

**UNIVERSITY OF PUNE**  
**Revised Syllabus effective from 2008-09 for**

**M. Sc. Environmental Science**

<b>Term</b>	<b>New Course Number</b>	<b>Title of Course</b>	<b>Theory /Thesis Optional /Practicals</b>
<b>I</b>	101	Environmental Geosciences	Theory
	102	Environmental Chemistry	Theory
	103	Environmental Biology	Theory
	104	Statistical and Research Methods	Theory
	105	Practical Courses + Field Work	Practicals
<b>II</b>	201	Environmental Economics	Theory
	202	Water and Wastewater Engineering	Theory
	203	Environmental Pollution: Water and Soil	Theory
	204	Environmental Law, Ethics and Policy	Theory
	205	Practical Courses + Field Work	Practicals
<b>III</b>	301	Air pollution and Climate Change	Theory
	302	EIA and Environmental Auditing	Theory
	303	Remote Sensing and GIS	Theory
		<b>Any one of the optional</b>	
	311	Restoration Ecology	Theory-Option 1
	312	Biodiversity and Conservation	Theory-Option 1
	304	Practical Based on courses opted	Practicals
		Selection of topic for Dissertation should be assigned at the end of second semester and assessed at the end of fourth semester) and Summer Training placement	
<b>IV</b>	401	Environmental Toxicology, Health and Safety	
	402	Watershed Management	
	411	Forestry and Habitat Management	Optional
	412	Environmental Planning and Management	Optional
	413	Environmental Management Systems (Theory and Job Licensing)	Optional
	404	Practical based on above	Practical
	405	Dissertation (Continue)	Thesis

**SEMESTER-III**  
**ENV 301 – AIR POLLUTION AND CLIMATE CHANGE**

<b>Air Pollution:</b>	<b>02 L</b>
Composition of Air, Chemical composition of atmosphere, Reactions in troposphere, stratosphere, mesosphere and ionosphere	
<b>Classification and effect of air pollutants:</b>	<b>04 L</b>
Classification of air pollutants, sources, effects of pollutants Particulates, NO <sub>x</sub> , SO <sub>x</sub> , and Oxides of Carbon and hydrocarbons, wet and dry deposition on plants, animals and properties, acid rains	
<b>Vehicular Pollution:</b>	<b>04 L</b>
Automobile emissions, dispersion of vehicular pollutants, carcinogenic potential of the automobile exhaust, prevention and control of vehicular pollution, alternative fuels, SPM pollution, path of a particulate particle, lead pollution, methyl tertiary butyl ether pollution through different technologies.	
<b>Greenhouse effect:</b>	<b>04 L</b>
Green house gases and their major sources, greenhouse effect and climate change, global temperature global warming and its effects agriculture, health and monsoon pattern	
<b>Aerosols:</b>	<b>02 L</b>
Sources of aerosols, classification and size of aerosols, adverse effects of aerosols, aerosols and health, cloud seeding	
<b>Industrial Air Pollution:</b>	<b>06L</b>
Point and non-point sources of air pollution, Principle causes of industrial pollution, environmental problems of some industries, thermal power plants and pollution, nuclear power plants, agro based industry, pulp and paper industry, plastic industry, mining and metallurgy industry, cement industry, Preventive measures of industrial pollution.	
<b>Ozone layer – the Earth’s umbrella –</b>	<b>03 L</b>
Creation of ozone layer, formation of ozone, mechanism of ozone depletion, Null and Holding cycles, Antarctic and arctic ozone hole formation, effects of ozone depletion, CFC and Ozone depletion, Montreal Protocol	
<b>Analytical methods for air quality analysis:</b>	<b>02 L</b>
Air monitoring instruments and technique, Monitoring of sulphur dioxide by different methods, monitoring of NO <sub>x</sub> , CO, hydrocarbons, SPM, trace metals.	
<b>Prevention and control of air pollution through different technologies:</b>	<b>04 L</b>
Control of air pollution by fuel selection and utilization through process modification with examples, General methods of air pollution control: zoning, air pollution	

**Equipments for Control of air pollution: Principle and working of following 09 L**

Control of particulate matter, **Cyclones** – cyclones and inertial separators

**Wet scrubbers** – wet scrubbing basics, types of wet particulate collectors, venturi scrubber, spray tower, cyclonic scrubber, plate and tray scrubber

**Electrostatic precipitators** – types of ESP, **Fabric filters** – Fibre types, media selection, shaker cleaning, reverse air cleaning, pulsejet cleaning

Control of gaseous pollutants - **Absorption** - packed column, Adsorption, Condensation, Vapour incineration

**Climate Change and Clean Development Mechanism: 08 L**

IPCC (Intergovernmental Panel on Climate Change), UNFCCC (United Nations Framework Convention on Climate Change), Kyoto Protocol, Clean Development Mechanism, Carbon sequestration, carbon trading, Certified emissions reduction, Green House Effect, Global Warming

