

**INDIRA GANDHI NATIONAL TRIBAL UNIVERSITY,  
AMARKANTAK (M.P.)**



**SYLLABUS**

**Department of Environmental Science  
Faculty of Science**

**RECOMMENDED COURSE  
FOR  
MASTER OF SCIENCE (M.Sc.) IN ENVIRONMENTAL  
SCIENCE  
(Effective from Session 2024-2025)**

*908* *Nirad* *Sharma*

## **Details of papers under M.Sc. in Environmental Science**

### **2 - Year PG**

#### **Semester 1**

Core paper 1: Basics of Physical Environment & Earth Sciences **Code: EST 101**

Core paper 2: Environmental Ecology **Code: EST 102**

Core paper 3: Remote sensing and Geo-informatics **Code: EST 103**

Core paper 4: Environmental Chemistry and toxicology **Code: EST 104**

Practical 1: Basics of Physical Environment & Earth Sciences & Environmental Ecology **Code: ESP 101**

Practical 2: Remote sensing and Geo-informatics & Environmental Chemistry and toxicology **Code: ESP 102**

#### **Semester 2**

Core paper 5: Environmental biotechnology & bioremediation **Code: EST 201**

Core paper 6: Environmental laws and treaties **Code: EST 202**

Core paper 7: Natural resources & sustainable development **Code: EST 203**

Core paper 8: Environmental impact assessment & environmental management system **Code: EST 204**

Practical 3: Environmental biotechnology & bioremediation & Environmental laws and treaties **Code: ESP 201**

Practical 4: Natural resources & sustainable development & Environmental impact assessment & environmental management system **Code: ESP 202**

#### **Semester 3**

Core paper 9: Environmental pollution and abatement **Code: EST 301**

Core paper 10: Biodiversity, wildlife conservation and management **Code: EST 302**

Core paper 11: Instrumentation and analytical techniques in environmental science **Code: EST 303**

Core paper 12: Environmental statistics and mathematical modelling **Code: EST 304**

Practical 5: Environmental pollution and abatement & Biodiversity, wildlife conservation and management **Code: ESP 301**

Practical 6: Instrumentation and analytical techniques in environmental science & Environmental statistics and mathematical modelling **Code: ESP 302**

#### **Semester 4**

Dissertation/internship & Presentation

### **1 - Year PG**

#### **Semester 1**

Core paper 1: Environmental pollution and abatement **Code: EST 101**

Core paper 2: Biodiversity, wildlife conservation and management **Code: EST 102**

Core paper 3: Instrumentation and analytical techniques in environmental science **Code: EST 103**

Core paper 4: Environmental statistics and mathematical modelling **Code: EST 104**

Practical 1: Environmental pollution and abatement & Biodiversity, wildlife conservation and management **Code: ESP 101**

Practical 2: Instrumentation and analytical techniques in environmental science & Environmental statistics and mathematical modelling **Code: ESP 102**

#### **Semester 2**

Dissertation/internship & Presentation



## Details of course under M.Sc. in Environmental Science

### 2 - Year PG

i) Core courses 48 credits (12 papers of 4 credit each)

Sem I: 4 Core paper 4x4=16 credits

Sem II: 4 Core paper 4x4=16 credits

Sem III: 4 Core paper 4x4=16 credits

ii) Practical work credit distribution (12 credits)

Sem I: 2 Practical 2x2 =4 credits

Sem II: 2 Practical 2x2 =4 credits

Sem III: 2 Practical 2x2 = 4 credits

iii) Project work

Sem IV: Dissertation/internship & presentation 20 credits

**Total credits: 48+12+20= 80 credits**

### 1 - Year PG

i) Core courses 16 credits (4 papers of 4 credit each)

Sem I: 4 Core paper 4x4=16 credits

ii) Practical work credit distribution (4 credits)

Sem I: 2 Practical 2x2 =4 credits

iii) Project work

Sem II: Dissertation/internship & presentation 20 credits

**Total credits: 16+4+20= 40 credits**

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## **SEMESTER I**

### **CORE PAPER 1: BASICS OF PHYSICAL ENVIRONMENTS & EARTH SCIENCES**

**Code: EST 101**

#### **Unit I: Introduction**

Definition, Principles and scope of Environmental Science, Human's relationship with the environment, physico-chemical and biological factor in environment, earth as a whole ecosystem, Laws of thermodynamics, heat transfer processes, mass and energy transfer across various interfaces, material balance, environmental challenges before humans & need to study the environmental sciences.

#### **Unit II: Atmosphere**

origin and evolution of atmosphere, structure and composition of atmosphere; evolution of atmosphere; composition of air; Meteorological parameters - pressure, temperature, precipitation, humidity, mixing ratio, saturation mixing ratio, radiation and wind velocity, Wind roses, earth's radiation balance.

#### **Unit III: Hydrosphere**

Hydrology and hydrogeology, global distribution of water, Water balance, water flow hydraulics, types of water, hydrological cycle, Streams and Rivers, Lakes and Reservoirs, Ground water, factors affecting the surface water, artificial recharge and rain water harvesting, water resource management, aquifers

#### **Unit IV: Lithosphere**

Primary differentiation and formation of core, mantle, crust, rocks and minerals, concept of minerals and rocks, weathering, erosion, transportation and deposition of earth's materials by running water, wind and glaciers.

