

**ENVIRONMENTAL SCIENCES**  
**SCHEME OF INSTRUCTION AND VALUATION FOR SEMESTER SYSTEM**  
(w.e.f. 2006-07)

PAPER CODE	TITLE OF THE PAPER	NO. OF HOURS PER WEEK		MAXIMUM MARKS	
		THEORY	PRACTICAL	THEORY	PRACTICAL
	<b>SEMESTER I</b>				
ES 1.1	FUNDAMENTALS OF ECOLOGY	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
ES 1.2	BIOSTATISTICS AND COMPUTER APPLIACTIONS	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
ES 1.3	NATURAL RESOURCES: CONSERVATION AND MANAGEMENT	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
ES 1.4	ENVIRONMENTAL CHEMISTRY AND INSTRUMENTATION	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
	<b>SEMESTER II</b>				
ES 2.1	WATER POLLUTION, MONITORING AND MANAGEMENT	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
ES 2.2	ATMOSPHERIC POLLUTION, MONITORING AND CONTROL	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
ES 2.3	ENVIRONMENTAL MICROBIOLOGY	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
ES 2.4	APPLICATIONS OF REMOTE SENSING AND GIS	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>

(CONTD...)

	<b>SEMESTER III</b>				
ES 3.1	ENVIRONMENTAL BIOTECHNOLOGY	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
ES 3.2	EIA & EMS	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
ES 3.3	ENVIRONMENTAL PROTECTION: ACTS, LEGISLATIONS AND POLICIES	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
ES 3.4	ENVIRONMENTAL TOXICOLOGY	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
	<b>SEMESTER IV</b>				
ES 4.1	INDUSTRIAL POLLUTION: MONITORING AND MANAGEMENT	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
ES 4.2	WASTE MANAGEMENT	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
ES 4.3	ENVIRONMENT AND DEVELOPMENT	<b>5</b>	<b>3</b>	<b>100</b>	<b>50</b>
ES 4.4	A). PROJECT WORK/ PROJECT REPORT AND INDUSTRIAL TRAINING. B)ENVIRONMENTAL ISTS DAIRY	<b>4 to 6 weeks</b>		<b>100</b>	<b>50</b>
	TOTAL			<b>1600</b>	<b>800</b>
	GRAND TOTAL				<b>2400</b>
<b>GRAND TOTAL = (T) 1600 + (P) 800 = 2400</b>					

**ENVIRONMENTAL SCIENCES**  
**S Y L L A B U S**

**ES 1.1 : FUNDAMENTALS OF ECOLOGY**

UNIT-I

1. Nature, Scope and Principles of Ecology
2. Concept, Structure and Functions of Ecosystem:
3. Concept of productivity and measurement of primary productivity
4. Ecological energetic: Transformation and transfer of energy. Degradation of quantity and upgradation of energy quality.

UNIT-II

5. Biogeochemical cycles: Maintenance of air; cycling of nitrogen, phosphorus, and sulfur and Hydrological cycle.
6. Leibig's law of minimum and Shelford's law of tolerance. Comprehensive account of the impacts of climatic, edaphic and biotic factors on plants and animals. Effect of Concept of ecological Niche; Microclimate; Ecological indicators.

UNIT-III

7. Population Ecology: Group attributes of populations; Population growth, regulation and the carrying capacity. Population interactions.
8. Community Ecology: Nature of communities; concept of a biotic community; Classification of communities; characteristics of communities.

UNIT-IV

9. Development of communities: Ecological succession, general trends in ecological Succession; concept of climax.
10. Biogeography: Biogeographic regions of India and the world. Endemic species; Endangered species; Major biomes of India and the World.

UNIT-V

11. Biodiversity: Concept, importance, threats to biodiversity; Conservation and Management.
12. Recent trends and developments in the topics mentioned in Units I to V.

## PRACTICALS

1. Area-species curves
2. Area-quadrat curves
3. Use of quadrats, transects and plot less techniques
4. Frequency, density, dominance and importance value index.
5. Indices of diversity, dominance and evenness.
6. Estimation of plant cover
7. Biomass structure and biomass allocation patterns
8. Adaptations of hydrophytes, xerophytes, halophytes and mangroves.

## LIST OF BOOKS SUGGESTED

1. Basic Ecology, E.P.Odum, 1983, Holt-Saunders International Edition.
2. Manuel C.Molles Jr. 2005. Ecology: Concepts and Applications.McGraw Hill Higher Education, Boston.
3. Systems Ecology. H.T.Odum 1983. John Wiley and Sons, New York.
4. Concepts of Ecology. E.J. Korondy, 1996. Fourth Edition, Prentice-Hall of India, Pvt. Ltd.
5. Introduction to Ecology, Paul Colinvaux, 1971. Wiley International Edition.
6. Fundamentals of Ecology, E.P. Odum, 1971, W.B. Saunders & Co.
7. Plant Ecology, Michael J. Crawley, 1986, Blackwell Scientific Publications.
8. Ecology : Individuals, populations and Communities; Begon, Harper and Townsend, 1986, Blackwell Scientific Publication.
9. Methods in plant Ecology, P.D.Moore & S.B. Chapman, 1986, Blackwell Scientific Publications
10. Environment and plant Response. Michael Treshow, 1970, McGraw Hill Publications.
11. Population Biology of Plants. J.L. Harper, 1977, Academic Press.

## **ES 1.2. BIostatISTICS AND COMPUTER APPLICATIONS**

### UNIT-I

1. Introduction and importance of Biostatistics. Data collection and categorization; primary and secondary data. Development of Questionnaire.
2. Sampling and sample designs: Introduction; census and sample methods. Random Sampling and Non-random sampling methods. Size of samples; Merits and limitations of sampling. Application of samplings in ecological and environmental monitoring studies.