**Suggested Readings:**

1. Environmental chemistry by B.K.Sharma Goel publishing house, Meerut.
2. Elements of environmental chemistry – H.V. Jadhav Himalaya Publishing house.
3. Environmental Chemistry – M.Satake, Y.M. DU edited by M.S. Sethi, S.A.Iqbal Discovery publication house, New Delhi.
4. Air Pollution Control by CP Mahajan, Capitol Publishing Co
5. Air Pollution by HVN Rao and M N Rao Tata McGraw-Hill
6. Air Pollution Engineering Manual Ed- Wayne T Davis, Air and Waste Management Association, Wiley Interscience
7. Environmental Engineers Handbook by David Liu and Bela Liptak
8. Standarad handbook of Environmental Engineering by Robert Corbitt, McGraw Hill
9. Text of the Kyoto Protocol on [www.unfccc.int](http://www.unfccc.int)
10. Clean Development Mechanism by Winrock International, India
11. Environmental Meteorology by B. Padmanabhan Murthy

### ENV 302: EIA AND ENVIRONMENTAL AUDITING

<b>Introduction :</b> Environmental Assessment process, objectives of EIA, Terminology, Hierarchy in EIA, Historical Review of EIA, Concepts related to EIA, Basic data collection for EIA	<b>05 L</b>
<b>Legislation and Procedures:</b> National Environmental Policy Act and Implementation, EIA legislative requirements and administrative procedures in India/Indian States, EIA notification 2006	<b>04 L</b>
<b>Techniques and Methodology:</b> Description of the environmental setting, Methods of Impact Analysis, Environmental risk assessment, baseline data collection for EIA	<b>05 L</b>
<b>Public Participation</b> in environmental decision making, regulatory requirement, techniques, advantages and disadvantages of public participation	<b>03 L</b>
<b>Preparation and writing of EIA report</b>	<b>02 L</b>
<b>Prediction and Assessment of Impacts</b> on Air, Water, Noise, Biological, Cultural and socio-economic Environment, Mining, blasting	<b>06 L</b>
<b>Case studies of EIA</b> for Industries like Oil, Petrochemical, iron and steel, fertilizer, sugar and distillery, projects of road/dams and housing etc.	<b>10 L</b>
<b>Environment Management Plan:</b> Planning, selection of appropriate procedures, Introduction to Environmental budget, to minimize environmental Impacts	<b>05 L</b>
<b>Environmental Audit:</b> Definition of Environment Audit and its importance for industries. Types of audits, General audit methodology and basic structure of audit. Elements of an audit process and its importance. Concept of ISO14000	<b>04 L</b>
Requirements of Rule 14 for Environmental Audit under Environmental protection Act 1986, Definitions of a. Signatory, b. Consumption Audit, c. Pollution audit, d. Hazardous audit, d. Solid waste audit, e. Disposal audit, f. Cost audit, g. Investment audit, h. Voluntary.	<b>04 L</b>

#### Suggested Readings:

1. Larry W. Canter, "Environment Impact Assessment", McGraw-Hill Book Company, New York
2. G.J. Rau and C.D. Weeten, "Environmental Impact Analysis Hand book, McGraw Hill, 1980.
3. Vijay Kulkarni and T V Ramchandra. "Environmental management" Capital Publishing Co
4. Mhaskar A.K., "Environmental Audit" Enviro Media Publications.
5. S.K. Dhameja, "Environmental Engineering and Management" S.K. Kalaria and Sons Publishers.

### ENV-303: REMOTE SENSING AND GIS

- Remote Sensing: Remote sensing system: historical perspective,** Definition, basic principals, process of data acquisition, storage, analysis and presentation, energy source for remote sensing, radiation principles, energy-matter interactions, data acquisition and interpretation, global positioning System, successful application of Remote Sensing **04 L**
- Photogrammetry:** Elements of Photographic Systems -Introduction, Early History of Aerial photography, Ventage points, types of photography on thebasis of flights, cameras, film etc. Basic Geometric Characteristics of Aerial Photographs - Photographic Scale, Ground Coverage, Aerial Measurement, Relief Displacement of vertical Features, Image Parallax, Ground Control, Mapping and Flight Planning **04 L**
- Types of Remote Sensing:** Active and passive remote sensing, Introduction to multispectral scanning, Across-Track and Along –Track Scanning, Operating Principles Multispectral Scanners, Thermal Radiation Principles, Interpreting Thermal Scanner Imagery, Hyperspectral Sensing, Microwave and Lidar Sensing, Radar Remote Sensing From Space, Passive Microwave Sensing, Lidar **04 L**
- Visual and Digital image processing:** Introduction, photographic elements for visual interpretation, Image Rectification, Enhancement, Manipulation, Classification - Supervised and Unsupersived, Hybrid, Post classification Smoothing, accuracy assessment, Data Merging and GIS Integration, scale Effects, Image Trasmission and Compression. **04 L**
- Earth Resources Satellites:** Introduction, Early History of space Imaging, Landsat Satellite Program, SPOT Satellite Program, Other Earth Resource Satellites, Meteorological Satellites Earth Observing System, Space Station, IRS series **04 L**
- Applications of Remote Sensing:** Visual Image Interpretation, Land Use / Land Cover Mapping, Geologic and Soil Mapping, geomorphology, lithology, Agricultural applications, Forestry applications, Rangeland applications, Water Resource applications, Urban and Regional Planning application, Wetland Mapping, Wildlife Ecology applications, Archaeological applications, Environmental and Disaster Assessment. **04 L**
- Fundamentals of GIS:** Introduction - Definitions and Terminology, Components of GIS, GIS Workflow, GIS Categories, Levels/Scales of Measurements **04 L**
- Digitization:** point, line, polygon, attribute data, various techniques of digitization, rasterization and digitization **04 L**

