

# **INTERNATIONAL COLLEGE FOR GIRLS (AUTONOMOUS)**

## **DEPARTMENT OF ENVIRONMENTAL SCIENCE**

**M.Sc.Part - 1**

### **FIRST SEMESTER**

#### **THEORY PAPERS**

- **Env-121:** Introduction to Environmental Sciences.
  - **Env-122:** Environmental Ecology
  - **Env-123:** Environmental Pollution
  - **Env-124:** Environmental Geosciences and Restoration Ecology
  - **Env-125:** PRACTICALS
  - **Env-126:** SEMINAR
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### **SECOND SEMESTER**

#### **THEORY PAPERS**

- **Env-221:** Environmental Waste Management
  - **Env-222:** Natural Resource Conservation
  - **Env-223:** Biodiversity and Wildlife
  - **Env-224:** Environmental Protection, Legislation and Education
  - **Env-225:** PRACTICALS
  - **Env-226:** SEMINAR
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**M.Sc Part – 2**

### **THIRD SEMESTER**

#### **THEORY PAPERS**

- **Env-321:** Environmental Toxicology
  - **Env-322:** Environmental Microbiology and Biotechnology
  - **Env-323:** Research Methodology, Systems Analysis and Ecomodelling
  - **Env-324:** Project preparation
  - **Env-325:** PRACTICALS
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### **FOURTH SEMESTER**

#### **THEORY PAPERS**

- **Env-421:** Environmental Impact Assessment
- **Env-422:** Pollution Monitoring and Control
- **Env-423:** Remote Sensing
- **Env-424:** Project (Submission)
- **Env-425:** PRACTICALS

# **FIRST SEMESTER**

## **M.Sc. ENVIRONMENTAL SCIENCE**

### **PAPER-I : INTRODUCTION TO ENVIRONMENTAL SCIENCE**

**PAPER CODE: ENV – 121**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**Objective of the paper:** To acquaint students with the subject and to make them learn the fundamentals of ecology and environmental science.

#### **UNIT 1: Introduction 12**

Definition, history, importance and scope of environmental science; Origin of life; Classification of living things (Five kingdom scheme); Gaia hypothesis; Multidisciplinary nature of Environmental Science and its interrelationship with other Sciences and society( with reference to Indian culture)

#### **UNIT 2: Terminology 12**

Species, population, community, ecosystem, Biosphere (Ecosphere), Biome, Ecad, Ecotype, Factor, Flora, Fauna, Standing crop, Biomass, Ecotone, Biological spectrum, Autecology, Synecology, Ecological amplitude, Sympatry, Allopatry, Niche, Palaeoecology, Exobiology, Micro and macroevolution, Coevolution, Microcosm.

#### **UNIT 3: Ecosystem Dynamics 14**

Types of ecosystems; Concept of ecosystems-structure and function; fundamental concepts related to energy; the energy environment; energy flow in ecosystems; energy flow models; First and Second law of thermodynamics; Food-chains and food webs; feedback and control; Homeostasis of the Ecosystem; Ecological pyramids

#### **UNIT 4: Principles Pertaining to Limiting Factors 16**

Liebig's Law of minimum, Shelford's law of tolerance, Combined concept of limiting factors, conditions of existence as regulatory factors, Brief review of factors of importance as limiting factors; Ecological indicators

## **UNIT 5: Nutrient Cycling**

**16**

Biogeochemical cycles: Patterns and basic types of cycles- hydrological, carbon, oxygen, nitrogen, phosphorus and sulphur; role of microbes in biogeochemical regulation.

### **SUGGESTED READINGS:**

- **Agrawal, K.C.: Fundamentals of Environmental Biology, 2001, Bikaner (India): Nidhi Publishers**
- **Odum E.P.: Fundamentals of Ecology, 1996, Dehradun: Natraj Publishers**
- **Chapman, J.L. & Reiss, M.J.: Ecology: Principles and Applications, 1995, Cambridge University Press**
- **Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai,**
- **Kemp: The Environment Dictionary**
- **Sharma, P.D. : Ecology and Environment, 1996, Meerut : Rastogi Publications**
- **Concepts of Ecology: Kormondy**

## **PAPER-II: ENVIRONMENTAL ECOLOGY**

**PAPER CODE: ENV – 122**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**Objective of the paper:** To understand the structure, function, and integration of the Ecosystem and its inhabitants and its four major spheres: land, water, living things, and air. To illustrate the interdisciplinary nature and complexity of environmental problems in our local communities

### **UNIT 1: Community Ecology 14**

The Biotic Community Concept; Composition and diversity Characteristics of a community; Concept of Ecological Dominance; Ecotones and Edge Effect; Paleoecology: Productivity: concept and its measurement, Habitat and Ecological Niche

### **UNIT 2: Habitat Ecology 15**

Biomes; freshwater, marine, estuarine, wetland, forest, desert and grassland ecosystems with special reference to their structure and functions; Rangelands and Wastelands.

### **UNIT 3: Population Ecology 15**

Population Structure-Aggregation and Allee's Principle, Territoriality and Isolation, Dominance and Hierarchy; Population Characteristics-density, natality, mortality, age distribution, biotic potential, fluctuations, dispersal and growth rate; k and r selections, environmental resistance, Lotka Volterra Model; Regulatory factors of population growth-density dependent and independent factors, growth curves.

### **UNIT 4: Species interactions 14**

Interactions amongst populations: intra- and interspecific interactions; Negative interactions: Predation, parasitism and antibiosis; Positive interactions: Commensalism, cooperation and mutualism.