### UNIT-II

3. Data Presentation - Classification and tabulation of data: Frequency distributions. Types of Tables. Diagrammatic and Graphic presentation. General rules for constructing Diagrams. Types of diagrams; Graphs; Logarithmic graphs; Frequency distribution graphs. Limitations of diagrams and graphs.
4. Measures of Central tendency and dispersion: Characteristics of average - Geometric, Arithmetic and Harmonic mean; Median and Mode.

### UNIT-III

5. Skewness and kurtosis & measures of dispersion probability.
6. Tests of significance: Testing of hypotheses; level of significance. Critical region; degrees of freedom; Standard deviation, Standard error, Coefficient of variation.

### UNIT-IV

7. Student's t-test; 'F' test; Chi-square Test; Analysis of Variance (ANOVA).
8. Correlation and regression: Types of correlation; scatter diagram; simple graph; Coefficient of correlation; regression significance.

### UNIT-V

9. Applications of linear regression correlations; Establishment of allometric equations; Non-destructive methods of measurement of biomass and productivity.
10. Application of computers in the Environmental Studies.
11. Recent developments in the topics mentioned in Units I to V.

### **PRACTICALS**

Exercises, examples, illustrations and applications based on the theory.

### **REFERENCES**

1. Gupta, S.C. and V.K.Kapoor, 2000. Fundamentals of mathematical statistics. Sultan Chand & Sons, New Delhi.
2. Gupta, S.C. and V.K.Kapoor, Fundamentals of Applied Statistics.
3. Bailey, N.J. Statistical Methods in Biology.
4. Palani Samy S. and M. Manoharam. Statistical methods for Biologists.
5. Ludwig, J.A., and J.F. Reynolds, 1988. Statistical Ecology, John Wiley & Sons, New York.

## **ES 1.3 - NATURAL RESOURCES: CONSERVATION AND MANAGEMENT**

### UNIT-I

1. Introduction and classification of Natural Resources.
2. Mineral resources; Occurrence and distribution.
3. Water Resources: Sources, Classification and distribution of water.  
Usage and management of Groundwater and surface water: Watershed management.  
Rainwater harvesting.

### UNIT-II

4. Bioenergy: Conversion of biomass: Pyrolysis, methanization, Alcoholic fermentation, Briquetting.
5. Solar energy: Collection, concentration and storage, use of solar energy. Photovoltaic cells, Flat plate collectors, Water stills and solar dryers.

### UNIT-III

6. Wind energy: Wind mills, Wind farms and aero generators.
7. Geothermal energy; Ocean thermal energy conversion (OTEC), Hydel energy.
8. Problems and prospects of Hydrogen as energy source.

#### UNIT-IV

9. Energy sources: Conventional and non-conventional energy sources. Conservation and Management of Non-renewable resources.
10. Land resources; soil erosion; land use planning; conservation of croplands. Wasteland reclamation:
11. Forests: Classification, characteristics, distribution, importance and conservation; Afforestation programs: JFM and community forestry. Social and agro forestry: Urban forests and green belts.

### UNIT-V

12. Desertification: Desert development programmes. Prevention of expansion of deserts.
13. Concept of Sustainable development – strategies for achieving sustainability. Measures of sustainability.
14. Concept of ecological deficit and its consequences.
15. Recent developments in the topics mentioned in Units I to V.

## **PRACTICALS**

1. Measurement of solar insolation.
2. Measurement of Ambient temperature and relative humidity.
3. Measurement of wind and velocity.
4. Measurement of rainfall.
5. Measurement of light Intensity.
6. Demonstration of working of photovoltaic module.
7. Estimation of physico-Chemical characteristics of soil.

8. Production of biogas from organic wastes.
9. Assessment of species diversity of the University Campus.
10. Study of the impact of grazing on fodder resources.

#### **LIST OF BOOKS SUGGESTED**

1. Our Common Future. WCED Report by Brundtland, G.H. 1987, Oxford University Press.
2. Wealth of India, C.S.I.R.
3. Bioenergy Society of India. Vols. 1 to 4.
4. Survey of Environment Published by the Hindu News paper from 1992 on wards.
5. Environments and Natural Resource Conservation by Trivedi 1994.
6. Environment and Natural Resources by R.K. Sinha 1995.
7. Environmental Resource Management by L.K. Jha 1997.
8. Global biodiversity by R.K. Sinha.
9. Environmental Management in India by M. Hussian.
10. Mineral Resources of India by R.K. Mukherjee.
11. Ecological Integrity and Management of Ecosystems by Woodley S., G. Francis and K. James.
12. Principles of Sustainable Development by Douglas M. Muschett.
13. Watershed Management in India by J.V.S. Murthy 1994.

## **ES 1.4 : ENVIRONMENTAL CHEMISTRY AND INSTRUMENTATION**

### UNIT-I

1. Fundamentals of Environmental Chemistry: Stoichiometry, Gibb's energy; Chemical Potential; Acid- base reactions: Solubility product, solubility of gases in water, the Carbonate system; unsaturated and saturated hydrocarbons, radionuclides.
2. Brief account of the chemical environment: Properties of lithosphere, atmosphere, hydrosphere and biosphere.

### UNIT-II

3. Rocks: Rock cycle; Classification and Chemical nature of rocks
4. Soil: Formation and development soil. Soil profiles; Morphology, texture, Structure and physico-chemical properties. Pollutants and pollution of soil.

### UNIT-III

5. Atmospheric chemistry: Structure and composition of atmosphere. Formation of smog and its effects; Sources of rain, acid rains and their effects.
6. Green house gases: Green house effect, Global warming and climate change. IPPC and Kyoto protocol.

