

M.Sc. in Environmental Sciences

(4 Semester programme)



Department of Environmental Sciences
Central University of Jharkhand
(Established by an Act of Parliament of India, 2009)

Department of Environmental Sciences

M. Sc. in Environmental Sciences

Semester I

Code	Paper	Credit (L+T+P)
ENV/M/411010	Ecology and Ecosystem	2+1+0
ENV/M/411020	Basics of Meteorology and Climatology	2+1+0
ENV/M/411030	Environmental Pollution and Monitoring	2+1+0
ENV/M/411040	Environmental Chemistry	2+1+0
ENV/M/411050	Environmental Laws and Legislation	2+1+0
ENV/M/412060	Ecology Lab & Field visit	0+0+2
ENV/M/412070	Environmental Chemistry Lab	0+0+2

Total Credit: 19

Semester II

ENV/M/421010	Environmental Microbiology and Biotechnology	2+1+0
ENV/M/421020	Environmental Toxicology and Industrial Safety	2+1+0
ENV/M/421030	Instrumentation and Analytical Techniques	2+1+0
ENV/M/426040	Forestry and Wildlife management (Elective)	2+1+0
ENV/M/426050	Biodiversity Conservation (Elective)	2+1+0
ENV/M/426060	Aerosol and Environment (Elective)	2+1+0
ENV/M/4260100	Introduction to Glaciology (Elective)	2+1+0
ENV/M/426070	Air pollution monitoring and control (Elective)	2+1+0
ENV/M/426080	Renewable energy Resources (Elective)	2+1+0
ENV/M/426090	Water and Waste water treatment (Elective)	2+1+0
ENV/M/422100	Toxicology Lab	0+0+2
ENV/M/422110	Environmental Microbiology and Biotechnology Lab	0+0+2

Total Credit: 22

Semester III

ENV/M/511010	Environmental Geology	2+1+0
ENV/M/511020	Environment Impact Assessment and Auditing	2+1+0
ENV/M/511030	Environmental Modelling and Statistics	2+1+0
ENV/M/511040	Fundamentals of Remote Sensing and GIS	2+1+0
ENV/M/516050	Carbon Sequestration and Agro-management (Elective)	2+1+0
ENV/M/516060	Restoration Ecology (Elective)	2+1+0
ENV/M/516070	Solid Waste Management (Elective)	2+1+0
ENV/M/516080	Land Surface processes and micro meteorology (Elective)	2+1+0
ENV/M/516090	Environmental Agriculture meteorology (Elective)	2+1+0
ENV/M/516100	Soil Sciences (Elective)	2+1+0
ENV/M/512110	Remote Sensing and GIS Lab	0+0+2
ENV/M/513120	Field Visit	0+0+2
	Synopsis preparation for dissertation	

Total Credit: 22

Semester IV

ENV/M/524010	Synopsis Presentation	0+0+4
ENV/M/524020	Mid Term Evaluation (Report)	0+0+2
ENV/M/524030	Dissertation (Both soft and hardcopy)	0+0+10
ENV/M/524040	Seminar (PPT presentation)	0+0+4

Total Credit: 20

FIRST SEMESTER

Ecology and Ecosystem (ENV/M/411010)

(Credit: 2+1+0=3)

UNIT 1: Environment

Concept, types and components of environment; Environmental Science: Objectives, principles, and importance; Multidisciplinary nature of Environmental Sciences; Role of Environmental Science in public awareness

UNIT 2: Basic Ecology

Ecology: Concept and Classification; Ecological Factors: Climatic, Topographic, Edaphic and Biotic; Tolerance range and Ecological Amplitude; Ecotypes and Ecads, Ecological Niche

UNIT 3: 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, Productivity, Energy Flow, Biogeochemical Cycle, Homeostasis

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.

Basics of Meteorology and Climatology (ENV/M/411020)

(Credit: 2+1+0=3)

UNIT 1: Introduction

Climatology: Definition, scope, aims and objectives; Subdivisions of climatology; Atmosphere: origin, composition and structure; Insolation and heat budget of atmosphere; Temperature of the atmosphere

UNIT 2: Atmospheric Circulation and Indian Monsoon

Thermal circulation on earth; general circulation of the atmosphere; Surface wind systems in Northern and Southern hemisphere; Wind belts; Westerlies; Polar winds; Jet stream; Different seasons; Distribution of Mean Sea level pressure/temperature in different seasons; Indian rainfall in different seasons; Indian summer monsoon, onset, withdrawal, rainfall distribution, inter annual variability of monsoon

UNIT 3: Meteorology

Meteorological Parameters, vertical motion of air, atmospheric stability, windrose diagram, wind direction frequency, Lapse rate, Temperature inversion, maximum mixing depth, Atmospheric dispersion, Plumes and Plume rise, Dispersion of pollutants; forecasting of meteorological information

UNIT 4: Scale of Meteorology

Precipitation(Process, forms and type of precipitation); Humidity(Hydrological cycle, humidity measurement, factors of evaporation, condensation and its forms), Fogs and cloud

UNIT 5: Climatology

Weather and climate, weather elements, Indian monsoons, *El nino* and *La nino* effects, Atmospheric disturbances: Cyclones and anti-cyclones, Tropical disturbances, Thunderstorms, Weather forecasting

References

- D. S. Lal, Climatology, Chaitanya Publishing House
- H. R. Byers, General Meteorology, 3rd Ed. McGraw Hill Book Company New York, Toronto, London
- Trewartha, Introduction to Weather and Climate

Environmental Pollution and Monitoring (ENV/M/411030) (Credit: 2+1+0=3)

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, 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 2: Water Pollution

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

UNIT 3: Soil Pollution

Introduction, sources, effect and control of soil pollution, Soil quality monitoring, 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: Environmental Monitoring

Basic knowledge and a whole idea of environmental monitoring and its objectives, characteristics and techniques; main environmental standards, importance of quality assurance and quality control system

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

Environmental Chemistry (ENV/M/411040)

(Credit: 2+1+0=3)

UNIT 1: 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 2: Air Chemistry

Chemical Composition of air, Chemical processes for formation of Inorganic and Organic particulate matters, Thermochemical and Photochemical reactions in Atmosphere, Oxygen and Ozone Chemistry, Chemistry of Air Pollutants, Photochemical Smog

