

**Course Structure**  
**Ph.D. in Environmental Sciences**  
**Department of Environmental Sciences**

**Theory Papers:** 04 (Total Credits: 4+4+4+4=16)

- Research Methodology (ENV/911010) (Compulsory)
- Basics of Environmental Sciences (ENV/911020) (Compulsory)
- **Research and Publication Ethics (ENV/911160) (Compulsory)**
- Any one optional paper according to the research field of the scholars.

<b>List of Optional Papers</b>		
Sl. No.	Course	Credits
1	Ecology (ENV/911030)	3+1+0=4
2	Biodiversity Conservation (ENV/911040)	3+1+0=4
3	Aerosol and Atmosphere (ENV/911050)	3+1+0=4
4	Micrometeorology and land surface processes(ENV/911060)	3+1+0=4
5	Climate Change and Current Issues (ENV/911070)	3+1+0=4
6	Analytical Techniques and Instrumentation (ENV/911080)	3+1+0=4
7	Atmospheric Sciences (ENV/911090)	3+1+0=4
8	Fundamentals of Soil Science (ENV/911100)	3+1+0=4
9	Water and Land Management (ENV/911110)	3+1+0=4
10	Forestry and Wild Life Management (ENV/911120)	3+1+0=4
11	Environmental Pollution and Management (ENV/911130)	3+1+0=4
12	Environmental Microbiology and Biotechnology (ENV/911140)	3+1+0=4
13	Environmental Toxicology and Industrial Safety (ENV/911150)	3+1+0=4
14	<b>Water Resource Management</b>	3+1+0=4
15	<b>Water and Waste Water Treatment</b>	3+1+0=4
16	<b>Glaciology</b>	3+1+0=4
17	<b>Application of Remote Sensing and GIS</b>	3+1+0=4
18	<b>Green Energy and Economy</b>	3+1+0=4
19	<b>Environmental Ethics</b>	3+1+0=4

**(HEAD, DEVS)**

CENTRE FOR ENVIRONMENTAL SCIENCES  
**CENTRAL UNIVERSITY OF JHARKHAND**  
**BRAMBE, RANCHI – 835205**

**Proposal for Ph.D. rules and regulation along with syllabus** (Under Section 28 of Central Universities Act, 2009 - Statutes15)

**Objectives of the Ph.D. Programme**

The objectives of this programme are to impart research training to the scholar, and prepare him/her for a career in independent investigation and original research so as to enable him/her to make a significant contribution to knowledge in his/her field and profession. The training programme shall ensure that it is not an end in itself, but a means for a fruitful research career.

To achieve these objectives, the training programme shall ensure the following:

- (a) Acquisition of fundamental knowledge in the chosen discipline.
- (b) Acquisition of in-depth knowledge in the field of research.
- (c) Training in the use of research tools of the field, and develop skill and capability to conduct original research.

**Eligibility and number of students permissible for guidance of Supervisor**

The Supervisor shall be a Professor, Associate Professor or an Assistant Professor with Ph.D. and with at least three years' experience of research/teaching experience and should be a teacher of this University. Research experience would be counted from the date of award of the thesis for the Ph.D. degree. The teacher should have at least one publication in a refereed journal. Provision of joint supervision will also be permitted.

A supervisor shall not have, at any given point of time, more than eight Ph.D. scholars and Five M.Phil. Scholars. However, in such cases where teachers are retiring or leaving and where redistribution/ reallocation of their Ph.D. students to other faculty members are required, the norm can be relaxed.

Faculty members having major research projects of two years duration (or) more with Project fellow can take two candidates for Ph.D. programme besides the stipulated strength of eight candidates. Faculty members can also admit the candidates with national award/fellowships under this category. However, the total no. of candidates should not exceed ten. The number of Part Time candidates under a Supervisor at any point shall not exceed four. Vacancy in Ph.D. course will arise under a guide as and when the candidates already registered, submitted their thesis.

**Minimum Eligibility Criteria:** M.Sc./M.Tech./M.Sc.(Tech.)/MS in Environmental Sciences, Environmental Sciences and sustainable Development, Earth & Atmospheric Sciences, Life Sciences, Chemistry or Allied Sciences with minimum 55% marks. Relaxation of 5% may be given to ST/SC candidate or as per Govt. of India rule. Students having NET/GATE score and/or having fellowships/scholarships instituted by the University/national and international agencies under schemes approved /recognized by the University, through procedure laid down by the University, may be registered provisionally by the Research Committee of the Centre and Board of Research Studies.