#### **Unit V: Fundamentals of Geology**

Fundamentals of Geology, major endogenic and exogenic processes, geological agents of changing environment viz. tectonics, magnetism, weathering, erosion and deposition, common geological structures-bedding, fold, faults, cleavages, fractures, deposits. **Emerging environmental geoscience issues** like carbon sequestration and natural disaster predictions, **earth system modeling**



### Suggested Readings

Environmental Science – Enger, Smith and Smith W.M.C. Brown company publication  
Environmental Science - Taylor and Miller  
Environmental Science – Botkin and Kelter, John Wiley and Sons, New York.  
Environmental Science – S.C. Santra  
Environmental Science – Neble  
Environmental Science Enger Smith, Smith, W. M. C. Brown ( Company Publishing  
Principles of Soil Science Watt K. E. F. (1973), (McGraw Hill Book Co., New Delhi  
Validia.K.S, Environmental Geology, Tata Mc Grace Hills Publishing Co. Ltd. New Delhi.  
Barry and Choslay, Atmosphere, Weather and Climate, The English Language Book Society.  
A Text Book of Environmental Sciences, S. S. Purohit, Q. J. Shammi and A.K. Agarwal, Student Edition (Agrobios), Jodhpur.  
B.K Sharma – Environmental chemistry –Goeyl publication.  
Essentials of Ecology & Environmental Science, S.V.S. Rana, Prentice Hall of India Pvt. Ltd., New Delhi.  
A Text Book of Environmental Studies, D. K. Asthana and Meera Asthana, S. Chand & Co., New Delhi.  
Environmental Science, S.C. Santara, New Central Book Agency (P) Ltd., Kolkata.

## CORE PAPER 2: ENVIRONMENTAL ECOLOGY

Code: EST 102

### Unit 1: Introduction

History and scope of ecology, autecology, synecology, population, community, biome, tolerance range and limiting factors. **urban ecology, climate change adaptation in ecosystems, and ecological restoration, ecological economics and human dimensions of ecosystem management.**

### Unit 2: Population and Community Ecology: Dynamics, Succession

Population and Community Ecology; Analytical characters, synthetic characters like forms, species diversity and measurement of diversity. Population dynamics, models for single and interacting population, stable points, stable cycles, chaos competition, prey predation etc. Ecological succession, primary and secondary processes in successions, models of successions, climax community and types of climax, The ecosystem concept, abiotic and biotic components.

### Unit 3: Energy Flow in Ecosystems

Energy input in ecosystem, standing crop, biomass, primary and secondary production, gross and net production, concept of food chain food web, ten percent law, net community production, methods of measuring productivity, pattern of primary production and biomass in the major ecosystem of the world, litter production and decomposition, Energy flow, Feedback and control. Biogeochemical cycles, gaseous and sedimentary turnover rate and turnover item. Hydrological cycle, carbon cycle, nitrogen cycle, sulphur cycle, phosphorus cycle, nutrient budget, man's impact on nutrient cycles.

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#### **Unit 4: Ecosystems and Invasives: Structure, Dynamics, and Ecological Impacts**

Distinguishing characters of forests grasslands, arid lands and wetlands; community organization- concept of habitat, functional role and niche, key stone species, dominant species, ecotone, edge effect. Structure of forest ecosystem, major forest types of the world, forest types and forest cover of India, regeneration ecology of forest trees. Concept of exotics and invasives; natural spread versus man-induced invasions; characteristics of invaders; stages of invasion; mechanisms of invasions; invasive pathways; impacts of invasion on ecosystem and communities; invasive ecogenomics – role of polyploidy and genome size in determining invasiveness; economic costs of biological invasions.

#### **Unit 5: Industrial Ecology**

Concept of Industrial Ecology. Principles of Industrial metabolism, Industrial ecosystems, Life cycle assessment, waste minimization, Eco-product design, Development and Eco labelling. Ecological industrial model. Eco-industrial parks, Industrial symbiosis.

#### **Recommended Books**

- \*Ecology and Environment, 2008-2009. P.D. Sharma (Rastogi Publications, Meerut)
- \*Fundamentals of Ecology Eugene P. Odum, (Natraj Publishers, Dehradun.)
- \*Principles of Ecology P. S. Verma, V. K. Agarwal (S. Chand and Co. New Delhi)
- \*Ecology and Field Biology Robert Leo Smith (Harper Collins college publication)
- \*General Ecology H. D. Kumar (Vikas Publishing house, New Delhi)
- \*Elements of Ecology Brijgopal, N. Bharadwaj (Vikas Publishing house, New Delhi)
- \*Environmental Ecology Bill Freedman (Academic Press, New York)
- \*Concepts of Ecology N. Arumugam (Saras Publication, Kottar, Dist. Kanyakumari)
- \*Concepts of Ecology E J Koromandy, (Prentice Hall of India)
- \*Ecology: Principles and Applications, J. L. Chapman and M.J. Reiss,

### **CORE PAPER 3: REMOTE SENSING AND GEO-INFORMATICS**

**Code: EST 103**

#### **Unit 1: Principles of remote sensing**

Fundamentals of Remote sensing (RS) & Geographical information system (GIS), Principles of aerial photography and satellite remote sensing, electromagnetic spectrum (EMS), RS Platforms and Sensors, Spectra of Environmental Components, ground truth data collection; GPS (Global positioning System) Technology and Navigation.

#### **Unit 2: Aerial remote sensing and satellite systems**

Aerial photography, cameras and satellite data: Imager analysis: elements of aerial photographic interpretation, Multispectral sensors, Orbits (Sun synchronous and Geo synchronous), stereoscopic data analysis and series of satellites. Future prospects of remote

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sensing in India.

### **Unit 3: Digital image processing**

Remote sensing types (Active and passive RS), Image characteristics, pre-processing, image classification (supervised and unsupervised), change detections. Classification accuracy.

### **Unit 4: Application of remote sensing**

Remote sensing applications in agriculture, forest resources, afforestation activities, forest density mapping, biomass, volume, issues in forest management Forest fire modeling, wildlife mapping and habitat suitability assessment, carbon sequestration; wetland conservation and management; Geospatial techniques in EIA.

### **Unit 5: Components of GIS and its applications**

Principles of GIS, raster and vector GIS, Data input, database creation, data storage, database standards, processing and manipulation. Studies related to environmental planning, Environment Impact Assessment, mining, and Environmental hazards with case studies. Decision Support System for Disaster Management System (DMS), **drone technology**, **AI-based remote sensing applications**, and **big data analysis** for environmental monitoring.

