

**ACHARYA NAGARJUNA UNIVERSITY :: NAGARJUNA NAGAR**



**DEPARTMENT OF ENVIRONMENTAL SCIENCES**

**S Y L L A B U S**

**(for the students admitted during 2013-2014 onwards)**

**ES 1.1: ECOLOGICAL PRINCIPLES AND BIODIVERSITY  
CONSERVATION**

(for the students admitted during 2013-2014 onwards)

UNIT-I

1. Nature, Scope and principles of Ecology
2. Concept of Ecosystem: Structure and Functions
3. Ecological energetic: Transformation and transfer of energy.

UNIT-II

4. Biogeochemical cycles: Maintenance of air; cycling of nitrogen, phosphorus, sulfur and Hydrological cycle.
5. Leibig's law of minimum and Shelford's law of tolerance. Concept of ecological niche; Microclimate; Ecological indicators.

UNIT-III

6. Population Ecology : Group attributes of populations; population interactions and natural regulation of populations.
7. Community Ecology: Nature of communities; concept of a biotic community; classification of communities; characteristics of communities.

UNIT-IV

8. Concept of productivity and measurement of primary productivity.
9. Development of communities : Ecological succession, general trends in ecological succession; concept of climax.

UNIT-V

10. Biogeography : Biogeographic regions of India and the world. Endemic species; Endangered species; Major biomes of India and the World.
11. Biodiversity : Conservation and Management.

**PRACTICALS**

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

### **LIST OF BOOKS SUGGESTED**

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

## **ES1.2. BIOSTATISTICS AND COMPUTER APPLICATIONS**

(for the students admitted during 2013-2014 onwards)

### UNIT-I

1. Introduction and importance of Biostatistics. Data collection and categorisation; primary and secondary data. Development of Questionnaire.
2. Sampling and sample designs : Introduction; census and sampling 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; Skewness and Kurtosis.

### UNIT-III

5. Tests of significance : Testing of hypotheses; level of significance. Critical region; degrees of freedom; Standard deviation, Standard error, Coefficient of variation.
6. Students. t-Test; 'F' test; Chi-square Test;

### UNIT-IV

7. Correlation and regression : Types of correlation; scattered diagram; coefficient of correlation; regression significance.
- 8.. Applications of linear regression correlations; Non-destructive methods of measurement of biomass and productivity.

### UNIT-V

9. Computer Applications: Components of computers; use of computers in Environmental Studies; Hardware, Software, Accessories of Computers.
10. Fundamentals of Data Operating Systems; Languages; Packages, Data Base Management System; M.S. Office, Internet.

### **PRACTICALS**

Exercises, examples and illustrations 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. Lud Wig, J.A., and J.F. Reynolds, 1988. Statistical Ecology, John Wiley & Sons, New York.

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

(for the students admitted during 2013-2014 onwards)

**UNIT-I**

1. Introduction and classification of Natural Resources.
2. Concept of sustainable utilisation of resources; demographic quotient.
3. Mineral resources of India and their distribution.

**UNIT-II**

4. Conservation and management of Non-renewable fossil fuel (coal and petroleum products) and Metallurgical resources.
5. Water Resources Management in India : Sources and Classification of water; Distribution of water; Groundwater management; Watershed management.
6. Renewable energy sources: Conventional and non-conventional energy sources.

**UNIT-III**

7. Solar energy: Collection, concentration and storage, uses of solar energy. Photovoltaic cells, Flat plate collectors, Water stills and solar dryers.
8. Wind energy: Wind mills, Wind farms and aerogenerators.
9. Geothermal energy; Ocean thermal energy conversion (OTEC), Hydel energy.

**UNIT-IV**

10. Hydrogen as energy source.
11. Bioenergy : Conversion of biomass -Pyrolysis, methanization, Alcoholic fermentation, Briquetting.
12. Integrated energy management practices.