## **UNIT 5: Ecological Succession**

**12**

Causes and trends of succession; basic types of succession; general process of succession; Hydrosere, Lithosere and Xerosere; Concept of the climax.

### **SUGGESTED READINGS:**

- **Chapman, J.L. & Reiss, M.J.: Ecology: Principles and Applications, 1995, Cambridge University Press**
- **Sharma, P.D. : Ecology and Environment, 1996, Meerut : Rastogi Publications**
- **Concepts of Ecology Kormondy**
- **Cunningham, W.P. & Saigo, B.W.: Environmental Science, 1999, Mc- Graw Hill Book Company**
- **Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science**
- **Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)**
- **Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA,**

**PAPER-III : ENVIRONMENTAL POLLUTION**  
**PAPER CODE: ENV – 123**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**Objective of the paper:** To make students aware of the deteriorating conditions of the environment due to anthropogenic interference.

**UNIT 1: Air Pollution** **16**

Atmospheric composition and stratification; history and episodes of air pollution, air quality standards, sources of pollution, nature, effects and classification of air pollutants, meteorological parameters, plume behavior. Photochemical reactions in the atmosphere. Causes and effects of acid rain, global warming, and ozone depletion.

**UNIT 2: Water Pollution** **14**

Water quality standards. Types, sources and effects of water pollution; water borne diseases; Marine Pollution: causes and impacts; Water quality parameters- chemical, physical and biological; Ganga Action Plan.

**UNIT 3: Soil Pollution** **12**

Chemical nature and composition of soil; Types and sources of soil pollution; Soil pollution control; Land degradation with special reference to soil erosion.

**UNIT 4: Noise Pollution** **14**

Basic concept and definition; sources of noise pollution; noise exposure levels and standards, impacts of noise on human health. Control of noise pollution.

**UNIT 5: Radioactive and Thermal Pollution** **14**

Radioactive Pollution: sources, types and effects of radiation; management and disposal of radioactive waste; control of radioactive pollution. Thermal Pollution: sources and effects.

**SUGGESTED READINGS:**

- Clark R.S., Marine Pollution, Clarendon Press Oxford (TB)
- Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p
- Gleick, H.P. 1993. Water in Crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press.
- Survey of the Environment, The Hindu (M)
- Trivedi R. K. and P.K. Goel, Introduction to air pollution, Jaipur:Techno-Science Publication
- Agarwal, S.K.: Pollution Management: Volume I-V, Delhi: A.P. H. Publishing Corporation
- Rowe, P.V., Introduction to Environmental Pollution.

**PAPER –IV : ENVIRONMENTAL GEOSCIENCES AND RESTORATION  
ECOLOGY  
PAPER CODE: ENV – 124**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**Objective of the paper:** This paper aims at making the students aware of the degradation of the earth and methods of its restoration

**UNIT 1: Geosciences and Earth Systems 15**

Environmental Geosciences- fundamental concept; earth system and biosphere. Interrelationship of various earth systems-geosphere, hydrosphere, atmosphere and biosphere; climate of India, Indian monsoon, *El nino*, Drought, Tropical cyclones and western disturbances.

**UNIT 2: Earth Process and Geological Hazards 14**

Earth Processes: Cycle in the earth system; Catastrophic Geological Hazards: Floods, landslides, earthquakes, volcanoes and avalanche; concept of disaster management.

**UNIT 3: Environmental Hydrology 14**

Hydrological cycle including surface and ground water; water balance, porosity, permeability, run-off processes, global water balance, marine resources, water crises and its conservation.

**UNIT 4: Mineral Resources and Mine land Reclamation 15**

Mineral Resources- Distribution in India with special reference to Rajasthan ;Environmental impact of exploitation of minerals and mining activities with reference to Rajasthan.Types of mine reclamation practices; Revegetation of mine spoils through plant fertilization and related practices.

**UNIT 5: Restoration Ecology 12**

Natural, restoring keystone species and ecological process, mitigation and replacement, creating an artificial ecosystem.

### **SUGGESTED READINGS:**

- **Cunningham, W.P.& Saigo, B.W.: Environmental Science, 1999, Mc- Graw Hill Book Company**
- **Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai**
- **De A.K., Environmental Chemistry, Wiley Eastern Ltd.**
- **Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut**
- **Sand, P. (1994) Trust For Earth, University of Hull, Cottingham.**
- **Our Common Future, Report of the OECD (1987) Oxford University Press.**
- **Smith, Keith (1996) Environmental Hazards- Assessing risk and reducing disaster, 2<sup>nd</sup> Edition, London & New York.**
- **Valdiya, K.S. (2004) Copying with Natural Hazards: Indian Context. New Delhi: Orient Longman.**
- **Rajan, Mukund Govind (1997) Global Environmental Politics: India and the North-South Politics of Global Environmental Issues, New Delhi:**
- **Rao, P.K. (2000) Sustainable Development, Massachusetts: Blackwell Publishers.**
  
- **Saxena H.M., Environmental Geography, 2004, Rawat Publications**



**PAPER –V: PRACTICALS**  
**PAPER CODE: ENV – 125**

**Credits: 8**

**Contact hours/semester: 190**

**Contact hours/week: 16**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**COMPUTER ORIENTATION**

Introduction to Computers

MS Word

MS Excel

Power Point Presentation

Internet

**ACQUAINTANCE WITH LABORATORY EQUIPMENTS AND PREPARATION OF A PRACTICAL RECORD**

pH Meter

Flame photometer

Spectrophotometer

Eckman's Dredge

Secchi Disc

Bamboo Float

BOD Incubator

**WATER ANALYSIS**

Quantitative Estimation of the following parameters in the given water sample:

- **Acidity**
- **Alkalinity**
- **B.O.D**
- **Conductivity**
- **Chlorine (Residual)**
- **Chloride**
- **Dissolved Oxygen**
- **Hardness (Total, Ca and Mg)**
- **Total Solids**
- **Total Suspended Solids**
- **Total Dissolved Solids**
- **Transparency**
- **pH**
- **Free Carbon Dioxide**
- **Oil and Grease**
- **Nitrate**
- **Phosphate**
- **Fluoride**

### **Field work and Report submission**

- Visit to a local area to document environmental assets: river/ forest/grassland/hill/mountain
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
- Study of simple ecosystems-pond, river, hill slopes, etc.

### **Green File Preparation**

PREPARATION OF A GREEN FILE/SCRAP BOOK COMPRISING OF ARTICLES/PHOTOGRAPHS/STORIES ON LATEST ENVIRONMENTAL ISSUES.

### **LABORATORY MANUALS:**

- **S.K. Maiti: Hand book of methods in environmental studies, Vol I and II, Jaipur:ABD publisher, Jaipur**
- **Shubhi Lall: Elementary Computer Applications : National publishers, New Delhi**
- **Handbook of standard methods for waste water analysis-APHA**

**PAPER –VI : SEMINAR**  
**PAPER CODE: ENV – 126**

**Credits:2**

**Contact hours/semester: 30**

**Contact hours/week: 2**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**SEMINAR:**

Each student will have to present a seminar within the specified period on the topic given to her. She will be guided by any one of the faculty members for the same. The topic allotted will be related to the current issues in the subject

## SECOND SEMESTER

### PAPER-I :ENVIRONMENTAL WASTE MANAGEMENT PAPER CODE: ENV – 221

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**Objective of the paper:** To help elucidate the role and responsibility of citizens in helping to achieve environmental quality by managing the waste generated.

**UNIT 1:Evolution and Introduction to Solid Waste Management 12**  
Definition, Historical Development, Functional Elements, Characteristics and Solid Waste Management Systems.

**UNIT 2: Sources and Handling of Solid Waste Management 14**  
Generation, sources and types of solid wastes, composition of municipal solid wastes, onsite handling, onsite storage and onsite processing of solid wastes, collection system and transport means and methods.

**UNIT 3: Solid Waste Management 16**  
Processing of solid wastes (Mechanical and chemical volume reduction), source reduction, recycling, recovery and disposal of solid wastes, landfilling (design criteria for sanitary landfilling, problems of landfilling, leachate)

**UNIT 4: E-Wastes, Biomedical Wastes and Hazardous Wastes 14**  
E-Wastes, Hazardous Wastes ( classification, generation, source, storage, collection and disposal ); Concept of LCA ( Life Cycle Assessment)

**UNIT 5: Legislative Approach For Waste Management 14**  
Hazardous Waste Management and handling rules 1989, Scheme of labeling of environmental friendly products (eco marks), Municipal Solid waste rules.

#### **SUGGESTED READINGS:**

- **Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p**
- **Survey of the Environment, The Hindu**
- **Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill**

- **Down to Earth, Centre for Science and Environment**
- **Mckinney, M.L. & School, R.M. Environmental Science Systems & Solutions,1996.**
- **Wanger K.D., Environmental Management. 1998 W.B. Saunders Co. Philadelphia**
- **Radhakrishnan, R., Biomedical Waste Management,2006, New Delhi: Sumit Enterprises**
- **Study Material(Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment**
- **Mhaskar A.K., Matter Hazardous, Techno-Science Publication**
- **Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA**

**PAPER –II :NATURAL RESOURCE CONSERVATION**  
**PAPER CODE: ENV – 222**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**Objective of the paper:** The course lays emphasis on equitable and efficient distribution of natural resources and its management for sustainable development

**UNIT 1: Introduction to Natural Resources** **16**

Definition, classification & types, a brief history of the Resource Conservation, Representation of the resources on India's & world's maps; Natural Resources, Conservation and Sustainable Development.

**UNIT 2: India's Natural Resources** **14**

India- General information, Climate; Physiogeography of India, Population of India; Vegetation of India; Birds, Animals and Fisheries of India; Food resources of India; Water Resources of India; Water conservation with special reference to Rajasthan.

**UNIT 3: Earth Resources** **14**

Resources and reserves; Minerals and population; Oceans as new areas for exploration of mineral resources; Ocean ores and recycling of resources; Environmental impact of exploitation, processing and smelting of minerals; Types and distribution of metals.

**UNIT 4: Land Resources** **12**

Soil profile and classification; Soil erosion and degradation; Soil conservation; Forest resources of India; Causes of forest degradation; Forest conservation measures; Deforestation; Types and classification of Deserts, Desertification with special reference to the Thar Desert.

**UNIT 5: Energy Resources** **14**

Sun as a source of energy; Energy resources and their exploitation; Conventional energy resources: fossil fuels-coal, oil and natural gas; and Non-conventional energy resources; Hydroelectric power, Ocean thermal energy conversion, wind, tidal, geothermal energy, biomass, solar energy and nuclear energy; energy use patterns in different parts of the world and its impact on the environment.

