



ANDHRA UNIVERSITY  
M.SC. ENVIRONMENTAL SCIENCES - SEMESTER SYSTEM  
(EFFECTIVE FROM THE ACADEMIC YEAR 2021-2022)  
SCHEME OF INSTRUCTION AND EXAMINATION

Paper No.	Title of the Paper	Hours/Week	Duration of Examination (Hours)	Maximum Marks	Credits
<b>I Semester</b>					
101	Ecological Principles & Applications	4	3	100	4
102	Biostatistics and Modeling in Environmental Sciences	4	3	100	4
103	Environmental Microbiology & Sanitation	4	3	100	4
104	Environmental Pollution and Instrumentation	4	3	100	4
<b>Practicals</b>					
P I	101 + 102	6	3	50	2
P II	103 + 104	6	3	50	2
<b>Total Marks and Credits for Semester I</b>				<b>500</b>	<b>20</b>
<b>II Semester</b>					
201	Environmental Problems & Eco-friendly Solutions	4	3	100	4
202	Energy Resources and Environment	4	3	100	4
203	Biodiversity Conservation and Management	4	3	100	4
204	Remote Sensing and GIS Applications	4	3	100	4
<b>Practicals</b>					
P III	201 + 202	6	3	50	2
P IV	203 + 204	6	3	50	2
<b>Total Marks and Credits for Semester II</b>				<b>500</b>	<b>20</b>
<b>III Semester</b>					
301	Ecotourism, Eco-restoration and Sustainable Development	4	3	100	4
302	Risk Assessment and Disaster Management	4	3	100	4
303	Pollution Control, Monitoring and Management	4	3	100	4
304	Environmental Impacts Assessment, Environmental Economics, Audit and Law	4	3	100	4

<b>Practicals</b>					
P V	301 + 302	6	3	50	2
P VI	303 + 304	6	3	50	2
MOOCS Course I				50	2
Intellectual Property Rights				50	2*
<b>Total Marks and Credits for Semester III</b>				<b>550</b>	<b>22</b>
<b>IV Semester</b>					
401	Chemical Ecology	4	3	100	4
402	Safety, Health and Environment	4	3	100	4
<b>Practicals</b>					
P VII	401 + 402	6	3	50	2
Seminars				50	2
Environmentalists' Diary and Assignments				50	2
<b>Project Work/Dissertation</b>				100	4
<b>Comprehensive Viva-Voce</b>				50	2
MOOCS Course II				50	2
Value Added Course				50	2*
<b>Total Marks and Credits for Semester IV</b>				<b>550</b>	<b>22</b>
<b>Grand Total Marks and Credits for all 4 Semesters</b>				<b>2100</b>	<b>84</b>

\*Credits not included in the CGPA

- Out of 100 Theory marks for each paper, 20 marks for internal assessment and 80 marks for semester-end examinations.

**SYLLABUS**  
**M.Sc. Environmental Sciences**  
**First Semester**

**PAPER – 101: ECOLOGICAL PRINCIPLES AND APPLICATIONS**

**Course Outcomes (Cos)**

- CO1: Gain knowledge on the importance of ecological principles
- CO2: Understand the biotic and abiotic components of ecosystems and their interrelationships
- CO3: Understand the earth's carrying capacity and factors affecting ecological balance
- CO4: Acquire in-depth knowledge on sustainability and importance of ecological applications
- CO5: Remember different types of ecosystems and their importance

**Course Specific Outcome (CSOs)**

- CSO1: Able to understand the fundamentals of ecological principles
- CSO2: Able to apply ecological principles for the management of natural ecosystems
- CSO3: Acquire knowledge to evaluate the environmental impacts of chemical agriculture
- CSO4: Able to enumerate and describe ground vegetation composition, structure and function
- CSO5: Able to apply ecological principles for sustainable development

**Unit -I:-**

Principles of Ecology: Definition, principles and scope of Ecology; Energy flow, ecological pyramids, types and diversity; Food chain and Food Web; Homeostasis – Theories of Limiting Factors; Ecological succession – population and communities; Reproductive strategies - r- and k- factors; Community ecology - structure, species diversity and species interactions

**UNIT-II**

Ecosystem Ecology: Ecosystem structure (abiotic and biotic components) and function; Ecosystem types - terrestrial and aquatic (fresh water and marine) ecosystems; Ecotones - concept of edge effect, ecological niche; Classification of biomes - general relationships, Bio-geographical regions of the World and modern biogeography.

**UNIT-III**

Ecological Imbalances: Human ecology and human settlements - evolution, origin of life and speciation; Population growth and ecological imbalances; Resources shortage; Earth's carrying capacity; Human engineered ecosystems – agriculture, agro-forestry; Biosphere concept - Man and Biosphere – Future of the Biosphere.

**UNIT IV**

Ecological Applications: Ecological sustainability; Organic farming, bio-fertilizers, bio-pesticides and Integrated Pest Management (IPM); Biological monitoring of the environment - Indicator species - Ecosystem Development; Theory of human ecology- ecology of space travel; Types of life supporting systems - Exobiology.

**UNIT V**

Weed ecology: Weed classification, life cycles, reproductive strategies; Ecological strategies of sexual and asexual reproduction in weeds; weed evolution, survival and invasion; Environmental and ecological impacts of control methods; Principles of herbicide chemistry, toxicological issues and environmental fate.

## **PRACTICALS:**

### **A. Ground Vegetation Analysis (*Quadrat Sampling*)**

1. Fixation of minimum size of Quadrates
2. Fixation of minimum number of Quadrates
3. Determination of Frequency
4. Determination of Density and Abundance
5. Determination of Dominance
6. Importance Value Index (IVI)

### **B. Aquatic Ecology (*Lake and Pond Ecosystems*)**

1. Hydro biological Characteristics of a Lake Ecosystem.  
(pH, Temperature and Dissolved Oxygen)
2. Estimation of Primary Productivity
3. Identification of Eutrophication Characteristics

### **C. Field Study / Visits (*Visiting different ecosystems*)**

- a. Rocky and Sandy coast
- b. Hilly terrain
- c. Marshy swamp
- d. Backwaters
- e. Forest Ecosystem
- f. Lake Ecosystem
- g. Riverine Ecosystem
- h. Mangrove Ecosystem.

## **LEARNING OUTCOMES (LOS)**

1. Students will be able to learn the basics of ecological principles and their applications, reproductive strategies of organisms
2. Students will be able to understand the structure and function of an ecosystem, ecosystem types, bio-geographic regions of the world
3. Students will be able to understand how the ecological imbalances contribute to changes in natural ecosystems, resources availability, and what are the different human engineered ecosystems
4. Students will be able to learn what is ecological sustainability, IPM, indicator species, and exobiology
5. Students will be knowledgeable of various aspects of weed ecology

## **Books for References:**

- ❖ Turk J and Turk A. 1984 **Environmental Sciences 3<sup>rd</sup> Edn.** Saunders College Publications.
- ❖ Odum E. P. 1971 **Fundamentals of Ecology 3<sup>rd</sup> Edn.** W. B. Saunders Company London.
- ❖ Kendeigh S. G. 1961 **Animal Ecology** Prentice- Hall Inc. Englewood Cliffs, N. J, U.S.A.
- ❖ Southwick C. H. 1972 **Ecology and the Quality of environment** D. Van Nostard Company, London.
- ❖ Edmund Hillary 1984 **Ecology 2000 The Changing Face of Earth**, Michel Joseph Ltd. London.
- ❖ Sharma P. D. 1994 **Ecology and Environment** Rastogi Publications. Meerut.
- ❖ Santra S. C. 2001 **Environmental Sciences** New Central Book Agency (P) Ltd. Calcutta.

## **PAPER – 102: BIOSTATISTICS AND MODELING IN ENVIRONMENTAL SCIENCES**

### **Course Outcome:**

CO1: Acquire the importance of system analysis and its application in the field of environment.

CO2: Understand the importance of mathematical modeling and their properties

CO3: Provides the knowledge on introduction of different systems models in the study of population, pollution and ecosystem with examples.

CO4: Understand the importance and application of biostatistics and gaining the knowledge on different sampling methods.

CO5: Provides the introduction and importance of different attributes and variable in the field of environment system analysis

### **Course Specific Outcome:**

CSO1:- Able to understand the Environmental systems analysis

CSO 2:- Acquire a sound knowledge on use of mathematical modeling,

CSO 3:- Able to get the information on Statistical approaches, biostatistics in deriving

CSO4:-Able to understand the environmental models in air, water, soil, floral and faunal analysis etc.

CSO5:- Acquire the Knowledge on the Different Probability Distributions.