**UNIT-V**

13. Land resources; soil erosion; land use planning; conservation of croplands.
14. Desertification: Desert development programmes. Prevention of expansion of deserts.
15. Forests : Classification, characteristics, distribution importance and conservation.

**PRACTICALS**

1. Measurement of solar insolation.
2. Measurement of wind direction and velocity.
3. Efficiency of solar collectors.
4. Production of biogas from organic wastes.
5. Assessment of species diversity of the University Campus.
6. Survey of the genetic diversity of the major crops and weeds.
7. 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. Environment 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.
12. Ecological Integrity and Management of Ecosystems by Woodley S., G. Francis and K. James.
13. Principles of Sustainable Development by Douglas M. Muschett.
14. Watershed Management in India by J.V.S. Murthy 1994.

## **ES1.4: ENVIRONMENTAL CHEMISTRY AND INSTRUMENTATION**

(for the students admitted during 2013-2014 onwards)

### UNIT-I

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

### UNIT-II

3. Composition of Lithosphere. Chemistry of - igneous, sedimentary, and metamorphic rocks.
4. Soil formation and development - Morphology, texture, Structure, physico-chemical properties.

### UNIT-III

5. Atmospheric chemistry : Atmospheric composition : Origin and occurrence of smog; Acid rain - sources and effects of smog and acid rain.
6. Green house gases - Green house effect - Global warming and climate change.

### UNIT-IV

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

### UNIT-V

9. Principles of Analytical methods : Titrimetry, gravimetry, colorimetry, spectrophotometry and chromatography.
10. Instrumental methods of Analysis : Principles and practices of spectroscopy, GC and GLC - Analysis of environmental samples by spectroscopy, GC, GLC and HPLC. Principles of AAS - Application and analysis of trace elements and heavy metals.

### **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 (c) Ni (d) Pb

### **LIST OF BOOKS SUGGESTED**

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

(for the students admitted during 2013-2014 onwards)

### UNIT-I

1. Introduction: Classification of water, Sources and importance : Water Quality parameters and standards.
2. Hydrological cycle : Movement of water; evaporation and precipitation; Conservation of water resources.

### UNIT-II

3. 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; Industrial wastes.
4. Waste Water sampling; Sampling methods; Grab sample, Composite sample; Quality of sample; Sample container, Sampling equipment, Frequency of sampling, Preservation of sample.

### UNIT-III

5. Methods of analysis : Gravimetric, Analytical and Colourimetric methods; Analysis of physical, Chemical and microbiological parameters of water, waste water and Industrial effluents.
6. Methods and equipment used in waste water treatment; Preliminary treatment; Screens, Grit chambers, Skimming tanks, Oil and Grease traps.

### UNIT-IV

7. Primary treatment: Sedimentation, Plain sedimentation sedimentation with coagulation; Filtration, stabilization and disinfection methods.
8. Secondary treatment : Design principles in Biological treatment, Activated sludge process, Sludge treatment and disposal.

### UNIT-V

9. Advanced waste water treatment: Adsorption; Ion exchange; Electrodialysis; Reverse osmosis; Treatment with activated carbon.
10. ETP design criteria. Common effluent treatment plants; Combined effluent treatment plants; Sewage treatment plants.

## **PRACTICALS**

1. Determination of Total Dissolved Solids (TDS)
2. Determination of Total Solids.
3. Measurement of Dissolved oxygen (DO)
4. Determination of Chlorides.
5. Determination of Hardness.
6. Determination of Calcium.