### **Suggested Readings**

1. A. Ganesh. (2006). Application of Geospatial Technology. Satish Serial Pub. House, Delhi.
2. Burrough PA. 1990. *Principles of GIS for Land Resources Assessment*. Oxford & IBH.
3. Chouhan, T.S. and Joshi, K.N. (1992). Remote Sensing for Natural Resources Management. Universal Scientific Publication, Jaipur.
4. Colwell, Robert W. (1971). Monitoring of Earth Resources from Aircraft and Spacecraft, NASA. Washington D.C.
5. Davidson, Donald A. (1998). Soils and Land Use Planning, Longman, London.
6. George Joseph (2005). Fundamentals of Remote Sensing. University Press (India) Ltd. Hyderabad.
7. John, R. Jensen, (2009). Remote Sensing of the Environment: An Earth Resource Perspective. Dorling Kindersley (India) Pvt. Ltd., NOIDA, India.
8. Lillsand TM. 1989. *Remote Sensing and Image Interpretation*. John Wiley.
9. Murk and Skinner. (1999). Geology Today- Understanding Our Planet, John Wiley and Sons Inc, New York.
10. Narayanan LRA. 1999. *Remote Sensing and its Application*. Universities Press (India) /Orient Longman.



## CORE PAPER 4: ENVIRONMENTAL CHEMISTRY AND TOXICOLOGY

Code: EST 104

### Unit 1: Introduction

Fundamental Chemistry: Elements, Chemical bonding, chemical reactions and equations, Organic functional groups, classes of organic compounds. Free radical reactions, catalytic processes.

Fundamentals of Environmental Chemistry: Classification of elements, Stoichiometry, Gibbs' energy, chemical potential, chemical kinetics, chemical equilibria, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons. **green chemistry** principles

### Unit 2: Atmospheric chemistry

Chemistry of the atmosphere – gases and particles; Greenhouse gases and climatic changes. Chlorofluorocarbons and their substitutes. Photochemical smog, Particulate matter, Oxygen and Ozone chemistry, Ozone shield; importance of ozone layer; causes and effects of ozone layer depletion, Fossil fuels: their types, properties, combustion and environmental implications.

### Unit 3: Water chemistry

Water as a universal solvent. Concept of DO, BOD and COD, eutrophication. Water quality parameters, water quality index. Persistent organic pollutants: pesticides usage, toxicity and their environmental degradation. Waste water treatment (primary treatment, secondary treatment, Tertiary treatment). **emerging contaminants** (e.g., microplastics, pharmaceuticals), **industrial pollution** and control strategies.

### Unit 4: Heavy metal toxicity

Inorganic and organic components of soils, Heavy metal (As, Cd, Cr, Pb) and metalloids (As, Se), CO, O<sub>3</sub>, PAN, VOC and POP toxicity, its effects on plants and humans, Bioaccumulation and biomagnifications of heavy metals, Detoxification of heavy metals.

### Unit 5: Toxicology

Concept of toxins, toxicity and toxicology, Classification of toxic compounds, Dose effect and Dose response relationship, levels of toxicity – acute, sub-acute and chronic, Types of toxicants, classification of toxicants – factors that affect environmental concentration of toxicants. Chemical and biological factors influencing toxicity. Concept of LC 50, LD 50 and ED 50. Biotransformation, bio concentration, bio accumulation, bioactivation toxicants in ecosystem. **chemical risk assessment methodologies**



## Suggested Reading

Environmental Chemistry by Stanely Manhan

Environmental Engineering by Peavy. McGraw Hill Book Co., New Delhi

Environmental Chemistry by A. K. De

Environmental Science – Enger, Smith and Smith W.M.C. Brown company publication

Environmental Science - Taylar and Miller

Environmental Science – Botkin and Kelter, John Wiley and Sons, New York.

Environmental Science Enger Smith, Smith, W. M. C. Brown (Company Publishing

Principles of Soil Science Watt K. E. F.(1973),(McGraw Hill Book Co., New Delhi

Validia K.S, Environmental Geology, Tata Mc Grace Hills Publishing Co. Ltd. New Delhi.

## Practical 1: ESP101 (based on EST 101 & EST 102)

### Recommended Practical

- Study of major rocks.
- Microscopic study of common rocks
- Study of toposheets/ aerial photograph.
- Study of geomorphic features of a watershed.
- Preparation of meteorological graphs, charts or windrose
- Physio chemical properties of soils
- Model study of structural folds and faults
- Study of vegetation of local area/college campus
- Study of fauna of local area/college campus
- To find out minimum size of the quadrat for vegetation study
- Study of vegetation density by quadrat method
- Study of vegetation frequency by quadrat method.
- To study species area curve of plant species from terrestrial ecosystem.
- To study the relative density of plant/animal species by quadrat method.
- To study the relative frequency of plant/animal species by quadrat method.
- To study the relative abundance of plant/ animal species by quadrat method
- To study species diversity of plant species from terrestrial ecosystem
- To study stratification of plant species from terrestrial ecosystem.
- Qualitative and quantitative study of land form and their environmental interpretation.

## Practical 2: ESP 102 (Based on EST 103 & EST 104)

### Recommended Practical

- Map reading: natural resources, settlements, slope estimation, drainage network.
- Identification of land cover/Use classes on aerial photographs and satellite imagery
- Image Display, enhancement



- Geo referencing of satellite images
- Supervised and unsupervised classification (general land use)
- Creation of database in GIS for a small watershed.
- **real-world applications** like smart agriculture, forest monitoring, or urban planning.
- Water quality Monitoring
- Water quality modelling INDEX
- Air Quality Index Assessment
- Assessment of TSPM in air samples
- Assessment of RSPM in air samples
- Monitoring major air pollutants like CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>x</sub>
- Estimation of Nitrate in wastewater samples.
- Estimation of Phosphate in wastewater samples.
- Macro elements estimation in soils like C, N and P
- Estimation of cations in soil and water samples

## SEMESTER II

### CORE PAPER 5: ENVIRONMENTAL BIOTECHNOLOGY & BIOREMEDIATION

Code: EST302

#### Unit 1: Fundamental biotechnological techniques & its applications I

Recombinant DNA technology: Cloning vectors, Enzymes used in recombinant DNA technology, Gene cloning, c-DNA library, Elementary information of gene transfer in plants; Genetic diversity analysis: PCR, molecular markers; Introduction to bioinformatics: biological databases-characteristics and sequence analysis