### **Unit-I: Introduction to Environmental Systems Analysis**

Concepts, Definition and Scope – Formal basis of Systems Analysis – Types of problems and types of systems – Systems diagrams and concepts – *Systems Classification*: Weaver's, Chorley and Kennedy's, Miller's classifications

### **Unit – II:- Mathematical Modeling:-**

Mathematical Modeling: Nature and goals of Mathematical Models, Basic elements and tools, Anatomy of Mathematical Models, Analysis of Model properties, Approaches to development of Models- Principles and Applications of Mathematical Models.

### **Unit-III: System Models with Applications**

Weather forecasting models, Models of population growth & Interactions, Lotka-Volterra Model, Box Model, Gaussian Plume Model, Leslie's Matrix Model, System analysis of Moorland ecosystem, Spatial interaction model – Future developments in urban modeling. Bayes theorem

### **Unit-IV: Biostatistics:**

***Basic elements and tools of statistical analysis:*** Measures of central value, Measures of Dispersion, Arithmetic, Geometric and Harmonic means. Distribution – Normal  $t$  and  $\chi^2$  Poisson and Binomial, Correlation and Regression Analysis. Tests of hypothesis and significance-

***Sampling types:*** Selective sampling, Random sampling and stratified random sampling. Sampling design, Sample size determination and limitation of sampling, Descriptive statistics

### **Unit – V: - Attributes and Variables:-**

Types of variables, Scales of measurement, Measurement of Central tendency and Dispersion, Standard error, Moments – measure of Skewness and Kurtosis, Basic concept of probability theory, Probability Distributions (Normal, log-normal, Binomial, Poisson, t, 2 and F-distribution), Significance and confidence limits.

#### **PRACTICALS:**

1. *Site Mapping*: Determination of points and objects – area and area classification
2. Water courses Mapping
3. Graphic Models for Niche breadth and overlaps
4. *Evaluation of Ecological variables*: Correlation and regression analysis
5. *Population Models*: Determination of growth rate and doubling time
6. *Population Model*: Leslie's Matrix Model
7. *Air Pollution*: Box Model
8. *Air Pollution*: Statistical Model
9. *Water Pollution*: Point Source Pollution in stream- QC Model
10. Compartment Model
11. *Urban Transport*: Disorganized complexity and Entropy Maximization Model
12. Basics of Computer Applications.

#### **Learning Outcome:**

1. Students will be able to learn the importance of system analysis and its application in the field of environment.
2. Students will be able to learn the different mathematical modeling and their properties
3. The student gains the knowledge on introduction of different systems models in the study of population, pollution and ecosystem with examples.
4. Students will be able to learn what biostatistics is and know the different sampling types.
5. Students will be able to learn the basics of attributes and variable in the field of environment.

#### **Books for References:**

- K.E.F. Watt (1966): **Systems Analysis in Ecology**. Academic Press, New York.
- I. Chaston (1971): **Mathematics for Ecologists**. Butter Works, London.
- E.P. Odum (1971): **Fundamentals of Ecology**. W.B. Saunders Co., London.
- B.C. Pattern (1971): **System Analysis and Simulation in Ecology. (2 Vols.)**, Academic Press, New York.
- R.V.Thomann (1972): **Systems Analysis and Water Quality Management**. McGraw – Hill Book Company, New York.
- R.W. Poole (1978): **An Introduction to Quantitative Ecology**. McGraw Hill Inc., Tokyo.
- A.G. Wilson (1981): **Geography and Environment: Systems Analytical Methods**. John Wiley and Sons, New York.

## **PAPER – 103: ENVIRONMENTAL MICROBIOLOGY AND SANITATION**

### **Course Outcome:**

CO1: This unit provides the importance of microbial groups, culturing and factors affecting their growth

CO2: The different inter and extra microbial relationships in the environment

CO3: This unit deals with the role of microbes in the field environment

CO4: Knowledge on different microbial diseases including bacteria, fungal and viral diseases

CO5: This unit provides the knowledge on different toxic agents from microbial world

### **Course Specific Outcome:**

CSO1:- Obtaining information on microbial groups and their role in biotechnology, ecofriendly applications, public health and sanitation.

CSO2:- Practical analysis on culturing of microorganisms in air, water and soil samples.

CSO3:- Evaluate the potential of microbial roles in the field environment

CSO4:- Acquire knowledge on the different microbial diseases.

CSO5:- Able to understand the distribution and excretion of toxic agents and disease control cycles.

### **Unit-I: Introduction to Environmental Microbiology:-**

**Microbial groups:** Bacteria, Fungi, Algae, Viruses, and Protozoa; their place in the classification of living world; their biology, nutrition, metabolism and reproduction

**Culturing of Microorganisms:** Types and composition of culture media and sterilization techniques

**Environmental Selecting factors for Microbial growth:** Physical factors (Temperature and light, Osmotic pressure, Hydrostatic pressure), Chemical factors (pH, O<sub>2</sub> and CO<sub>2</sub>),.

### **Unit-II: Microbial Interactions:-**

**Intermicrobial relationships** – symbiotic relationships (mutualism, commensalisms and parasitism), Lichens, Lysogeny, Paramecium-Chlorella association, Bacteria-Bdellovibrio-Virus association, Myco-Viruses, Cyanophages,

**Extramicrobial relationships** – Microbial – ruminant association, Microbial-Insect associations, Microbial-Higher plant associations' (Mycorrhiza, Rhizobium-Legume association), Microbial (bacterial, fungal and algal) toxins and their role in environment.

### **Unit-III: Importance of Microbes:-**

**Role of microbes in:** Nitrogen, Sulphur, Phosphorus and Iron cycles – Microbes in the recovery of minerals (bioleaching of minerals) - *In energy production:* (Methane); Microbial biomass or single cell protein, Waste water Treatment.

**Environmental Biotechnology:** Fermentation technology – Vermiculture technology and Bio-fertilizer technology. Biofuels, Biosensors & Bioindicators.

### **Unit-IV: Microbial Diseases:-**

**Bacterial:**– Boils and Carbuncles, 'Strep' sore throat, Pneumonia, Tuberculosis, Cholera, Salmonellosis, Typhoid fever, Anthrax, Brucellosis, Plague, Gonorrhoea, Syphilis -

**Viral:** - Smallpox, Poliomyelitis, Measles, Hepatitis, Encephalitis, Rabies

**Fungal:** - Dermatomycoses, Systemic mycosis and **Protozoa:**- Amoebiasis, Malaria

**Epidemiological Diseases:** Fluorosis, Arsenocosis, Goitre, Dengue

### **Unit – V: - Toxicology and Microbiology:-**

Absorption, distribution and excretion of toxic agents, acute and chronic toxicity, concept of bioassay, threshold limit value, margin of safety, therapeutic index, and biotransformation. Major water borne diseases and air borne microbes, Environmental Sanitation and Disease Control.

#### **PRACTICALS:**

1. Demonstration of air samplers used in microbial studies
2. Preparation of media for microbial growth
3. Techniques in culturing microbes
4. Microbial examination of potable waters:
  - (a). Detection of fecal pollution (E.coli)
  - (b). Standard Plate Count
  - (c). Most Probable Number (MPN) of coliforms.
5. Gram staining
6. Identification of common pathogenic microbes:
  - (a). Salmonella
  - (b). Vibrio sps.
  - (c). Entamoeba sps.
  - (d). Shigella sps.
  - (e). Mycobacterium sps.
  - (f). Plasmodium sps.
7. Total Plate count of soil microorganisms
8. Isolation of Rhizobium sps. From root nodules
9. Microbial growth curves
10. Detection of microorganisms in spoiled foods (bread, rotten meat, fish, fruits etc..)

#### **LEARNING OUTCOMES (LOS)**

1. Students will be able to learn the basics of Environmental Microbiology and different Environmental factors affecting the microbial growth with Practical Approaches.
2. Students will be able to understand the different microbial interactions in the Environment.
3. Students will be able to understand how the microbes will be useful in different fields.
4. Students will be able to learn the different Bacterial, Viral and fungal diseases.
5. Students will be knowledgeable of various aspects of Toxicology and Microbiology.

#### **Books for References:**

- Paul Edmonds (1978): **Microbiology: An Environmental Perspective**. Mac Millan Publishing Co. Inc. New York.
- Dart R. K. and Stretton R.J. (1980): **Microbiological aspects of Pollution Control**. Elsevier Scientific Publishing Company, New York.
- Atlas R.M. and Bartha R. (1981): **Microbial Ecology Fundamentals and Applications**. Addison Wesley Publishing Company, Massachusetts.
- Alexander M. (1977): Introduction to Soil Microbiology 2<sup>nd</sup> Ed., John Wiley and Sons, New York.
- Higgins I.J. and Bunns R.G. (1975): **The Chemistry of Microbiology of Pollution**. Academic Press, New York.



