations of sea levels with their factors influencing the surface water. Human use of surface ground waters.*

### **Unit 4**

*Management of Earth Resources: landscape geochemistry and human health, desertification and its management. relationship between human use of land and health, impact of mining activities on ecosystem and health, restoration of mined areas.*

### **References:**

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



## **SPT 1.4 A - ENERGY AND ENVIRONMENT**

### **Unit 1**

*Introduction to Energy:* Work and power; energy sources, resource and reserves, an overview of the current global and national energy scenario. Fossil fuels: Oil, coal, natural gas, shale, tar sands – sources, exploration, exploitation; environmental consequences.

### **Unit 2**

*Nuclear energy:* Nuclear fission, nuclear fusion, nuclear minerals, nuclear fuel cycle, nuclear fuel production; nuclear reactors (PWR, BWR, Gas Cooled Breeder) and nuclear power, advantages and disadvantages of nuclear power, environmental consequences: safety, waste disposal and management.

### **Unit 3**

*Renewable and alternative energy sources:* Solar energy and insulation, active and passive solar systems, photovoltaic cells, hydropower, tidal power, wind power, geothermal energy, ocean energy, fuel cells, environmental consequences of renewable energy, advantages and disadvantages. *Bio-energy:* Biomass as energy source; energy farming, biomass types and their characteristics, biomass production, biomass conversion processes: thermo-chemical and bio-chemical combustion, gasification, liquefaction and pyrolysis of biomass, fermentation of biomass, anaerobic digestion of biomass and digester types and biodiesel, environmental consequences of biomass resource harnessing.

### **Unit 4**

*Energy storage and distribution:* Distribution of energy, energy storage- heat storage; mechanical storage and types of carbon sequestration. Energy conservation: National energy policy, energy efficiency improvement, audit and energy saving concept. Carbon foot print, carbon trading and carbon credits

### **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
3. Non-conventional Energy Sources - G.D. Rai
4. Energy Explained: v. 1&2: Conventional Energy and Alternative – Vikram Janardhan and Bob Fesmire
5. Non-Conventional Energy System - S.K. Agarwal
6. An Introduction to Environmental Energy Resources - Manjunatha

## **SPT 1.4 B - NATURAL RESOURCES**

### **Unit 1**

*Principles:* Classification, concepts and approaches of natural resource classification and conservation. Land resources, plant, animal and microbial resources. Soil components, soil moisture, nutrient content of soil, micro and macro fauna of soil. Role of organic matter in soil fertility and its maintenance in soil. Natural resources in India. Concept of resources and reserves, mineral resources and their exploitation. Oceans as new areas for exploration of mineral resources.

### **Unit 2**

*Water Resources:* Concept and classification, integrated water resource management (IWRM), participatory watershed development in water harvesting, lakes and river conservation programmes. wetland management, coastal zone management. Implications of national river linking programme on environment.

### **Unit 3**

*Forest resource:* Flora and fauna, microbes, medicinal and herbal resources. Relevance, threats and need for conservation of forest resources. Forest management: forest land use pattern in India, future demand of forestlands. Community forest management: social forestry, agro-forestry, protected area management. Eco-development committee & Eco-tourism. Gene pool management wild habitat protection, maintaining hydrology, nutrient cycling and soil moisture conservation techniques, effect and control measures of fire on forest ecosystem.

### **Unit 4**

*Sustainable development:* Concept of sustainability and development, urban planning and environmental management system, Understanding the resource of ecology and life-supporting capacity of resources. Economic models: concepts of green building and green technology. Wasteland development: concept scope, issues and strategies.

### **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

### **CPP 1.5 PRACTICALS BASED ON ENVIRONMENTAL BIOLOGY**

1. Vegetation studies by line, quadrat 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.
7. Visit to Environmental Analysis Labs for studies on Instrumentation.

#### **References:**

1. A Text book of Environmental Science - PrabhatPatnaik
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.
7. Visit to mined areas and study of restoration.
8. Visit and studies of various geological formations at Mahabaleshwar

#### **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.
7. Visit to Solar Park

#### **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.
6. Visit to model sites on sustainable development

#### **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, suspended particulate matter and respirable suspended particulate matter (SPM & RSPM), air pollution control equipment, vehicular pollution monitoring and abatement technologies.