#### Unit 2: Fundamental biotechnological techniques & its applications II

Genetic engineering: Applications of genetic engineering: Herbicide resistance, Insect resistance, Disease resistance, Abiotic stress tolerance, Molecular farming: golden rice, edible vaccine; Plant tissue culture: Micropropagation, Organogenesis, Somatic embryogenesis, Protoplast fusion, Haploid plant production, Somaclonal variation, *In vitro* conservation, Biosafety issues with transgenic plants, cisgenic and intragenic plants, gene editing & **CRISPR technology** and its environmental applications

#### Unit 3: Biodegradation and bioremediation technologies

Bioremediation: Process of bioremediation; In situ and Ex situ bioremediation, Bioremediation of synthetic compounds, petrochemicals, and inorganic wastes; Bioremediation of VOCs, Biodegradation: use of microbes and plants in biodegradation, Phytoremediation: Waste watertreatment using aquatic plants, **industrial**

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**bioremediation case studies on oil spills, heavy metals, and agricultural waste management, bioenergy and biofuels in pollution control.**

#### **Unit 4: GMOs and pollution control/bioremediation**

Genetically modified microbes & plants and their uses in pollution control, Use of genetically modified organisms in the remediation of soil and water resources, Challenges of genetically engineered microbes for in situ applications and impact on the Environment

#### **Unit 5: Microbial biotechnology**

Industrial applications of microbes: Fermentation, Bioreactors, Microbial production of industrial products, Primary and secondary metabolites, Extracellular enzymes, biotechnologically important intracellular products, Representative examples of ethanol, organic acids, antibiotics, etc., Biofertilizer

#### **Recommended books**

Environmental Biotechnology, M. H. Fulekar, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi  
Mohapatra. P. K., 2006, Text Book of Environmental Biotechnology. I K International.  
Evans, G.M. and Furlong J.C. 2003. Environmental Biotechnology: Theory and Application. John Wiley and Sons.  
Thomas, J.A. and Fuchs, R. 2002. Biotechnology and Safety Assessment. Academic Press.  
Wang L.K. Hung Y.T. and Shamas N.K.(Eds). 2006. Advanced Physicochemical Treatment Processes. Springer-Verlag New York, LLC  
Introduction to Environmental Microbiology. Mitchell, R.1974.Prentice Hall Int.  
Microbiology-M.J. Pelczar, E.C.S. Chan, N.R. Kreig.1996. Mc Graw Hill Books Co., New York  
Microbiology-Fundamentals and Applications. Atlas, R.M. MacMillan Pub. Co., New York  
A Textbook of Biotechnology: R. C. Dubey, S. Chand & Company, New Delhi (2002).  
Biotechnology: B.D. Singh, Kalyani Publishers

### **CORE PAPER 6: ENVIRONMENTAL LAWS AND TREATIES**

**Code:EST202**

#### **Unit 1: National Environmental Policies and Legislative Frameworks in India**

National policy statement, environment and development, National Environment Policy 2006: an overview Legislative framework of environmental protection, historical perspectives and Indian constitutional provisions. Sanction and enforcement bodies of environmental laws- role of high court (green bench), supreme court, State and Central Pollution Control Boards

#### **Unit 2: Enforcement Bodies and Environmental Legislation in India: Acts, Rules, and Regulations:**

Environmental acts and rules-Environmental Laws, The Water (Prevention and control of Pollution) Act 1974; The Air (Prevention and Control of Pollution) Act 1981; The



Environment (Protection) Act 1986; Forest Act 1927; Forest Conservation Act 1980; The Wild life Protection Act 1972 (2002 Amendment); Biodiversity Act 2002; The Noise Pollution (Regulation) 2000, Scheduled Tribes And Other Traditional Forest Dwellers (Recognition Of Forest Rights) Act, 2006; Motor Vehicles Act, 1988. Bio-Medical Waste (Management & Handling) Rules, 1998; Hazardous Waste (Management, Handling Rules, 1989); Transboundary Movement Rules, 2008. Plastics manufacture, Sale and Usage Rules, 1999. Coastal Regulation Zones (CRZ), Rules 1991. Public Liability Insurance Act, 1991. Rules, Regulations and Guidelines for Municipal Solid Waste; Electronic Waste, **climate-related policies** (e.g., Paris Agreement),

### **Unit 3: International Environmental Conventions and Their Impact: Global Agreements and India's Implementation:**

International Conventions — Stockholm Declaration, 1972; Ramsar Convention; World Heritage Convention; Kyoto Protocol; Rio Summit (Earth Summit); Johannesburg Summit, 2002. Montreal Protocol. Biodiversity act 2002 and related rules: an overview of application in India. Convention on International trade of endangered species.

### **Unit 4: Environmental Movements**

movements related to the environment – sacred groves, bishnoi tradition, chipko movement, tehri dam, sardar sarovar, narmada dam, almatti dam, silent valley.

### **Unit 5: Environmental Ethics and Sustainable Development:**

Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness. Value education, individual, community, corporate social responsibility. role of ngos. sustainable development: definition and concepts. Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context. **emerging global environmental laws, and environmental justice, environmental compliance and enforcement mechanisms**

### **Recommended Books**

\*Principles of Environmental Science, Cunningham, W and Cunningham, M.A, Enquiry and applications, Tata Mc Graw hills publication, New Delhi, 2nd edition, 2003.

\*Forest resources, Conservation and Management, Kumar, A.D, Affiliated East West press Pvt. Ltd, 2001.

\*Handbook of Environmental Laws, Acts, Rules, Guidelines, Compliances and Standards, Vol. I and II, BS Publications, Hyderabad.

\*Introduction to Environmental Legislation, B.L.Chavan, A.R.Shahane and C.S. Rawandale, Asian Inst. Env. Law., Karmala.

\* Environmental Law, Bell Stuart & Mc Gillvray Donal, 2001, Universal Law Publishing Co.

\*Environmental Law and Policy Diwan Shyam and Rosencranz Armin, 2002. Hughes David, 1992,



Environmental Law, Butterworths.