## **PAPER – 104: ENVIRONMENTAL POLLUTION AND INSTRUMENTATION**

### **Course Outcome:**

CO1: Provides the knowledge on classification of elements and fundamentals of environmental chemistry

CO2: Understand the knowledge on the sources, impacts of air pollution and controlling methods

CO3: Acquire the knowledge on the sources, impacts of water pollution and different controlling methods

CO4: Understand the knowledge on the sources, impacts of soil pollution and different controlling methods

CO5: Provides the information on instruments used in pollution analysis studies (Air, Water and Soil)

### **Course Specific Outcome:**

CSO1:- Acquire the Knowledge on classification of elements and fundamentals of environmental chemistry

CSO2:- Able to understand the concept of Air Pollution, impacts and controlling devices.

CSO3:- Able to understand the concept of Water Pollution, impacts and different treatment methods.

CSO4:- Able to understand the concept of Soil Pollution, impacts and Soil erosion.

CSO5:- Evaluate the use of Use of different types of instruments and principles in analyzing physico-chemical and heavy metal analysis.

### **Unit-I: Fundamental of Environmental Chemistry**

Fundamentals of Environmental Chemistry: Classification of Elements, Stoichiometry, Gibbs' Energy, Chemical Potential, Chemical kinetics, Chemical Equilibrium, Solubility of gases in water, The Carbonate System, unsaturated and saturated Hydrocarbons, Radioisotopes.

### **Unit-II: Air Pollution:-**

**Structure of Atmosphere:** Temperature Profile – Influence of Meteorological factors on Air Pollution

**Air Pollutants:** Oxides of Sulphur – Oxides of Nitrogen – Carbon monoxide – Particulate matter; Principles and instruments for measurements of (i) ambient air pollutants concentration and (ii) stack emissions, Lapse Rate, Carbon sequestration and carbon credits.

**Impacts of Air Pollution:** - Impacts (Photochemical smog – Green house effect – Ozone depletion – Acid Rains), Impacts of Air Pollution on human health and structures.

**Control devices for particulate matter:** - Principle and working of: settling chamber, centrifugal collectors, wet collectors, fabric filters and electrostatic precipitator.

**Control of gaseous pollutants:** - through adsorption, absorption, condensation and combustion including catalytic combustion. Vehicular emission norms in India.

### **Unit-III: Water Pollution:-**

Types and sources of water pollution. Impact on humans, plants and animals. Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Microbiological analysis – MPN.

**Drinking water treatment:** Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Wastewater Treatment: Primary, Secondary and Advanced treatment methods. Common effluent treatment plant

#### **Unit – IV: - Soil Pollution**

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

#### **Unit-V: Pollution Analysis and Instrumentation**

**Analysis of Pollutants:** Titrimetry – Gravimetry – Spectrophotometer – Chromatography and Flame techniques.

**Instrumentation:** Instruments for specific parameters – Principles and Applications of UV – VIS Spectrophotometer – Flame Photometer – Atomic Absorption Spectrophotometer – Gas Chromatography – GLC – HPLC – Instrumentation for Weather monitoring.

#### **PRACTICALS:**

1. **Soil Analysis:** Determination of soil types and texture, pH, Hydraulic conductivity. Soil Moisture, Nitrogen, Potassium, Phosphorus and Organic matter.
2. **Water Analysis:**
  - (a). Determination of pH, Dissolved solids and Suspended solids, Dissolved Oxygen, COD, BOD, Alkalinity / Acidity, Nitrogen, Phosphorus and Potassium.
  - (b). Determination of Chromium and Zinc by Spectrophotometer.
3. **Solid Waste Analysis:** Characteristics of Waste.
4. **Liquid Wastes:** Characterization and suggesting Treatment Plan.
5. **Visits** to Industrial establishments to know more about pollution devices and pollution management.

#### **Learning Outcome:**

1. Students will be Able to gain knowledge on basics and fundamentals of environmental chemistry
2. Students will be knowledgeable on the sources, impacts of air pollution and practical knowledge on PM 2.5 & PM 10 Equipments’.
3. Students will be skilled in practicing of different Water quality parameters.
4. Students will understand the sources, impacts of soil pollution and different controlling methods
5. Students will be knowledgeable on instruments used in pollution analysis studies (Air, Water and Soil).

#### **Books for References:**

1. Laurent Hodges – **Environmental Pollution**
2. C.S. Rao – **Environmental Science and Engineering**
3. Moore and Moore – **Environmental Chemistry**
4. H.C. Perkins – **Air Pollution**
5. M.N.Rao and A.K.Datta – **Waste Water Treatment**
6. Brady – **The Nature and Properties of Soil**
7. Willard, Merritt and Dean – **Instrumental Analysis**
8. APHA – **Analysis of Water and Waste Water**

9. JOM Bockins – **Environmental Chemistry**
10. H.C. Stern – **Air Pollution (Volumes I – IV)**
11. E.P. Odum – **Fundamentals of Ecology.**

## Second Semester

### **PAPER-201: ENVIRONMENTAL PROBLEMS AND ECOFRIENDLY SOLUTIONS**

#### **Course Outcome:**

Unit-1: Need of Creating awareness on environmental education and ethics of environment.

Unit-2: Understand the problems affecting global warming by focusing on ozone depletion, GHG effect, acid rains and Atmospheric turbidity

Unit-3: Acquire the knowledge on environmental problems and specifying possible ecofriendly solutions for their mitigation.

Unit-4: Understand the Aspects on current environmental problems associated in India.

Unit-5: Providing information on environmental conventions at global level and their objectives, targets and achievements

#### **Course Specific Outcome:**

CSO1:- Acquire the knowledgeable on environmental education and ethics in India

CSO2:- Acquiring knowledge towards understanding complex environmental issues like global warming and their economic-social challenges in solving.

CSO3:- Understand and evaluate the global scale of environmental problems like over population, food, health & energy security etc

CSO4:- Analyze and evaluate the overview on current environmental issues and movements in India

CSO5:- Able to understand the Environmental conventions and agreements

#### **UNIT – I: Environmental Education and Awareness**

Environmental education and awareness; Need of Environmental Education in India, The Environmental Paradox; Environmental Ethics;

*Outdated ethics* – The purpose ethic. The myth of super abundance, Dilution is not the solution. The idea of progress;

*Updated ethics* – Attitude for survival, Reverence for all life, the right of existence for all environments, according the highest priority to environmental quality.

#### **UNIT – II: Global Environmental Problems**

*The Ozone layer Depletion*– Ozone, Importance of Ozone, Causes of Ozone layer depletion, Antarctica ozone Hole, Effects of Ozone layer depletion & Controlling measures, The Montreal Protocol

*The Greenhouse effect* – Global Warming, Greenhouse Gases, Causes of Green House effect, Effects of Global warming and Ecofriendly solutions, The Kyoto Protocol

*Atmospheric turbidity (atmosphere aerosols)* – Aerosol types, production and distribution, Aerosols and radiation, volcanic eruptions and atmospheric turbidity,. The human contribution to atmospheric turbidity. The atmospheric turbidity and related environmental problems, Eco friendly solutions and technologies.

*Acid rain* – The nature and development of acid rain, the pH scale, the geography of acid rain, Effects of Acid Rains, Eco friendly solutions and technologies.

#### **UNIT – III: Environmental Problems and Ecofriendly Solutions:**

Over population, Food security, Health security, Energy security, Environmental security, Green revolution, Desertification, Deforestation.

#### **Unit – IV:- Current Environmental Issues in India**

Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States. Water conservation-development of watersheds, Rain water harvesting and ground water recharge. National river conservation plan – Namami Gange and Yamuna Action Plan. Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India

#### **Unit – V:- Environmental Conventions and Agreements:**

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

#### **Practical's:-**

1. Need of Environmental education and awareness programmes
2. Concept of Environmental Ethics
3. Concept of Global Warming
4. Concept of Ozone Layer Depletion
5. Concept of Acid Rains
6. Namami Ganga Action Plan
7. Ramsar Convention on Wetlands (1971)
8. Clean Development Mechanism (CDM),
9. Earth Summit at Johannesburg, 2002,
10. Basel Convention (1989, 1992),

#### **LEARNING OUTCOMES (LOS)**

1. Students will be able to understand the concept of environmental education and creating awareness among others and encouraging values of environmental ethics
2. Students will be able to realize the problems associated with environmental issues and their role in finding solution
3. Students will be capable to find out ecofriendly solutions to the global environmental problems like desertification, deforestation etc
4. Students will obtain knowledge on current environmental issues in India related to water resource projects like hydel power and dams construction
5. Students will be able to learn the global environmental conventions and agreements in combating the climate change

#### **BOOKS RECOMMENDED:**

1. Kemp D.D. 1990. Global Environmental Issues, A Climatologically approach, Routledge, London.
2. Disaster Management: A disaster Manager's Handbook, ADB Publications, 1991.
3. Gopal Bhargava 1992. Environmental Challenges and Ecological Disasters, Mittal Publication, New Delhi.
4. Petak W.J and A.A. Atkisson 1982. Natural Hazard Risk Assessment and Public Policy – Anticipating the Unexpected Springer series on Environmental Management Springer – Verlag, New York.