**Spatial Data Modeling:** Stages of GIS Data Modeling, Representation of Spatial Data, Raster and vector Data Representation, Raster and vector GIS Models, Comparison (4) **04 L**

**GIS Data Management:** Data Base Management Systems (DBMS) – Components, Data File Management, Data Base Models, data storage, Representations for Spatio-Temporal Data. **Data Input and Editing:** The Data Stream - existing datasets, data creation, Data Inputs Methods, GPS for GIS Data Capture, data Editing, detecting and correcting errors, data reduction and generalization methods. **Data Analysis and Modeling:** Introduction, Format Conversion, Digitization process, Scan Digitizing Systems, DTM Generation, GIS Output, Maps As Output, Graphical Outputs, Interpretation of GIS data **08 L**

**Integration of Remote Sensing and GIS** **04 L**  
Introduction, Remote Sensing and GIS Synergy, Raster Data For GIS, Vector Data For GIS, Need For Integration, General view On applications, Software Scenario (4)

#### **Suggested Readings:**

- Textbook of Remote sensing and GIS (Third edition, 2006) by M. Anji Reddy BS Publication, Hyderabad
- Fundamentals of remote sensing (Second edition, 2005) by George Joseph Universities press (India) Private Ltd., Hyderabad.
- Remote sensing and image interpretation (Fifth edition, 2007) by Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chapman Wiley India publication, New Delhi .
- Remote sensing of the environment (2000) John R. Jensen, Dorling Kindersley India Pvt. Ltd,
- Current sciences special issue remote sensing for national development Volume 61 numbers 3 and 4 August 1991

**ENV: 311 RESTORATION ECOLOGY (OPTIONAL)**

<b>Restoration Ecology:</b> Definition, Concept. Role of basic ecological principles and restoration ecology: biotic and abiotic interaction, ecological succession, role of pioneer species in restoration.	<b>08 L</b>
<b>Restoration of degraded ecosystem:</b> Soil, role of soil microflora-rhizosphere flora and decontamination of soils with case studies. Bioremediation and phytoremediation- concept. Bioremediation of mines soil dumps, ecological restoration of degraded ecosystems and wastelands, restoration of saline, alkaline soils, hydrocarbon and heavy metals contaminates sites. Bioscrubber for removal of obnoxious odors. Control measures for the leachates from solid-waste dumping areas.	<b>08 L</b>
<b>Restoration degrade aquatic ecosystems:</b> role of plants and microbes. Restoration of riverine and coastal ecosystems, Wastewater treatment using constructed wetlands.	<b>04 L</b>
<b>Watershed Management :</b> Introduction to watershed, concept and significance. Physical characteristics of watershed. Hydrological characteristics of watershed. Land-use and land-cover classification, resource appraisal.	<b>04 L</b>
<b>Water and soil conservation measures :</b> Drain-line treatment; Area treatment-Goals, features and watershed as unit of sustainable development. Selection of plant species for plantation. Organic farming and organic fertilizers.	<b>06 L</b>
<b>Social Institutions:</b> Gram-Panchayat, Self-help Groups for Women, Farmer. Managed small-scale irrigation systems (cooperative – Lift-irrigation); Watershed Development Committees. Roof-top Water Harvesting and Watershed Development for Semi-urban Areas. Problems of Scaling up the Watershed Approach.	<b>06 L</b>
<b>Agro-forestry systems :</b> (a) Classification; (b) Agrosilvopastoral systems; (c) Silvopastoral systems; (d) Land Agroforestry. Silviculture, (a) Role of exotics; (b) Ethnosilvicultural refugia. horticulture and pastureland	<b>10 L</b>
<b>**Current Developments in the Subject.</b>	<b>02 L</b>

**Suggested Readings:**

- Reed, S.C., Crites RW and Middlebrooks EJ 1995: Natural system for waste management and treatment. McGraw Hill
- Bradshaw; Restoration of wastelands
- Wasteland Development – Khan, *et al.*,
- Forestry – Segreiya : Champion and Seth.
- Wasteland News : Periodical.
- Watershed Manual by Bharat Kakade (BAIF, Pune)