### UNIT-IV

7. Stratospheric chemistry: Chemistry of ozone layer; Light absorption and principles of Photochemistry; Catalytic and noncatalytic destruction of ozone, Ozone depleting Substances, Biological consequences of ozone depletion.
8. Chemical Toxicology: Toxic chemicals in environment; impact of toxic chemicals on enzymes; biochemical effects of arsenic, cadmium, lead, mercury and Fluoride.

### UNIT-V

9. Principles of Analytical methods: Titrimetry, gravimetry, Colorimetry, Spectrophotometry and chromatography.
10. Applications of spectrophotometry, GC, HPLC, AAS, FTIR, in environmental chemistry.
11. Recent developments in the topics mentioned in Units I to V.

## PRACTICALS

1. Volumetric analysis by EDTA titrations.
2. Gravimetric estimation - sulphate ion.
3. Conductometric experiments
  - (a) Redox titrations
  - (b) Acid-base titrations
  - (c). Determination of solubility of sparingly soluble salts.
  - (d) Precipitation titrations.
4. Potentiometric experiments:
5. Colorimetric experiments: Determination of cation Concentrations of (a) Fe (b) Cr in Units I to V (c) Ni (d) Pb

## LIST OF BOOKS SUGGESTED

1. Colin Baird, 1999. Environmental Chemistry, W.H. Freeman & Company, New York.
2. Gary W. VanLoon & Stephen J. Duffy. 2000. Environmental Chemistry : A Global Perspective. Oxford University Press.
3. R.A. Bailey, H.M. Clerke, J.P. Ferris, S. Krause and R.L. Strong, 1978. Chemistry of the Environment, Academic Press, New York.
4. APHA, 1998. Standard Methods for the Examination of Water and Waste Water, 20th Edn. Washington.
5. De A .K. 1995. Environmental Chemistry. New Age International Ltd., New Delhi.
6. Ramteke D.S. and C.A. Moghe. 1988. Manual on Water and Waste Water analysis, NEERI, Nagpur.
7. Samuel, J., Williamson, 1971, Fundamentals of Air Pollution, Addison-Wesley Publishing Company.
8. Richard P. Wayne, 1985, Chemistry of Atmosphere - Clarendon Press, Oxford.
9. Fuller, E.C. 1974, Chemistry of Atmosphere - Clarendon Press, Oxford.
10. Johnson, D.O., Netterville, J.T. Wood, J.C. and James, M., 1973, Chemistry and the Environment, W.B. Saunders Company, Philadelphia.
11. Truk, et al.. Environmental Sciences, Saunders Collen Series.
12. Auria, D., J.M. Gilchrist, and Johnson, J.J. 1972. Chemistry and the Environment - A Laboratory Experience.
13. Bender, G.T. 1972, Chemical Instrumentation, A Laboratory Manual Based on clinical Chemistry, W.B. Saunders Company, Philadelphia.

## **ES 2.1 - WATER POLLUTION: MONITORING AND MANAGEMENT**

### UNIT-I

1. Introduction: Classification of water, Sources and importance: Unique properties of water. Water Quality parameters and standards.
2. Hydrological cycle: Movement of water; evaporation and precipitation; Conservation of water resources.
3. Measurement and quantification of water resources. Rain water-harvesting systems.

### UNIT-II

4. Sources of water pollutants and their effects. Oxygen demanding wastes; Synthetic Organic compounds; Inorganic and mineral substances; Plant nutrients, sediments; Radioactive substances; Thermal discharges; oils; point source stream pollution model.
5. Waste Water sampling; Sampling methods; Grab sample, Composite sample; Quality of sample; Sample container; Sampling equipment; Frequency of sampling; Preservation of sample.

### UNIT-III

6. Methods of water analysis: Gravimetric, Analytical and Colorimetric methods; Analysis of physical, Chemical and microbiological parameters of water, waste water and Industrial effluents.
7. Methods of water and wastewater treatment: Trickling filters; Sewage treatment (STP), effluent treatment (ETP), common effluent treatment (CTP) and combined effluent treatment plants. Criteria for selection of treatment facilities; Treatment equipment - Screens, Grit chambers, Skimming tanks, Oil and Grease traps.

### UNIT-IV

8. Preliminary and Primary treatment: Sedimentation, Plain sedimentation and sedimentation with Coagulation; Filtration, stabilization and disinfection methods.
9. Secondary treatment: Design principles in Biological treatment; Activated sludge Process, Sludge treatment and disposal.
10. Advanced wastewater treatment: Adsorption; Ion exchange; Electro dialysis; Reverse Osmosis; Treatment with activated carbon.

### UNIT-V

11. Common effluent treatment plants, combined effluent treatment plants Sewage treatment plants design criteria. Standards for disposal, recycling and land application of treated effluents.
12. Recent developments in the topics mentioned in Units I to V.

## ***PRACTICALS***

1. Determination of Total Solids. (TSS and TDS)
2. Measurement of evaporation losses in relation to temperature, humidity and light intensity.
3. Determination of Light Penetration.
4. Measurement of Dissolved oxygen (DO)
5. Determination of Chlorides.
6. Determination of Hardness.
7. Determination of Calcium.
8. Determination of Magnesium.
9. Determination of Nitrates.
10. Determination of Sulphate.
11. Determination of Phosphate.
12. Determination of Fluorides.
13. Determination of residual chlorine.
14. Determination of Biological Oxygen Demand (BOD)
15. Determination of Chemical Oxygen Demand (COD)