## **PAPER – 202: ENERGY RESOURCES AND ENVIRONMENT**

### **Course Outcomes (Cos)**

CO1: Understand the importance of energy resources, consumption pattern and solar spectral characteristics  
CO2: Describe non-renewable energy resources and environmental impacts of each energy resource  
CO3: Describe non-biological renewable energy resources, their limitations and environmental problems  
CO4: Describe biological renewable energy resources, their limitations and environmental problems  
CO5: Understand energy use pattern, energy demand and green energy auditing concept

### **Course Specific Outcome (CSOs)**

CSO1: Able to understand Energy forms, green energy and solar spectral characteristics  
CSO2: Able to understand the environmental problems linked to non-renewable energy resources  
CSO3: Evaluate the potential of non-biological energy resources and their limitations  
CSO4: Evaluate the potential of biological energy resources to meet energy demand  
CSO5: Acquire knowledge on energy use, demand and options, and socio-economic impacts of energy crisis

### **UNIT – I:**

Energy Resources and Conservation: Energy forms, Laws of Conservation of Energy, Energy resources classification, Green energy, Cultural changes and energy consumption patterns, solar radiation and its spectral characteristics.

### **UNIT – II:**

Non-Renewable Energy Resources: Fossil fuels (Coal, Petroleum, Natural gas, Tar sand, Shale Oil and Gas Hydrates) and environmental problems, Nuclear energy (Nuclear fission and fusion) and environmental problems, nuclear fuel cycle and nuclear accidents.

### **UNIT – III:**

Renewable Energy Resources (Non-biological): Hydropower, its limitations and environmental problems, Tidal energy, its limitations and environmental problems, Wind energy and its limitations, Geothermal energy, its limitations and environmental problems, Solar energy (Solar collectors, Solar cells and Solar ponds), its limitations and prospects.

### **UNIT – IV:**

Renewable Energy Resources (Biological): Fuel wood energy and its limitations; Energy plantations; Biogas and Biodiesel; Organic solid waste energy; Bio-energy advantages and disadvantages; Environmental impacts of biofuel production.

### **UNIT – V:**

Energy use pattern, environmental implications of energy use and energy options: India and Global energy use pattern; Present and future energy demands, and energy options in India; Energy crisis and its socio-economic impacts; Environmental implications of energy use in urban and rural sector; Green energy auditing.

**PRACTICALS:**

1. Enumeration of fuel wood species in a locality
2. Listing of Fossil fuels and related pollution problems
3. Listing of hydrocarbon plant species
4. Conversion of sea water into fresh water by using sunlight
5. Examination of biogas plant designs
6. Field visits to biogas plants
7. Electricity Diary
8. Energy Bill
9. Energy Audit
10. Fuel consumption pattern in different classes of an urban society

**LEARNING OUTCOMES (LOS)**

1. Students will be able to learn energy forms and types, energy utilization pattern and characteristics of solar spectrum
2. Students will be able to understand the utilization of energy resources and their impacts on the environment and society
3. Students will be able to acquire complete understanding about the potentiality of non-renewable and renewable energy resources in India and in the world
4. Students will be knowledgeable of the potential future sources of renewable energy and intelligently analyze reported aspects of the energy
5. Students will be able to evaluate and interpret the energy crisis, issues and rational utilization of energy resources

**BOOKS RECOMMENDED:**

1. Encyclopedia of Environmental Sciences – Environmental Energy Resources, R.P. Trivedi and Gurudeep Raju, Vol. 7.
2. Living in the Environment, G. Tyler Miller, Jr. 1996. Wadsworth Publishing Company, California.
3. Renewable Energy Sources and their environmental impact, S.A. Abbasi and N. Abbasi 2002. Prentice Hall of India, New Delhi.
4. Non-conventional Energy Sources, G.D. Rai 2001. Khanna Publishers.
5. Renewable Energy Resources, Twidell & Wier, CRC Press.
6. Energy Technology – Non-conventional, renewable and conventional, S. Rao and B.B. Parulekar, 2000. Khanna Publishers.

## **PAPER – 203: BIODIVERSITY CONSERVATION AND MANAGEMENT**

### **Course Outcome:**

CO1: Understand the Concept of biodiversity and biological regions of the world

CO2: Provide the knowledge on different Methodologies in measuring the biodiversity using statistical indices of biodiversities.

CO3: Acquire the knowledge on Biodiversity and wildlife conservation practices in India.

CO4: Understand the Conservation and management of biodiversity and statutory practices involved.

CO5: Provides the knowledge on different Environmental movements in India in 19<sup>th</sup> & 20<sup>th</sup> century.

### **Course Specific Outcome:**

CSO1:- Able to understand the conceptual understanding of biodiversity and its significance with information on Biogeographical regions of the world.

CSO2:- Critically examining and measuring flora and fauna using statistical indices

CSO3:- Provides knowledge on wildlife and its conservation and management practices

CSO4:- Able to identify the reasons for biodiversity loss and evaluate the status of biodiversity in a particular region

CSO5:- Able to have a brief history on environmental issues and movements in India

### **UNIT – I: Introduction to Biodiversity**

**Introduction;** Definition and concepts. *Significance of Biodiversity:* Ecological, Economical and Aesthetic importance. Types of Biodiversity as per IUCN.

*Biogeographical regions of the World,* Distribution of world climatic regions and Vegetation types, distribution pattern of flora and fauna at Latitudes and Altitudinal; Patterns of species diversity, species importance, species area relationships, theories of species diversity, Equilibrium theory, Biodiversities of Tropical and Temperate regions.

### **UNIT – II: Measures of Biodiversity**

Indices of diversity; Evenness Index, Shannon Wiener's Index of Diversity, The Simpson Index, *Estimating the diversity of large community:* Margalef's Index diversity, Similarity Index, Bray- Curtis measures (B), Morisita's Index of similarity. Hierarchical diversity. Diversity on Environmental gradients- Alfa Beta and Gamma diversities.

### **UNIT – III: Biodiversity in India:-**

India is Mega biodiversity. Why?, Biodiversity Hotspots in India, Present status of Biodiversity in India – Extinct, Rare, Endangered and Threatened for a & Fauna in India, Man and Biosphere program, Future of Biosphere, National Biodiversity Strategy and Action Plan.

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

### **UNIT- IV: Biodiversity Conservation and Management:**

Conventions on Biological diversity, Aims and Objectives, *Conservation strategies and legislations* - Forest and Environment Protection Acts, Wildlife (Protection) Act 1972, Biosphere reserves, National Parks, and Wildlife Sanctuaries, Remote Sensing applications in Measuring



Biodiversity. Introduction to Gene pools in forestry - Biodiversity Act, 2002 – Biodiversity Trade – Biopiracy issues.

**UNIT – V: - Environmental Movements:-**

Bishnoi Movement, Chipko movement, Appiko movement, Navdanya Movement, Jungle Bachao Andolan, Narmada Bachao Andolan, Chilka Bachao Andolan, Silent Valley movement, Tehri dam conflict and Gandhamardhan movement. People Biodiversity register, Biodiversity and life security.