## **ENV 312 - BIODIVERSITY AND CONSERVATION (OPTIONAL-I)**

<b>Introducing Biodiversity and its assessment:</b>	<b>02 L</b>
Introduction, Concept, Definition, Aims and objectives, need for assessment, Scope of Biodiversity Science	
<b>Characterization of Biodiversity:</b>	<b>03 L</b>
Introduction, need for characterization, various disciplines of Biodiversity- Evolutionary, taxonomic, Ecology, Genetics, Population, composition and levels of biodiversity, Ecological, Organismal, genetic and cultural diversity, alpha-Beta-Gama diversity, process of diversification at genetic and species level	
<b>Magnitude and distribution of biodiversity:</b>	<b>03 L</b>
Introduction, Distribution: Geographical pattern, Gradients, Centers of diversification, introduced species, domestication and rarity, biodiversity patterns, environmental factors, ecological theories of species diversity, endemism and biodiversity,	
<b>Biodiversity Loss:</b>	<b>06 L</b>
Loss of Species and Genetic Diversity: Introduction, Factors causing loss of species and genetic diversity, Founder Effects, Demographic bottlenecks, Genetic Drift, Inbreeding Depression, IUCN Threatened species Categories Loss of Ecosystem Diversity: Factors Affecting Ecosystem Degradation & Loss	
<b>Reasons for Loss in Diversity of Major Ecosystems of the World</b>	
Loss of Agro-biodiversity, Loss of Biodiversity as an Economic Process	
<b>Biodiversity and Ecosystem Functioning:</b>	<b>04 L</b>
Introduction, biodiversity and ecosystem services, functional properties of biodiversity, drivers and dynamics of changes in biodiversity, ecosystem analysis	
<b>Inventorying and Monitoring of Biodiversity:</b>	<b>04 L</b>
Introduction, Necessity, scales, planning and approaches to inventorying and monitoring, integrated approaches, capacity building.	
<b>Management of Biodiversity</b>	<b>07 L</b>
Organizations Primarily Involved in Framing Policies and Methodologies for Execution such as IUCN, UNEP, UNESCO, WWF, ICSU, FAO, CAB International, WCMC, ISBI. Organizations Involved in Financing Biodiversity Management: GEF, WHF. Biodiversity Legislation and Conventions: Introduction, International Biodiversity Law. Convention on Biological Diversity, Trade-related Intellectual Property Rights, CITES, Ramsar Convention, National Legislation: Environmental Protection Act 1986, Biodiversity Act, Biodiversity Rules and Regulations.	

**Data and information management:**

Introduction, nature and uses, data collection and management, tools and techniques, sources, legal aspects, institutional capacity development

**Biotechnology:**

04 L

Introduction, Biotechnology and its Role in Assessment of Biodiversity and Bioresources, Conservation, and Utilization. Adverse Impacts of Biotechnology on Biodiversity: Direct Impacts, Indirect Impacts

**Economic value of Biodiversity:**

02 L

Introduction, Biodiversity Values, Ethical and Aesthetic Values, use and non-use values

**Conservation of Biodiversity:**

08 L

Introduction, necessity, Current Practices in Conservation, Conservation of Genetic Diversity, Species Diversity, Ecosystem Diversity, *In-situ Conservation*: Protected Areas: Introduction, Biosphere Reserves and National Parks, On-farm and Home Garden Conservation, *Ex-situ Conservation*: Germplasm Collections, Botanical Gardens, Seed Banks, Test-tube Gene Banks, Pollen Banks, Field Gene Banks, DNA Banks, *In-vitro* Conservation Methods, Ecosystem Restoration, *Social Approach to Conservation and Indigenous Knowledge Systems*: Sacred Groves, Sthalavrikshas, People's Movement for Biodiversity Conservation, Participatory Forest Management, Role of Universities and other Educational Institutions in Biodiversity Conservation such as Biodiversity Awareness Programmes and Biodiversity Education Resources, Media, Concept of Sustainable Development

**Biodiversity Prospecting and Indigenous Knowledge Systems:**

05 L

Bioprospecting, Indigenous Knowledge Systems, Bio-piracy IPR's and Ownership of Traditional Knowledge, Traditional Resource Rights Problems and Prospects in Participatory Management of Biodiversity

**Suggested Readings:**

- An Advanced Textbook on Biodiversity-Principles and Practice (2003), K.V. Krishnamurthy, Oxford and IBH Publ. New Delhi
- Biodiversity and Conservation (2005), Michael J. Jeffries, Routledge, London
- Biomass Studies – Field Methods for Monitoring Biomass (1997), Shailaja Ravindranath and Sudha Premnath. Oxford and IBH, New Delhi.
- Ecological Census Techniques – A Handbook (1997). William J. Sutherland. Cambridge Uni. Press.
- Ecological Diversity and Its Measurement (1988). Magurran Anne. Chapman and Hall India
- Ecological Methods for field and Laboratory investigations (1984) Michael P., TMH Co. Ltd. Bombay.
- Forest Genetic Resources: Status, Threats and Conservation Strategies (2001), Uma Shaanker, R. Ganeshiah, KN. and Bawa KS (Eds); Oxford and IBH, New Delhi
- Global Biodiversity Assessment (1995), Heywood and Watson (Edt.) UNEP, Cambridge University Press.
- Global Biodiversity: Status of the Worlds Living Resources (1992); WCMC; Chapman and Hall, London

- Handbook of Biodiversity Methods – Survey, Evaluation and Monitoring (2004) Edt.- David Hill, Matthew Fasham, Graham Tucker, Michael Shewry and Philip Shaw; Cambridge
- Handbook of the Convention on Biological Diversity (2001), Secretariat of the Convention on Biological Diversity. Earthscan publ., London
- Molecular Markers, Natural History and Evolution (1994), Avise JC; Chapman and Hall, London
- Paradise Lost? The Ecological Economics of Biodiversity (1994); Barbier EB, Burgess JC and Folke C.; Earthscan, London
- Plant Diversity Hotspots in India – An Overview (1997) Edt.- Hajra P.K. and V. Mudgal, BSI
- Plant Ecology (1938). John E. Weaver and F.E. Clement. Mc Graw-Hill. NY.
- Preservation and Valuation of Biological Resources (1990); Orians GH, Brown GM, Kunin WE and Swierbinski JE.; Univ. Washington Press
- Restoration of Endangered Species (1996) edt- Bowles M.L. and Whelan C.J.; Cambridge Univ. Press.
- Status, Conservation and Management of Wetlands (2002). T.V. Ramchandra, R. kiran, N. Ahalya., Allied Publ. New Delhi.
- This Fissured Land: An Ecological History of India (1992) Gadgil M. and Guha R.; Oxford University Press, New Delhi
- Understanding Biodiversity- Life, sustainability and Equity (1997) Ashish Kothari; Orient Longman