## Areas of Research

- i. Ecology
- ii. Biodiversity Conservation
- iii. Forestry and Agroecosystem
- iv. Soil Sciences
- v. Boundary Layer Meteorology and land surface processes
- vi. Atmospheric Sciences
- vii. Climatology and Climate change
- viii. Environmental Microbiology
- ix. Eco-Toxicology
- x. Water and Land Management
- xi. Environmental Pollution and Management
- xii. Biofuels: Development and Characterization
- xiii. Rain Water Harvesting
- xiv. Algology

## Course Work

There shall be a compulsory pre-Ph. D. course work of 24 credits for two semesters as per the UGC regulation 2009. A candidate must secure at least 60% marks in the pre-PhD course work during their Ph. D. programme and it should be completed within two semesters.

The course work will include a compulsory paper on research methodology with quantitative methods and computer applications, and the rest of the two papers shall be as prescribed by the Centre for Environmental Sciences. There will be two term papers

## Course Structure

### Semester – I

**Theory Papers**– 2 (Total Credits: 4+4 = 8)

- I. Research Methodology
- II. Basics of Environmental Sciences

**Term Paper (s) – I** (Total Credit: 2+2= 4; One Review Paper and One Presentation)

### Semester – II

**Theory Papers** – 2 (Total Credits: 4+4 =8)

These papers based on their Research topic from above mentioned areas of research

**Term Paper (s) – II** (Total Credit: 2+2= 4; One Review Paper and One Presentation)

**Proposed Syllabus for Ph. D. Course Work  
Centre for Environmental Sciences  
Semester I**

---

**Paper-I: Research Methodology (ENV 911010)**

**(Credit: 3+1+0=4)**

**UNIT 1: Research**

Objective, Types of research, process and steps in it; Research proposal and concept;

Research Design- meaning, need, concept and different research designs; Literature survey and review, research design process error in research;

Research Modelling- Types of Models, Model building and stages, Data consideration and testing (Sampling, Collection and Analysis), Heuristic and Simulation

**UNIT 2: Design of Experiments**

Objectives, strategies, Factorial experimental design, Designing engineering experiments, basic principles- replication, randomization, blocking, guidelines for design of experiment

Analysis of variance- ANOVA- Basic principle, one way and two-way technique

Analysis of Co-variance- ANOCOVA technique

**UNIT 3: Report writing and Interpretation**

Pre- writing considerations; Meaning and technique of interpretation;

Different steps in report writing, Formats of report writing, Thesis writing, Formats of publication in Research journals

**UNIT 4: Computer Application**

Introduction to computers, generations of computers, systems and application software, generation of languages, compiler, interpreter, assembler, number systems, computer arithmetic; Application of MS-office; Data presentation and analysis in MS-Excel, Report writing in MS word, Seminar presentation by using PPT

**References**

1. Montgomery, Douglas C. (2007)5/e, Design and Analysis of Experiments. (Willey, India)
2. Kothari, C. R. (2004). 2/e, Research Methodology- Methods and Technique.(New Age International, New Delhi)
3. Montgomery, Douglas C. and Runger, George C. (2007), 3/e. applied statistics and probability for Engineers. (Willey, India)
4. Zar (1974) Fundamental of Statistics

**UNIT 1: Introduction**

Environment: Concept, types and components; Atmosphere: Composition of Air, Importance, Layers; Importance of Hydrosphere; Basic concepts of Lithosphere and Biosphere

Environmental Sciences: Definition, objectives, principles, stages, importance and scope

Multidisciplinary nature of Environmental Sciences; Environmental Ethics; Environmental Management; Needs of Environmental Science

**UNIT 2: Fundamental of Environmental Chemistry**

Stoichiometry, Gibbs Energy, Chemical Potential, Chemical Equilibrium, Acid Base Reactions, Solubility Product, Solubility of gases in water, unsaturated and saturated hydrocarbon, radionuclide

**UNIT 3: Environmental Pollution**

Introduction, Sources and mitigation of pollution, Classification and effect of air pollutants, Transport and diffusion of pollutants, Vehicular Pollution, Smog formation and effects, Monitoring and control of air pollution, Air quality standards; Acid Rain, Ozone layer depletion, Global warming

**UNIT 4: Environmental Law and Legislation**

Fundamental principles of environmental protection; sustainable development; Constitutional Perspective: Fundamental right to wholesome environment, Directive principles of state policy; Fundamental duty; National Environmental Policy; Environmental Regulatory Framework in India; Role of International Environmental Agencies -UNEP, GEF, UNFCCC and IPCC

**References**

- E. P. Odum, Fundamentals of Ecology, Nataraj Publisher, Dehradun 1996
- M. C. Dash, Fundamentals of Ecology, Tata McGraw Hill, 1994
- S. S. Dara, A Text Book of Environmental Chemistry and Pollution Control, 2004
- R. S. Shukla & P. S. Chandel, A Text Book of Plant Ecology including Ethnobotany and Soil Science
- J. P. Sharma, Comprehensive Environmental Studies (For Under Graduate Students) Laxmi Publication (P) Ltd.
- P. D. Sharma, Ecology and Environment, Rastogi Publication
- D. K. Asthana & Meera Asthana, Environment: Problems and Solutions, S. Chand Publication
- K. S. Rao, Practical Ecology, Anmol Publication Pvt. Ltd., 1998
- E. D. Enger & B. E. Smith, Environmental Science – A study of Inter relationships, 5<sup>th</sup> edition, W C B publication.