**PRACTICALS:**

1. *Vegetation Analysis:*
  - a) Frequency
  - b) Abundance and Density
  - c) Cover and Basal area
  - d) Importance Value Index
2. *Vegetation Sampling*
  - a) Transects
  - b) Plot less Methods
3. Degree of Maturity of a plant community
4. Community Coefficients
5. Study of communities (Based of percentage, Density, Frequency, Basal area and size classes).
6. *Diversity Measure:* Shannon Wiener, Simpson and Brillion's Index.
7. Listing of indicator species in a Forest, Ecosystem (Based on Field trip).
8. *Identification Techniques for wild fauna:*
  - a) Pug Marks
  - b) Hair sample
  - c) Faecal analysis
9. Diversity Measure of Birds fauna in different habitat conditions.
10. Listing of Threatened and Endangered Fauna in a Forest Ecosystem (Based on field trip)

**LEARNING OUTCOMES (LOS)**

1. Students will be able to understand biodiversity and its vital role in ecosystem function
2. Students will realize the need of biodiversity conservation in the context of various developmental pathways and policy framework
3. Student will obtain knowledge and understanding of: Ecological and evolutionary processes that are important for conservation of biodiversity - Important approaches and practices in biodiversity conservation and management
4. Students will be skilled in planning management of biodiversity and biological resources in the light of ecological and evolutionary dynamics
5. Students will be knowledgeable in critically examine biodiversity and human linkages, and help policy formulating for conservation and develop appropriate policy options for conserving biodiversity

**BOOKS FOR REFERENCE:**

1. Pianka, E.R. (1983). *Evolutionary Ecology* (Third Edition) Harper & Row Publishers, New York.
2. Mac Arthur, R.H. (1972). *Geographical Ecology: Patterns in the Distribution of Species*, Harper & Row Publications, New York.
3. Pielou, E.C. (1975). *Ecological Diversity*, A Wiley Inter Science Publications, John Wiley & Sons, New York.
4. Whittaker, R.H. (1975). *Communities and Ecosystems* (Second Editions) Macmillan Publishing Co., Inc., New York.
5. Samar Singh (1986). *Conserving India's Heritage*, Nataraj Publishers, Dehradun.
6. Frankel, O.H. and Bennett, E. (1970), *Genetic Resources in Plants. Their Exploitation and conservation*, I.B.P. Handbook No.11, Blackwell Scientific publications Oxford and Edinburgh.
7. Stracey, P.D. (1963) . *Wildlife in India – Its Conservation and control*, Ministry of Food and Agriculture, Govt. of India, New Delhi.
8. *The Wildlife (Protection) Act, 1972 (as Amended upto 1991)*, Nataraj Publications, Dehradun.
9. V.B. Saharia (1982). *Wildlife in India*, Nataraj Publishers, Dehradun.
10. B. Seshadri (1982), *Indian Wildlife Resources*, Sterling Publishers, New Delhi.
11. Subba Rao, M.V. 1993. *Bioresources, Conservation and Management*, Andhra University Press, Visakhapatnam.

## **204: REMOTE SENSING AND GIS APPLICATIONS**

### **Course Outcome:**

CO1: Understand the Importance of Remote sensing and Geographic Information systems in the field of environment.

CO2: It helps to know the different Satellite systems and applications in environment

CO3: Acquire the knowledge on Image classification and applications

CO4: Understand the knowledge on Preparation of management plan for forest fire risk zoning, large scale mapping with case studies.

CO5: Provides the information of different Data interpretation techniques.

### **Course Specific Outcome:**

CSO1:- Able to have a foundation about remote sensing and GIS as a powerful tool for geo spatial analysis in the field of environment.

CSO2:- Understand working principles of remote sensing and history of satellite development in India and globally.

CSO3:- Analyze and evaluate the Mapping of large scale areas by using remote sensing techniques.

CSO4:- Able to understand the Applications of GIS software to know the impact of natural calamities by developmental activities.

CSO5:- Obtain Basic competence in skills with functional knowledge of the fundamentals to carry out GIS (RS-GIS) based project

### **UNIT – I: introduction to Remote Sensing & GIS:-**

Definition and Overview of Remote Sensing and Remote Sensing Systems Electromagnetic Radiation, terms and Definitions, Laws of Radiation, Electromagnetic Spectrum, Active and Passive Systems, Imaging and Non Imaging System, Resolution – Spatial, Spectral and Temporal. GIS & Its Fundamentals

### **UNIT – II: Satellite systems & Applications**

Earth Observation Satellites (LANDSAT, SPOT, IRS, RADARSAT etc) and their characteristics Remote Sensing Systems, Indian Meteorological Satellites, Navigation satellites

Application of remote sensing and GIS in land cover/land use planning and management (urban sprawling, vegetation study, forestry, natural resource), waste management and climate change.

### **UNIT – III: Image classification:-**

*Fundamentals of image Classifications* - Satellite image interpretation (visual) of mapping - Satellite image interpretation (digital) of mapping - and its applications – Key elements of Visual Image Interpretation, Fundamentals of Image Rectification and Fundamentals of GPS

### **UNIT – IV: Forest Inventory:-**

Principles of inventory; sampling techniques - Preparation of Management Plan - Site suitability analysis - Sustainable management - Fire risk zoning – Vegetation change detection and monitoring - Microwave remote sensing - Wildlife habitat evaluation - Forest ecosystem analysis - Large scale mapping with GPS

### **Unit – V:- Nature of Qualitative Information and Sequence in Interpretation;**

Elements of Image Patterns-Landforms, Drainage, Erosion Details; Remote Sensing Applications in Environmental Studies; Digital Image enhancement and classification methods; Principles of Microwave Remote Sensing; Characteristics of Microwave remote sensing Data; Radar and Lidar: Applications of Microwave Remote Sensing Data, Spectral Characteristics of Common Natural Objects; Atmospheric Effects on Remote Sensing Data;

### **PRACTIALS:**

1. Study of Satellite Image Annotation (information) LANDSAT, SPOT and IRS
2. Study of Satellite data, identification and mapping of different surface features
3. Study of Ground Data collection instruments, Radiometers, Spectrometers etc.
4. Study of Satellite imagery (Black/White) in different bands and visual interpretation
5. Loading image data and display, identification of objects on video display, display of Histograms
6. Image enhancement techniques Contrast Enhancement, Band Rationing, Edge
7. Image Registration – Image to map, Image to Image, Image to user coordinates
8. Image classification techniques – supervised and unsupervised
9. Forest vegetation analysis & mapping using satellite images
10. Forest change detection
11. Site suitability analysis
12. GIS database creation

### **LEARNING OUTCOMES (LOS)**

1. Students will be able to understand the basic concept of remote sensing and GIS and its applications, know different types of data representation in GIS
2. Students will be able to build the foundation of understating of cartography, digital image, spatial and non-spatial data and geospatial terminology
3. Students will be able to illustrate spatial and non spatial data features in GIS and understand the map projections and coordinates systems and application in GIS based software and different platforms
4. Students will be able to identify specific data and methodologies for effective mapping and evaluation of natural resources, flood management, watershed management, LULC classification, forest resource management etc for decision making
5. Student will be able to pursue lifelong learning for professional advancement

### **BOOKS RECOMMENDED:**

- Jensen, JR.1996, Introductory Digital images processing: remote Sensing Perspective, (2<sup>nd</sup> Ed New Jersey: Pretince Hall).
- Lillesand, T.M., & Keifer, R.W.2000, Remote Sensing and Image Interpretation;(4<sup>th</sup> EdNew York:John Wiley&Sons).
- Richards, j.A., & Xiuping,Jail.1999,Digital image Analysis;(3<sup>rd</sup> Ed.New York:Springer).
- Wolf, PR.1974, Elements of Photogrametry,(New York;Mc GrawHill).

- Forestry and Ecology Division.1999, Manual on Biodiversity Characterization at Landscape of Remote Sensing).
- Champion, H.G.1968 Revised forest types of India
- Roy, PS,Ranganath,BK,Diwakar,PG,Bhan TPS,Singh.SK,1991,
- Tropical forest type mapping and monitoring using remote sensing. **Int. J. Remote Sensing**, 12(11) 2205
- Chacko, VJ. 1965. **A manual on sampling techniques for forest surveys.** (Govt. of India publications)
- Hamilinton, GJ. 1992. **Forest menstruation handbook**, (Delhi: Periodical expert book agency)
- Loetsch, F& Haller, KE. 1973. **Forest inventory.** (Muendhen: BL. Verlag-Gesselschaft)
- Food and agriculture Organization. 1984. **Land evaluation for forestry**, FAO, Rome
- Sing, IJ & Roy. PS 1990. Growing stock estimation through stratified random sampling, **Photonirvachak**, 18,29.