### **ENV-304: PRACTICAL BASD ON ABOVE COURSES**

**STUDENTS ARE EXPECTED TO COVER 06 PRACTICALS FROM EACH OF THE OFFERED COURSES FROM THE ABOVE INCLUDING THE OPTIONAL COURSE**

#### **AIR POLLUTION AND CLIMATIC CHANGE (ANY 06 PRACTICALS)**

- Comparative analysis of air sampling from clean and polluted area using key parameters. (2 P)
- Collection and Interpretation of weather data (Calculation of stability and wind rose diagrammes, field visit to observatory) (2 P)
- Measurement of sounds by DB meter in silent, industrial, residential and commercial zones. (2 P)
- Carbon sequestration in vegetation and soil (4 P)
  - Estimation of above and below ground biomass
  - Calculation for total carbon sink
  - Estimation of soil organic carbon
  - Estimation of dead wood and litter for carbon
- Estimation of Carbon di oxide from air sample (2 P)

#### **EIA AND ENVIRONMENTAL AUDIT (ANY 06 PRACTICALS)**

- Content of EIA studies and collection of secondary data for at least 3-4 developmental projects and preparation of the report.
- Environmental audit : protocols and data collection and analysis
- Field work for rapid EIA studies and environmental audit (3-4 days duration).

#### **REMOTE SENSING AND GIS (ANY 06 PRACTICALS)**

- Explore various software's used for Remote Sensing image analysis and GIS and Demonstration of any working GIS model from the Government / Non Government officials, Demonstration on any application of RS data (3 P)
- Analysis of aerial photographs by using stereoscope (3 P)
- Visual interpretation of Satellite photographs using FCC (3 P)
- Acquisition of Google Earth images for the known and unknown area for land use - land cover mapping (3 P)
- Interaction of GIS and RS/ toposheet data – digitization, raster-vector conversion etc. (3 P)

#### **BASED ON OPTIONAL PAPER - BIODIVERSITY (ANY 06 PRACTICALS)**

- Study of morphological and structural adaptations of locally available hydrophytes, mesophytes, xerophytes, halophytes and epiphytes and associated fauna to correlate with their particular habitats (3 P)
- Analysis of similarity and diversity indices using phytoplankton from two water bodies (2P)
- Find out various diversity indices with the help of computer software (2P)

**RESTORATION ECOLOGY (ANY 06 PRACTICALS)**

- Isolation of microbes from contaminated soils and analysis of their potential for bioremediation using any contaminated site/s (3P)
- Analysis of key parameters from inlet and outlet of Phytoremediation bed using wastewater treatment (3P)
- Visit to reclamation sites (2P)

**SEMESTER-IV**  
**ENV 401: ENVIRONMENTAL HEALTH AND TOXICOLOGY**

<b>Safety, Health and Environment:</b>	<b>04 L</b>
Perspectives and concerns, interrelationship and interactive approach, development projects and related aspects of safety and health, environment as the ultimate beneficiary / loser.	
<b>Safety and Health Hazards :</b>	<b>04 L</b>
Identification of potential safety and health hazards in industrial and development projects, reduction strategies, policies and legislation, international and national perspective, safety standards and management systems, ISO 18000. Industrial health safeguards and implementation mechanisms.	
<b>Health and Safety Risk Management :</b>	<b>06 L</b>
Risk identification, allocation and mitigation strategies, responsibilities and authority, potential of health risks in industrial and development processes, local and national policies, public awareness and participation in prevention procedures. Industrial environmental conditions, emissions and noise abatement.	
<b>Toxicology :</b>	<b>08L</b>
Basic concepts, toxicity and its impacts, industrial toxicants and hazardous materials, toxic and hazardous waste management, measurement of toxicity, TLM and lethality studies, physiological and metabolic effects on flora and fauna.	
<b>Evaluation of toxicity</b>	<b>08 L</b>
Methods used to assess toxicity classification of toxic materials. Physiological and metabolic effects of toxicants, such as VOC and organic solvents, used in industry heavy metals such as Mg Cl, Cu, Pb, Al, AS, Zn, Mutagenic and carcinogenic compound. Anti cancer drugs.	
<b>Water and airborne Diseases :</b>	<b>08 L</b>
Potential and widespread effects, water and airborne bacteria and viruses, human immune-system and its vulnerability to these bacteria and viruses, preventive and curative measures, epidemics and their containment, biological warfare and protective measures. Safeguarding water sources and ambient air quality, disaster management.	
<b>Human Environment and Health Status in Urban and Rural India :</b>	<b>08 L</b>
Water and sanitation situation in urban and rural context, historical perspective, WHO and other bodies and their role in public health projects development, eradication programs and their efficacy, development impacts in urban and rural sectors, psychological impacts, public awareness of sanitation and hygiene issues and role of NGOs.	
<b>Current developments in the subject</b>	<b>02 L</b>