\*Environmental Law Case Book Leela Krishnan. P, 2004, Lexis Nexis, Butterworths \*Environment and Pollution Law Mohanty. S. K., 2004, Universal Law Publishing Co. Pvt. Ltd.

\*Environmental Law in India Singh Gurdip, 2004, McMillan & Co.

\*International Environmental Law, Singh Gurdip, 2003, in Gurdip Singh, International Law, Macmillan.

## **CORE PAPER 7: NATURAL RESOURCES AND SUSTAINABLE DEVELOPMENT**

**Code: EST 203**

### **Unit 1: Water Resources**

Water resources: Global distribution of water on Earth, Surface water and Ground Water resources, shrinking water resources, water crisis and other major issues related to water demand, water footprint analysis

### **Unit 2: Land and mineral resources**

Land resources: Land use pattern, eco generation of wastelands, soil erosion and conservation, soil reclamation.

Mineral resources: Types and importance of minerals, uses and exploitation, environmental effects of extracting and using mineral resources, case studies

### **Unit 3: Forest Resources**

Forest resource: Forest and environment, National Forest Resources National Forest policy, Endangered and rare species, National parks and sanctuaries, Biosphere reserves

### **Unit 4 Agricultural resources**

Agricultural resource: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizer, pesticide problems, water lodging, salinity, case studies, Livestock resource: Livestock's resource in India: an overview

### **Unit 5: Sustainable development**

Sustainability- Developing the concept, Developing indices of Sustainability - status of environment, quality of life indicators, Quality of Environmental indicators

Sustainable development: The concept of sustainable development; **renewable energy sources**, Environmental degradation and conservation issue: Rehabilitation of degraded rural landscape, Rehabilitation of specialized habitats, e.g water bodies, mangroves, Mined area rehabilitation and regional planning, **sustainable urban planning, global sustainability**

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**frameworks** like SDGs and circular economy principles.

### **Suggested Readings**

A text book of Environmental Studies., 2006. D.K. Asthana, Meera Asthana (Chand & Co.)  
Essential Environmental Studies, 2009, S.P. Misra, S.N. Pandey, (Ane Books Pvt. Ltd. Chennai)  
Text Book of Environmental Studies, Erach Bharucha, 2005. Orient Longman Pvt. Ltd. Ernakulam  
Principles of Environmental Biology P.K. G. Nair (Himalaya Publ. House, N, Delhi)  
Environmental Biology M. P. Arora (Himalaya Publishing House, New Delhi)

## **CORE PAPER 8: ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT SYSTEM**

**Code: EST 204**

### **Unit 1: Concept of EIA.**

Environmental Assessment process, objectives of EIA, terminology, Hierarchy in EIA, framework of EIA, EIA Notification, 1994, 2006. **social impact assessment, cumulative environmental impact assessment**, and the integration of **ecosystem services in EIAs**.

### **Unit 2: Evaluation methodologies**

Techniques and Methods in EIA Evaluation of impacts - different methods (ad hoc, checklist, overlays, matrix, network and Bettle Environmental Evaluation Systems). risk assessment, environmental clearance for establishing an industry.

### **Unit 3: Case studies**

Case studies of EIA for thermal power, Iron and steel industry, road, dams, and mining projects. **case studies on sustainable development practices**

### **Unit 4 Environmental management**

Introduction and scope of environmental management, environmental management plan, environmental safety, risk management and emergency preparedness, post project monitoring., environmental planning concept legal and administrative framework.

### **Unit 5 Environmental audit and CSR**

Definition of Environment Audit and its importance for Industries. Types of audits, General audit methodology and basic structure of audit. Elements of an audit process and its importance. Concept of ISO14000, life cycle analysis. Corporate social responsibility.

### **Recommended books:**

\*Larry W. Canter, "Environment Impact Assessment", McGraw-Hill Book Company, New York  
\*G.J. Rau and C.D. Weeten, "Environmental Impact Analysis Hand book, McGraw Hill, 1980.  
\*Vijay Kulkarni and T V Ramchandra. "Environmental management" Capital Publishing Co



\*Mhaskar A.K., "Environmental Audit" Enviro Media Publications.

\*Glasson J., Therivel R., Chadwick. A., 1994, Introduction to environmental impact assessment- Principles and procedures, process, Practice and prospects. Research Press, Delhi.

\*Morris. P. & Therivel. R., 2001, Methods of environmental impact assessment, 2<sup>nd</sup> Ed. Spon Press, New York, With a chapter on GIS and EIA by A.R. Bachiller & G. Wood, p. 381-401.

\*Petts Judith, 1999, Handbook of environmental impact assessment. Vol. 1, Blackwell Science.

## **Practical 1**

**Code: ESP 201 (Based on EST 201 & EST 202)**

### **Recommended Practical**

- Study of sterilization equipment and Laboratory equipment
- Preparation and sterilization of culture media
- Preparation of MS medium
- Culture of explants on MS medium for shoot multiplication and in vitro rooting
- Bioinformatics tools/exercise NCBI, BLAST, CLUSTAL W, SSR identification tools (SSRIT),
- Primer designing (Primer 3)
- DNA isolation using CTAB method
- Demonstration of PCR, gel electrophoresis
- Isolation of bacteria from Soil
- Differential (Gram's) staining
- Case studies/spots on environmental laws and environmental movements

## **Practical 2**

**Practical ESP 202 (Based of EST 203 & EST 204)**

- Practical based on theory for natural resources and sustainable development
- To study different EIA methodologies
- Prepare energy audit report of an industry.
- To prepare EIA report of highway project, mining project.
- To conduct the baseline study of an industrial area.
- Prepare environment quality index of an industrial area.
- Conduct Environmental Audit of a thermal power plant
- Conduct energy Audit of a industry
- Conduct energy audit of a village.