## **BOOKS SUGGESTED**

1. Water Pollution. Kudesia V.P. Pragati Prakasham, Meerut.
2. Water and Waste water analysis, Sundaresan B.B., Manual on Ramtake D.S. and C.A., Moghe (1988), NEERI, Nagapur.
3. Standard methods for the examination of water and wastewater APHA, American Water Works Association, Water Pollution Control Federation, New York.
4. Ecological aspects of used water treatment. Curds, C.R. and Howkes H.A. Academic Press, London 1983.
5. Waste water treatment and use in Agriculture. Pescod, M.B. F.A.O. Irrigation and Drainage paper. Scientific publishers, Jodhpur.
6. Water and wastewater Technology, Mark, J.H. 1986, John Wiley and Sons, New York.
7. Analysis of water and Industrial effluents, Shivaji Rao, T.Lavanya Publishers, Visakhapatnam.
8. Environmental Ground water management. Thanh N.C. 1990 Oxford University Press, New Delhi.
9. Environmental Instrumentation, Bulusu K.R. NEERI, Nagapur.
10. Environmental Chemistry Moore, W.A. and Moore E.A. Academic Press, London.
11. Environmental Chemistry De. A.K. 1993, Wiley Eastern Limited, New Delhi.
12. Quality criteria for water. Russel, E. Train, Castle House Publication 1979, London.
13. Waste water treatment. Mogens Henze, Pul Marremoes, Jansen, Arvin, Springer - verlag publication.
14. Water and Waste Water Analysis: Biridi & Biridi 1996.
15. Sustainability criteria for water resource systems, Daniel, P.L. John, S.G. Cambridge University Press.
16. Water Pollution - Causes, Effects and Control. P.K. Goel 1997. New Age International Publishers.

## **ES 2.2: ATMOSPHERIC POLLUTION: MONITORING AND CONTROL**

### UNIT-I

1. Evolution of present atmosphere; Chemical composition; vertical structure; thermal profile; air circulation; Weather and climate.
2. Sources of Air Pollution: Natural and combustion; stationary and mobile sources. Classification of atmospheric pollutants.

### UNIT-II

3. Effects of the primary and secondary pollutants such as Sox, NO<sub>x</sub>, CO<sub>2</sub>, CO, O<sub>3</sub>, HC, Particulate matter and PAH, PAN on vegetation and animals, materials and structures and human health. Effects of smoking on health and environment.
4. Automobile pollution - Growth of automobiles; problems of transport and traffic congestion. Primary and secondary pollutants. Impact of technology and fuels, National and Euro standards.

### UNIT-III

5. Noise pollution: Sources, properties and measurement of noise. Impact of noise on human health. Thresh hold levels of noise and noise control.
6. Meteorological aspects of air pollution: Temperature lapse rates and atmospheric stability, wind, turbulence, atmospheric inversions, stagnations, ventilation, wind and pollution roses. Causes, consequences and control of Global warming and climate change.

### UNIT-IV

7. Plume behaviour: Coning, Fanning, Looping, Lofting, trapping and fumigation. Impacts of wind and temperature on the plume; Eddy diffusion. Modeling of pollutant dispersion. Box model and Gaussian – plume model.
8. Measurement and monitoring of air pollution:
  - a. Elements of sampling system; sampling systems for gaseous, and particulate system; static and stack sampling systems.
  - b. Analysis and measurement of gaseous pollutants and particulates.

### UNIT-V

9. Air Pollution Control Technology and Engineering aspects: Engineering Control Concepts: Introduction; process change; fuel change; pollution removal; disposal of Pollutants.
10. Control devices: Introduction; Removal of dry particulate matter, liquid droplets and Mists; gaseous pollutants; odours.
11. Recent developments in the topics mentioned in Units I to V.

## **PRATICALS**

1. Construction of wind rose and pollutant Roses.
2. Sampling and analysis of particulate matter.
3. Estimation of NO<sub>x</sub>.
4. Estimation of SO<sub>x</sub>.
5. Estimation of H<sub>2</sub>S.
6. Estimation of Lead.
7. Identification of Episode days.
8. Determination flow rate.
9. Determination of ESH.
10. Measurement of Deposition velocities.
11. Measurement of smoke density.

## **BOOKS SUGGESTED**

1. A. Stern, 1987. Fundamentals of Air Pollution. Academic Press, New York.
2. Shivaji Rao, T., 1988, Elements of Air Pollution and its Control, Lavanya Publishers, Visakhapatnam.
3. Samuel, J.W., 1971, Fundamentals of Air Pollution, Addison Wesley Publishing Co.,
4. Rao, HCV, Air Pollution 1990.
5. Kudesia, V.P., 1994. Air Pollution, International Student Edition, McGraw-Hill - Kosakusha Ltd., Tokyo.
6. Perkins, H.C., Air Pollution, McGraw-Hill - Kosakusha Ltd., Tokyo.
7. De, A.K., 1993. Environmental Chemistry, Second Edition, Wiley Eastern Limited, New Dlehi.
8. Sewall, G.H., Environmental Chemistry, Second Edition.
9. Warne, R.P., 1985. Chemistry of Atmosphere, Claredon Press, Oxford.
10. Mackenthum, K.M. 1998. Basic concepts in Environment Management. Lewis Publ. London.
11. Fuller, E.C., 1974. Chemistry and Man's Environment, Houghton-Muflin Company, Boston.
12. Lee, S.D., 1977, Biochemical Effects of Environmental Pollutants. Ann Arbor Science Publishers Inc., Ann.

## **ES 2.3 : ENVIRONMENTAL MICROBIOLOGY**

### UNIT-I

1. Diversity of microorganisms: General characteristics, occurrence, distribution and ecological importance of microorganisms.
2. Classification and Characteristics of Prokaryota, Protista and Viruses. Five kingdom and three-kingdom classification. Outline classification of Bacteria.

### UNIT-II

3. Nutrition and metabolism of microbes: Photoautotrophs, chemolithotrophs, organotrophs, parasites and symbionts and their environmental importance.
4. Soil borne microorganisms and their interactions Autochthonous and allochthonous microbes. Factors effecting the actions and activities of soil micro flora.
5. Water borne pathogens and water borne diseases : Hepatitis, Polio, Cholera, Bacterial dysentery, Typhoid, Giardiasis, Amoebiasis, and Schistosomiasis. Detection of fecal contamination of water; Detection of viruses; Microbial standards of water quality.