### ENV 402 – WATERSHED MANAGEMENT

- Concept of watershed management:** Definition of watershed, principle, objectives, benefits, causes of deterioration, consequences, identification of problems. **02 L**
- Characteristics of watershed:** Delineation, coding, geomorphological characteristics, linear aspect, aerial aspect and relief aspect. **02 L**
- Land capability classification:** objectives, role of soil characteristics, external factors, climatic factors, scheme for classification, characteristics of land classes, land use. (Case Studies) **04 L**
- Watershed resource appraisal:** watershed survey, guidelines, data requirement, institutions and cultural aspect, resources appraisal techniques, resource map, watershed problem, format for resource appraisal. **03 L**
- Watershed planning:** need, level of planning, planning for land use and soil conservation, planning for watershed protection, planning for rural and integrated watershed development, plan formulation, implementation of the plan, monitoring, evaluation and follow up, constraint, management alternatives, use of format for planning for case study. **04 L**
- Watershed and environment:** environmental assessment, monitoring parameters, environmental impact of watershed projects, environmental impact assessment, improvement in the environmental quality, environmental regeneration. **03 L**
- Peoples participation in watershed development and management:** rational factors, incentives, mobilization of peoples, peoples organization, participatory rural appraisal, techniques for promotion of peoples participations, role of women. **02 L**
- Hydrological process in watershed:** hydrological cycles, computation, measurement and estimation of precipitation, interception, infiltration, evaporation, evapo-transpiration, surface runoff, ground water-flow. **04 L**
- Soil erosion process:** types, mechanism and estimation of water erosion, wind erosion, factors affecting water and wind erosion and its estimation **04 L**
- Conservation measures for erodible land:** Contour farming, strip cropping, tillage practices, mulching, vegetative ridges, biological measures, mechanical measures for water erosion control, counter bunds, graded bunds, terraces, vegetative waterways, diversion drains. **04 L**

**Conservation measures for non- aerable lands:** contour trenches, staggered, continuous gully control measures, temporary structures, reclamation of ravine land, improvement of grasslands, rehabilitation of mined lands **04 L**

**Role of horticulture, forestry and agro- forestry:** Agro-forestry: Objectives, benefits, different systems, Regeneration, Conservation through improved practices - horticulture, forestry **04 L**

**Storage and control of water:** Objectives, functions, traditional methods, nala band, different techniques of water harvesting and storage of harvested water **02 L**

**Farming system in watershed:** watershed based farming systems, crop-production technology, dry land farming, livestock production, energy plants, and sericulture.. **02 L**

**Monitoring and evaluation of watershed projects:** Need, target groups, selection of indicators, evaluation of self help groups, ecosystem management challenges. **02 L**

**Watershed development programmes:** National and State policies, Funding agencies and implementation strategies. **02 L**

#### **Suggested Readings:**

- Watershed Planning and Management, 2<sup>nd</sup> edition, Dr. Rajvir Singh, Yash publishing house, Bikaner, India.
- Soil and watershed conservation Engineering, 2<sup>nd</sup> edition, R. Suresh –Standard Publication Distributors, Delhi.
- Soil and water conservation Engineering, 4<sup>th</sup> edition, G. O. Schwab, etc- John Wiley and Sons
- Manual of Soil and water conservation practices, ICAR, soil consv.Res.st. Dehradun, ICAR Pub, Agril Min, GOI.
- Watershed Mannual by Bharat Kakade (BAIF publications)
- Recent Publications / Notes by the State Department of Agriculture, Maharashtra State.

**ENV-412: ENVIRONMENTAL PLANNING AND MANAGEMENT (OPTIONAL)**

- Environmental Planning:** Historical background to know the adverse effects of lack of environmental planning. Importance and measurement of Baseline environmental data their appraisal such as Water, Soil, Air, Natural assets, Demography, Heritage, meteorology. **08 L**
- Important concepts and parameters for planning:** a. State and national law and Act to protect the Environment, Socio-economic issues and demographic factors, b. Industrial and business growth patter, c. Natural resources and exploitation patter, d. Transportation and accessibility, e. Human resources, social behavior, economical status and aspiration for growth. **08 L**
- Important issues in planning** a. Willingness to pay for development, b. Rehabilitation and resettlement, c. Waste generation and disposal, d. Impacts on socio-economical status, e. Change in quality of life. (Case studies) **06 L**
- Urban and Rural Planning:** Demographic considerations, national and regional planning parameters for urban and rural areas. Development indices, industrial and business growth pattern, indigenous assets and liabilities, natural resources and exploitation patterns, accessibility and transportation development, industrial development and growth prospects, human resources, services levels and social aspirations, willingness to pay, rehabilitation and resettlement issues. **08 L**
- Equity, Environment and Development:** Equitable development and its principles, Importance of critical review of plan with respect to local and regional levels, Immediate and long term gains and effect of development. Comparison between a. Exploitation and safe guard for conservation, b. Rate of utilization and regeneration, c. Natural and manmade growth, d. Survival need of mankind and protection of environment. Agenda 21: Role of various stakeholders in Environmental Planning and Development process **04 L**
- Development in the context of carrying capacity of Environment:** Case study of current issue – Development plan for Urban Areas, **06 L**
- National Policy on EIA and Regulatory Framework:** Rule and regulations of central and state Government and Central and State pollution control boards for Safeguard for Environmental Protection e.g. Water (Prevention and control of pollution) Act. 1974, Air (Prevention and control of Pollution) Act 1981, etc. **06 L**
- Rule, regulations and guidelines** given for disposal of hazardous waste, municipal solid waste and bio-medical waste e.g. Hazardous Waste (Management and Handling) Act 1989. **02 L**