### **Paper I: Ecology (ENV 921010)**

**(Credit: 3+1+0=4)**

**UNIT 1:** Environment: Concept, types and components; Atmosphere: Composition of Air, Importance, Layers; Importance of Hydrosphere; Basic concepts of Lithosphere and Biosphere; Environmental Sciences: Definition, objectives, principles, stages, importance and scope; Multidisciplinary nature of Environmental Sciences; Environmental Ethics; Environmental Management; Needs of public awareness

### **UNIT 2: Basic Ecology**

Ecology: Concept, Scope and Classification; Ecological Factors: Climatic, Tropographic, Edaphic and Biotic; Ecological Adaptations and Tolerance range; Ecotypes and Ecads

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

Basic Concepts of Population Ecology; Population Characteristics: Population size and Density, Dispersion, Age structure, Natality, Mortality, Life Tables; Population Regulation; Population Interactions: Positive and Negative.

### **UNIT 4: Community Ecology**

Community Characteristics: Analytical and Synthetic; Methods of Community study: Floristic, Physiognomic and Phytosociological; Ecological Succession: Causes, Types and Processes; Climax concept; Ecotone and Edge effects

### **UNIT 5: Ecosystem Ecology**

Ecosystem: Concept, Structure, Types and Functions; Food Chain and Food Web, Trophic levels and Standing crops, Productivity, Ecological Pyramids, Energy Flow, Biogeochemical Cycle, Homeostasis, Ecological Niche

### **References**

- E. P. Odum, Fundamentals of Ecology, Nataraj Publisher, Dehradun 1996
- M. C. Dash, Fundamentals of Ecology, Tata McGraw Hill, 1994
- S. S. Dara, A Text Book of Environmental Chemistry and Pollution Control, 2004
- R. S. Shukla & P. S. Chandel, A Text Book of Plant Ecology including Ethnobotany and Soil Science
- J. P. Sharma, Comprehensive Environmental Studies (For Under Graduate Students) Laxmi Publication (P) Ltd.
- P. D. Sharma, Ecology and Environment, Rastogi Publication
- D. K. Asthana & Meera Asthana, Environment: Problems and Solutions, S. Chand Publication
- K. S. Rao, Practical Ecology, Anmol Publication Pvt. Ltd., 1998
- E. D. Enger & B. E. Smith, Environmental Science – A study of Inter relationships, 5th edition, W C B publication.

**UNIT 1: Introduction to Biodiversity**

Diversity of major groups of plants, animals and Microorganisms

Plants: Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms (Monocots and Dicots); Animals: Invertebrates and Vertebrates (Mammals, Birds, Fish, Reptiles and Amphibians); Bacteria, Viruses and Actinomycetes; Lichen

**UNIT 2: Biodiversity & Conservation**

Biodiversity: Definition and Scope; Levels of biodiversity: ecosystem, species and genetic; Values and Importance; Threats; Biodiversity at local and national level

Biodiversity conservation- *In-situ* and *Ex-situ* conservation; International and national efforts for biodiversity conservation

**UNIT 3: Conservation Initiatives**

Hotspots of biodiversity, Himalaya, Indo-Burma and Western Ghats and Sri Lanka in details; India as Mega-biodiversity Nation; Endemism: Concept and Types with examples; IUCN Red-List Categories; Species Extinction; Keystone Species

**UNIT 4: Biogeography**

Vegetation of India with special reference to Jharkhand: Different Forest Types; Mangroves in India; Wetlands in India; Ramsar sites; Biogeographical Regions of India; Climatic Zones of India

**UNIT 5: Economic Importance of Biodiversity**

Economically Important Plants, Animals and Microorganisms; Microbial diversity and their uses in industry, agriculture, medicine and food; Wildlife goods and services, Wildlife as commercial resources, Edible and non-edible wildlife products; Plants in industry, medicine, forage and foods, Fuelwood, timber and vegetable

**References**

- E. P. Odum, Fundamentals of Ecology, Nataraj Publisher
- P. D. Sharma, Ecology and Environment, Rastogi Publication
- M. C. Dash, Fundamentals of Ecology, Tata McGraw Hill
- Kormondy Edward J. Concept of Ecology, Fourth Edition, PHI Learning
- K. C. Agrawal, Fundamentals of Environmental Biology, Nidhi Publisher
- R. S. Shukla & P.S. Chandel, A Text Book of Plant Ecology: Including Ethnobotany and Soil Science, S. Chand Publisher
- K.S. Rao, Practical Ecology, Anmol Publication Pvt. Ltd