UNIT 3: Water Chemistry

Chemistry of Water, Inorganic and Organic Compounds: Carbonates, Sulphates, Nitrates, Phosphates; Concept of DO, BOD, COD, Sedimentation, Coagulation, Filtration, Redox Potential, Buffer in Water System

UNIT 4: Soil Chemistry

Inorganic and Organic components of Soil, Nitrogen pathways and NPK in Soil, Acid-Base and Ion Exchange reactions in Soil, Micronutrients and Macronutrients

UNIT 5: Chemical Toxicology

Toxic Chemicals in Environment, Biochemical Aspects of Arsenic, Cadmium, Fluorides, Lead, Mercury, Carbon monoxide, O₃ and PAN, Pesticides, Insecticides, MIC, Carcinogens in the Environment

References

- S. S. Dara, A Text Book of Environmental Chemistry and Pollution Control, 2004
- P. D. Sharma, Ecology and Environment, Rastogi Publication
- D. K. Asthana & Meera Asthana, Environment: Problems and Solutions, S. Chand Publication
- E. D. Enger & B. E. Smith, Environmental Science – A study of Inter relationships, 5th edition, W C B publication.
- A. K. De, Environmental Chemistry, Wiley Eastern Ltd.
- B. K. Sharma, Environmental Chemistry, Geol. Publ. House, Meerut, 2001
- S. E. Manahan, Environmental Chemistry, Lewis Publishers, Florida, USA
- Tripathi & Goel, Water Pollution and Experimental Approach

Environmental Laws and Legislation (ENV/M/411050)

(Credit: 2+1+0=3)

UNIT 1: Basic Concepts in Environmental Law and Policy

Introduction to environmental laws in India; Constitutional provisions; National Environmental Policy; Constitutional Provisions (Article 48A, 51A); Role of Ministry of Environment & Forests

UNIT 2: Acts, Rules and Regulations

Acts, rules and amendments thereof - Wildlife (Protection) Act 1972, Water (Prevention and Control of Pollution) Act 1974; Forest Conservation Act 1980, Environment (Protection) Act 1986, Environmental Protection Act & Environmental rules 1986. Air (Prevention and Control of Pollution) Act 1981; Biomedical Waste Management Rules, 2016; Hazardous Waste Management & Handling Rules, 2008; Coastal Regulation Zones (CRZ) Rules 1991. Public Liability Insurance Act, 1991. E-waste Management Rules 2016; Solid waste management rules, 2016

UNIT 3: Environment protection laws on large Projects

Legal framework on environment protection-Environment Protection Act as the framework legislation–strength and weaknesses; EIA; National Green tribunal

UNIT 4: International Environmental Treaties and Conventions

Evolution and development of International Environmental laws with reference to Stockholm Conference on Human Environment, 1972, Ramsar Convention on Wetlands, 1971, Montreal Protocol, 1987, Basel Convention (1989, 1992), Earth Summit at Rio de Janeiro, 1992, Kyoto Protocol, 1997; Earth Summit at Johannesburg, 2002. UN Summit on Millennium Development

Goals 2000, Copenhagen Summit 2009, Role of International Environmental Agencies - UNEP, GEF, UNFCCC and IPCC.

UNIT 5: Environmental Ethics and Landmark Judgments

Movements related to Environment – Sacred groves, Bishnoi tradition, Chipko movement, Tehri dam, Narmada dam, Almatti dam, Silent Valley. Supreme Court Cases – Ratlam Municipality, Ganga Action Plan, Taj Trapezium, Delhi CNG

References

- Shyam Divan and Armin Rosencranz (2005), *Environmental Law and Policy in India*, Oxford University Press, New Delhi.
- Leelakrishnan. P (2008), *Environmental Law Case Book*, Lexis Nexis, Butterworths
- Mohanty. S. K. (2011) *Environment and Pollution Law*, Universal Law Publishing Co.Pvt. Ltd.
- Sahasranaman P. B. (2008) *Handbook of Environmental Law in India*, Oxford University Press (India)

Ecology Lab & Field Visit (ENV/M/412060)

(Credit: 0+0+2=2)

1. Field Ecology: Identification of Terrestrial Flora 30-03-2021 Tusar
2. Determine the minimum size of the quadrat by species area curve method
3. Determine the minimum number of quadrats to be laid down in the field.
4. Study of community by quadrat method for determining frequency, density, abundance and species dispersion pattern by A/F ratio
5. Study of community by quadrats method for determining IVI, diversity index, concentration of dominance, evenness index, species richness indices (Dmg & Dmn), and effective number of species
6. Study of different communities by quadrat method for determining the similarity indices (Jaccard and Sorenson)
7. Study of grassland vegetation by line transect method
8. Study of forests vegetation by belt transect method
9. Study of the life-form and biological spectrum of the nearby vegetation of DEVS, CUJ
10. Phenological study of nearby vegetation of DEVS, CUJ campus
11. Stratification study in vegetation of CUJ campus
12. Study of the regeneration status of selected tree species of CUJ campus/nearby forests
13. Determination of allelopathic effects of *Parthenium hysterophorus* on germination of Mung seeds 23-03-2021 Abhijit
14. Determination of leaf area index of selected plant species 30-03-2021 Shreya
15. Determination of carbon content of leaf litter of selected plant species
16. Determination of primary productivity of herbaceous community by harvest method
17. Determination of moisture content and biomass of leaf litter of selected plant species
18. Determination of litter decomposition rate by litter bag technique of selected plant species
19. Determination of seedling survival and monthly growth rate of selected tree species in CUJ campus/nearby forests

Water Quality Parameters

- pH
- Electrical Conductivity
- Alkalinity/Acidity
- Total Solid (TS)
- Total Dissolved Solid (TDS)
- Total Suspended Solid (TSS)
- Hardness
- Free CO₂
- Chloride
- Dissolved Oxygen (DO)
- BOD
- COD

Soil Quality Parameters

- Determination of PH of Soil
- Soil Acidity/Alkalinity analysis
- Determination of EC of Soil
- Determination of Moisture content of soil
- Determination of Bulk Density & Porosity of Soil
- Determination of Water Holding Capacity of soil
- Soil texture analysis
- Determination of Soil Organic Matter
- Determination of Organic Carbon
- Determination of Available Potassium
- Determination of Available Nitrogen and TKN

SECOND SEMESTER**Environmental Microbiology and Biotechnology (ENV/M/421012)****(Credit: 2+1+0=3)**

UNIT 1: Fundamentals of Microbiology

Prokaryotic and eukaryotic microorganisms: Characteristics; Classification, Nutrition and Growth, Structures; Microbes in air, water, soil, and extreme environment,

Microbial Culture: pure culture techniques, Methods of sterilization, Culture Media: physical and chemical types of media and preservation techniques.