**WEBSITES:**

<http://www.ciesin.org>

<http://edcwww.cr.usgs.gov/landdace>

<http://daac.gsfc.nasa.gov>

<http://eosweb.larc.nasa.gov>

<http://ghx.insfa.nasa.gov>

**Third Semester**  
**PAPER-301: ECOTOURISM, ECORESTORATION AND SUSTAINABLE**  
**DEVELOPMENT**

**Course Outcomes (Cos)**

- CO1: Understand tourism types and the concept of ecotourism and its benefits
- CO2: Understand ecotourism types, ecotourism promotion and development
- CO3: Acquire knowledge on eco-restoration, its process and limitations
- CO4: Understand restoration process in different ecological settings
- CO5: Understand the concept of sustainable development and the ways to achieve sustainability

**Course Specific Outcome (CSOs)**

- CSO1: Able to evaluate the advantages and disadvantages of tourism versus ecotourism
- CSO2: Able to understand the potential of different ecosystems for ecotourism
- CSO3: Analyze and evaluate the steps in eco-restoration process and the importance of phyto-remediation
- CSO4: Able to understand the fundamentals of restoration activity in different ecosystems
- CSO5: Acquire knowledge on sustainable development in different eco-sectors green growth and economy

**UNIT – I:**

Fundamentals and importance of ecotourism: Tourism definition, historical background, conventional tourism, mass tourism, nature-based tourism; Eco-tourism definition and its principles and guidelines; Importance of parks and gardens in ecotourism; Role of photography and electronic media in ecotourism, Potential sites for ecotourism promotion in India. Environmental impacts of ecotourism; Trends and future of ecotourism.

**UNIT – II:**

Ecotourism promotion and development: Ecotourism benefits – environmental awareness, environmental education, recreation, conservation and economic development; Wetland ecotourism, coastal ecotourism; bird ecotourism, butterfly ecotourism; Role of butterfly parks and gardens in ecotourism promotion, environment conservation and management; Communities involvement in ecotourism development.

**UNIT – III:**

Introduction and need for eco-restoration: Eco-restoration - definition, introduction, historical development; Restoration process – steps in the process and understanding biological, physical and chemical limitations, and overcoming limitations; Phyto-remediation for re-vegetation; philosophical and ethical context for good restoration and significance of community involvement.

**UNIT – IV:**

**Eco-restoration in different ecological settings:** Restoration of degraded waste lands, forests and agricultural soil fertility; Ground water restoration; Restoration of inland and coastal wetlands; Restoration of ecology in urban and industrial centers – Indicators for restoration and reclamation.

## **UNIT – V:**

**Sustainable Development:** Concept of sustainability and sustainable Development; Brundtland Commission and its contribution to sustainable development; Sustainable agriculture; Sustainable forest management, sustainable forestry; Sustainable fisheries; Green growth and economy; Sustainable economic growth, environmental worldviews and ethics.

### **PRACTICALS**

1. Collection and identification of insect fauna
2. Bird watching and identification
3. Field study of a local park/wild habitat
4. Examination of host plants of butterflies
5. Examination of life cycle of butterflies
6. Nesting habits of bees
7. Development of an eco-restoration strategy for denuded hills
8. Development of an eco-restoration strategy for aesthetic enhancement of beaches
9. Development of eco-restoration strategies for Visakhapatnam city

### **LEARNING OUTCOMES (LOS)**

1. Students will be able to differentiate between ecotourism and other forms of tourism and their impacts on environment and society
2. Students will be able to understand the role of media, parks, gardens, birds and butterflies in promoting ecotourism
3. Students will be able to learn what is eco-restoration, its process and its importance in restoring the ecology of natural areas, urban and industrial centers
4. Students will be able to learn the criteria as indicators for restoration and reclamation
5. Students will be knowledgeable of the environmental, social and economic dimensions of sustainable development and environmental ethics

### **BOOKS FOR REFERENCE:**

- Hammitt, W.E. & Cole D.N. 1998. Wild land Recreation: Ecology and Management, 2nd Ed. New York: John Wiley & Sons.
- Liddle M. 1997. Recreation Ecology: The Ecological Impact of Outdoor Recreation and Ecotourism. New York: Chapman & Hall.
- Mieczkowski, Z. 1995. Environmental Issues of Tourism and Recreation. Lanham, MD: University Press of America.
- Wall G. & Wright C. 1977. The Environmental Impact of Outdoor Recreation. Publication Series No. 11. Department of Geography. Waterloo, Ontario: University of Waterloo.
- Higgs, E. 1997. What is Good Ecological Restoration? Conservation Biology, pp. 338-348.
- Egan, B. 1998. Ecological Restoration for British Columbia. British Columbia Environmental Report.
- Martha Honey 1999. Ecotourism and sustainable development, Island Press, Washington DC
- Martin Mowforth and Ian Munt 1998. Tourism and sustainability, Routledge, U.K.
- Robert U Ayres, Paul M Weaver. Ecostructuring: Implications for sustainable development. IN-05457.
- R.B. Jain. Environmental Stewardship and Sustainable Development IN-04021.

## **PAPER-302: RISK ASSESSMENT AND DISASTER MANAGEMENT**

### **Course Outcome:**

CO1: Provides the knowledge on the concept of risk, hazard and the purpose of contingency plans

CO2: Gain knowledge on process of risk assessment and hazard identification in environmental management

CO3: Describe the Overview of disasters caused by natural, climatic and edaphic factors

CO4: Gives information on manmade disasters and their involvement in the destruction of environment with case studies.

CO5: Acquire the knowledge on Disaster management, mitigations and control measures with statutory acts and guidelines

### **Course Specific Outcome:**

CSO1:- Able to provides sound knowledge on concept of risk and hazard in environmental management and specifying contingency plans.

CSO2:- Acquire information on natural and anthropogenic disasters and their mitigation methods with case studies.

CSO3:- Understanding foundations of hazards, disasters and associated natural/social phenomena.

CSO4:- Evaluate the potential of Disaster management, mitigations and control measures in India.

CSO5:- Knowledge about existing global frameworks and agreements on pre and post Disaster management

### **UNIT – I: Concepts of Environmental Risks**

Definitions for Environmental Risk – concepts of Hazard, exposure, dose and response, Communication of Risk – Developmental activities/projects/programmes required to carry out Risk assessments and propose Contingency Plans for Risk Management.

### **UNIT – II: Environmental Risk Assessment**

Catastrophic geological hazards, Risk Assessment - Hazard identification, Hazard accounting, Scenarios of exposure, Risk characterization and Risk management, Prediction of hazards and mitigation of their impacts.

### **UNIT – III: Natural Disasters**

*Disasters* – Natural, understanding the causative factors vulnerability, their analysis and evaluation. Environmental implications of Earthquakes, Avalanches, Volcanic eruptions, Landslides, Floods (Riverine Floods) and tsunamis, cyclones (Diviseema Uppena, Hud-Hud & Titli), hurricanes, typhoons, tornadoes, cloud bursts.

### **Unit: - IV: - Human Influenced Disasters:-**

Disasters due to nuclear chemical and biological weapons, Earthquakes in the areas of larger dams, forest fires and wild life destruction, Minamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukushima Daiichi nuclear disaster, 2011 LG Polymers accident in Vizag, Major Train accidents in India.

### **UNIT – V: Disasters Mitigation and Management**

Identification of Disaster prone areas and high risk groups - Disaster warning programmes, Disaster preparedness and prevention of loss to life, livestock, property, natural resources and ecology – Development of Disaster Mitigation Plans – Awareness programmes and capacity building among the Risk Groups - Post disaster environmental problems and their management.



### **PRACTICALS:**

1. Global Climate Change
2. Global warming
3. Green House Effect
4. Cyclone and three case studies
5. Major Forest Fires with Case studies
6. Floods with case study
7. Major train accidents in India
8. Nuclear Disasters with two examples
9. Biowarfares
10. Disaster management in India

### **LEARNING OUTCOMES (LOS):-**

1. Students will be capable in understanding the fundamentals of the environmental risk assessment and management procedures
2. Students will have better knowledge in identifying and classifying environmental hazards and risks and evaluating the significance and likelihood of harm
3. Students will have basic conceptual understanding of disasters and its impacts, mitigation, control measures etc
4. Students will be aware of major disasters occurred world-wide and their impacts and management
5. Students will be acquiring the skills in assessing, planning, mitigating, responding to and recovery from disaster from local through global levels

### **REFERENCES:**

1. Gilbert, M. Masters (2000) *Introduction to Environmental Engineering and Science*, Prentice Hall of India Pvt. Ltd., New Delhi.
2. Khitoliya, R.K. (2004) *Environmental Pollution: Management and Control for Sustainable Development*.
3. Santra, S. (2001) *Environmental Science*. New Central Book Agency (Pvt) Ltd., Kolkotta.
4. Susan, L.C. (Ed)(1999) *Environmental Risks and Hazards*. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Gopal Bhargava 1992. *Environmental Challenges and Ecological Disasters*, Mittal Publication, New Delhi.
6. UNCHS (1983) *Planning for Human Settlements in Disaster Prone Areas*, UNCHS-Habitat.