**UNIT 1: Weather and Climate**

Introduction: Concept of weather and climate, climatic elements, climatic factors, earth-sun relationship, ecliptic and equatorial plane, rotation and revolution of the earth, equinox, solstice, perihelion, cause of seasons

**UNIT 2: Basic concepts of Atmospheric Radiative Transfer**

Fundamental radiometric definitions and terms, Blackbody radiation, Kirchoff's law, Planck's law, Application to bodies not in thermodynamic equilibrium, Extinction, absorption and scattering, Definitions and notation, Lambert's and Beer's laws, Single scattering, Multiple scattering, Atmospheric optics

**UNIT 3: Natural greenhouse gases and radiative properties of aerosols**

Description of the climate system, natural greenhouse effect and the effect of trace gases and aerosols, Radiation properties – visibility, climate effects; principles of particulate control systems, feedbacks in the climate system, climate change in the past, ice ages, proxy records, abrupt climate change

**UNIT 4: Atmospheric Aerosols**

Physics of aerosols: size and size distributions, mechanics of motion, agglomeration, diffusion, electrical effects and light scattering; Characterization of aerosols, size distributions, measurement methods; Transport behaviour: diffusion, sedimentation, inertial, electrical and thermal; Particle size distributions: number, surface area, volume and mass, Properties of gases

**UNIT 5: Clouds and Aerosols**

Warm cloud processes, Cloud droplet microphysics (homogenous/heterogeneous nucleation, Kelvin equation, solute effect, CCN), Droplet growth by condensation, Initial cloud droplet size distributions (CCN spectrum measurements, effect of CCN on cloud, droplet concentration), Droplet coagulation and warm cloud precipitation processes

**References**

- Salby, M.L., Fundamentals of Atmospheric Physics, Academic Press (AP), 1996.
- Roger, R. R and Yau, M. K., A Short Course in Cloud Physics, Pergamon Press, 3rd edition, 1989.
- Wallace, J. M, and Hobbs, P. V., Atmospheric Science: An Introductory Survey, 1st or 2nd edition.
- Twomey, S., Atmospheric Aerosols, Elsevier Publishing, 1977
- Pruppacher, H.R., and J.D. Klett, Microphysics of Clouds and Precipitation
- Liou, K.N. An Introduction to Atmospheric Radiation, AP, 1980
- Houghton, H.G., Physical Meteorology, MIT Press, 1985
- Charlson, R. J. and J. Heintzenberg, Editors, Aerosol Forcing of Climate, Wiley and Sons 1995
- Goody, R. M. and Y. L. Young, Atmospheric Radiation: Theoretical Basis, Oxford Univ. Press, 1989



## **Paper IV: Micrometeorology and land surface processes(ENV 921040)**

**(Credit: 3+1+0=4)**

### **UNIT 1:**

Meaning and scope of micrometeorology; Divisions of the atmosphere; Importance of the lower region of the atmosphere

### **UNIT 2:**

Distinctive features of micrometeorology compared with macro and mesometeorology

### **UNIT 3:**

Profiles of temperature, humidity and wind under different stability conditions;

### **UNIT 4:**

Laminar and turbulent conditions; Reynold and Richardson number; Turbulent transfer of mass, momentum and energy; Concepts of exchange co-efficient, exchange coefficient relationships

### **UNIT 5:**

Atmospheric boundary layer, its structure and properties, Distribution of important meteorological parameters in the boundary layer; Importance of different layers in the PBL; Instrumentation in PBL & LSP

### **Reference**

- Arya, S.P., 1988: Introduction to Micrometeorology. Academic Press, San Diego, 303 pp.
- Garratt, J.R., 1992: The Atmospheric Boundary Layer. Cambridge University Press, 316 pp.,
- Kaimal, J.C., and J.J.Finnigan, 1994: Atmospheric Boundary Layer Flows, Oxford University Press, New York/Oxford, 289 pp., ISBN: 0-19-506239-6
- R. B. Stull, An Introduction to Boundary Layer Meteorology, Kluwer Academic Publishers, 1988.
- T.R. Oke, Boundary Layer Climates, Roulledge Publications, Taylor & Fransis, 2<sup>nd</sup> ed., 2003
- Sorbjan, Z., Structure of the Atmospheric Boundary Layer. Prentice-Hall, 1989.
- Seinfeld J.H. and S. Pandis, Atmospheric Chemistry and Physics, John Wiley, 1998
- Zannetti, P. Air Quality Modelling, Volume 1 fundamentals, EnviroComp Institute and Air & Waste Management Association, 2003.
- Arya, S.P.S., Air Pollution Meteorology and Dispersion, Oxford Univ. Press, 1999.
- Wark, K. and C. F. Warner, Air pollution: Its Origin and Control, Harper and Row Publisher, New York, 1981.