UNIT 2: Basics of Biotechnology

Structure of proteins and protein synthesis, general concepts of lipids and polysaccharides; Bonds in biomolecules; Stereoisomerism in biomolecules; RNA and its types, DNA structure

and replication, Repetitive DNA, Coding and non-coding sequences in genomes, Basic techniques in genetic engineering and Recombinant DNA Technology.

UNIT 3: Microbial Fermentation Technology

Introduction to various fermentation processes, Microbial culture selection for fermentation processes, Media formulation and process optimization. Bioreactors; Basic concepts of bioreactors/ fermenters, different types of bioreactors: Scale-up of fermentation processes. Industrial Fermentation Technology.

UNIT 4: Microbial Metabolism and Kinetics

Anabolism and catabolism; Phosphorylation; Glycolysis; TCA cycle; Electron transport chain; Anaerobic respiration; Energy balances; Microbial kinetics; growth curve, growth pattern of microbes in bioreactors: Batch, fed-batch, and synchronous growth; Specific growth rate and doubling time; Monod's model, Enzymes and Enzyme kinetics.

UNIT 5: Cleaner Bioprocesses

Role of microbiology and biotechnology in environmental Protection: Xenobiotics, biosurfactants, bioscrubbers, biobeds, and biofuel; Role of microorganisms in wastewater treatment and metal removal from soil and water: bioremediation; Bioindicator microorganism

References

- Patrick K. Jemba. Environmental Microbiology Principles and Applications.
- P D Sharma- Environmental Microbiology.
- Eweis JB, Ergas SJ, Change DPY and Schroeder ED (1998) Bioremediation – Principles, McGraw-Hill Inc., New York.
- Pelczar MJ Jr., Chan ECS and Kreig NR (1993) Microbiology, Tata McGraw Hill, Delhi.
- Agarwal SK. Environmental Biotechnology, APH Publishing Corp., New Delhi.
- Chatterji AK. Introduction to Environmental Biotechnology, Prentice Hall of India Pvt. Ltd, New Delhi.
- Dubey RC. A Text Book of Biotechnogy, S. Chand & Company Ltd., New Delhi.
- Gupta PK. Elements of Biotechnology, Rastogi Publishing House, New Delhi
- Jones and Barlett. Fundamentals of Microbiology. New Edition-2013.

Environmental Toxicology and Industrial Safety (ENV/M/421020)

(Credit: 2+1+0=3)

UNIT 1: Toxicants in the Environment

Principles of toxicology, toxic substances in the environment, their sources and entry routes, Influence of ecological factors on the effects of toxicity.

UNIT 2: Industrial Pollution and Chemical Safety

Hazards by industry, major chemical contaminants at workplace, major industrial environmental accidents, major environmental diseases; asbestosis, silicosis, synopsia, asthma, fluorosis

UNIT 3:Occupational Health and Safety

Occupational hygiene/safety and disease; principles and methods of occupational health, health issues due to industrial dust, chemicals, noise, pesticides and metals

UNIT 4:Man and Environmental Toxin

Routes of toxicants to human body: entry through ingestion, inhalation and skin/dermal absorption; distribution and excretion of toxicants; dose-response relationships; lethal and sub-lethal doses; LD50, LC50, margin of safety, therapeutic index (TI); detoxification mechanisms in human body.

UNIT 5:Ecotoxicology

Introduction to ecotoxicology, ecosystem influence on the fate and transport of toxicants; transport of toxicants by air and water; transport through food chain-biotransformation and biomagnification

References

- Shaw I. C. & Chadwick J., Principles of Environmental Toxicology; Taylor & Francis Ltd
- Morgan Monroe T., Environmental Health
- Koren H., Handbook of Environmental Health and Safety – principle and practices; Lewis Publishers
- Frank C. Lu, Basic Toxicology: Fundamentals, Target Organs, and Risk Assessment, Taylor and Francis
- Principles of Toxicology, Environmental and Industrial Applications, John Wiley & Sons
- Principles of Ecotoxicology, C. H. Walker, R. M. Sibly, S. P. Hopkin, D. B. Peakall, CRC Press

Instrumentation and Analytical Techniques (ENV/M/421030)

(Credit: 2+1+0=3)

UNIT 1: Sampling Techniques

Sampling equipment for air, water and soil; Sample preparation for trace metal analysis in water and soil: digestion and dissolution techniques; Microwave-assisted digestion

UNIT 2: Separation Techniques

Different separation techniques: Crystallization, Ionic Precipitation, Electrochemical Reduction, Reduction with Gas, Carbon Absorption and Ion Exchange, Solvent Extraction and Electrolytic Processes; Principle and process of solvent extraction, Extraction reagents and its practical applications

UNIT 3: Microscopy

Principle and application and types of Optical (Simple, Compound: Bright and Dark Field, Phase-Contrast, Fluorescence, Oil Immersion, Stereo, Polarizing, Confocal, Confocal Laser scanning, Interference microscope, etc.), Electron (SEM, TEM, REM, STEM) Scanning Probe Microscopes (AFM, STM) and Others (X-ray Microscope, Scanning Helium Ion Microscope, Scanning acoustic microscope and Neutron Microscope)

UNIT 4: Principles of Analytical Methods

Theory, instrumentation and application of Colourimetry, Spectroscopy, Atomic Absorption Spectroscopy, Electrophoresis, X-Ray Fluorescence, X-Ray Diffraction, Flame Photometry and Inductively Coupled Plasma, Mass Emission Spectrometry, Raman Spectroscopy

UNIT 5: Chromatography

Principle, theory and application of Paper, Liquid, Gas and Thin layer chromatography; Ion Exchange Chromatography, High-Performance Liquid Chromatography

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

Forestry and Wildlife Management (ENV/M/426040)

(Credit: 2+1+0=3)

UNIT 1: Introduction

Forest: definition, growth stages, crown differentiation, forest types of India, 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