# **PAPER-303: POLLUTION CONTROL, MONITORING AND MANAGEMENT**

## **Course Outcome:**

CO1: Provides information on different sources, impacts of noise pollution and controlling methods

CO2: Understand the pollution sources from thermal pollution, marine pollution and radioactive pollution and their controlling measures

CO3: Able to evaluate the impacts of solid waste and their role in waste management

CO4: Understand the disposal, reuse & recycling and management of e-waste, hazardous waste, fly ash and plastic waste

CO5: Acquire knowledge on goals on national action plan of climate change by the Government of India by implementing different missions for mitigating climate change.

## **Course Specific Outcome:**

CSO1:- Ability to identify noise pollution problems and interpret criteria of noise quality

CSO2:- Acquire knowledge on pollution caused from specific industries such as thermal, nuclear etc are explained in detailed.

CSO3:- Ability to identify solid/hazardous wastes, waste minimization, source reduction and elucidate the management, treatment and disposal of wastes.

CSO4:- To enrich knowledge about characteristics of hazardous, e-waste, fly ash and plastic wastes and their management

CSO5:- Able to understand the different missions in national action plan for combating climate change

## **Unit-I: Noise Pollution:**

Vibrations and their measurements. Impact of noise and vibrations on human health. Sources, weighting networks, measurement of noise indices (Leq, L10, L90, L50, LDN, TNI). Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods.

## **Unit-II: Thermal, Marine Pollution and Radioactive:**

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

## **Unit-III: Solid Waste and its Management:-**

Solid Waste - types and sources. Solid Waste characteristics, Generation rates, Solid waste components, Proximate and Ultimate analyses of Solid wastes. Solid waste collection and transportation: Container systems - hauled and stationary, layout of collection routes, transfer stations and transportation, Waste Management – Swachha Bharat Abhiyan.

Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and vermicomposting, biomethanation of solid waste. Disposal of solid wastes – sanitary land filling and its management, incineration of solid waste.

## **Unit –IV: - Environmental monitoring and Management:-**

**Hazardous waste** – Types, characteristics and health impacts. Hazardous waste management: Treatment Methods – Neutralization, Oxidation Reduction, Precipitation, Solidification, Stabilization, Incineration and Final disposal.

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

### **Unit- V: National Action Plan on Climate Change**

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

### **PRACTICALS**

1. Estimation of pollution load for wastewaters.
2. Characterization of Municipal Solid Waste.
3. Monitoring of Noise levels at strategic points.
4. Analysis of Soil for pollutants.
5. Industrial visits for hands on experience of Industrial Pollution Management.

### **LEARNING OUTCOMES (LOS)**

1. Students will be able to define noise, sources, calculate noise levels and related pollution with noise control regulations and their limit values
2. Student will have acquaint knowledge and understanding of fate/behavior of marine, thermal and radioactive pollution and their problems/solutions.
3. Students will be able to identify the sources of solid and hazardous wastes and manage them
4. Students are able to understand the importance of environmental monitoring and management in hazardous, e-waste, flyash and plastic waste pollution
5. Students will be aware of various national action plans and missions implemented by GoI for challenging climate change

### **Books for References:**

- Air Pollution, **Arthur C. Stern**, Vol. I-IV, Academic Press, INC. New York.
- Principles of water quality control, **T. H. Y. Tebbutt**, Pergmon Press, New York.
- Air Pollution, **H. C. Perkins**, Mc Graw Hill series, New Delhi.
- The Nature and Properties of Soil, **Brady**.
- Analysis of water and wastewater, **APHA** publication.

## **PAPER-304: EIA, ENVIRONMENTAL ECONOMICS, AUDIT AND LAW.**

### **Course Outcome:**

CO1: Acquire the knowledge on EIA Notification and legal requirements and process of EIA

CO2: Acquire the knowledge on EIA methodologies in preparing EMP and EIS

CO3: Provides the information on Objectives, scope and approaches for environmental audit in preparing and finding corrective/preventive actions

CO4 & 5: Understand the Acts, gazettes, guidelines on different environmental laws in India

### **Course Specific Outcome:**

CSO1:- Able to sound knowledge on process of EIA for upcoming developmental projects and providing control measures through Environmental Management Plan

CSO2:-Able to understand the EIA methodologies and assessing the impacts of various projects.

CSO3:-Able to evaluate the environmental audit to find corrective/preventive actions.

CSO4:- Acquire the Information on Environmental Laws in India.

CSO5:- Ability to understand the benefits, challenges and gaps under the current scenarios of laws

### **UNIT – I: EIA (Environmental Impacts Assessment)**

EIA Notification of the Govt. of India - Definitions and Objectives of Environmental Impacts Assessment; Scope and Advantages; *Legal requirements and compliance*: Screening and identification of projects; public involvement. Project criteria and thresholds; Environmental criteria and thresholds; Initial Environmental Evaluation; Practical Applications.

### **UNIT – II: *Methods and Tools for EIA***

Activities in EIA and Impact characteristics; Map-overlay methods; Checklists Method (Descriptive and Scaling); Matrix Methods; Networks; Scoping Methods on Baseline Studies – Preparation of Environmental Impact Statement (EIS) – Development of Environmental Management Plan (EMP) - Role of Monitoring and Auditing in EIA.

### **UNIT – III: Environmental Audit**

*Definition; Objectives; Scope, Coverage – Policy development*: Defining boundaries; Goals; Policy compliance – Organization and staffing of Audit team – Resources – *Approaches to Audit*: (a) Pre-visit Activity; (b) On-site Activities; (c) Post-Audit activities – Audit principles – Benefits to Industry.

*Audit Report and Environmental Statement (ES)*: Importance of Audit Report – Reporting Environmental Audit Findings;– Environmental Statement and Public Information; Preparation of Flow diagrams; Material Balance; Preparation of EIS.

### **UNIT – IV: Environmental Laws - I**

(1) The Water (Prevention & Control of Pollution) Act, 1974; (2) The Air (Prevention and Control of Pollution) Act, 1981; (3) The Water (Prevention and Control of Pollution) Cess Act, 1977; (4) The Environment (Protection) Act, 1986; (5) The Motor Vehicles Act, 1939; (6) The Public

Liability Insurance Act, 1991; (7) The Factories Act, 1947; (8) Wildlife (Protection) Act, 1972; (9) The Indian Forest Act, 1857, (10) National Forest Policy, 1988,

#### **UNIT – V: Environmental Law - II**

(1) The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, (2) The Plastic Waste Management Rules, 2016, (3) The Bio-Medical Waste Management Rules, 2016, (4) The Solid Waste Management Rules, 2016, (5) The e-waste (Management) Rules 2016, (6) Noise Pollution (Regulation and Control) Rules, 2000, (7) Coastal Regulation Zones (CRZ) 1991, (8) National Water Policy, 2002, (9) National Environmental Policy, 2006

#### **PRACTICALS**

1. Preparation of Activity-processes Flow diagrams.
2. Case study Analysis for EIA of a major Industry.
3. Case study Analysis for EIA of a Reservoir/Land Conversion/Mining activity.
4. Case study Analysis of Environmental Audit of a major industry.
5. Preparation of Environmental Statement.
6. Application of Matrices Method.
7. Cost-benefit Analysis for Resource Allocations: Transportation Method.
8. Visit to understand Institutional arrangements and functioning of Pollution Control Boards.
9. Visit to understand Environmental Management system of an Industry.

#### **LEARNING OUTCOMES (LOS)**

1. Students will be able to gain knowledge on EIA and its process with legal requirements
2. Students will be capable of application of EIA methodologies and preparing EMP and EIS
3. Students will be skilled in practicing Environmental audit and findings
4. Students will learn about the significance of developments in international and national environmental law and the fundamental principles that have emerged
5. Students will be knowledgeable of various comprehending the statutory and regulatory mechanisms pertaining to environment in India

#### **Books for REFERENCE:**

1. L.W. Canter (2002). Environmental Impact Analysis, McGraw Hill Book Co., New York.
2. International Chamber of Commerce (1986) ICC Guide to Effective Environmental Auditing, ICC, New York.
3. A.D. Little (1990) Principles for conducting Environmental Health, and Safety Audits, Centre for Environmental Assurance.
4. Ministry of Environment & Forests (1992) Policy Statement for Abatement of Pollution, Govt. of India, New Delhi.