#### **Unit 2**

*Noise Pollution:* Definition, type's, 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:* Introduction, methods of sampling, water quality standards, inorganic & organic pollutants in the aquatic environment. Soil pollution: types, sources, effects of soil and water pollution on man and climate & control measures, marine water pollution: types, sources, soil and water pollution abatement technologies. Technologies for restoration of degraded soil.

#### **Unit 4**

*Radioactive Pollution:* Definition, radioactivity, radionuclides, radiation emissions, sources, radioactive decay and buildup. Biological effects of radiation, radiation exposure standards, pollution control measures and 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, Mitigation and Recycling - P. C. Trivedi
7. Environmental Pollution – Narayanan

## **CPT 2.2 SOLID WASTE MANAGEMENT**

### **Unit 1**

*Global Scenario of Solid Waste Management:* Definition, types, sources, characteristics. 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. Solid waste impact on environment and human health.

### **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 and landfill bioreactors, leachate and landfill gas management, landfill closure and post-closure environmental monitoring and landfill remediation. Recent trends in global solid waste processing technologies.

### **Unit 3**

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

### **Unit 4**

*Biomedical and Electronic Waste Management:* Sources, characterization, types, impact of biomedical and electronic waste on environment, global scenario for biomedical and e-waste management. Effects of e-waste and biomedical waste control 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 2.3A - ENVIRONMENT AND CONSERVATION

### Unit 1

*Magnitude of biodiversity:* Levels of Biodiversity: Genetic diversity, species diversity (alpha, beta and gamma biodiversity, point diversity). Ecosystem diversity, measurement of biodiversity, microbial diversity, plant diversity, agro-biodiversity, soil biodiversity and economic value of biodiversity, community diversity, gradients of biodiversity.

### Unit 2

*Ecosystems diversity:* Biomes, mangroves, coral reefs, wetlands and terrestrial diversity. Species diversity: richness and evenness, loss of species, magnitude of biodiversity. Molecular techniques for Biodiversity analysis like RAPD, RFLP, AFLP, DNA sequencing etc. India as a mega diversity nation and biodiversity hot spots of India, biodiversity prospecting, significance of indigenous knowledge system.

### 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. Endemic and endangered species in India, Wild life exploitation, Effects of climate change on biodiversity.

### Unit 4

*Methods of conservation:* In-situ: Biosphere reserves, National Parks, Sanctuaries, Sacred groves etc).Protection area network, Biosphere region and ex-situ: Botanical gardens, Zoological gardens, gene banks, pollen, seed and seedling banks, tissue culture and DNA banks. CBD, Nagoya protocol, biological diversity act 2002 and biodiversity informatics. Social approaches for conservation, Role of WWF, National Biodiversity authority in conservation and bio-piracy.

### 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 -PrabhatPatnaik
6. A Textbook of Environmental Sciences-Purohit

## SPT 2.3 B - ENVIRONMENTAL TOXICOLOGY

### Unit 1

*Basics of Toxicology:* Definition and scope, Toxic chemicals in the environment and biochemical aspects of As, Cd, Pb, Hg, CO, O<sub>3</sub>, PAN, pesticides and carcinogens in air, water and soil. Acute and chronic toxicity, selective toxicity, dose synergism and antagonism.

### Unit 2

*Toxicity testing:* Bioassay: Definition, purpose, criteria for selection of test organism, methodologies, estimation of LC<sub>50</sub>, limitation and importance of bioassay, *Dose-Response relationships:* Graded response, quantal response, time action curves, threshold limit value (TLV), margin of safety, toxicity curves, cumulative toxicity, LD<sub>50</sub> & CTF.

### Unit 3

*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 in food chain.

### Unit 4

*Occupational Health and safety:* principle of environmental occupational safety, definition, concept, scope, occupational exposure, occupational hazards and diseases, control of toxicants and protection measures, toxicity of bio hazardous substances and its management.

### References:

1. Environmental Toxicology set of 3 volumes- Peter Gomes
2. Aquatic Environment and Toxicology-Pawan Kumar Bharath
3. Toxicology: Principles and Methods-Second Revised Edition - M A Subramanian
4. Toxicology: A Manual for Students and Practitioners. - Edwin Welles Dwig
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 ON 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.
7. Visit to electronic waste management Units.