**UNIT 1:**

Elements of climate, climate controls - Earth's radiation balance, Latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity, cloud formation and precipitation - Water balance, spatial and temporal patterns of climate parameters - Air masses and fronts - SW and NE monsoon - Jet stream, tropical and extra-tropical cyclone, Classification of climate.

**UNIT 2:**

Global Environmental problems - Ozone depletion, causes and effects; Acid Rain – Formation and adverse effect, Photochemical smog, Factors and effect of photochemical smog

**UNIT 3:**

Green house gases – green house effect and climate change, Global warming facts – Effects of Global warming – control and remedial measures of green house effect, global warming and climate change, impacts of sea level rise, Control of Global Warming

**UNIT 4:**

Man and Ecodegradation of Natural Environment, Present status of wasteland in India. Problems and prospects of wasteland development; Wasteland reclamation through Social Forestry, Bioaesthetic planting for pollution abatement

**UNIT 5:**

Eutrophication and restoration of Lakes, Environmental ethics, Fly ash utilization, wet land conservation, environmental disaster (man made) episodes; Minamata, itai itai, London smog, Los Angeles smog, Bhopal gas tragedy, Water conservation, Water shed development, Rain water harvesting, Desertification

**References**

- Nanda A. N. (1996) Environmental Education
- Agarwal K. M., Sikdar P. K. and Deb S. C. (2002) A text book of Environment, MacMiller India Ltd., Calcutta
- Tyler Miller Jr. G (1996) Living in the Environment – Principles, Connections and Solutions, Wadsworth Publishing Co. New York
- Botkin D. B. (1989) Changing the Global Environment, Academic Press, San Diago

## **Paper VI: Analytical Techniques and Instrumentation (ENV 921060)**

**(Credit: 3+1+0=4)**

### **UNIT 1: Sampling Techniques**

Sampling equipment for Air, Water and Soil; Preparation of sample for trace metal analysis in water and soil: Dissolution techniques and microwave digestion; Principles of measurement and error analysis, fundamentals of field measurements, in situ measurement of atmospheric temperature, humidity, pressure, wind, radiation, precipitation and upper Air Observations: Radiosondes, Radiometersondes, Ozone sonde.

### **UNIT 2: Separation Techniques**

Principle and process of solvent extraction, Extraction reagents and its practical applications

### **UNIT 3: Microscopy**

Principle and application of Simple, compound, phase-contrast, fluorescent and Electron microscope

### **UNIT 4: Principles of Analytical Methods**

Theory, instrumentation and application of Colourimetry, Spectrophotometry, Atomic Absorption Spectrophotometry, Electrophoresis, X-Ray Fluorescence, X-Ray Diffraction, Flame Photometry and NMR, FTIR, Anode Stripping Voltametry

### **UNIT 5: Chromatography**

Principle and application of thin layer and ion exchange chromatography, Theory, instrumentation and application of Gas Chromatography, Gas Chromatography-Mass Spectrometry, Ion-chromatography, High Performance Liquid Chromatography, GLC

### **References**

- A. E. Greenberg & A. D. Eaton, Standard Methods for Examination of water and waste water, APHA, AWWA, WEF
- C. N. Sawyer, P. L. McCarty and G. F. Parkin Chemistry for Environmental Engineering and Science
- H. H. Rupa and H. Krist: Laboratory Manual for the Examination of Water, Waste water and soil: V C H Publication

**UNIT 1:**

Introduction: Concept of weather and climate, climatic elements, climatic factors, earth-sun relationship, ecliptic and equatorial plane, rotation and revolution of the earth, equinox, solstice, perihelion, cause of seasons

**UNIT 2:**

Laws of radiation, radiation balance near earth atmosphere continuum.

**UNIT 3:**

Indian Climatology: Principal seasons of India, annual and seasonal rainfall and its variability; Definition and concept of drought, aridity, drought indices and drought assessment; Climatic Classification: Koppen and Thornthwaite schemes applicable to India.

**UNIT 4:**

Description of the climate system, natural greenhouse effect and the effect of trace gases and aerosols, feedbacks in the climate system, climate change in the past, ice ages, proxy records, abrupt climate change

**UNIT 5:**

Instrumental record of climate, climate variability on various time-scales, simple models of climate, natural and anthropogenic climate change: detection and attribution, impacts and mitigation of climate change.