## SEMESTER III

### CORE PAPER 9: ENVIRONMENTAL POLLUTION AND ABATEMENT

Code: EST 301

#### Unit 1: Introduction

Environmental Pollution basic concept, sources of environmental pollution, point and non-point sources, categories of environmental pollutants, primary and secondary pollutants, modern approaches for pollution control: concepts of clean environment, **climate change fundamentals**, impacts on the physical environment

#### Unit 2: Air pollution

Sources and types of Pollutants - Natural and anthropogenic sources, primary and secondary pollutants. Criteria air pollutants. Sampling and monitoring of air pollutants (gaseous and particulates); period, frequency and duration of sampling. Principles and instruments for measurements of (i) ambient air pollutants concentration and (ii) stack emissions. Indian National Ambient Air Quality Standards. **global air quality standards** Impact of air pollutants on human health, plants and materials. Acid rain. Dispersion of air pollutants. Mixing height/depth, lapse rates, Gaussian plume model, line source model and area source model. 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. Indoor air pollution, Vehicular emissions and Urban air quality. **climate-sensitive pollution mitigation**.

#### Unit 3: Water pollution

Water Quality: Definitions, Characteristics, Water quality parameters (Physical, Chemical, biological), Water pollution: Sources of water pollutants, effects of water pollutants on plants, animals and human health, Water pollution control strategies, Water purification in natural system, water treatment process. Sources and impact of Marine Pollution. Methods of Abatement of Marine Pollution. Coastal management. **Advanced pollution control technologies** like **biofiltration** and **phyto-remediation**

#### Unit 4: Soil Pollution

Soil pollution: sources of soil pollution, nature of soil pollutants, impact of soil pollution on plants, animals and human health, soil pollution monitoring and control strategies: soil quality management concept. Solid Waste - types and sources. Solid waste characteristics,

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generation rates, solid waste components, proximate and ultimate analyses of solid wastes. Solid waste processing and recovery – Recycling, recovery of materials for recycling and direct manufacture of solid waste products

## **Unit 5: Noise and Radioactive Pollution**

Noise pollution: Sources of noise, effects of noise on human health, monitoring of noise pollution management & control, status of noise pollution in India, Radioactive material and sources of radioactive pollution; effect of radiation on human health; thermal pollution and its effects. Hazardous waste – Types, characteristics and health impacts. Hazardous waste management: Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal.

## **Recommended Books**

Air pollution by Stern (Vol 1-Vol VIII)

Air Pollution and its control: Sumit Malhotra (Pointer publishers, Jaipur)

Air Pollution: M. N. Rao (Tata McGraw – Hill publishing company, New Delhi)

Environmental chemistry: B. K. Sharma, H. Kaur (Krishna Prakashan media, Meerut)

Air pollution: S. K. Agarwal (A. P. H. Publishing corporation, New Delhi)

Air Pollution: V. P. Kudesia (Pragati Prakashan, Meerut)

Environmental Science - Taylor and Miller

Environmental Science – Botkin and Kelter, John Wiley and Sons, New York.

Environmental Science – S.C. Santra

Environmental Science – Neble

Environmental Science Enger Smith, Smith, W. M. C. Brown (Company Publishing

\*Principles of Soil Science Watt K. E. F. (1973), (McGraw Hill Book Co., New Delhi)

## **CORE PAPER 10: BIODIVERSITY, WILDLIFE CONSERVATION & MANAGEMENT**

**Code: EST 201**

### **Unit 1: Concept of biodiversity, measurement and its importance**

Biodiversity concept, Level of biodiversity: Species diversity, ecological diversity, genetic diversity; biodiversity measurements: richness and evenness, alpha, beta and gamma diversity; Simpson and Shannon index; importance of genetic diversity, estimation of genetic diversity; Economic importance of biodiversity, ecosystem services

### **Unit 2: Threat to biodiversity**

Factors causing biodiversity loss: Natural and anthropogenic disturbances: climate change, pollution, deforestation; habitat destruction and fragmentation; hunting; over-exploitation; Exotic species; **invasive species management**, consequences of biodiversity loss, habitat



connectivity, and the impacts of **climate change on biodiversity**

### **Unit 3: IUCN threat Categories**

Red List categorization, Red Data book, Concept of Extinction, Threatened and Endangered Species, Endemism, Biodiversity hotspots and their characteristic features

### **Unit 4: Biodiversity conservation and wildlife management**

Protection of Wild Flora, Fauna and Natural Habitats; Biodiversity conservation strategies: In-situ conservation: National Parks, Wildlife Sanctuaries, Biosphere Reserves; Ex-situ conservation: botanical gardens, zoological gardens, gene banks, seed banks, pollen culture, DNA banks, In vitro conservation: advantages of in vitro conservation, Cryopreservation, artificial seed technology; role of local communities and traditional knowledge in conservation, Concept and importance of sacred groves, **genomic tools in conservation, community-based conservation models**

### **Unit 5: Status of protected areas of India and Indian initiatives in wildlife conservation and management**

Status of protected areas and biosphere reserves in India; threatened plants and animals of India, Indian initiatives in biodiversity conservation- Biodiversity Act 2002, Biodiversity Rules 2004, National Biodiversity Strategy and Action Plan (NBSAP), National Biodiversity Authority (NBA), etc; Various conservation projects implemented in India: Project Tiger, Project Elephant, Project Rhino, Project crocodile; Salient features of the Wildlife Protection Act-1972

#### **Suggested Readings**

1. Gaston, K.J. & Spicer, J.I. 1998. *Biodiversity: An Introduction*. Blackwell Science, London, UK.
2. Krishnamurthy, K.V. 2004. *An Advanced Text Book of Biodiversity - Principles and Practices*. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
3. Pandit, M.K. & Grumbine R.E. 2012. Ongoing and proposed hydropower development in the Himalaya and its impact on terrestrial biodiversity. *Conservation Biology* **26**:1061-1071.
4. Primack, R.B. 2002. *Essentials of Conservation Biology* (3rd edition). Sinauer Associates, Sunderland, USA.
5. Singh, J. S. & Singh, S. P. 1987. Forest vegetation of the Himalaya. *The Botanical Review* **53**: 80-192.
6. Singh, J. S., Singh, S.P. & Gupta, S. 2006. *Ecology, Environment and Resource Conservation*. Anamaya Publications, New Delhi.
7. Sodhi, N.S. & Ehrlich, P.R. (Eds). 2010. *Conservation Biology for All*. Oxford University Press.
8. Sodhi, N.S., Gibson, L. & Raven, P.H. 2013. *Conservation Biology: Voices from the Tropics*. Wiley-Blackwell, Oxford, UK.