## SUGGESTED READINGS:

- Ahmaob, I, and Deloman, J. (1995) **Beyond Rio**, MacMillan.
- **Our Common Future**, Report of the OECD (1987) Oxford University Press.
- Khanna, Gopesh Nath (1990) **Environment Problems and the United Nations**, Ashish Publishing House, New Delhi.
- Agarwal, Anil, Narain, Sunita and Sharma, Anju (Eds.) (1999) **Global Environmental Negotiations I: Green Politics**, Centre for Science and Environment, New Delhi.
- Field, B. (199ss **Encyclopaedia of Environment: Environmental Problems and Policies Vol. I & II**, 2005, New Delhi: Anmol Publications
- Owen, S., **Natural Resources Conservation]**
- Study Material(Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment

## Internet Sites

- wwfindia.org
- [www.biodiv.org](http://www.biodiv.org)
- <http://en.wikipedia.org>
- <http://nbpgr.delhi.nic.in>
- envfor.nic.in/nef/mef.html.
- <http://www.unep.ch/conventions/geclist.htm>
- <http://www.epw.org.in>
- <http://www.cities.org/eng/disc/what.shtm>

**PAPER-III : BIODIVERSITY AND WILDLIFE**  
**PAPER CODE: ENV – 223**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**Objective of the paper:** The course lays emphasis on importance and conservation of biodiversity which will lead to sustain life on earth.

**UNIT 1: Introduction to Biodiversity** **14**

Definition and concept of Biodiversity; Types of Biodiversity; Importance of Biodiversity-Ethical and aesthetic values, Economic values; Hotspots of Biodiversity; Common flora and fauna of India and Rajasthan; Endemic species, Endangered and threatened species of India and Rajasthan.

**UNIT 2: Biodiversity Conservation** **14**

Causes of loss of Biodiversity; Extinction, Conservation methods and strategies-*in situ* (National parks, Sanctuaries, Biosphere reserves, sacred groves, etc) and *ex situ* (Botanical gardens, Zoos, Gene banks, live museums) methods; Role of biotechnology in biodiversity conservation; Agenda 21

**UNIT 3: Introduction to Wildlife** **14**

Wildlife resources, Wildlife habitat, Home range, territory; Types of animal movements; Mortality factors; Wildlife depletion; Methods of population estimations of animals- Census, sampling, indices, transect estimates, aerial survey and mark recapture estimate; Bird counting methods.

**UNIT 4: Wildlife Management in India** **14**

Conservation and management strategy of wildlife, Action plan for conservation and management of wildlife, Restoration of wildlife population-Captive breeding, soft and hard release; important projects for the conservation of wildlife in India-Project Tiger, Operation Rhino, Gir Lion Project; National and International organizations involved in Wildlife protection (WWF, IUCN, BNHS, IBWL); Red Data Book

**UNIT 5: Legal implementation towards Wildlife and Biodiversity** **14**

Wildlife (Protection) Act, 1972; Wildlife (Protection) Amendment Act, 1991; Man and Biosphere programme, Convention on Biological Diversity (CBD), Biodiversity and Patent Law; Biosafety Protocol; Intellectual Property Right (IPR); the TRIP Agreement



## **SUGGESTED READINGS:**

- **Kothari, Asish , Understanding Biodiversity, New Delhi: Orient Longman.**
- **Mathew, Richard A. Environment, Population and Conflict: New Modalities of Threat and Vulnerability in South Asia, Journal of International Affairs, vol.56,No.**
- **UNESCO,2002. Biosphere Reserves: Special places for people and nature.UNESCO, Paris.**
- **UNESCO,2002. Biosphere Reserves: Special places for people and nature.UNESCO, Paris.**
- **Glowka, L. et.al., (1994) A Guide to the Convention on Biological Diversity, IUCN Gland and Cambridge.**
- **Wcmc (1992) Global Biodiversity. Status of the earth's Living Resources.**
- **National Biodiversity Plan and Strategy of India, Draft of (2002).**
- **IUCN (1999) Resource Material on Biodiversity for General Certificate of Education.**
- **Agarwal, Anil, Narain, Sunita and Sharma, Anju (Eds.) (1999) Global Environmental Negotiations I: Green Politics, Centre for Science and Environment, New Delhi.**
- **Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad**
- **Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)**
- **Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press**
- **Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub.**
- **Hossetti, B.B.:Wildlife management in India**
- **Study Material(Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment**

## **Internet Sites**

- [wwfindia.org](http://wwfindia.org)
- [www.biodiv.org](http://www.biodiv.org)
- <http://en.wikipedia.org>
- <http://nbpgr.delhi.nic.in>
- [envfor.nic.in/nef/mef.html](http://envfor.nic.in/nef/mef.html).
- <http://www.unep.ch/conventions/geclist.htm>
- <http://www.epw.org.in>
- <http://www.cities.org/eng/disc/what.shtm>

**PAPER-VI : ENVIRONMENTAL PROTECTION, LEGISLATION AND EDUCATION**  
**PAPER CODE: ENV – 224**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**UNIT 1: Environmental Protection 14**

Introduction; a disheartening trend; issues and problems; International and National efforts for Environmental protection; Response to Environmental challenges, National Environmental Advisory Committee (NEAC); Provision of Constitution of India regarding Environment (Article 48A and 58A)

**UNIT 2: Environmental Legislations 14**

Environmental Policy resolution, legislations, public policy strategies in pollution control, Wildlife Protection Act, 1972 amended 1991; Forest Conservation Act, 1980; Indian Forests Act (revised) 1982; Air (Prevention and Control of Pollution) Act, 1981 as amended by Amendment Act, 1987 and Rule 1982; Motor Vehicle Act, 1988; Water (Prevention and Control of Pollution) Act, 1974 as amended up to 1988 and Rules 1975, the Environment (Protection) Act, 1986 and Rules 1986

**UNIT 3: Environmental Management 14**

Overview of the ISO 14000 family, key aspects of the international standard ISO 14001; Environmental management systems- Benefits, principles and elements of successful environmental management; Comparison between EMAS, BS7750 and ISO 14001; Auditing of EMS, Environmental Labeling, Ecotourism.