Social forestry in National Forest Policies, Multipurpose tree species (MPTs), Nitrogen fixing tree species (NFTs), characteristics of MPTs, NFTs. Community participation in social forestry programme, Pattern of planting, calculation of number of plants (line, square, triangular and quincunx), Eco restoration of eroded hill slopes and degraded *Jhum* land

UNIT 3: Agroforestry

Origin and definition, type, gains of agro forestry 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. Shifting and Taungya cultivation

UNIT 4: Introduction to Wildlife

Exploring the History and the Importance of Wildlife Conservation, Species Endangerment, Identifying Problems Caused by Wildlife

UNIT 5: Wildlife Biology and Ecosystems

Understanding Life Processes, Understanding the Food Chain and Natural Selection, Defining Wildlife Habitat and Recognizing Its Importance, Conserving Wildlife and Wildlife Habitat, Creating Wildlife Habitat, Urban Wildlife

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.
- Majumdar, D. N. (1994) *Shifting cultivation in North East India*, Om Sons Publications, New Delhi.

Biodiversity Conservation (ENV/M/426050)

(Credit: 2+1+0=3)

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

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 detail; India as Mega-biodiversity Nation; Endemism: Concept and Types with examples; IUCN Red-List Categories

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

Aerosol and Environment (ENV/M/426060)

(Credit: 2+1+0=3)

UNIT 1: Basic 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 2: 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 3: Particle motion and radiative properties of aerosols

Uniform particle motion: Newton's resistance law and Stoke's law, Aerosol dynamics: nucleation, condensation and coagulation, Radiation properties – visibility, climate effects; principles of particulate control systems

UNIT 4: Spectral Behaviour of Aerosols

Molecular absorption, Summary of important absorbing gases in the atmosphere, Descriptive summary of molecular absorption principles (vibration-rotation etc), Overview of spectral line shapes

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

UNIT 1: Introduction and scope

The cryosphere: importance of Snow and Glaciers, World distribution of existing snow and glaciers and glacier types; transformation of snow to ice; Ice Volume, Water Storage, Glaciers as a source of water in the Himalaya; Climate and Society Linkages; its global and local relevance.

UNIT 2: Glacier Dynamics and Glacier Climate Relationship

Glaciers in equilibrium state, glacier; Glacier Dynamics: Ice flow and geometry- ice flow, glacier flow, ice deformation, Glen's flow law, crevasses formation. Glacier-Climate relationship: Glacier length changes due to climate shift, response time, glacier surface evolution, advance and retreat.

UNIT 3: Glacial morphology

Structure and morphology of glaciers; Glacial erosion; Landscape evolution and different glacial landforms; Deposition and Transportation with special emphasis on mountain/valley glaciers. Glacial hazards and its monitoring: Avalanches, Glacial Lake Outburst Flood (GLOF).

UNIT 4: Glacial Mass Balance and Processes

Mass balance of a glacier and related terms (e.g. ELA, AAR, mass balance gradient), Mass balance variations of mountain glacier; Methods of determining glacier mass balance: Direct glaciological method, Geodetic Method, Hydrological Method, Temperature Index Model, Linear Mass Balance Model, Energy Mass Balance Model.

UNIT 5: Glacial Hydrology

Snow and Glacier Melt and Runoff; Water balance of a glacierised catchment, contribution of melt to stream flow, impact of Climate Change on Water Resources; Discharge measurement methods: Runoff measurements, water level measurements, area velocity method, current meter velocity sensor, tracer method.

References

1. Kurt M. Cuffey & W. S. B. Paterson, (2010): The Physics of Glaciers, Fourth Edition, Elsevier, ISBN No. 9780123694614.
2. Encyclopedia of Snow, Ice and Glaciers (2011): Springer, ISBN No. 9789048126415.
3. Robert Sharp: (1988): Glaciers, First Edition, Cambridge University Press, ISBN: 978-0521330091.
4. Glacier Curriculum jointly compiled by the Swiss Agency for Development and Cooperation (SDC) and The Department of Science and Technology (DST), Government of India. <http://glaciology.in/>
5. Bryn Hubbard, Neil F. Glasser (2005): Field Techniques in Glaciology and Glacial Geomorphology, John Wiley & Sons.
6. M. J. Hambrey, Jürg Alean By M. J. Hambrey, Jürg Alean (2004): Glaciers ,Cambridge University Press.
7. David M. Mickelson, John W. Attig (1999): Glacial Processes Past and Present, Geological Society of America.
8. Matthew M. Bennett, Neil F. Glasser (2011): Glacial Geology: Ice Sheets and Landforms, John Wiley & Sons.
9. Peter G. Knight (2008): Glacier Science and Environmental Change, John Wiley & Sons.
10. Strahler Alan, Strahler Arthur (2007): Physical Geography, Wiley India Pvt Ltd.
11. Douglas I. Benn, David J. A. Evans (2010): Glaciers & Glaciation, Oxford University Press, USA.

12. M. J. Hambrey (1994) : Glacial Environments, UCL Press.
13. W. Kenneth Hamblin & Eric H. Christiansen (2003): Earth's Dynamic Systems (10th Edition), Prentice Hall.
14. Georg Kaser, Andrew Fountain and Peter Jansson (2003): A manual for monitoring the mass balance of mountain glaciers, IHP-VI, Technical Documents in Hydrology, No. 59, UNESCO, Paris.
15. Ostrem, G. & Brugman M (1991): Glacier mass balance measurements, a manual for field and office work, NHRI Science Report No. 4.

Air Pollution and Monitoring (ENV/M/426070)

(Credit: 2+1+0=3)

UNIT1: Introduction to Air pollution:

Air and its composition, Air Pollution, Sources of air pollution and its classification, Major air Pollutants and their characteristics, Specific group pollutants such as CFC, GHG etc. Air Pollutants from various industrial sectors, photochemical smog, Impact of air pollution on human health and vegetation.

UNIT2: Pollutant dispersion:

Temperature lapse rate & stability, wind velocity & turbulence, plume behavior, measurement of meteorological variables, wind rose diagrams, Plume Rise, estimation of effective stack height and mixing depths. Development of air quality models-Gaussian dispersion model

UNIT3: Sampling:

Sampling of particulate and gaseous pollutants (Stack, Ambient & indoor air pollution), Monitoring and analysis of air pollutants (PM_{2.5}, PM₁₀, SO_x, NO_x, CO, NH₃).