**References**

- Peixoto, J. P., and Oort, A. H., Physics of Climate, Springer, 1992
- Imbrie, J., and Imbrie, K. P., Ice Ages: Solving the Mystery, Harvard University Press, 2005
- Climate Change 2007 - The Physical Science Basis: Working Group I Contribution to the Fourth Assessment Report of the IPCC (Climate Change 2007), Cambridge University Press, 2007
- Washington, W. M., and Parkinson, C. L., An Introduction to Three-Dimensional Climate Modeling, 2nd Edition, University Science Books, 2005 Cambridge University Press, 2007
- Climate Change 2007 - Mitigation of Climate Change: Working Group III contribution to the Fourth Assessment Report of the IPCC (Climate Change 2007), Cambridge University Press, 2007 g) Houghton, J., Global Warming: The Complete Briefing, Cambridge University Press; 3 edition, 2004
- Sellers: Physical Climatology
- Trewartha: Introduction to Climates
- Haurwitz & Austin: Climatology

**UNIT 1: Soil Genesis**

Origin, Nature and Classification of parent materials: Rocks and Minerals; Processes of Soil Formation: Physical, Chemical and Biological Weathering, Pedogenesis: Humification, eluviation, illuviation, Mineralization; Soil Profile: Concept, Morphological characteristics, Processes; Soil Classification, Soil aggregation

**UNIT 2: Soil Morphology**

Components, Soil Texture; Structure and other Physical, Chemical and Biological properties of Soil; Soil water, Soil water retention, Soil-moisture characteristic curve Soil air, Major Soil Types of India with special reference to Jharkhand

**UNIT 3: Soil Fertility**

Role of soil nutrients (major, minor and trace) in plant growth; immobilization and mineralization, Soil microbes and its role in soil fertility, Soil organic matter decomposition, Biofertilizer, Compost, Vermicompost, Soil Conditioners

**UNIT 4: Soil and Plant Nutrients**

Essential plant nutrients-functions; Nutrient deficiency symptoms; Forms, Availability and nutrient cycling in Soil, Integrated Plant Nutrients Management

**UNIT 5: Soil Erosion and Management**

Soil Erosion, Types of erosion, Water erosion and wind erosion, types, mechanism and factors affecting water and wind erosion; Effects of Soil Erosion; Factors Affecting Soil Erosions, Methods of Soil Conservation

**References**

- Dhyan Singh, P. K. Chhonkar and B. S. Dwivedi, Manual on Soil, Plant and Water Analysis, Westville Publishing House.
- D. K. Das, Introductory Soil Science, Kalyani Publishers
- [Millar, Charles Ernest and L M Turk](#). Fundamentals of Soil Science, Biotech Books
- [Henry D. Foth, H. D. Foth](#), Fundamentals of Soil Science, Wiley.

**Paper IX: Water and Land Management (ENV 921090) (Credit: 3+1+0=4)**

**UNIT 1: Water Resource**

Water resources and its Importance, Necessity for conservation and development of water resources, Purpose and factor of water resources management, water budget, Water resources of India and Jharkhand, National Water Policy

**UNIT 2: Water Quality Management**

Management and conservation of water resources; Rain water harvesting; Wetland conservation and Management; Ground water resources, Subsurface water, factors affecting resources, Surface storage and its purpose, Reservoirs, tanks, Dam; Physical, chemical and biological treatment of water such as sedimentation, filtration, chlorination, coagulation, flocculation, water softening, activated sludge, trickling filter and example problems

**UNIT 3: Land resource management**

Land resources and its Importance; Land Use concept, Urban and rural land use policy, land use planning

**UNIT 4: Land Degradation & Land slide hazard**

Land pollution, Desertification, Soil conservation, Soil erosion, Soil contamination, Mining-reclamation of mined area; Landslide hazard: Causes, destabilizing forces; mass movement types; human use and landslides; Identification of landslide zones and their control, strength of materials and instability of slopes

**UNIT 5: Natural Hazards and management**

Natural and manmade hazards- types, causes, impacts, forecasting and management (viz. earthquake, flood, drought, cyclone, tsunami, *El Nino* and *La Nino*, volcano, landslide, Industrial accident like Bhopal gas tragedy)

**References**

- Sharma P. D., Ecology and Environment, Rastogi Publication
- Shukla R. S. & Chandel P. S., A Text Book of Plant Ecology including Ethnobotany and Soil Science, S. Chand Publication
- D. S. Chauhan, Non-conventional Energy Resources, New Age International
- Ashthana & Ashthana, Environment: Problems and Solution, S. Chand Publication
- Rao & Dutta, "Wastewater Treatment", Oxford & IBH Publishers
- Warbs Ralph A. & James Wesley P., Water Resources Engineering

**PaperX: Forestry and Wild Life Management (ENV 921000) (Credit: 3+1+0=4)**

**UNIT 1: Introduction**

Forest: definition, growth stages, crown differentiation, forest types of India with special reference to Jharkhand, measurement of height and girth of trees, form factor, estimation of volume of logs, Role of plantation forestry in environmental conservation