**UNIT 4: Environmental Education 14**

Introduction; Goals, objectives and guiding principles; Classification of environmental education programmes; Environmental education in India; Environmental Ethics

**UNIT 5: Environmental Problems 14**

Ecopolitics, Ecotourism, Ecoeconomics, Biopiracy, Ecoterrorism, Dams and Environment

**SUGGESTED READINGS:**

- Arif, N. (1996) *International Environmental Laws*, New Delhi: Lancers Books.
- Birnie, P.W., and Boyle, Alan E. (1994) *International Law and Environment*, Oxford: Clarendon Press.
- Lang, Winfried (Ed.) (1995) *Sustainable Development and International Law*, London: Graham and Tort.

- **Khanna, Gopesh Nath (1990) Environment Problems and the United Nations, Ashish Publishing House, New Delhi.**
- **Agarwal, Anil, Narain, Sunita and Sharma, Anju (Eds.) (1999) Global Environmental Negotiations I: Green Politics, Centre for Science and Environment, New Delhi.**
- **Rajan, Mukund Govind (1997) Global Environmental Politics: India and the North-South Politics of Global Environmental Issues, New Delhi**
- **Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and**
- **Standards, Vol I and II, Enviro Media**
- **Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment**

**PAPER –V : PRACTICALS**  
**PAPER CODE: ENV – 225**

**Credits: 8**

**Contact hours/semester: 190**

**Contact hours/week: 16**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**SOIL ANALYSIS**

- **Acidity**
- **Alkalinity**
- **Electrical Conductivity**
- **Chloride**
- **Nitrate**
- **Phosphate**
- **Organic Carbon**
- **pH**
- **Exchangeable Sodium and Potassium**
- **Exchangeable Calcium and Magnesium**
- **Heavy Metals**
- **Micronutrients**
- **Specific Gravity**
- **True Density and Porosity**
- Identification of **Texture** of the given soil sample of a degraded land.
- Estimation of **Moisture Content** in the given soil sample.
- Determination of **Wilting Point** in the given soil sample.
- Estimation of Water Holding Capacity in the given soil sample
- Measurement of the rate of litter decomposition

**VEGETATION DYNAMICS**

Determination of **Leaf Area Index (LAI)**

Determination of **Chlorophyll Content** of given material for polluted and non-polluted area.

Estimation of **Dust Retention Capacity** of the given soil sample.

Study of **Diversity Indices** of plant/organisms.

Least Size of Quadrant for community study.

Determination of Frequency, Density and Abundance of various plant species in a community.

Determination of IVI of various plant species.

Study of population age structure and growth.

## **EXERCISES ON WILDLIFE**

Identification of Mammalian species by Hair Imprinting Method

Wildlife Census Methods

## **PREPARATION OF A RECORD COMPRISING OF THE FOLLOWING TOPICS**

Mineral resources in India

Islands of India

Major Soil types of India

Deserts of India

Deserts of the World

Forests of India

Major Biomes of the World

Hotspots of Biodiversity in the World

Protected Areas of India

Vanishing Wildlife of the World

Important Indian Institutes of Environmental Education

Important Environmental Organisations (National and International)

## **VISIT**

In this semester it is compulsory for each student to visit a National Park/ Sanctuary/Research organization and prepare a report of the same.

## **LABORATORY MANUALS:**

**S.K. Maiti: Hand book of methods in environmental studies, Vol I and II, Jaipur:ABD publisher, Jaipur**

**PAPER-VI : SEMINAR**  
**PAPER CODE: ENV – 226**

**Credits:2**

**Contact hours/semester: 30**

**Contact hours/week: 2**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**Seminar :**

Each student will have to present a seminar within the specified period on the topic given to her. She will be guided by any one of the faculty members for the same. The topic allotted will be related to the current issues in the subject.

## **THIRD SEMESTER**

### **PAPER-I : ENVIRONMENTAL TOXICOLOGY**

**PAPER CODE: ENV -321**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

#### **UNIT 1: Fundamentals of Ecotoxicology 14**

Introduction, history and scope of toxicology, Principles of Ecotoxicology, Basic divisions of toxicology, Goals of toxicology, Terrestrial and Aquatic Ecotoxicology, Acute and Chronic Toxicity Testing.

#### **UNIT 2: Dose and toxicity 15**

Determinants of dose, Dose Response Relationship; Toxicants and toxicity; Factors that affect environmental concentration of toxicants, Factors influencing toxicity, Selective Toxicity, Species differences and individual differences.

#### **UNIT 3: Toxicants of Public Health Hazards 15**

Basic classification of Toxicants including Agrochemicals, pesticides, Solvents, Metals, Radioactive chemicals; Absorption, Translocation, Biotransformation and Excretion of Xenobiotics ( including Phase I and Phase II reactions).