### UNIT-III

6. Microorganisms in Biogeochemical cycles: Role of microbes in Carbon, Nitrogen, Phosphorus and sulphur cycling.. Biofertilizers.
7. Microbial decomposition of organic matter: organic sources; aerobic and anaerobic decomposition. Factors affecting organic matter decomposition. Biodegradation of Xenobiotic and recalcitrant compounds.

### UNIT-IV

8. Air-borne microbes; Dispersal of microorganisms. Spread of microbes through air. Microbes in air pollution and purification.
9. Microbial damage of crops. Fungal, bacterial and viral diseases of crop plants. Biopesticides

### UNIT-V

10. Microbes in industry, effluent treatment. Biocatalysts. Microbes in Environmental monitoring of smog, PAN, Ozone and carcinogens.
11. Microbes in genetic engineering, biotechnology and cleaner production strategies
12. Recent developments in the topics mentioned in Units I to V.

### **PRACTICALS**

1. Types and composition of media.
2. Preparation and sterilization of media.
3. Preparation of slants and plates.
4. Techniques of isolation, inoculation and sub culturing of Fungi and bacteria.
5. Staining and microscopic study of fungi and bacteria.
6. Examination and analysis of microbial populations in water samples.
7. Estimation of bacterial populations by standard plate count method.
8. Estimation of microbial population by MPN methods.
9. Detection of fecal contamination of water.
10. Measurement of size of microbes by micrometry.
11. Measurement of soil respiration.
12. Degradation of organic matter under different Conditions.
13. Identification of bacteria in root nodules.

### **LIST OF BOOKS SUGGESTED**

1. Michael J. Pelzar Jr., Chan E.C.S and Merna Foss Pelczar. 1993 (Reprint 2004) Tata McGraw Hill Publishing Company Limited, New Delhi
2. Atlas, R.M., 1984. Microbiology: fundamentals and applications. Macmillan Publishing Co., New York.
- 3 Paul Edmonds, 1978. Microbiology - An Environmental Perspective. Macmillan Publishing Co., New York.
4. Mitchell, R., 1974. Microbiology. Prentice-Hall, London.
5. Alexander, M., 1971. Microbial Ecology. John Wiley & Sons, Inc., New York.
6. Alexander, M., 1977. Introduction to Soil Microbiology, John Wiley & Sons, Inc., New York.
7. Brock, T., 1966. Principles of Microbial Ecology. Prentice-Hall - Englewood Cliffs, New Jersey.
8. Schlegel, N.G., 1986. General Microbiology. Cambridge University Press, UK.
9. Ross, F.C., 1986. Industrial Microbiology (Second Edn.) Charles E. Merrill Publishing Co., Columbus.
10. Weber, C.I., 1973. Biological field and laboratory methods for measuring the quality of surface water and Effluents, EPA-670/4-73, Ohio.

## **ES 2.4 : APPLICATIONS OF REMOTE SENSING & GIS**

### UNIT-I

1. Fundamentals of remote sensing. Electromagnetic radiation and its interaction with atmosphere.
2. Spectral reflectance of Earth's surface features in different wave regions of Electromagnetic spectrum. Spectral signatures.

### UNIT-II

3. Characteristics of space Platforms and sensors; Satellite types and their sensors.
4. Fundamentals of satellite image interpretation, techniques of digital data acquisition and interpretation. Multi spectral data analysis.

### UNIT-III

5. Image processing methods for feature extraction: Aerial Photographs; Visible, infrared and microwave data; Digital data storage and retrieval.
6. Introduction, definition and Terminology of GIS. GIS categories, components, and fundamentals. Theoretical framework of GIS; Data collection, data inputs and output;

### UNIT-IV

7. GIS types : Raster GIS; Vector GIS; feature based GIS mapping. GIS spatial analysis; Computational Analysis Methods (CAM); Visual Analysis Methods (VAM).
8. GIS data storage, manipulation and analysis. Integrated analysis of spectral and attribute data. GIS analysis functions.

### UNIT-V

9. Applications of remote sensing and GIS in environment monitoring; resource assessment and management; and disaster management.
10. Applications of Remote sensing and GIS in Risk assessment, Pollution monitoring; Resource management; Urban development and aquatic resource evaluation.
11. Recent developments in the topics mentioned in Units I to V.

### **PRACTICALS**

1. Audiovisual reports of RS & GIS.
2. Base Map
3. Drainage pattern Map.
4. Contour Map.
5. Land use / Land cover Map.
6. Image interpretation Map
7. Data acquisition and interpretation

### **TEXT BOOKS**

- 1 Anji Reddy, M. (2001). Remote Sensing and Geographical Information Systems B.S. Publications, Hyderabad.
2. Anji Reddy, M. (2004). Geoinformatics for Environmental Management. B.S. Publications, Hyderabad.
- 3 Narayan LRA, (1999). Remote Sensing and its Applications. Universities Press

4. Elements of Photogrammetry by Paul, Wolf.
5. Elements of Photogrammetry by K.K.Rampal.
6. Principles and Applications of Photogeology by Shiv Pandey.
7. Remote Sensing and Image Interpretation by T.M.Lillesand and R.W.Kiefer.
8. Remote Sensing in Hydrology by E.T.Engman and R.J. Curney.
9. Geographic information systems - A Management Perspective by Stan Aronoff.
10. Geographic Information Systems - David Martin.