**UNIT 2: Social Forestry**

Origin, definitions, objectives, scope of social forestry, Community participation in social forestry programme, Multipurpose tree species (MPTs), Nitrogen fixing tree species (NFTs), characteristics of MPTs, NFTs, Pattern of planting, calculation of number of plants (line, square, triangular and quincunx), Eco restoration of eroded hill slopes and degraded *Jhum* land; Tree species suitable for different edaphic conditions

**UNIT 3: Agroforestry**

Origin and definition, type, gains of agroforestry system, Tree and crop management, Production potential of alley cropping, Agroforestry models developed for hill farming system- Three tier system, Tree-greenhedge-crop Farming system and Contour- Tree- Greenhedge-Crop Farming system, Acidic, Saline and alkaline soils and their reclamation techniques

**UNIT 4: Introduction to Wildlife**

Wildlife: Definition, Importance and Ethics of Wildlife, Wildlife resources-classification, Wildlife as commercial resources, Edible and non-edible wildlife products, Species Endangerment, Distribution of rare, threatened, endemic wildlife species of India, factors influencing the distribution pattern of wildlife, Major habitats of wildlife, Component of wildlife habitat

**UNIT 5: Wildlife Conservation and Management**

Threats to wildlife, Poaching of wildlife, Need for conservation, Importance of Wildlife Conservation, Wildlife conservation: in-situ and ex-situ Conservation methods, Protected area: National park, Wildlife Sanctuary, Conservation reserve, Community reserve, Wildlife conservation Act, Role of IUCN & CITES in conservation, Wildlife management: Definition, goal of management, population management, habitat management, Wildlife health management, Human-wildlife relation, Problems Caused by Wildlife, Human-Wildlife Conflict

**References**

- Khanna L. S. (1985) *Forest Mensuration*, Intl. Book Distributors, Dehradun.
- Agrawal P. (2008) *Forest Mensuration*, Bishen Singh & Mahendrapal Singh, Dehradun
- Ghosh S. K. & Singh R. (2003) *Social Forestry and Forest Management*, Global vision publication, Delhi.
- Dwivedi A. P. (2003) *A Text Book of Silviculture*, Intl. Book Distributors, Dehradun.
- Jha, L. K. & Sen Sarma P. K. (2008) *Forestry for the people*, APH publishing corporation, New Delhi
- Jha, L. K. & Sen Sarma P. K. (2008) *Agroforestry: Indian Perspectives*, APH publishing corporation, New Delhi.
- Jha L. K. (2009) *Advances in Agroforestry*, APH Publication Corporation, New Delhi.

## **Paper XI: Environmental Pollution and Management (ENV 921001) (Credit: 3+1+0=4)**

### **UNIT 1: Air Pollution**

Introduction, Composition of air, Chemical reactions occurring in different layers of atmosphere, Sources of air pollution, Classification and effect of air pollutants, Vehicular Pollution, Smog formation and effects, Monitoring and control of air pollution

### **UNIT 2: Water Pollution**

Introduction, Types of water Pollution, Sources of Water Pollution, Classification and effect of Water Pollutants, Eutrophication, Biological Magnification, Industrial wastes and treatment processes, Water Purification, Prevention and control of water pollution, Thermal Pollution; Marine Pollution

### **UNIT 3: Soil Pollution**

Introduction, Sources and effect of soil pollution, Soil pollution control, Industrial waste effluents and heavy metals, their interactions with soil components; Soil microorganisms and their functions, degradation of different insecticides, fungicides and weedicides in soil, Different kinds of synthetic fertilizers (N, P & K) and their interactions with different components of soil

### **UNIT 4: Noise Pollution**

Sources of noise pollution, measurement of noise and indices, effect of meteorological parameters on noise propagation; **Noise exposure levels and standards**; Noise control and abatement measures. Impact of noise on human health

### **UNIT 5: Electronic waste (E-waste)**

Sources and types, constituents of E-wastes, recycling of e-waste and its environmental consequences, Transboundary movement and management of e-wastes; Radioactive wastes: Types, hazards, storage and management

### **References**

- Cunningham, W.P. and W.B. Saigo (2005) Environmental Science, McGraw Hill, New York.
- Bell, J.N.B. (2002) Air Pollution and Plant Life, (II ed.), John Wiley and Sons, New Delhi.
- Fellenberg, G. (1999) Chemistry of Pollution, John Wiley and Sons, New Delhi.
- Tirvedi, R. K. and Geol, P. K. (2010) An Introduction to Air Pollution, (II Ed), DVS Publication, New Delhi.
- De, A. K. (2000) Environmental Chemistry, New Age International P. Ltd., New Delhi.
- Santra, S. C. (2001) Environmental Science, New Central Book Agencies, Pvt., Ltd. Kolkata