#### **UNIT 4: Occupational Health 16**

Introduction; Occupational Hazards, Occupational Exposure: Limits and routes of exposure Occupational diseases: pneumoconiosis- Silicosis, Anthracosis, Byssinosis, Bagassosis, Asbestosis, Farmers' Lung; Lead Poisoning; Occupational Cancers; Occupational Dermatitis; Radiation Hazards

#### **UNIT 5: Biomonitoring of Toxic Chemicals 15**

Bioaccumulation; Biomagnification; Biomonitoring; Parameters of Biomonitoring; Bioindicators and environmental monitoring, bioassay and its applications in Toxicology; Specific responses of toxicity: Mutagenicity, Carcinogenicity and Teratogenicity and their assessment; Wildlife Toxicology.

### **SUGGESTED READINGS:**

- **Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p**
- **De A.K., Environmental Chemistry, Wiley Eastern Ltd.**
- **Casserett and Doull's Toxicology: The basic source of Poisons. (VI Edition)**
- **Gleick, H.P. 1993. Water in Crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press.**
- **Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment**
- **Smith, Keith (1996) Environmental Hazards- Assessing risk and reducing disaster, 2<sup>nd</sup> Edition, London & New York.**
- **Wisnr B., Adams, J. (Ed.) (2002) WHOEnvironmental Health in Emergencies and Disaster- A practical guide, World Health Organisations.**
- **Conner, David (1994) Managing the environment with rapid Industrialisation- Lessons from the East Asian Experience, OECD, Paris.**
- **Khanna, Gopesh Nath (1990) Environment Problems and the United Nations, Ashish Publishing House, New Delhi.**
- **Sharma P.D., Ecotoxicology and Health, Meerut: Rastogi Publications**
- **Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment**



**PAPER II: ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY**  
**PAPER CODE: ENV 322**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**UNIT 1: General Microbiology 14**

Three domain classification; Introduction to Microbial diversity, distribution and ecology; Oxygenic photosynthetic and anoxygenic photosynthetic microbes; Oxidative transformation of metals; Oxidation of S, H and ammonia; Unculturable and culturable bacteria; conventional and molecular methods of studying microbial diversity

**UNIT2: Microbial Diversity 15**

Microbial diversity in anoxic ecosystem- methanogens, reduction of iron, S, Mn, nitrate and oxygen; Extremophiles- acidophiles, alkalophiles, thermophiles and oxmophiles; Types of microbial population in soil; Mycorrhiza- Host fungus interactions and specificity; role of microbes in N, P and C cycles; Symbiotic and non-symbiotic nitrogen fixation.

**UNIT3: Microbial Degradation of Environmental pollutants 15**

Degradation of lignocellulose compounds: Structure of lignocellulose, degradation of cellulose, cellulase, xylanases, and ligninases. Degradation of xenobiotic compounds: organic pollutants, persistent compounds. Bioleaching: microorganisms used, biochemistry, extraction from mixture. Types of bioleaching, methods of bioleaching.

**UNIT 4: Environmental Biotechnology 16**

Bioremediation: Microorganisms involved, technologies measuring bioremediation in fields and monitoring of efficiency of bioremediation.

Biomethanation: Anaerobic treatment for biogas generation. Microbiology and biochemistry. Factors affecting biogas production. Design of digesters. Kinetics of anaerobic fermentation. Use of spent slurry. Composting: Types, material, process, physicochemical characteristics of environment, decomposition stages, methods, vermicomposting.

**UNIT 5: Biotechnological and Resource conservation 15**

Biotechnology in biodiversity conservation: Biotechnological processes for bioresource assessment, biotechnology in ex-situ conservation of biodiversity, Biotechnology and its role in utilization of biodiversity. Bioreactors: Modeling of activated sludge process, biogas reactors, solid waste bioreactors, biofilms. Biopesticides and integrated pest management: pest control, the pest, genesis of IPM concept, biopesticides in IPM

## **SUGGESTED READINGS:**

- **Stanier ,General Microbiology**
- **Verma, Environmental Biology**
- **Glick ,Molecular, Biotechnology : Principles and Applications of Recombinant DNA**
  
- **Maier, Raina. M, Environmental Microbiology Maier, Raina. M**
- **Nester, Microbiology: A Human Perspective**
- **Pelzer, Microbiology**
- **Atlas, Ronald M. Microbial Ecology:Fundamental and Applications**
- **Allsopp,Dennis Introduction to Biodeterioration**
- **Borem,Aluizio Understanding Biotechnology**
- **Chatterji, A.K Introduction to Environmental Biotechnology**
- **Indu S. Thakur, Environmental Biotechnology: Basic concept and Applications. I.K. international Pvt. Ltd.**
- **Kurt Konhauser, Introduction to Geomicrobiolog. Blackwell Publication USA.**
- **P.K. Mohapatra, Text book of Environmental Biotechnology.I.K. International pvt. Ltd.**

**PAPER-III: RESEARCH METHODOLOGY, ECOMODELLING AND BIOMETRICS**  
**PAPER CODE: ENV –323**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**UNIT 1: Environmental Research 14**

Environmental Research- an example, methodology and Data collection, Sampling techniques of field questionnaire, sampling techniques of field questionnaire, secondary data, methodology and content of the field survey; Social research- Concept, objective and scope, Types of research, research approaches, sources of data (documentary and field sources), Utility of social research, Qualities of a good research worker (general and specific), Criteria of good research, Problems encountered by researchers in India.