## **CORE PAPER 11: INSTRUMENTATION AND ANALYTICAL TECHNIQUES IN ENVIRONMENTAL SCIENCE**

**Code: EST303**

### **Unit 1: Fundamentals and Instrumentation in Environmental Science**

Requirement of analytical techniques to study the environmental sciences, outline of some basic and advance techniques used in environmental sciences. Basic Terminology: Equivalent weight of an acids and bases, Normality, Molarity, Molality, Specific weight, Buffer solution. Precision and accuracy. Instrumental Methods for Analysis.

### **Unit 2: Instrumentation and Spectroscopy**

Fundamentals of basic instruments: Concept, Electromagnetic spectrum, Quantum theory, Beer-lambert law. Instrumentations: Theory, Principles, Working operation and application of Colourimetry, Flame photometry, Polarimetry, Spectrophotometry: Atomic Absorption Spectroscopy, Fourier Transform Infra-Red spectroscopy, Gamma Spectroscopy, Liquid chromatography–mass spectrometry, Gas chromatography–Mass Spectrometry, InfraRed Spectroscopy

### **Unit 3: Advanced Microscopy and Analytical Techniques in Environmental Science**

Microscopy- Different types of Microscopes light, fluorescence, phase contrast microscopes, Electron Microscopy: Scanning and Transmission electron microscopes, Electrophoresis, solid and liquid scintillation, X-ray florescence, X-ray diffraction, auto radiography, Ultracentrifugation, **next-generation sequencing** techniques, **real-time data analytics**, and **advanced spectrometry** tools.

### **Unit 4: Chromatographic and Bioinstrumentation Techniques**

Chromatographic techniques (Paper chromatography, thin layer chromatography, ion exchange chromatography, Column chromatography), Gas-Liquid-Chromatography, functioning of Gas chromatograph, High pressure liquid chromatography, (HPLC), GC-MS. Bioinstrumentations: Biosensors, Electrophoresis, Gel electrophoresis, Polymerase chain reaction, conventional microscopy, Bioreactors. Green methodology in labs.

### **Unit 5: Environmental Sample Processing and Analysis**

Methods for processing and analysis of Environmental Samples-- techniques and applications Environmental sampling: Air, Water, Soil-collection, preservation, storage and analysis of samples. **automation in environmental monitoring** and **remote sensing tools** for large-scale environmental sampling.



## Recommended books

1. Skoog, D.A., Holler, F., Crouch, S.R., Instrumental Analysis, Cenage Learning India Pvt. Ltd, New Delhi, 2007
2. Settle, F. Instrumental Techniques for Analytical Chemistry, Prentice-Hall, Inc., Englewood Cliffs, NJ, (1997).
3. Popek, E. P. Sampling and analysis of environmental pollutants: a complete guide, USA: Academic (2003).
4. Lillesand, T., Kiefer, R. W., & Chipman, J. Remote sensing and image interpretation. John Wiley & Sons, (2014)
5. Handbook of Thin-Layer Chromatography, 2003. 3rd Edition; Edited By Joseph Sherma, Bernard Fried. CRC Press

## CORE PAPER 12: ENVIRONMENTAL STATISTICS AND MATHEMATICAL MODELING

Code: EST304

### Unit 1: Data and its expression

Population and samples, tabulation of data, frequency tables and frequency curves, mean, mode and median; variance and standard deviation, coefficient to variation, data presentation techniques, probability

### Unit 2: Data sampling and testing

Concept of sampling; types of sampling, simple random, random sampling and stratified random sampling; Correlation and regression, concept of testing of hypothesis; tests for single mean and difference of means; Chi-square test, students t-test, and F-test. ANOVA,

### Unit 3: Environmental modelling

Introduction to Environmental System analysis, approaches to development of models, linear, simple and multiple regression model, validation and forecasting, weather forecasting

### Unit 4: Application of modelling

Models of population growth and interactions –Lotka – Volterra model, Leslie’s matrix model, point source stream pollution model, box model, Gaussian plume model, prey-predator model. **advanced geostatistics**, and **predictive modeling for climate change impacts**, **machine learning applications** in environmental data analysis

### Unit 5: Statistical software for analysis

computer applications: Structure, function, capabilities and limitations of computer, computer packages, applications of computer in environmental science; Ecological modeling using computer softwares, Software for statistical analysis like MS-Excel, SPSS, MiniTab, Sigmaplot, Statistica. **open-source statistical tools** like R and Python for environmental analysis.



### Recommended books:

- \*Fundamental of applied statistics – S.C. Gupta and V.K. Kapoor.
- \*Elements of statistics – Donald R. Byrkit.
- \*Multivariate analysis- Hunt and Shelly
- \*Computer fundamentals
- \*Computer – Newman Ed.
- \*Computerized environmental modeling – J. Hardstay, D.M. Tailor & S.E. Metcalf
- \*Computerized aided environmental management – S.A. Abbassi and F.I. Khan.
- \*Biostatistics M.P. Arora & P K Malhan Himalaya publication
- \*Principle of biostatistics Satguru Prasad

### Practical 1

#### ESP 301: (Based on EST 301 & 302)

#### Recommended Practical

- Study of high-volume sampler and respirable dust sampler.
- Determination of acidity of water.
- Determination of pH and temperature of water.
- Determination of hardness of water.
- Determination of carbon dioxide in water.
- Interpretation of wind rose diagram.
- Determination of wind velocity.
- Determination of Air pollution index.
- Determination of Noise Level by dB meter
- Study of Wind mills
- To study the relative density of plant species by quadrat method
- To study the relative frequency of plant species by quadrat method
- Calculating Simpson index of two or more communities
- Calculating Shannon index of two or more communities
- Estimation alpha, beta and gamma diversity
- Genetic diversity analysis based on molecular marker data
- Preparation of artificial seed development (*Ex situ* conservation method)

### Practical 2

#### ESP 302 (Based on EST 303 and EST 304)

#### Recommended practical

- To study the principal and functioning of UV-Visible spectrophotometer
- Analysis of water samples on UV-Visible spectrophotometer

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- To Study the working of PCR
- Analysis of water samples with titration method
- To compare means of boys' and girls' height in class for a t-test.
- To carry out a length-weight regression analysis of the given sample.
- To compare the dihybrid cross of pea seeds using Chi-Square analysis
- To compare the effect of irrigation, fertilizer and photoperiod on growth of plant seedlings using ANOVA.
- To run prey-predator simulation using the Lotka Volterra model in MATLAB.