UNIT4:Control Techniques andequipment:

Introduction to control methods and equipment for Particulate matter and gases, Design and working of scrubbers, Electrostatic Precipitator, Gravity settlers, Cyclone separator, Filter bags etc. Other mechanisms of air pollution control such as Biochemical Processes, catalytic processes

UNIT5: Vehicular pollution: Air pollution due to automobiles, standards and control methods. Monitoring of vehicular pollutants; sampling and analysis

References:

- Jacobson M.Z. (2002) Atmospheric Pollution: History, Science, and Regulation, Cambridge University Press, Cambridge.
- Godish T. (2003) Air Quality, by Thad Godish, 4th Edition, Lewis Publishers.
- Burlington, M.A. (2008) Fundamentals of Air Pollution. 4th Edition, by Daniel Vallero. Academic Press.
- Holgate S.H. (1999) Air Pollution and Health Eds., Academic Press.
- Steinfeld J., Pandis S. (1997) Atmospheric Chemistry and Physics, John Wiley & Sons, 1997.
- De A.K. (2018) Environmental Chemistry 9th edition, New age international publishers.
- Goldman B. (2018) Air Pollution: Monitoring and Assessment. Callisto publisher.
- O'Neal B (2017) Air Quality Monitoring and Control Strategies. Larsen and Keller Education

UNIT 1: Introduction

Energy basics, Energy efficiency, Energy sources & consumption, Energy conservation, increased efficiency, cogeneration, and Sustainable-energy policy; Role of energy in economic development and social transformation: Energy & GDP, GNP and its dynamics

UNIT 2: Global Energy Scenario

Discovery of various energy sources: Energy Sources and Overall Energy demand and availability, Energy Consumption in various sectors and its changing pattern, Exponential increase in energy consumption and projected future demands; Conventional Energy Resources: Coal, Oil, Natural Gas, Oil Shale and Tar sands; Depletion of energy sources; Status of Nuclear and Renewable Energy: Present Status and future promise

UNIT 3: Indian Energy Scenario

Energy resources & Consumption: Commercial and noncommercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India, their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption; Development and Environment; Energy for Sustainable Development; Energy and Environmental policies; Need for use of new and renewable energy sources in India's perspective

UNIT 4: Alternative energy & the environment

Introduction to Alternative Energy Sources; Solar energy, Water power, Ocean Energy, Wind power; Geothermal Energy, Biofuels

UNIT 5: Environmental Impacts caused by Energy Resources & its Mitigation

Impact of exponential rise in energy consumption on economies of countries and on international relations; Environmental effects of conventional and nonconventional sources of energy; National and international Efforts to mitigate Environmental problem: Kyoto protocol, Rio Summit, Montreal protocol, Carbon credit, etc.

References

- M. Dayal, Renewable Energy – Environment and Development, Konark Pub. Pvt. Ltd.
- D.B. Botkin, E.A. Keller, Environmental Science. Earth as a living Planet, John Wiley & Sons, Inc.
- S. Vandana, Alternative Energy; APH Publishing Corporation
- S. K. Agarwal, Nuclear Energy–Principles, practice and prospects, APH Publishing Corporation
- Chaturvedi, Bio-Energy Resources, Concept Pub.
- J. D. Chapman, Geography and Energy – Commercial energy systems and national policies
- D. S. Chauhan, Non-conventional Energy Resources, New Age International

Unit 1: Water Quality

Water Quality: Definitions & Characteristics; Physical Water Quality parameters, Chemical Water Quality parameters, Biological Water Quality parameters, Water Quality Requirements

Unit 2: Purification

Water Purification processes in natural systems. Physical Processes: Dilution, sedimentation, filtration, gas transfer, heat transfer; Chemical processes; Biochemical processes, Application of natural processes in engineered systems

Unit 3: Water Quality Standard

Assessing water quality - Comparison of various criteria: WHO, Bureau of Indian Standards

Unit 4: Water Treatment

Engineered systems for water purification, Unit processes in water treatment, Identifying and selecting sources, Sedimentation, Mixing, Coagulation and Flocculation, Rapid filtration, Slow sand filtration, Adsorption, Disinfection in potable water supply

Unit 5: Waste Water Treatment

Engineered systems for wastewater treatment and disposal, Unit processes in wastewater treatment, Characteristics of wastewater –Types and flows; Primary treatment: Screening, grit chambers, primary sedimentation; Secondary treatment: Trickling filters, Activated Sludge process, Ponds & Lagoons, Rotating Biological Contractor (RBCs); Disinfection of wastewater, Sludge disposal, Anaerobic digesters

References

- Peavy, Rowe and Tchobanoglous (1985), *Environmental Engineering*, McGraw-Hill International Editions, New Delhi.
- Masters G.M. and Ela W.P. (2016), *Introduction to Environmental Engineering and Science*, Pearson Education, Inc.
- Inc. Metcalf & Eddy (2002), *Wastewater Engineering: Treatment and Reuse*, McGraw Hill Education

Toxicology Lab (ENV/M/422100)**(Credit: 0+0+2=2)**

- To study the effects of heavy metals on the germination of seeds and Seedling Vigour Index
- To study the effects of heavy metals on the root and shoot length of seedlings cultivated in metal contaminated growing medium
- To study the effects of heavy metals biomass of plants (fresh and dry weight of roots and shoots)
- To study the effects of heavy metals on the phytotoxicity and Metal Tolerance Index (MTI)

- To study the effects of heavy metals on the chlorophyll and carotinoide content in the leaf of plants
- To study the effects of heavy metals on carotinoide content in the leaf of plants
- To study the effects of heavy metals on the protein content in the leaf of plants
- To study the effects of heavy metals on carbohydrate content in the leaf of plants

Environmental Microbiology and Biotechnology Lab (ENV/M/422110)

(Credit: 0+0+2=2)

- Preparation of culture media for microbial culture from soil, water and air
- Preparation of bacterial media: Nutrient agar and nutrient broth
- Sub-culturing of bacterial culture.
- Sterilization technique by autoclaving.
- Preparation of fungal media (PDA)
- Preparation of slants and pouring of Petri plates
- Bacteria staining by simple staining method (methylene blue/crystal violet) from curd.
- Micrometric estimation of Microbes
- Camera lucida drawing of fungal spores
- Cell counting by haemocytometer

THIRD SEMESTER

Environmental Geology (ENV/M/511010)

(Credit: 2+1+0=3)

UNIT 1: Basic Geology

Origin, Evolution of earth, Composition of earth, Major endogenic and exogenic processes, geological agents of changing environment viz. tectonics, magnetism, weathering, erosion, and deposition; common geological structure- bedding, fold, faults, cleavages, fractures, deposits and erodibility of rocks.