## **Paper XII: Environmental Microbiology and Biotechnology (ENV 921002)**

**(Credit: 3+1+0=4)**

### **UNIT 1: Microorganisms and Environment**

Classification, characteristics, occurrence, distribution and ecological importance of microorganisms; Prokaryotic and Eukaryotic microorganisms; basic concept of major groups of microorganism: bacteria its classification, reproduction and economic importance, ultra structure of bacterial cell; fungi, algae, protozoa, viruses and photoautotrophs, chemolithotrophs, organotrophs and parasites. Microbes in air, water, soil and extreme environment

### **UNIT 2: Basic Biotechnology**

Basic concepts of molecular biology: DNA structure and organization into chromosomes; DNA replication, Repetitive DNA, Coding and non-coding sequences in genomes, Gene structure and expression in prokaryotes and eukaryotes, Mechanics of transcription, translation and their regulation in both prokaryotes and eukaryotes; Basic techniques in genetic engineering, DNA sequencing

### **UNIT 3: Biotechnology and Environment**

Role of Biotechnology in environmental Protection; Microbial interactions; Microbes in wastes degradation, pests and diseases control, Xenobiotics, biodegradation of toxic organic pollutants: pesticides & herbicides; Applications of microbes in removal of heavy metals and other contaminants from water and soil; Microorganisms as bioindicator

### **UNIT 4: Cleaner Bioprocesses**

Concept, need, scope, principles, mechanisms and types of Bioremediation; role of bioremediation in pollution control and Environmental management, advantages and disadvantages; use of microorganisms in bioremediation of soil and oil spills. Release of genetically engineered microbes and environmental risk; Bioleaching, Bio-hydrometallurgy, Biodeterioration, Vermitechnology and Vermicomposting

### **UNIT 5: Eco-friendly Bioprocesses**

Biodegradable and Ecofriendly Products: Biodegradable Plastics, Biosurfactants, Bioscrubbers and Biobeds; Biofuel: concept, characteristics, current status, production, usage, advantages and socioeconomic implications

### **References**

- Patrick K. Jemba, Environmental Microbiology Principles and Applications.
- P. D. Sharma- Environmental Microbiology.
- Singh Shree N. & Tripathi Rudra D., Environmental bioremediation technologies.
- Rao A. S., Introduction to Microbiology.
- Subba Rao N. S. (2004) Soil Microbiology. 4th Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Agarwal S. K., Environmental Biotechnology, APH Publishing Corp., New Delhi.
- Dubey R.C., A Text Book of Biotechnology, S. Chand & Company Ltd., New Delhi.
- Gupta P. K., Elements of Biotechnology, Rastogi Publishing House, New Delh
- Singh B. D., Biotechnology, Kalyani Publishers, New Delhi.

## **Paper XIII: Environmental Toxicology and Industrial Safety (ENV 921003)**

**(Credit: 3+1+0=4)**

### **UNIT 1: Industrial Pollution and Chemical Safety**

Extent of industrial pollution, Public exposure from industrial sources, Hazards by industry, Major chemical contaminants at workplace, Industrial environmental accidents

### **UNIT 2: Occupational Safety, Health and Environmental Diseases**

Asbestosis, Silicosis, Synosis, Asthma, Fluorosis and Allergies; Epidemiological issues - Malaria and Kalaazar; The relationship of occupational hygiene/ safety and disease; Principles and methods of occupational health, Health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals, Health hazard in agriculture - Pesticides and environment, Pesticides and human health

### **UNIT 3: Ecotoxicology**

Introduction to ecotoxicology, Principles of toxicology, Types of toxic substances: degradable and non-degradable; Influence of ecological factors on the effects of toxicity; sigmoid relationships, Corollary of toxicology

### **UNIT 4: Toxicants in the Environment**

Toxic substances in the environment, their sources and entry roots, Ecosystem influence on the fate and transport of toxicants; Transport of toxicants by air and water; Transport through food chain - biotransformation and biomagnification

### **UNIT 5: Man and Environmental Toxin**

Routes of toxicants to human body: entry through inhalation, skin absorption, indigestion and injection; Response to toxin exposures: Dose response, Frequency response and cumulative response; Lethal and sub-lethal doses; Dose-Response relationships between chemical and biological reactions; Detoxification in human body: detoxification mechanisms, organs of detoxification

### **References**

- Shaw I. C. & Chadwick J., Principles of Environmental Toxicology; Taylor & Francis Ltd
- Yassi Annalee, Kjellström Tord, Theo de Kok, Tee Guidotti (2001) Basic Environmental Health
- Morgan Monroe T., Environmental Health
- Koren H., Handbook of Environmental Health and Safety – principle and practices; Lewis Publishers