**Suggested Readings:**

- Environmental Impact Assessment, L. W. Canter, Mc Graw Hill Publication, New York.
- Proceedings Indo-US Workshop on environmental impact analysis and assessment (1980), NEERI, Nagpur.
- Environmental and social impact assessment, Vanclay F., Bronstein DA (1995), John Wiley and Sons, New York.
- EIA – A Biography, B. D. Clark, B. D. Bissel, P. Watheam.
- Agenda 21: Guidelines for Stakeholders by Patwardhan & Gunale
- Environmental Planning by A.S. Bal
- Second world congress on engineering and environment 1985

**ENV-411: FORESTRY AND HABITAT MANAGEMENT (OPTIONAL)**

- Forestry:** Definition of forestry and habitat management, Concepts, terms and terminologies, need, scope of the subject **02 L**
- Forest Ecology and Ethnobotany:** Forest as a ecosystem, Biotic and abiotic components, productivity, nutrient cycling, stresses, Forest types in India and conservation initiatives Role of Ethnobotany **04 L**
- Silviculture:** General Silvicultural Principles, ecological and physiological factors influencing vegetation, nursery system, Silvicultural systems – wood selection, felling, establishment and management of standards, technical methods and constraints, Silviculture practices in specialized ecosystems like Mangroves and Cold desert: Silviculture of trees -Traditional and advance methods, Silviculture of some of the economically important species in India **06L**
- Agroforestry, Social Forestry, Joint Forest Management and Tribology:** scope and necessity; objectives, techniques, participatory approach, Research and Extension needs, stages of tribal economy, education, cultural tradition, customs, ethos and participation in forestry programmes. **04 L**
- Forestry and Environmental Conservation:** Soil and water Conservation through Forestry, Environment; components and principles of conservation, impact of deforestation; forest fires and various human activities like mining, construction and developmental projects, population growth on environment, pollution. **04 L**
- Tree Improvement and Seed Technology:** General concept of tree improvement, methods and techniques, variation and its use, problems, forest genetic resources and gene conservation in situ and ex-situ. Cost benefit ratio, economic evaluation. **02 L**
- Forest Management Systems:** Objective and principles; techniques; stand structure and dynamics, sustained yield relation; rotation of growing stock through management, Forest Working Plan, integrated approach, Forest Mensuration - Methods of measuring - diameter, girth, height and volume of trees; form-factor; volume estimation of stand, annual increment. Sampling methods and sample plots. Yield calculation; yield and stand tables. Forest cover monitoring through remote sensing, Geographic Information Systems, management and modelling. Surveying and Forest Engineering General principles, objects, types, methods **08 L**
- Forest Resources and Utilization :** Direct and indirect, Environmentally sound forest harvesting practices, logging and extraction techniques and principles, transportation system, storage and sale, Need and importance of wood seasoning and preservation; Non-Timber Forest Products (NTFPs) definition and scope - **06 L**

collection; processing and disposal.

**Forest Protection:** Injuries to forest, Susceptibility of forests to damage, chemical and biological control, protection against fire and other natural disasters. Role of afforestation and forest regeneration, shifting cultivation and control. **04 L**

**Forest Economics and Legislation:** Fundamental principles of forest economics, Socio-economic analyses of forest productivity and attitudes, cost-benefit analyses; estimation of demand and supply, national and international market and changes in production and consumption patterns; assessment and projection of market structures; role of private sector and co-operatives; role of corporate financing.; valuation of forest goods and service. Legislation – History of forest development; Indian Forest Policy of 1894, 1952 and 1990. National Forest Policy, 1988 of People's involvement, Joint Forest Management, Involvement of women; Forestry Policies and issues related to land use, timber and non-timber products, sustainable forest management; industrialization policies; institutional and structural changes. Decentralization and Forestry Public Administration. Forest laws, necessity; general principles, Indian Forest Act 1927; Forest Conservation Act, 1980; Wildlife Protection Act 1972 and their amendments; Application of Indian Penal Code to Forestry. Scope and objectives of Forest Inventory. **08 L**

### **Suggested Readings:**

- Principal and Practices of Silviculture by LS Khanna
- Silviculture of Indian Trees (Revised Ed.) Vol 1-7 Editorial Board of Forest Research Institute, Dehradun (original 3 vol. by RS Troup)
- Forestry in India by AP Dwiwedi
- Forest and forestry by KP Sagaraya
- Handbook of Forestry by SS Negi
- Introduction to Forest Genetics by Wright
- Foresters Companion by AR Malsekar
- Social Forestry by KM Tiwari
- Forest Ecology by AS Puri
- Revised Survey of Forest Types of India by Champian and Seth
- Forest Mensuration by LS Khanna
- Forest Utilization by Tribhuwan Mehta
- Manual of Joint Forest Management Training Manual
- Minor Forest Products of India by T Krishnamoorthy
- India's Forest Policies: analysis and Appraisal by LK Jha