## **GENERIC ELECTIVE PAPER 1: NATURAL HAZARDS AND DISASTER MANAGEMENT:**

**Code: ESTGE301**

### **Unit 1**

Concept of hazard, disaster, risk, vulnerability, exposure and response. Distinction between natural hazards and anthropogenic environmental disturbances, Hybrid hazards.

Landslides- Causes, Types, prevention and correction.

### **Unit 2**

Coastal hazards- Tropical cyclone and tsunamis, coastal erosion, sea level changes and impact on coastal areas, Flood – cause nature and frequency of flood, Flood hazard, Urbanization and flooding, Flood mitigation methods.

### **Unit 3**

Geological hazards: Earthquakes- Cause intensity and magnitude of earth quakes, geographical distribution of earth zones and seismic waves, nature of destruction, protection from earthquake hazards. Tsunami causes and impact assessment, Volcanism – Nature extent and causes of volcanism volcanic materials and pollution, geographical distribution of volcanoes. Snow and avalanches

### **Unit 4**

Various phases of disaster management- Mitigation, preparedness, response, recovery scope of disaster management/emergency management Tools of Disaster management – Emergency Management Information Systems organization related to disaster management.

### **Unit 5**

Disasters and Hazard Management: Human and ecological impacts; Risk assessment and vulnerability analysis; National preparedness and adaptation strategies; Hazards policies and agencies; National and International Agencies in disaster management, NDMA, NIDM, State level disaster management authorities.

**Recommended Books**

\*Arya, A.S (1997) key note Address, Seminar on “Built Environment & Natural hazards”. Indian buildings congress. February, New Delhi.

\*Dr. Satendra, Disaster Management in Hills, Concept Publishing Co., New Delhi.

\*D.K. Asthana and Meera Asthana, Environment: Problems and Solutions, S. Chand & Co., New Delhi

\*T. N. Khoshoo Environmental Concerns and Strategies, Ashish Publishing House, New Delhi

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## **GENERIC ELECTIVE PAPER 2: CLIMATE CHANGE AND MITIGATION**

**Code: ESTGE302**

### **UNIT 1: Introduction to Climate and Climate change**

Definition of weather and climate, meteorology, climatology, types of classification systems-empirical, Koeppen classification systems, climate groups.

### **UNIT 2: Climate change impacts on ecology**

Impacts on water resources, drought and soil moisture, wetlands, glaciers melting, terrestrial ecosystem, loss of biodiversity, agriculture and food supply, marine ecosystem and coastal lives, global warming.

### **UNIT 3: Physical evidences**

Introduction to Paleoclimatology: Major events: Oceanic Anoxic Events, Holocene climatic optimum, Paleocene–Eocene, Tree ring analysis, Palynology and Sclerochronology, Polar ice, Isotopes, Ice melting and Ice core analysis, glaciers and arctic sea loss, Sea level changes and Shore line changes (Strand lines) and Temperature changes

### **UNIT 4: Climate indices**

Measurement of various climate indices, aridity indices, Seismic activity, Remote sensing data for temperature and precipitation.

### **UNIT 5: Concept of Mitigation and Stabilization**

Climate change response measures, definition and evolution, mitigation in regional and national context, global climate policies, role of civil society and social movements, global inequality and climate justice.

### **Suggested Readings**

1. Climate changes: Causes, Effects and Solutions, John T. Hardy, Wiley
2. The Atmosphere: An Introduction to Meteorology, Frederick K. Lutgens, Edward J. Tarbuck, PHI Learning
3. Global Warming-The complete briefing, John Houghton, Cambridge
4. Climate and Global Environmental Change by L.D. Danny Harvey, Prentice Hall publication
5. Climate Change- An Indian Perspective by S.K.Das, Foundation books
6. Global Warming- A very short introduction by Mark Maslin, Oxford publication
7. Climatology-An Atmospheric Science (second edition) by John Oliver & John Hildre- Indian edition
8. Climate change: Biological and Human aspects by Jonathan Cowie



## **GENERIC ELECTIVE PAPER 3: TRIBAL ECOLOGY AND ETHNOBIOLOGY**

**Code: ESTGE303**

### **Unit 1**

Ethnicity and tribes of India, major tribes of India: Nagas, Khasis, Mundas, Kols, Baigas, Bhils, Santhals and Gonds and their geographical distribution.

### **Unit 2**

Resources and habitat relationships, forest, rivers, coasts, hills and desert population growth census, sociality, sex ratio, social relations, rites and rituals,

### **Unit 3**

Ecology and economics of tribal system, ecology and tribal settlement, Govt policies of developments ownership rights of forest land and resources.

### **Unit 4**

Tribal discontent, developmental activities and displacement procedures, tribal health, education and social cases, joint forest management in tribal areas.

### **Unit 5**

Ethnobiology –Concepts, indigenous and traditional knowledge, documentation TRIPs and biodiversity uses in tribal interest, a case study of tribal village.

## **SEMESTER IV**

### **Research project**

Each student will work on an M. Sc. Project during the entire period of the 4<sup>th</sup> Semester. The work on the project will start in the 4<sup>th</sup> semester under the supervision of the concerned faculty members. One co-supervisor may opt for an external academic institution/industry. The dissertation will be completed by the 4<sup>th</sup> semester with the submission of the project report. Project work will be evaluated by a 3-member expert committee. Students will have to present their work in an open presentation.