## **ES 3.1 : ENVIRONMENTAL BIOTECHNOLOGY**

### **UNIT-I**

1. Introduction: Scope, importance and applications of environmental biotechnology.
2. Basic concepts of Biotechnology - Recombinant DNA technology, Gene cloning, gene transfer and production of transgenic plants, animals and microbes.
3. Environmental safety evaluation of GEMs and GMOs. Role of genetic engineering approval committee.

### **UNIT-II**

4. Production of renewable fuels like methane (biogas), hydrogen and alcohol.
5. Removal and recovery of metals; biosorption, metal leaching and microbial mining.

### **UNIT-III**

6. Microbial production of SCP; food and feed supplements. Mushroom cultivation.
7. Biological control of pests, pathogens and insects.
8. Biofertilizers; Biological nitrogen fixation, VAM fungi and mycorrhiza.

### **UNIT-IV**

9. Use of microbes in bioreactors; Augmentation and stimulation; production of Vaccines, hormones, enzymes, antibiotics.
10. Immobilization of microbes and enzymes. Bio films and biocatalysts.
11. Production of biodegradable plastics.

### **UNIT-V**

12. Vermicomposting and composting.
13. Bioremediation and ecorestoration.
14. Biotechnology and IPR; TRIPS, Patents.
15. Recent developments in the topics mentioned in Units I to V.

### **PRACTICALS**

1. Production of biogas from different organic waste materials.
2. Application of Biofertilizers.
3. Mushroom Cultivation.
4. Production of extra cellular enzymes (amylase).
5. Vermicomposting.
- 6 Biosorption
7. Immobilization of microbes.
8. Solid-state fermentation and production of amylase.
9. Bioleaching of copper from copper sulphite.
10. Bioleaching of pulp by using white rot fungi.

### **LIST OF BOOKS SUGGESTED**

1. Satyanarayana, U. 2005. Biotechnology. Books and Allied (P) Ltd., Kolkata.
2. Arora, M.R. 2003. Biotechnology. Himalaya Publishing House, Mumbai.
3. Gupta, P.K. 1995. Elements of Biotechnology, Rastosi Co.
4. Casida, 1994. Industrial Microbiology, Wiley Eastern Publishers.
5. Bilgrami, K.S. and A.K. Pandey, 1992. Introduction to Biotechnology. CBS Publishers & Distributors, Delhi.
6. Jogdand, S.N. 1995. Environmental Biotechnology, Himalaya Publishing House, Bombay.

## **ES3.2: ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND MANAGEMENT SYSTEMS (EMS)**

### **UNIT-I**

1. Introduction: Aims and objectives, of EIA; Scope of EIA. Basic Contents of Environmental Impact Statement (EIS); Frame Work of EIA. Description of Environmental Setting.
2. Methods of EIA: Qualities of a good method. Types of Methods: Adhoc procedures, Checklists, Matrices, Networks, Overlay maps and Quantitative methods. Criteria for evaluation of efficiency of methods; Comparative studies on methodology.

### **UNIT-II**

3. Prediction and Assessment of Impact on air water and noise.
4. Environmental impacts on biological, Socio-economic and cultural environments.

### **UNIT-III**

5. Preparation of Environmental Management Plan: Criteria for selection of Environmental Factors; Factor importance coefficient; Alternatives.
- 6 Preparation of Environmental Impact Statement; public participation and Environmental decision-making.

### **UNIT-IV**

7. EMS: ISO 9000., ISO 14000 and OSHAS guidelines, standards and certification procedures.
8. Risk Assessment, emergency management and preparedness.

### **UNIT-V**

9. Environmental Audit in Polluting industries: Introduction and scope; Advantages of Environmental Audit, Types of Audits - Compliance Audit, Surveillance audit, and EMS audit.
10. General approach; audit team; Guidelines for preparation of audit report; pre audit activities; activities at the site; post audit activities; problems encountered during the audit.
11. Recent developments in the topics mentioned in Units I to V.

### **PRACTICALS**

1. Site mapping.
2. Location of different units of an industry within the site.
3. Construction of wind rose.
4. Identification of Episode days.
5. Guidelines and preparation of questionnaire.
6. Preparation of questionnaire for Environment Health Survey.
7. Developing environmental considerations for Thermal, Hydroelectric, Fertilizers, Cement Industry.

8. Preparation of Model EIA Report.
9. Preparation of Environmental Audit Reports.

#### **BOOKS SUGGESTED**

1. Erickson, P.A. 1979. Environmental Impact Assessment Principles and Applications.
2. Canter, L.W., 1977. Environmental Impact Assessment McGrawhill, New York.
3. Rosen, J.J., 1976. Manual for Environmental Impact Evaluation. Prentice Hall Inc., New Jersey.
4. Rao and Wooten (Eds.) 1980. Environmental Impact Analysis Handbook. McGraw Hill Book Company.
5. Bindu N. Lohani, 1984. Environmental Quality Management. EmSeries, South Asian Publishers, New Delhi.
6. Alan Gilpin, 1995. Environmental Impact Assessment. Cambridge University Press.
7. Weinstein, 1996. The Basic Total Quality Management, CRC Press, Florida.
8. Sherman, J. Rosen, 1976. Manual for Environmental Impact Evaluation. Prentice-Hall, New Jersey.

### ES 3.3 : ENVIRONMENTAL PROTECTION : ACTS, LEGISLATION AND POLICIES

**Note:** With specific reference to the objectives, application, achievements, deficiencies and defects of the following legislations / acts/ rules and regulations.

#### UNIT-I

1. Development of Environmental Legislation in India. Constitutional Provisions of Environment Protection.
2. Water Pollution (Prevention and Control) Act, 1974. (as amended from time to time).
3. Air Pollution (Prevention and Control) Act, 1981.
4. Public Liability Insurance Act. 1991.

#### UNIT-II

5. Hazardous Chemicals (Handling and Disposal) Act, 1997.
6. Forest Conservation Act, 1980.
7. Indian Wildlife Protection Act, 1972 ( as amended in 1991).
8. Biomedical Waste (Management and Handling) rules - 1998.