#### **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. Toxicogenomic and pharmacogenomic evaluation of pollutants.
7. Visit to various industries for collection of effluent samples

#### **References:**

1. Environmental Toxicology set of 3 volumes- Peter Gomes
2. Aquatic Environment and Toxicology- Pawan Kumar Bharath
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**

*Introduction to Environmental systems:* An overview of mathematical models applied to various environmental issues, model classification, scope and objectives of environmental modeling air quality modeling, ground water flow modeling. Role of mathematical models in environmental quality management. Different states involved in model building. Calibration and verification of model, limitations of 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 interaction with earth surface features.

##### **Unit 3**

*GIS Platforms and other technologies:* Basic components of GIS, geographic information system and spatial data types, GIS design analysis and organization. Products used in remote sensing, images, scale, mosaics, time and seasons of orbital cycles, photographic systems and satellite data products. Photogrammetry, digital image processing. Satellites and their characteristics – geo-stationary and sun-synchronous, Indian space programme.

##### **Unit 4**

*Applications of Remote sensing and GIS:* GIS uses for environmental monitoring. GIS and spatial distribution of environmental data, data integration and analysis, data based structure, satellite data analysis, GIS software. Basics of GPS mapping and software. Survey of India (SOI), applications of remote sensing and GIS for coastal zone management, disaster management, forest and wild life management, land use pattern changes, water resource management, weather and climate studies, further trends in remote sensing applications.

##### **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

## **CPT 3.2 WATER AND WASTEWATER MANAGEMENT**

### **Unit 1**

*Global distribution of water:* Sources of water and its characteristics, physical and chemical properties of water, distribution and supply, global, national and regional levels. Water balance on earth, Types of water resources: Surface water, ground water, Causes and effects of water resource depletion. Various types of water demand, per capita demand, water quality standards for various uses. Effects of water pollutants on fresh and marine water ecosystem, Water harvesting and water shed management.

### **Unit 2**

*Ground water hydrology:* Occurrence of groundwater, ground water zones, porosity, permeability and types of aquifers, water table, changes in water quality and saltwater intrusion. Ground water pollution, depletion, control measures for the improvement of ground water quality.

### **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, 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**

*History and Scope of Microbiology:* Ultra structure of prokaryotes and eukaryotes cell, general characters of a) Protozoa b) algae c) fungi d) bacteria e) virus, sterilization techniques, preparation for media for isolation of microorganisms, microbial growth and reproduction, quality control and quality assurance in environmental microbiology.

#### **Unit 2**

*Microbial Ecology:* Distribution of microorganisms in air, water and soil, factors influencing the growth of micro-flora in various habitats, adaptation of microorganisms to extreme environment, interaction among microorganisms, interaction between microorganisms and plants: rhizosphere, phyllosphere, mycorrhizae and antimicrobial activity.

#### **Unit 3**

*Bio-indicators:* Introduction, 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 lichens. *Biosensor:* Definition, components, advantages and limitations, biocatalysts, ion-affinity based and microorganism based biosensors, applications of biosensors.

#### **Unit 4**

*Applied Environmental Microbiology:* Air and water borne diseases, bio-aerosols, environmental control measures. Microbial biodegradation of ores, Xenobiotic compounds and biomass.

#### **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**

*Introduction:* Basic concept and principles of EIA, origin and development of EIA, short term and long term objectives of EIA, EIA 2006 Notification (GOI). Components of EIA, screening, notification, public participation, impact statement, review of EIA Analysis and alternatives.

*EIA Method:* ADHOC Method, Check list, Matrix and network method, merits and demerits of EIA.

#### **Unit 2**

*Environmental Audit:* General approaches to environmental auditing, audit methods, benefits of environmental auditing. On-site and post – audit activities, statutory environmental statements. Environmental audit of river valley projects, mines, cement industry, nuclear power, thermal power, wind energy, dams and highway construction.

#### **Unit 3**

*Environmental Planning and Monitoring:* Guidelines and policies, document planning and Environmental documentation, environmental monitoring, environmental management plan, post project audit, recent trends in environmental monitoring, intellectual property, environmental ethics, social economic impact assessment, power and function of CPCB and SPCB.

#### **Unit 4**

*Legal control of Environmental pollution in India:* Historical background of Laws in India, constitutional mandate for Environmental Protection.

- i. The Wildlife protection Act – 1972
- ii. The Water prevention and control of pollution Act, 1974, amended 1988.
- iii. The Forest Conservation Act, 1980.
- iv. The Air prevention and control of pollution Act, 1981, amended in 1990.
- v. The Environment protection Act. 1986.
- vi. Biodiversity Act 2002.
- vii. Noise Pollution Rules 2000.
- viii. Hazardous waste management rules-1989 & amendment rules
- ix. International laws agreements and rules

National Green Tribunal: Structure and functions, people's biodiversity register.