**UNIT 2: Methods of Data Collection 12**

Schedule, Purpose of schedule, essentials of a good schedule, Procedure of forming a good schedule; Questionnaire, Types of questions; Interviews, types and technique of interviews; Observation, Types, limitations and importance of Observation.

**UNIT 3: Systems analysis and Ecomodelling 16**

Complexity of systems, objective of system ecology, Mathematical models, basic tools in model building, analysis of model properties-unstable and damped oscillations; Ecosystem analysis, analysis of system processes and conditions; model for steady state condition; Modelling for eutrophic assessment of water bodies-Box model, Compartmental model for dry matter dynamics and nutrient flow in Forest ecosystem, Residence time, Microcosm model, Concentration factor, Bioaccumulation and microcosm.

**UNIT 4: Biometrics 14**

Basic elements and tools of statistical analysis, sampling, measurement of distribution of attributes; Distribution- normal, Poisson and binomial.

**UNIT 5: Statistical Analysis 14**

Student's t test and Chi square test; Arithmetic, geometric and harmonic means; Standard deviation; Regression and Correlation; Analysis of Variance(ANOVA).

**SUGGESTED READINGS:**

- **Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment**
- **Gupta ,S.P., Fundamentals of Statistical Methods**
- **Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.**

**PAPER-IV: PROJECT PREPARATION**

**PAPER CODE: ENV –324**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

Each student is required to undergo a specialized training before the commencement of the third semester. Thereafter she has to prepare an extensive report under the guidance of any one of the faculty members. The training shall last for a period of 30-45 days in a recognized institute/ a well-reputed industry/ any renowned environmental laboratory/ NGO. At the end of the third semester each student shall have to write a Research paper on the topic covered in the training and thereafter present it as a part of Semester end evaluation.

**PAPER –V : PRACTICALS**  
**PAPER CODE: ENV – 325**

**Credits: 8**

**Contact hours/semester: 190**

**Contact hours/week: 16**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**BIOLOGICAL MONITORING OF DIFFERENT WATER SAMPLES**

Macrophytes

Phytoplankton, Zooplankton

Diversity indices-Shannon Index

**MICROBIOLOGICAL ANALYSIS**

Multiple fermentation technique- MPN index for polluted and non polluted waters

IMVIC tests

Heterotrophic plate count

Study of soil microorganism

**BIOTECHNOLOGY**

TLC

Gel Electrophoresis

**STATISTICS**

Calculation of standard deviation, correlation, regression

Calculation of analysis of variance ANOVA

**LABORATORY READINGS:**

- **Adams,Dany Spencer,Lab Math:A Handbook of Measurements, Calculations and Other Quantitative Skills for Use at the Bench**
- **Laboratory Manual in General MicrobiologyKannan, N**

# FOURTH SEMESTER

## PAPER-I : ENVIRONMENTAL IMPACT ASSESSMENTS AND SUSTAINABLE DEVELOPMENT PAPER CODE: ENV -421

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

### **UNIT 1: Introductory Background of EIA** **12**

Definition of EIA, its objectives and principles (basic principles and operating process)  
Relationship of EIA to sustainable development; benefits of EIA; EIA Notification 2006

### **UNIT 2: Process and Methods Used in EIA** **16**

EIA in project planning and implementation; procedure of EIA- screening, scoping, description of project, Collection of baseline information, impact identification, prediction and evaluation, post project monitoring. Methods used in EIA; Checklists, matrices, networks, adhoc, overlays, etc. and geographical information system; advantages and disadvantages of methods. Environment management Plan.

### **UNIT 3: Preparation of EIA Reports** **14**

Methods and procedures of EIA report (EIS) preparation; Environmental management plan, EIS methods and efforts of participation and consultation, mitigation criteria, project modification;.

### **UNIT 4: Prediction and assessment of Impacts** **14**

Prediction and assessment of impacts on the air environment, surface-water environment, soil and ground water environment, noise environment, biological environment; Cultural (Architectural, Historical and Archeological) prediction and assessment of impacts on socio-economic environment.

### **UNIT 5: Environmental Auditing and Sectoral Experience, EMS And ISO** **14**

Origin, definition, functions, benefits and costs of Environmental Auditing, Auditing stages (process), report structure, setting up Environmental Audits. EIA of Energy Projects, Mining Projects, Cement, and Oil Industry; Road and Rail infrastructure.

## **SUGGESTED READINGS:**

- **Lang, Winfried (Ed.) (1995) Sustainable Development and International Law, London: Graham and Tort.**
- **Mahhub ul Haq (2002) Human Development Centre, Human Development in South Asia, Oxford University Press.**
- **Smith, Keith (1996) Environmental Hazards- Assessing risk and reducing disaster, 2<sup>nd</sup> Edition, London & New York.**
- **Study Material(Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment**
- **Rao, P.K. (2000) Sustainable Development, Massachusetts: Blackwell Publishers**
- **Warthen, Peter, Introduction to Environmental Impact Assessment**
- **Canter,L.W., Environmental Impact Assessment**
- **Khan, T.I., Environmental Impact Assessment**
- **Study Material(Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment**

**PAPER-II : POLLUTION MONITORING AND CONTROL**  
**PAPER CODE: ENV – 422**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**UNIT 1: Air Pollution Monitoring 20**

Introduction; Classification of sampling methods; difficulties encountered in sampling; Instruments for sampling waste gases and for atmospheric sampling; Duration of sampling period; Location of sampling sites; Sampling of particulates (suspended and respirable) by High Volume Sampler/ Respirable dust sampler; Stack sampling Techniques; Planning the study; Selection of sampling location; Representative sample; Size of sampling point; Traverse points; Isokinetic conditions; Determination of gas composition; Determination of moisture content; Determination of temperature and velocity; Gaseous sampling; Methods for collection of gaseous samples; Expression and interpretation of results.