#### UNIT-III

9. Environmental Protection Act 1986 and Rules.
10. CRZ notification; WTO; IPR and Patenting Acts.
11. Municipal Solid Waste (Management and Handling) rules - 2000.

#### UNIT-IV

12. International Conventions: Stockholm Conference 1972; Earth Summit, 1992.
13. Montreal Protocol; Kyoto Protocol.
14. Prominent litigations on Environmental issues in India.  
(a) Mathura Refinery      (b) Silent Valley Project  
(c) Sardar Sarovar Project   (d) Tehri Dam

#### UNIT-V

15. Enforcement of laws, rules and regulations. Powers and responsibilities of CPCB and SPCB's.
16. Creation of environmental awareness through environmental education; role of media, Government and non-governmental organizations
17. Recent developments in the topics mentioned in Units I to V.

## **PRACTICALS**

*Case discussions, case presentation and debates on the topics mentioned above.*

## **SUGGESTED BOOKS**

1. The Environment Protection Act, 1986. Commercial Law Publishers (India) Pvt. Ltd.
2. National Environmental Policy Act, 1969. L.W. Canter, E.P.A. Publications.
3. Hazardous Chemicals (Handling and Disposal) Act, 1997, APPCB, Hyderabad.
4. Air Pollution, V.P. Kudesia, 1994. International Student Edition.

## **ES 3.4 : ENVIRONMENTAL TOXICOLOGY**

### **UNIT-I**

1. Introduction: Environmental toxicants; Cycling of toxic chemicals in Environment.  
Types of Hazardous substances:  
(a) Toxic substances (b) Highly reactive substances (c) Explosive substances  
(d) Radioactive substances.
2. Toxicants present in atmosphere; sources, status and affects of dioxin, PAH, PCB and PBB.

### **UNIT-II**

3. Toxicants present in hydrosphere. Industrial solvents and vapours, Agricultural Discharges, Thermal and Nuclear Power Wastes.
4. Heavy metals and their adverse effects:  
Toxicity of (a) Mercury, (b) Lead, (c) Cadmium, (d) Arsenic,  
(e) Chromium, (f) Copper, (g) Zinc.

### **UNIT-III**

5. Uptake and entry of toxic chemicals. Routes of exposure and sites of exposure, duration and frequency of exposure. Dose- Response relationship.
6. Biotransformation of toxicants: Biotransformation sites.
7. Nature of enzymes and reactions. Factors effecting Biotransformation of Xenobiotics.

### **UNIT-IV**

8. Methods for testing chemical toxicity: ASTM standard methods; single species Toxicity, Algal growth toxicity, acute toxicity tests; sub acute dietary toxicity tests.
9. Measurement and interpretation of ecological effects of chemicals: Toxicity at population and community levels;

### **UNIT-V**

10. Biological monitoring of toxic chemicals. Methods and objectives of exposure monitoring. Food chain as a source of toxic chemical exposure. Bio-Chemical markers.
11. Biomedical aspects of Environmental Toxicology : Physico-chemical and physiological variables influencing the toxicity of chemicals. Effects on human beings; the skin, blood, immune system, respiratory system and liver; long term and short-term effects.
12. Recent developments in the topics mentioned in Units I to V.

### **PRACTICALS**

1. Effect of pesticides on fish, insects and earthworms.
2. Effects of noise on persons working in noise-polluted units - A survey.

3. Health problems of smokers Vs non-smokers - Survey.
4. Pesticide effects on professional sprayers - Survey.
5. Prevention of spoilage of food and vegetables.
6. Purification of water for drinking purposes.
7. Prevention and spread of communicable diseases: Preparation of dos and don'ts for public use.

### **BOOKS SUGGESTED**

1. Ram Kumar, 2000. Environmental Chemical Hazards, Sarup & Sons, New Delhi.
2. Beyer, W.N., Heing, H.G. and Norwood, AWR 1996, Environmental Contaminants in Wildlife, CRC Lewis Publishers, New York.
3. Dikshith, T.S.S., 1996, Safety evaluation of Environmental Chemicals New age international (P) Ltd., New Delhi.
4. Lave, L.B. and Upton, A.C., 1987. Toxic chemicals, health and the environment. John Hopkins University Press, Baltimore and London
5. Treshow, M. Environment and Plant Response, 1970, McGraw-Hill Pub.
6. National Book Trust. You and Your Health 1995, NBT, New Delhi.
7. American Public Health Association (APHA) Manuals.
8. WHO - Our planet, Our Health 1993, Oxford University Press, Delhi.
9. Survey of Environment - Published by the Hindu News Paper.
10. Dikshith, T.S.S. 1991, Toxicology of pesticides in Animals, CRC Press Inc. Boca Raton, Florida.
11. Kiernan, J.A. 1990. Histological and Histochemical Methods: Theory and Practice 2nd ed. Pergamon Press, New York.
12. Bartosek, I. Animals in Toxicological Research 1982, Ravan Press, New York.
13. Dinham, B., 1993. The Pesticide Hazard: A Global Health and Environmental Audit.

## ES 4.1: INDUSTRIAL POLLUTION: MONITORING AND MANAGEMENT

### UNIT-I

1. Classification of Industries based on environmental impacts. Criteria for selection of site for establishment of industry. EIA; pre production and post-production EMP.
2. Social, economic environmental impacts of industries. Legal and statutory requirements. Permits, Licences, CFE and CFO.
3. Introduction to industrial environment monitoring and management.