### **ENV 413: ENVIRONMENTAL MANAGEMENT SYSTEMS (OPTIONAL)**

<b>Environmental Management</b> Fundamentals of environmental management, international standards in environmental management. Background and development of the ISO 14000 series of standards. EMAS- European Union	<b>06 L</b>
<b>Environmental Management Systems</b> Definition and scope, Goals and purposes of EMS, Planning, Implementation, Review and Improvement (Plan, do, check, act model), Benefits of EMS- Environmental benefits, economic benefits, Costs associated with EMS	<b>06 L</b>
<b>Life Cycle Analysis</b> Definition, Goals and purpose, Stages in product LCA, Procedure for LCA- defining the goal and scope, analyzing the inventory, assessing the environmental impact and evaluating the environmental profiles, LCA uses and tools, Variants of LCA- cradle to grave, cradle to gate, cradle to cradle, gate to gate, well to wheel, Benefits and limitations of conducting LCA	<b>08 L</b>
<b>Environmental design</b> Principles, benefits, motivation, ED for manufactured products, ED for buildings ED for developmental planning	<b>05 L</b>
<b>Solid Waste Management</b> Properties of solid waste material, types of solid waste- industrial, domestic, agricultural Health impacts due to solid waste treatment.	<b>03 L</b>
<b>Municipal Solid Waste management with reference to India</b> Generation, Collection, Composition, Transportation, Transfer stations, Recycling of components and processing of MSW, Ultimate disposal, Assessment of existing situation, Possible areas for improvement.	<b>08 L</b>
<b>Disposal and Treatment of solid waste:</b> Engineering principles of solid waste disposal techniques, Pyrolysis and incineration, composting and hydrolysis, sanitary landfill, disposal at sea.	<b>06 L</b>
<b>Hazardous solid waste:</b> Types and characteristics, biomedical and industrial. Criteria used in identification of hazardous waste site, development and management.	<b>06 L</b>
<b>Suggested readings:</b>	
<ul style="list-style-type: none"> <li>• Vijay Kulkarni and T V Ramchandra. "Environmental management" Capital Publishing</li> <li>• T V Ramchandra, "Management of Municipal Solid Waste" Capital Publishing</li> <li>• A K Mhaskar, " Matter hazardous", Enviromedia</li> <li>• David Liu and Bela Liptak, "Environmental Engineers Handbook</li> <li>• Goerge Tchobanglous, "Solid Waste Engineering: Principles and management issues"</li> <li>• C S Rao, "Environmental Pollution Control Engineering"</li> </ul>	

**ENV-404: PRACTICAL BASED ON ABOVE COURSES:**

**STUDENTS ARE EXPECTED TO COVER 06 PRACTICALS FROM EACH OF THE OFFERED COURSES FROM THE ABOVE INCLUDING THE OPTIONAL COURSE**

**Forestry and Habitat Management (06 P)**

- Silviculture techniques in association with State Forest Department (04 P)
- Monitoring of ongoing silviculture plot (02 P)
- Assessment of Urban forestry / industrial forestry (02 P)
- Studies on the legislative cases under Forest act (02 P)

**Watershed Development (06 P)**

- Visit to the watershed project site, interaction with the watershed committee members, project scientists and prepare a study report based on the following parameters: Details of watershed (location, villages, project tenure, structure etc.); Entry point activities, Land and area treatments, maps and toposheet readings, contour mapping, calculation of slope, actual working – details of various treatments like CCT, bunds, plugging etc., forestation, success rate and the anticipated change in social and ecological assets of the villages. (based on 5 visits and participation in ongoing activities of the project). (04 P)
- Mapping of watershed area based on toposheet, aerial photographs or satellite imagery and comment on the treatments. (04 P)
- Visit to watershed development project in the vicinity of the college. (04 P)
- Resources appraisal and standard in above watershed. (04 P)
- Preparing enumeration report of watershed development water resources, crop production, livestock and other production, Involvement of people, etc. (04 P)

**Environmental Planning and Management (06 P)**

- Evaluation of environmental impacts and identification of significant aspects with the help of industrial processes. (e.g. Sugar industry or beverage industry or any developmental project) (04 P)
- To plan for an emergency preparedness program for industrial unit (case studies of any automobile or energy industry) (04 P)
- Basic units for rural and urban planning: assign each student or group of students to collect information from specific region or area and work with local / regional authority like Gram Panchayat or Municipal Corporation etc.

**Environmental Toxicology, Health and Safety (06 P)**

- Safety in Information and Technology and service industries (practical based on data collection and analysis preferably in consultation with the medical practitioner) (1 P)
- Safety in social life: Case studies - Identification, measurement (water, air, noise, soil, food etc.) (2 P)
- Demonstration of Mock Drill (industrial visit) (1 P)

- Evaluation of LC 50 using available heavy metal on the organism (fish/prawn/crab/mollusks etc.) (3 P)
- Evaluation of toxicity of industrial waste on seed germination and statistical interpretation of data (2 P)
- Estimation of protein levels from various body parts (intestine/gills/muscells) using Lowris method (2 P)
- Estimation of carbohydrates from exposed seeds by Anthrone method (1 P)
- Estimation of total chlorophyll (a,b,c) from control and exposed plant (1 P)

#### **ENV-405: SUBMISSION OF DISSERTATION**

The write up should include: Clear title, Introduction / background, Hypothesis, Aim & objectives, Review of literature, Methodology, Observations & results, Discussion. Summary & conclusion, Suggestions for future scope, Literature cited