**UNIT 2: Air Pollution Control 20**

Introduction; Air pollution control from stationary sources; control of air pollution by equipments (Settling chambers, Separators, Cyclones, Filters, Electrostatic precipitators, and Scrubbers), Control of gaseous Contaminants (Absorption, Adsorption, Combustion, Closed Collection and recovery systems, Masking and Counteracting), Control of the Source; Preventive Techniques (Shift of the sources, Substitution of raw material and fuels, process modification, alteration of equipments good operating practices.

**UNIT 3: Water Pollution Monitoring and Control 15**

Sources and nature of industrial effluents, Principles of industrial waste treatment. Primary, secondary and tertiary treatment; Fundamentals of biological treatment; Criteria for application of aerobic and anaerobic Biological treatments; Monitoring of the efficiency of the biological treatment plant; Types of biological treatment: Aerobic and anaerobic treatment ; Role of microbes in sludge digestion and disposal.

**UNIT 4: Soil Sampling and Analysis 10**

Methods of Soil Sampling; Soil microbes and their functions, degradation of different insecticides, fungicides and weedicides in soil and their effects on soil components; different kinds of synthetic fertilizers and their interaction with different components of soil.



## **UNIT 5: Noise Pollution Monitoring and Control**

**10**

Measurement of Noise level; Noise levels in different cities of the world; Prevention and control of Noise Pollution; Industrial and community noise control; Noise Pollution Analyser; Sound absorption coefficient (ast), sound absorbing materials, reverbration time; Acoustic silencers, mufflers, barriers, vibration and impact isolation.

### **SUGGESTED READINGS:**

- **Agarwal, S.K., Environmental Biotechnology**
- **De A.K., Environmental Chemistry, Wiley Eastern Ltd.**
- **Rao M N. & Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd.**
- **Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publishers, Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut Publication**
- **Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment**

**PAPER-III : REMOTE SENSING**  
**PAPER CODE: ENV – 423**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**UNIT 1: BASICS OF AERIAL PHOTOINTERPRETATION 15**

Development of aerial photography, fundamental principles of aerial photography, types of aerial photographs, types of films, factors affecting photo-images, stereoscopic vision and its conditions, different viewing instruments, geometry of aerial photographs, relief displacement and tilt distortions, scale of aerial photographs, vertical exaggeration, flight planning, photomosaics and its significance

**UNIT 2: PRINCIPLES OF REMOTE SENSING 15**

Development of remote sensing, fundamental principles of remote sensing- electromagnetic radiation, EM spectrum, atmospheric windows, interaction with earth materials, remote sensing platforms- sensors, Landsat, SPOT, Sea-Sat, ERS, IRS, Space-shuttle, meteorological and communication satellites

**UNIT 3: INTERPRETATION OF DATA PRODUCTS 15**

Data products- Photographic and digital data, False colour composites, elements of interpretation of satellite imagery, spectral signatures, ground truth.

**UNIT 4: APPLICATIONS OF REMOTE SENSING 15**

Water quality and management, pollution monitoring equipment, visual and digital analysis of remotely sensed data, detection of spectral properties of air, land and water Hydrological cycle, aquifers, movement and occurrence of groundwater, evaluation of hydrogeologic parameters, watershed modelling, hydrogeomorphological mapping, visual and digital analysis of remote sensing data for water resources pollution,

**UNIT 5: INTRODUCTION TO DIGITAL IMAGE PROCESSING AND GEOGRAPHICAL INFORMATION SYSTEM (GIS) 15**

Principles of digital image processing, image enhancement, edge enhancement, spatial filtering, density slicing; Introduction to GIS, basic principles of integration of remote sensing and GIS, applications of GIS.

### **SUGGESTED READINGS:**

- **M. Anji Reddy: Textbook of remote sensing and GIS, Hyderabad: B.S. Publications**
- **Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecotourism.**

**PAPER-IV : PROJECT PREPARATION**  
**PAPER CODE: ENV –424**

**Credits: 5**

**Contact hours/semester: 75**

**Contact hours/week: 5**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

A Project Report of the work done in the Third Semester (Env-324) has to be submitted for the partial fulfillment of the award of the Post Graduate Degree in Environmental Science and Technology. The student shall have to give a power point presentation for the work done for semester end evaluation.

**PAPER-V : PRACTICALS**  
**PAPER CODE: ENV – 425**

**Credits: 8**

**Contact hours/semester: 190**

**Contact hours/week: 16**

**Maximum marks: 100 (Continuous Assessment-30 & Semester End Exam-70)**

**REMOTE SENSING**

(I) Interpretation of Satellite imagery for

- Identification of Water Resources
- Urban Planning
- Classification and identification of Vegetation Cover
- Preliminary interpretation of Geology

(II) Study of Geomorphology through imagery

- Drainage analysis
- Identification of Neotectonic faults

(III) Studies of suitable areas for Watershed Management

**EIA EXERCISES**

- Preparation of EIA report according to the given case study
- Prediction of Impacts using Matrix method
- Use of Software designed specifically for EIA.