### UNIT-II

4. Environmental Monitoring and Management of ----
  - (a) Agro based industries - Sugar and distilleries; vegetable oils; Ginning and dairy.
  - (b) Cement industries and stone crushers.
  - (c) Textile mills

### UNIT-III

5. Environment monitoring and management of ---
  - (a) Bulk drug industries
  - (b) Pharmaceutical industries
  - (c) Fertilizer plants

### UNIT-IV

6. Environment monitoring and management of --
  - (a) Power Plants - Thermal, gas based, and hydroelectric power plants
  - (b) Solar, wind, nuclear power plants
  - (c) Mini power plants – Solid waste power plants.

### UNIT-V

7. Environment monitoring and management of --
  - (a) Petrochemical industries
  - (b) Steel plants
  - (c) Paper and Pulp industry
8. Recent developments in the topics mentioned in Units I to V.

## **PRACTICALS**

1. Every student is required to do a project of four to six weeks duration in industry of his/her choice at the end of third semester or during the fourth semester.
2. Ambient Air quality monitoring - Equipment and methodology.
3. Stack monitoring - Equipment and Methodology.
4. Effluent treatment plants - Design criteria.
5. Effluent treatment monitoring - Equipment and methodologies.
6. Industrial EMS.
7. Environmental Auditing.
8. Compliance of rules and regulations.

## **BOOKS SUGGESTED**

1. Beta G. Iptak. Environmental Engineers, Vol.I to III. Chilton Book Co., Rednor, Pennsylvania.
2. Lead better. Air Pollution Vol.I & III.
3. Stern, A.C. Air Pollution Vol.I to V.
4. Metcalf & Eddy. Waste Water Engineering. Treatment and Disposal.
5. Edmond Besselièvre & Max Schwart. The treatment of Industrial Wastes. McGraw Hill.
6. Gotax - Solid Waste Management.
7. Booklets on different industries.

## **ES 4.2 : WASTE MANAGEMENT**

### **UNIT-I**

1. Characteristics, criteria and classification of wastes.
2. Waste management and handling rules.
3. Scope and objectives of waste management.
4. Waste reduction, recycling, and reuse strategies.

### **UNIT-II**

5. Sources of wastes, collection, segregation, transportation, storage, treatment and disposal of wastes. Consequences of open burning.
6. Esign criteria for a secure landfill. Structure and construction of landfills. Land fill monitoring and reclamation.
7. Liquid effluents: Sources, characteristics, treatment and disposal

### **UNIT-III**

- 8 Handling and Management of biomedical waste. Characteristics, composition, collection, treatment and disposal of biomedical waste.
9. Handling and Management of Hazardous Waste. Characteristics, composition, collection, treatment and disposal of hazardous waste. Treatment, storage and disposal facilities (TSDF) for hazardous waste.
10. Safety, security, handling and disposal of nuclear waste.

### **UNIT-IV**

11. Handling and Management of Municipal Solid Waste (MSW). Characteristics, composition, collection, segregation, treatment and disposal of MSW.
12. Strategies for conversion of biodegradable waste in to organic fertilizers and fuels. Composting, Vermicomposting and biomethanization.
13. Problems of disposal of sludge from effluent treatment plants (ETP's), combined effluent treatment plants (CETP's) and sewage treatment plants (STP's).

### **UNIT-V**

- 14 Disposal of fly ash from thermal power plants.
15. Disposal of plastics and synthetic polymers.
16. Energy plantation social forestry.
17. Recent developments in the topics mentioned in Units I to V.

### **PRACTICALS**

1. Testing for degradability, persistence and toxicity of different types of wastes.
2. Study of the impact of the chosen waste materials on seed germination and radicle Elongation.
3. Composting and vermicomposting techniques.
4. Exercises on estimation, composition and segregation of solid waste.
5. Landfill designs & design criteria.

### **LIST OF BOOKS SUGGESTED**

1. The Municipal Solid Waste Handbook, U.S. Environmental Protection Agency.
2. Waste incineration and Public Health. National Research Council, National Academy Press, Washington DC. 1999.
3. Richard T. Wright and Bernard J. Nebel. 2002. Environmental Science. Towards a sustainable Future. Prentice Hall of India Pvt. Ltd. New Delhi - 110 002.

## **ES 4.3 ENVIRONMENT AND DEVELOPMENT**

### **UNIT – I**

1. Environment and Development conflict. Concept of sustainable development. Indicators of sustainability. Strategies for sustainable development.
2. Environment and development trade offs. Benefit cost analysis. Indicators of economic viability. Internalization of externalities.
3. Values and ethics: Environmental ethics.

### **UNIT –II**

4. Economic growth and Human development. Indicators of Human development.
5. Impact of commerce and trade on consumerism and life styles.
6. Consequences of consumerism on environment and resource capital. Depletion of environmental resources. Concept of ecological deficits.

### **UNIT – III**

7. Biological metabolism and external metabolism. Affluence and its impacts on environment. Change in needs and life styles.
8. Concept of carrying capacity. Ecological footprint as a measure of carrying capacity.
9. Population growth, migration, urbanization and their consequences.

### **UNIT – IV**

10. Impacts of technology: cleaning and clean technologies, Ecofriendly technologies. Role of technology on Development.
11. Food security: Improvement of yields and quality; alternate and additional sources of food. Food processing and distribution.
12. Water wars, Famines, Disasters, Natural calamities and Climate change on development.

### **UNIT-V**

13. Measures of economic development: GDP, GNP and HDI. Their merits and demerits.
14. Future energy sources: Problems, prospects and challenges in development of clean and renewable fuels.
15. Recent development in the topics listed in units I to V.

### **PRACTICALS**

1. Methods & Techniques of estimation/quantification of costs and benefits.
2. Transformation and values into currency.
3. Calculation of ecological footprint for some selected resources.
4. Calculation of carrying capacity based on different assumptions.

**Note:** Further details will be provided for paper ES 4.3 in course of time before the beginning of the IV Semester in 2009.