UNIT 2: Soil Genesis and Management

Parent materials: rocks and minerals; processes of soil formation: weathering, and pedogenesis: soil profile: concept and different horizons, profile development processes; Soil types of India with special reference to Jharkhand; Soil Erosion types and effects, Soil conservation methods

UNIT 3: Natural Hazards and Disasters

Natural and man-made disasters- 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)

UNIT 4: Hydrogeology

Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration and subsurface movement of water. Rock properties affecting groundwater, Vertical distribution of subsurface water Types of aquifer, aquifer parameters, anisotropy and heterogeneity of aquifers

UNIT 5: Groundwater management

Surface and subsurface water interaction, Groundwater level fluctuations, Basic concepts of water balance studies, issues related to groundwater resources development and management, Rainwater harvesting and artificial recharge of groundwater

References

- A. C. Fortescue 1980. Environmental Geochemistry, Springer-Verlag,
- A. H. Bownlow 1978. Geochemistry, Prentice Hall
- J. A. Plant and R. Raiswell 1983. Principles of Environmental Geochemistry, New Academic Press
- D. N. Wadia 1939. Geology of India, Mac Milan

Environmental Impact Assessment and Auditing (ENV/M/511020)

(Credit: 2+1+0=3)

Unit 1: Introduction

Introduction to environment impact assessment, Environmental impact statement and Environmental management plan, ISO14000, EIA guidelines 1994, Notification of Govt. of India, EIA Notification 2009; Environmental impact of human activities: impact of industrialization, modern agriculture, housing, mining & transport on Environment

Unit 2: Techniques and Methodology

Impact assessment methodologies, generalized approach to impact assessment; Procedure for reviewing environmental impact assessment and statement; Impact assessment of Air environment, Water environment, Noise environment, Land environment, Social and Cultural environment; Case studies: river valley projects, thermal power plants, mining projects, oil refineries & petrochemicals, highway projects

Unit 3: Environmental Management System

Introduction & benefits of environmental management system (EMS); Principles & elements of successful environmental management: implementing an EMS, measurement & evaluations required for EMS, environmental management reviews & improvements; ISO principles; creating an EMS in line with ISO: 14000; Legal and regulatory concerns; Integrating ISO 9000 & ISO 14000; Life cycle assessment: Elements of LCA, Life Cycle Costing

Unit 4: International Strategies

International environmental agreements, conventions and protocols; Guidelines of preparation of project report and its evaluation, methods of clearance from the concern authorities at various levels

Unit 5: Environmental Auditing

Concepts, objectives, Steps & Guidelines of environmental audit; Baseline information and prediction (land, water, atmosphere, energy), Restoration and rehabilitation technologies

References

- 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.
- S.K. Dhameja, "Environmental Engineering and Management" S.K. Kalaria and Sons Publishers
- M. Anji Reddy, Textbook of Environmental Science & Technology, BS Publications, 2010
- Technological guidance manuals of EIA. MoEF.
- Canter, EIA

Environmental Modeling and Statistics (ENV/M/511030) (Credit: 2+1+0=3)

UNIT 1: Elementary statistics

- Data Sources, data types, organization of data, Scale of Measurements.
- Organization of data: Review of frequency distribution. Presentation of Data: Tables, Diagrams (Bar, Pie, histogram, polygon and frequency curve).
- Descriptive Statistics: Measure of central tendency, measure of location, dispersion, skewness and kurtosis.
- Matrix theory: Types, Addition, Subtraction, Multiplication and Inverse.
- Mean, Median, Mode, Standard deviation and Standard error

UNIT 2: Correlation, regression and probability

- Correlation: Simple Correlation, Rank Correlation and partial correlation.
- Curve Fitting: Simple linear regression analysis by method of least square, multiple regression
- Sampling: Concept of sample, population, parameter and statistics. Brief review of sampling technique, its type and applications.
- Concept of Probability, Addition, Multiplication and Independence law. Probability distribution, Discrete and Continuous probability distribution. Binomial, Poisson and Normal distribution with Application.

UNIT 3: Hypothesis testing and analysis of variance

- Statistical Hypothesis, One sided and two sided test, General procedure of hypothesis testing.
- Testing of population means for large and small samples (One sample and two samples)
- T-test, F-test and Chi-Square goodness of fit test.
- Analysis of variance: One way and two way analysis of variance test.
- Introduction to non-linear Regression. Simulation of data and Model validation.

UNIT 4: Multivariate Statistics

- Introduction to multivariate techniques, Mean vector, variance and covariance matrix.
- Correlation matrix, testing of population mean vector.
- Principle component analysis.

UNIT 5: Environmental Modeling

- Introduction to Environmental System analysis; Approaches to development of models: Linear, simple and multiple regression models; validation and forecasting; Models of population growth and interactions-Lotka-Volterra Model, Leslie's Matrix model, Point source stream pollution model, Box model, Gaussian plume model; Statistical software and their use

References

- Arora, P. N., Arora, Sumeet and Arora, S. Comprehensive Stat. Methods. S. Chand Pub.
- Sharma, D.D. (2002). Geostatistics with application in earth science, Capital Pub.
- Chiles, J.P., (1999). Geo-statistics: Modeling spatial uncertainty, Wiley Interscience Pub.
- Gupta, S.C. and Kapoor, V. K. (2004). Fundamentals of Mathematical Statistics. Sultan Chand Pub.