#### **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

### **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 and ISRO, National Center for Earth Sciences

#### **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. Case 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 3.7A - 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.
7. Visit to extreme habitats for collection of samples and isolation of microbes.

#### **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 ASSESSMENT, 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.
7. Visit to environmental sites of importance for mock assessment and audit
8. Mock assessment and people's court.

**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**

*Disaster:* Introduction, classification of major disaster, *Geological Hazards:* Earthquakes, Volcanoes, Tsunami. *Hydrological hazards:* Floods, droughts, water quality, contamination, cyclones and hurricanes, typhoon, cloud burst.

*Minor Disasters:* Heat waves, cold waves, mass movements (avalanche, mud slides, and landslides). Atmospheric/Climatic hazards - extreme weather events, global climatic change.

#### **Unit 2**

*Disaster Management Cycle:* Importance and Scope of Disaster Management. nature of natural disasters, their types and effects, Effect of El Nino and La Nino phenomenon on global climate.

*Anthropogenic disasters:* Chemical disasters, biological disasters, deforestation, radiological disasters, nuclear disasters, bhopal gas tragedy and Chernobyl disaster, Fukushima, BP oil leak disaster, London Smog, Gujarat earthquake, Odisha super cyclone and other industrial disasters.

#### **Unit 3**

*Disasters and Hazard Management:* Human and ecological impacts, risk assessment and vulnerability analysis, national preparedness and adaptation strategies, Disaster Management act 2005, National policy on disaster management 2009 and role of NDMA.

#### **Unit 4**

*Prediction of natural disasters:* Precaution and disaster management, modeling of disaster and Hazards. Role of GIS and remote sensing in surveillance, monitoring, risk assessment, estimation of losses and planning Role of Information, Education, Communication, and Training in Disaster Management. Role of Government, NGO's and Information Technology in disaster management.

#### **References:**

1. Natural and Man-Made Disasters-Sharma
2. Natural Hazards and Disasters-Hyndman
3. Environmental Disasters - K. K. Singh, Lotfi Aleya and Mahadevi Singh
4. Environmental Disaster: Causes, Impact and Remedies - Mahesh V. Joshi
5. The Chernobyl Nuclear Disaster (Environmental Disasters) - Scott Ingram
6. Perils of Progress: Environmental Disasters in the 20th Century (Connections: Key Themes in World History) - Andrew L Jenks.
7. This Borrowed Earth: Lessons from the Fifteen Worst Environmental Disasters around the World (Macmillan Science) - Bill McKibben, Robert Emmet Hernan and Graham Nash
8. Environmental Disasters, Natural Recovery and Human Responses - Roger del Moral and Lawrence R. Walker

## **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 data. Measures of dispersion: relative measures, range, standard deviation, variance, quartile deviation, co-efficient of variability Probability.

### **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: 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 discussions. 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. Plagiarism detection tools.

### **Unit 4**

*Computer applications:* Computer fundamentals, operating system, database management system, hardware and software concept, basics of HTML and internet, Application of computer in understanding environmental processes and management.

### **References:**

1. Environmental Statistics (Handbook of Statistics) - Ganapati P. Patil and C. Radhakrishna Rao
2. Environmental Statistics - Books LLC
3. Scientific Writing: A Reader and Writer's Guide - Lebrun, Jean-Luc
4. Scientific Writing - Hall Marian Rose
5. From Research to Manuscript: A Guide to Scientific Writing- Michael J. Katz
6. 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
7. Statistics for Environmental Science and Management-Manjunatha

## **SPT 4.3 A - ENVIRONMENTAL EDUCATION AND AWARENESS**

### **Unit 1**

*Introduction to environmental education:* Need for the public awareness for environmental protection through print, electronic and Social Media. Environmental communication strategy and environmental ethics. Role of NGO's and case studies in environmental protection and awareness, Carrying capacity of Environment.

### **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 law: 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:**

*Social Perspectives on Environment:* Global and Indian issues, value education, people participation in resource conservation, environmental protection and sustainable development. Role of individual for protection of environment.

### **Unit 4**

*Definition and concepts of sustainable development:* Integration of economic, social and environmental sustainability, biodiversity and availability of natural resources in development. Marine bio resource management, freshwater bio resource management, microbial resource management, wildlife management, Status and strategies for bio resources management across the globe.