**Fourth Semester**  
**M.Sc., Environmental Sciences**  
**PAPER - 401: CHEMICAL ECOLOGY**

**Course Outcomes (Cos)**

CO1: Understand the importance and scope of chemical ecology in the context of environmental pollution

CO2: Acquire knowledge on soil chemical ecology in relation to allelopathy and drought conditions

CO3: Understand the chemical ecology of interactions between plants and pollinator animals

CO4: Understand the chemical defenses in vascular plants and impact of air pollution on chemical defenses

CO5: Understand the climate change effects on interactions between plants and insects, and the effects of plastic on plant and soil microbial community

**Course Specific Outcome (CSOs)**

CSO1: Able to understand the effects of air pollution on biogenic volatiles, plant and insect herbivores

CSO2: Able to understand the weed chemical ecology

CSO3: Acquire knowledge on the role of plant-derived Pyrrolizidine alkaloids in butterflies

CSO4: Analyze and evaluate the relationships between volatile trees, air pollution and air quality

CSO5: Able to evaluate climate change effects on plants and insects and also the effects of micro-plastics on plant as well as soil microbial biota.

**UNIT 1:**

Definition, scope and importance of chemical ecology; effects of air pollution on biogenic volatiles and ecological interactions; Interaction between plant and insect herbivores in elevated CO<sub>2</sub> atmosphere

**UNIT II:**

Soil chemical ecology: Allelopathy, allelochemicals, weed chemical ecology; Chemical defense of organisms in terrestrial and aquatic habitats; Role of drought in chemical ecology of plants

**UNIT III:**

Chemical ecology of plant-pollinator interactions (bees, butterflies, moths, birds and bats); Role of plant-derived Pyrrolizidine alkaloids in butterflies; Chemical ecology of fruit defense

**UNIT IV:**

Phytoliths (solid biosilicates) as chemical defenses in vascular plants; Negative and positive effects of heavy metal pollution in plants and animals; relationships between volatile trees, air pollution and air quality; ecological roles of biogenic volatile organic compounds.

## **UNIT V:**

Climate extreme conditions effect on plant chemical composition; Global climate change effects on plant-insect interactions, insect pests and crop production; Micro-plastics and their effect on plant growth, litter decomposition, plant community and soil microbial community

### **PRACTICALS**

1. Measurement of nectar volume
2. Nectar analysis for sugar types
3. Nectar analysis for amino acids
4. Determination of nectar sugar content
5. Examination of butterflies that feed on plant species that produce Pyrrolizidine alkaloids
6. Qualitative analysis of sugar concentration of pulpy fruits of zoochorous species
7. Examination of Phytoliths in grasses
8. Listing of plant species producing fragrant flowers
9. Classification of flower syndromes using chemical aspects of nectar
10. Field study on foraging activity of pollinators on different plant species

### **LEARNING OUTCOMES (LOS):-**

1. Students will be able to learn what is chemical ecology and its connection to plants, animals and pollution chemistry
2. Students will be able to understand what is allelopathy and its importance in weed chemical ecology, chemical defense of organisms in different ecosystems
3. Students will be able to understand the chemical ecology of plants and their pollinating and fruiting dispersing animals.
4. Students will be able to learn how Phytoliths act as chemical defenses in plants, how heavy metals effect plants and animals, and how the relationships exist between trees and air pollutants
5. Students will be knowledgeable of the climate change effects on plant chemical composition, plant-insect interactions, plant pests, and also effect of micro-plastics on plant growth, litter decomposition and soil microbial community

## **BOOKS FOR REFERENCE:**

- Harborne, J.B. 1993. Introduction to Ecological Biochemistry. Gulf Professional Publishing, 318 pp. ISBN 0123246865, 9780123246868.
- Kumar, H.D. 2000. Plant-animal interactions. Affiliated East-West Press Pvt. Ltd. New Delhi, 399pp.
- Quinn, S.M., Jose, D.F., T'ai, R., James, C.K. and Manuel, L. 2009. Effects of air pollution on biogenic volatiles and ecological interactions. *Oecologia* 160: 411-420.
- Robert, S.B. 2010. Heavy metal pollutant and chemical ecology: exploring new frontiers. *J. Chem. Ecol.* 36: 46-58.
- Amy, L.P. and Jessamyn, S.M. 2015. The chemical ecology of plant-pollinator interactions; recent advances and future directions. *Curr. Opinion in Insect Science* 8: 41-46.
- Joshua, S.Y., Sari, J.H., Jarmo, K.H., Feng, C., and Neal Stewart Jr, C. 2009. Smelling global climate change: mitigation of function for plant volatile organic compounds. *Tree* 323-331.
- Caroline, A.E.S., Veronica, S.D.S. and Zhaoliang, S. 2016. The functional role of silicon in plant biology - Functions of phytoliths in vascular plants: an evolutionary perspective. *Functional Ecology* 30: 1286-1297.



## **PAPER – 402: SAFETY, HEALTH AND ENVIRONMENT**

### **Course Outcome:**

**CO1:** Acquire the knowledge on importance of SHE practices in industrial and occupational safety

**CO2:** Provides the information of Planning and purpose of health and safety practices involved in Industrial units

**CO3:** Understand the Educating and Training of employees in SHE from grass root levels.

**CO4:** Acquire the knowledge on Competency building techniques (CBT) involved in training various standard operating procedures in safety methods and their applications.

**CO5:** Obtain information on accidents occurred due to human factors and their behavior in effecting safety positive culture.

### **Course Specific Outcome:**

CSO1:- Acquire knowledge on importance of SHE in practices of industrial and occupational safety

CSO2:- Able to be familiar with safety planning and developing an understanding about the role in health and safety in workplaces.

CSO3:- Able to understand the Imparting training, education, competence building techniques to the manpower working at all levels of industry

CSO4:- Able to have knowledge about Hazard assessment studies and ways to handle hazard situations in industry

CSO5:- Able to provides information on human errors and their behavior towards safety practices

### **UNIT-I:**

1.1. Introduction- Management Principles & Types of Management; Managerial Role, Authority, Responsibility and Power. Span of Management, Delegation and decentralization of authority,

1.2 Safety, Health and Environment Management (SHE). Occupational Safety, Health and Environmental Safety Management – Principles & practices. Role of Management in Industrial Safety, Employees participation in safety.

### **UNIT 2:-**

Planning for Safety: Planning: Definition, purpose, nature, scope and procedure. Range of planning, variety of plans. Strategic planning and tools of implementation. Management by objectives and its role in SHE. Policy formulation and implementation.

### **UNIT: 3**

Education and training: SHE: Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies, types of training. Evaluation and review of training programs. Communications and types

### **UNIT 4:-**

Competence Building Technique (CBT), Concept for training, safety as an on-line function. Role of Multi-Media, Communication, Applications of Computers. Relevance of WTO regarding SHE. Role of trade union in SHE. Safety Promotion and Safety Awards and suggestion Schemes, Safety Competitions, Safety Incentives Publicity Schemes, Audio Visual publicity, other Promotional Methods.

## **UNIT 5:-**

Human factor: Human factors contributing to accidents. Human behavior : Individual differences, behavior as function of self and situation, perception of danger and acceptance of risk, knowledge, and responsibility *vis-a-vis* safety performance, theories of motivation and their application to safety, role of, supervisors and safety departments in motivation. Conflicts & frustration:

### **PRACTICALS**

1. Monitoring of
  - a) Air quality
  - b) water quality and
  - c) Soil quality parameters.
2. Visit to a health center in a industry to understand the monitoring of health quality of work force
3. Visit to understand Institutional arrangements and functioning of SHE in industry.
4. Visit to understand functioning of safety aspects in an organization.

### **LEARNING OUTCOMES (LOS)**

1. Students will be able to gain a comprehensive knowledge at the introductory level, in the area of Safety, Health and Environment
2. Students will be able to Identify and apply safety policy in an industry and List out the duties and implement Safety Targets, Objectives, Standards, Practices and Performances.
3. Students will be able to understand the role of occupational health, safety and environment in the workplace in the prevention of incidents, injury and illness
4. Students will have knowledge about Hazard assessment studies and ways to handle hazard situations in industry acting as Environment and Safety officers
5. Students will be able to create a job safety analysis by applying the concepts of workplace injury prevention, hazard and risk management

### **Text Books:**

1. Industrial Safety, Health Environment and Security, 2013, Basavadeva Panda, Paperback –Rs. 233/-
2. Environmental and Health and Safety Management, 1995, **Nicholas P. Cheremisinoff, Madelyn L. Graffia**, 1<sup>st</sup> Edition, © William Andrew.
3. Principles of Environmental, Health and Safety Management, [Gordon West](#) and Ronald Michaud, ISBN-13: 978-0865874787, ISBN-10: 0865874786
4. Safety, Health And Environment Handbook, K T Narayanan, 2015, ISBN: 9781259058752 Rs. 949-50