Fundamental of Remote Sensing and GIS (ENV/M/511040) (Credit: 2+1+0=3)

UNIT 1: Principles of Remote Sensing

Concepts of Remote Sensing, Physics of Remote Sensing, Stages of Remote Sensing Process, Wavelength regions and their applications atmospheric windows, Interaction of EMR with atmosphere & Earth's Surface, Spectral response pattern, Resolutions-Spectral, Spatial, Temporal and Radiometric

UNIT 2: Space and Photographic Imaging

Introduction, Geostationary & Sun Synchronous, Active and Passive, across track & along track scanning, Earth Resource Satellite Sensor: IRS Series of Satellites, LANDSAT, SPOT, IKONOS, QUICKBIRD, MODIS, RADARSAT, Weather & Communication Satellites: Introduction, NOAA, TERRA, MOS, INSAT, GOES, etc., Advances in remote sensing technologies: Thermal, RADAR, Microwave, Hyperspectral

UNIT 3: Digital Image Processing

Principles of DIP, Image Preprocessing (Geometric Correction & Radiometric Correction), Image enhancement (Spectral, Spatial, Radiometric), Image classification (Supervised & Unsupervised), Ground Truthing and Accuracy Assessment

UNIT 4: GIS, Cartography and GPS

Basic concepts, GIS tools and components , Raster and vector data, Topology, Overlay analysis, Data structure, Application of GIS, Map projection and Scale, Basic elements of map, Digital cartography, Basic principles and Applications of GPS in environmental studies

UNIT 5: Remote Sensing Applications

Brief introduction to Remote Sensing (RS) Applications: Agriculture, Forestry, Land cover/ Land use, Water resources, disaster management- floods, landslide, cyclone, forest fire, drought & Environmental Impact Assessment (EIA)

References

- J. R. Jensen, Remote Sensing of the Environment– An earth resource perspective, Pearson Education
- Heywood, Pearson, An Introduction to GIS
- Martin, Routledge, Geographic Information Systems
- Yadav, Remote Sensing in Land Evaluation, Rajesh Pub
- N. K. Agarwal, Essentials of GPS (2004), Spatial Networks Pvt. Ltd., Hyderabad
- Burrough, Peter A. and Rachael McDonnell (1998), Principles of Geographical Information Systems, Oxford University Press, New York.
- Sathish Gopi (2000), GPS and Surveying using GPS

Carbon Sequestration and Agro-Management (ENV/M/516050)

(Credit: 2+1+0=3)

UNIT 1: Agroforestry and Agroecosystem

Origin and definition, types, and benefits of agroforestry system, Tree and crop management, Production potential of alley cropping, Contour and Terrace farming system, Shifting and Taungya cultivation; Apatani-Wet Rice Cultivation

UNIT 2: Carbon Sink and sequestration

Ecosystem Productivity and Biomass; Carbon sequestration and its importance; Carbon and Ecological Footprint, Food, Environmental and Social security; Agroforestry, Forest and Marine environment as Carbon Sink

UNIT 3: Agro-Management and Carbon Pool

Agricultural Management Practices and Soil Organic Carbon Storage; Carbon Sequestration in Agricultural Soils; Organic agriculture; Integrated Pest and Weed Management; Biofertilizer; Nitrogen fixing Crops

UNIT 4: Climate Change Mitigation through Agroforestry

Carbon Sequestration to Mitigate Climate Change; Soil Carbon Sequestration Impacts on Global Climate Change and Food Security; Potential of agroforestry for carbon sequestration and mitigation of greenhouse gas emissions from soils

UNIT 5: Carbon trading and Carbon credits

Carbon trading; Carbon credits; Carbon Trade Exchange, Carbon Offsets; Carbon credit Network; carbon credit in India

References

- 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.

- Hardy, John T. *Climate Change: Causes, Effects, Solutions*. Wiley & Sons, USA. 2003.
- Harris, F. *Global Environmental Issues*. Wiley & Sons, Inc., USA. 2004.

Restoration Ecology (ENV/M/516060)

(Credit: 2+1+0=3)

UNIT 1: Basics of Restoration Ecology

Restoration ecology its concept, goals and constraints; Natural Ecosystem, Degraded Ecosystem and Wasteland; Community-based restoration and environmental education

UNIT 2: Ecological disturbances

Ecological disturbance and its impact on the structure and functioning of terrestrial and aquatic ecosystems; invasive species biology, control & management, fire and fire regimes; overgrazing and its impacts, floods and draughts, landslides, earthquakes, cyclones and tsunami, volcanoes, shifting cultivation

UNIT 3: Restoration of Degraded Ecosystem

Ecorestoration its needs and strategies; ecosystem reconstructions; physical, chemical, biological and biotechnological tools of restoration; ecological engineering, Restoration of contaminated soils, mined land restoration

UNIT 4: Restoration of biological diversity

Acceleration of ecological succession, reintroduction of biota, restoration of rare and endangered plants species; soil, seed and vegetation dynamics, planting methods and nursery operations

UNIT 5: Management Techniques

Monitoring & assessment techniques, ecological design and sustainability; ethics in restoration ecology, ecological assembly rules, spatial dynamics: metapopulations, corridors, dispersal and refugia; ecoregional planning: prioritizing land for conservation and restoration

References

1. *Restoration Ecology: A synthetic approach to ecological research*. Jordan, W.R., III, M.E. Gilpin, and J.D. Aber. 1987. Cambridge University Press, New York, New York, U.S.A.
2. *Ecology*. Ricklefs, R.E. 1990. Third edition. W.H. Freeman, New York, New York, U.S.A
3. *Terrestrial Plant Ecology*. Second edition. Barbour, M.G., J.H. Burk, W.D. Pitts. 1987. Benjamin/Cummings Publishing Company, Menlo Park, California, U.S.A

Solid Waste Management (ENV/M/516070)

(Credit: 2+1+0=3)

UNIT 1: Solid Waste

Introduction to solid waste, Domestic, Industrial, Biomedical & Hazardous Waste; Sources of solid waste: Industrial, mining, agricultural and domestic; impact of solid waste on environmental health; Concepts of waste reduction, recycling and reuse; Collection & Disposal method

UNIT2: Solid waste processing technologies

Mechanical and thermal volume reduction; Biological and chemical techniques for energy and other resource recovery: composting, vermicomposting, fermentation; Incineration of solid wastes; Disposal in landfills: site selection, design, and operation of sanitary landfills; Leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation

UNIT 3: Municipal Solid Wasteand Management

Handling and segregation of wastes at source; Collection and storage of municipal solid wastes; analysis of Collection systems; Mechanical and thermal volume reduction of MSW; composting, vermicomposting, Incineration of MSW; Disposal of MSW in landfills: Regulatory aspects of municipal solid waste management