### **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 - ArchanaTomar

## **SPT 4.3 B - ENVIRONMENTAL BIOTECHNOLOGY**

### **Unit 1**

*Introduction to Environmental Biotechnology:* Brief account on restriction enzymes, cloning vectors, DNA ligases, Linkers, blotting techniques, gene libraries, expression methods, cloning and selection of individual gene, Types of PCR and its application.

### **Unit 2**

*Applications:* Microbial process involvement, vermin-composting, bio-fertilizer, bio-pesticide production. Bio-mining: microbial leaching of low grade mineral ores 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 waste, sewage water, industrial effluents, heavy metals and radioactive substances. *Phytoremediation* - Abatement of different types of pollution using plants, types of phytoremediation.

### **Unit 4**

*Environmental Genomics:* Metagenomics and metaproteomics, ecogenomics or community genomics, study of genetic material recovered directly from environmental samples.

### **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

#### **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.
5. Visit to biorefinery

#### **References:**

1. Environmental Biotechnology -Dr Alan H. Scragg
2. 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, 2<sup>nd</sup> 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:**

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

#### **4.8 CORE PAPER PROJECT PRACTICALS**

**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:* Linkage between population, development & environment, basics of global warming and climate change. Importance of global water resources and environment, biodiversity and other emerging issues.

**Unit 2**

*Pollution-I: Air and Water pollution:* 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 - settleable and suspended particulate matter - dust fall jar and impingement method, high volume air sampler. Vehicular pollution monitoring and abatement technologies, air pollution control equipment, sampling methods, water quality parameters: inorganic, organic, heavy metals and biological pollutants. Marine water pollution-Types, sources.

**Unit 3**

*Pollution-II: Noise and Soil:* 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. Soil pollution: types, sources, effects of soil pollution on man and climate, soil and abatement technologies.

**Unit 4**

*Environmental toxicants and human health:* Definition and scope, toxicants in environment, biochemical aspects of As Cd, Pb, Hg, CO, O<sub>3</sub>, PAN, pesticides and carcinogens in air. Acute and chronic toxicity, selective toxicity, synergism and antagonism. Estimation of LC<sub>50</sub>, limitation and importance of bioassay, stratospheric Ozone depletion, environmental toxicants & human health.

**References:**

- Global Environmental Issues - Ed. Frances Harris and Frances Harris
- Global Environmental Issues - K. Jagamohan Reddy
- Global Environmental and Pollution Issues by Dr. AaradhanaSalpekar and Dr. Kadambari Sharma
- The Global Casino: An Introduction to Environmental Issues, Fourth Edition -Nick Middleton

## **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 health: Ozone, water resources
3. Awareness studies on environmental disasters.
4. Basic Hygiene and safety standards.
5. Potable water quality assessment.
6. Study of environmental carcinogens.

### **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**

*Climate change:* 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**

*Key scientific facts on climate change:* Impact of climate change on biodiversity, spread of diseases, food production, natural resources and human health, global mitigation strategies for climate change, links between conservation, local knowledge, intellectual properties and climate change, Environmental consequences of nuclear, chemical and biological warfare.

### **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**

*Climate Solutions:* Adaptation, mitigation with renewable energy technologies, green building, energy efficiency and reducing consumption, the Smart Grid, clean coal technology, Kyoto protocol, clean development mechanism, COP series and other laws.



**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**

**Time: 3 hours**

1. **Answer in Brief (Answer any eight)** **8 X 2 = 16**
  - a.
  - b.
  - c.
  - d.
  - e.
  - f.
  - g.
  - h.
  - i.
  - j.
  
2. **Write short notes on the following (Answer any four)** **4x4=16**
  - a.
  - b.
  - c.
  - d.
  - e.
  - f.
  
3. **Essay type questions (Answer any three )** **16 x 3 = 48**
  - a.
  - b.
  - c.
  - d.
  - e.

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

**PRACTICAL QUESTION PAPER PATTERN**

- |                     |                        |
|---------------------|------------------------|
|                     | <b>Max. Marks = 40</b> |
| 1. Major Experiment | 10 Marks               |
| 2. Minor Experiment | 05 Marks               |
| 3. Spotters (05)    | 15 Marks               |
| 4. Records          | 05 marks               |
| 5. Viva -Voce       | 05 marks               |