UNIT 4: Hazardous Waste and Management

Hazardous waste definition; Physical and biological routes of transport of hazardous substances: sources and characterization categories and control; Sampling and analysis of hazardous, Hazardous waste treatment technologies - Physical, chemical and thermal treatment of hazardous waste, Hazardous waste landfills - Site selections, design and operation; Hazardous waste reduction and Recycling-Regulatory aspects of HWM

E-Waste characteristics, generation, collection, transport and disposal of E waste. Method used for disposal of E waste

UNIT 5: Biomedical and Radioactive Waste Management

Biomedical waste: Definition, sources, classification, collection, segregation Treatment and disposal; Radioactive waste: Definition, Sources, Low level and high level radioactive wastes and their management, Radiation standard by ICRP and AERB

References

- Prof. Y. Anjaneyulu, Hazardous waste management
- Charles A. Wentz, 1995. Hazardous waste management. Second edition; McGraw Hill International.
- George Tchobanoglous, Hilary Theisen &Sammuel A. Vigil, Integrated solid waste management
- Criteria for hazardous waste landfills – CPCB guidelines 2000.
- Daniel B. Botkin and Edward A. Keller, 2009. Environmental Science, Wiley student, 6th edition

Land surface processes and Micrometeorology (ENV/M/516080)

(Credit: 2+1+0=3)

UNIT 1: Micrometeorology

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

UNIT 2: Micrometeorological Features

Distinctive features of micrometeorology compared with macro and mesometeorology

UNIT 3: Meteorological parameters

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

UNIT 4: Land surface processes

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

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, Roultdge Publications, Taylor &Fransis, 2nd ed., 2003
- Sorbjan, Z., Structure of the Atmospheric Boundary Layer. Prentice-Hall, 1989.

Environmental Agriculture Meteorology (ENV/M/516090) (Credit: 3+1+0=4)

UNIT 1: Agrometeorology and Solar radiation

Agrometeorology: Definition and scope, future thrust; Solar radiation and crop plant: A,R,T, selective absorption of green leaf response to spectral radiation components, solar spectra and plant processes

UNIT 2: Meteorological factors in photosynthesis

Meteorological factors in photosynthesis: diffusion process, photochemical process, biochemical process, solar radiation and photosynthesis, Role of CO₂ concentration and turbulence in photosynthesis

UNIT 3: Environmental temperature and crop

Effects of temperature and moisture in plant growth, Soil temperature, thermal properties of soil, soil temperature and crop yield, heat transfer from plant leaves, damage due to freezing temperature and high temperature for crops. Concept of Growing Degree Days (GDD), Soil moisture, water stress and plant Development, Evaporation,transpiration, Evapotranspiration, Rainfall characteristic, Soil and crop growth: Soil water balance, Radiation balance

UNIT 4: Moisture factor and crop growth model

Climatic normal for crop and livestock production, Crop yield forecast model, modeling crop growth and production, Rainfall Climatology for Agricultural planning, sowing dates, Moisture Availability Index (MAI) and Assured rainfall drought, classification, Analysis

UNIT 5: Climate change and crop production

Climate change and crop production, weather forecasting for Agriculture, Crop weather calendar, Effects of Pest and diseases in Agriculture production

References

- Hand book of Agricultural Meteorology, Edited by J.F.Griffiths
- Drought Management on Farmland by J.S Whitmore Kluwer Academic Publisher
- Introduction to Agrometeorology by H.S.Mavi

Soil Science (ENV/M/516100)

(Credit: 2+1+0=3)

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, mineralization, eluviation and illuviation, Factors affecting soil formation, soil profile: concept and different horizons, morphological characteristics of soil profile, profile development processes: podzolization, laterization, gleization, melanization, calcification

UNIT 2: Soil Morphology

Soil and its components, soil air, soil water, soil water retention (water holding capacity), texture; structure (soil aggregation) and other physical, chemical and biological properties; soil classification and major soil types of India with special reference to Jharkhand;

UNIT 3: Soil Fertility

Soil microbes and its role in soil fertility, soil organic matter decomposition, nutrient cycling in soil, immobilization and mineralization, forms and availability of soil nutrients, integrated plant nutrients management, soil Conditioners (soil amendment)

UNIT 4: Soil and Plant Nutrients

Major, minor and trace elements essential for plant growth; essential plant nutrients: sources, functions and nutrient deficiency symptoms in plants

UNIT 5: Soil Erosion and Management

Soil erosion: types and mechanism of erosion, factors affecting soil erosions, effects of soil erosion; methods of soil conservation: biological and mechanical

References

- M. M. Rai, Principles of Soil Sciences; Mc. Millan Publishers India Ltd.
- R. S. Shukla & P. S. Chandel, A Text Book of Plant Ecology including Ethnobotany and Soil Science
- P. D. Sharma, Ecology and Environment, Rastogi Publication
- Dhyani Singh, P. K. Chonkar and B. S. Dwivedi, Manual on Soil, Plant and Water Analysis, Westville Publishing House.
- D. K. Das, Introductory Soil Science, Kalyani Publishers
- C. E. Millar, and L. M., Turk. Fundamentals of Soil Science, Biotech Books
- D. Henry, and H. D., Foth, Fundamentals of Soil Science, Wiley.

Remote Sensing and GIS Lab (ENV/M/512110)

(Credit: 0+0+2=2)

- Familiarization with topographical sheet and satellite images, base map preparation through visual image interpretation.
- Digital Image Processing Erdas Imagine: Geometric correction, mosaicking, subset, NDVI, supervised & unsupervised Classification, accuracy assessment.
- Digitization and thematic data preparation and overlay analysis using ArcGIS software
- Map composition using ArcGIS.
- Hands-on exercise of GPS & DGPS and applications in environmental survey and monitoring

Field Visit (ENV/M/513120)

(Credit: 0+0+2=2)

Synopsis Preparation for Dissertation

FOURTH SEMESTER

ENV/M/524010	Synopsis Presentation	0+0+4
ENV/M/524020	Mid Term Evaluation (Report)	0+0+2
ENV/M/524030	Dissertation (Both soft and hardcopy)	0+0+10
ENV/M/524040	Seminar (PPT presentation)	0+0+4