7. Determination of Magnesium.
8. Determination of Nitrates.
9. Determination of Sulphate.
10. Determination of Phosphate.
11. Determination of Fluorides.
12. Determination of Na (sodium).
13. Determination of K (potassium).
14. Determination of residual chlorine.
15. Determination of Biological Oxygen Demand (BOD)
16. Determination of Chemical Oxygen Demand (COD)

### **BOOKS SUGGESTED**

1. Water Pollution. Kudesia V.P. Pragati Prakasham, Meerut.
2. Standard methods for the examination of water and wastewater  
APHA, American Water Works Association, Water Pollution  
Control Federation, New York.
3. Ecological aspects of used water treatment. Curds, C.R. and  
Howkes H.A. Academic Press, London 1983.
4. Water and waste water Technology, Mark, J.H. 1986, John Wiley  
and Sons, New York.
5. Environmental Chemistry Moore, W.A. and Moore E.A. Academic  
Press, London.
6. Environmental Chemistry De. A.K. 1993, Wiley Eastern Limited,  
New Delhi.
7. Quality criteria for water. Russel, E. Train, Castle House  
Publication 1979, London.
8. Waste water treatment. Mogens Henze, Pul Marremoes, Jansen,  
Arvin, Springer - Verlag publication.
9. Water and Waste Water Analysis : Birdi & Birdi 1996.
10. Water Pollution - Causes, Effects and Control. P.K. Goel  
1997. New Age International Publishers.

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

(for the students admitted during 2013-2014 onwards)

### UNIT-I

1. Evolution of present atmosphere; vertical structure; thermal profile; air circulation; weather and climate.
2. Sources of Air Pollution : Natural and combustion; stationary and mobile sources.

### UNIT-II

3. Effects of the primary and secondary pollutants such as SO<sub>x</sub>, 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 - Impact of technology and fuels, National and Eurostandards.

### UNIT-III

5. Noise pollution : Sources, properties and measurement of noise. Impact 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. Global warming and climatic change and their impacts and control.

### UNIT-IV

7. Air pollution modelling and prediction : Plume rise, modelling nonreactive pollutants; modelling pollutant transformation; model performance, accuracy and utilization.
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, particulates, visibility and acidic depositions.

### 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.

### **PRACTICALS**

1. Principles and functioning of Air pollution equipment (demonstration)
2. Sampling and analysis of particulate matter.

3. Construction of Windrose
4. Estimation of NO<sub>x</sub>.
5. Estimation of SO<sub>x</sub>.
6. Estimation of CO<sub>2</sub>.
7. Estimation of CO.
8. Identification of Episode days.
9. Effective Stack Height
10. Determination of Flow Rate for stack monitoring
11. Box model

### **BOOKS SUGGESTED**

1. A. Stern, 1987. Fundamentals of Air Pollution. Academic Press, New York.
2. Rao, HCV, Air Pollution 1990.
3. Kudesia, V.P., 1994. Air Pollution, International Student Edition, McGraw-Hill - Kosakusha Ltd., Tokyo.
4. Perkins, H.C., Air Pollution, McGraw-Hill - Kosakusha Ltd., Tokyo.
5. De, A.K., 1993. Environmental Chemistry, Second Edition, Wiley Eastern Limited, New Delhi.
6. Sewall, G.H., Environmental Chemistry, Second Edition.
7. Warne, R.P., 1985. Chemistry of Atmosphere, Clarendon Press, Oxford.
8. Mackenthum, K.M. 1998. Basic concepts in Environment Management. Lewis Publ. London.
9. Fuller, E.C., 1974. Chemistry and Man's Environment, Houghton-Muffin Company, Boston.
10. Lee, S.D., 1977, Biochemical Effects of Environmental Pollutants. Ann Arbor Science Publishers Inc., Ann.

## **ES 2.3: ENVIRONMENTAL MICROBIOLOGY**

(for the students admitted during 2013-2014 onwards)

### UNIT-I

1. Diversity of microorganisms : Classification, occurrence, distribution and ecological importance of microorganisms.
2. Characteristics of Protists, Prokaryotes and Viruses.

### UNIT-II

3. Nutrition and metabolism of microbes : Photoautotrophs, chemolithotrophs, organotrophs, parasites and symbionts and their environmental importance.
4. Microbial decomposition of organic matter : organic sources; carbon cycle; aerobic and anaerobic decomposition. Factors affecting organic matter decomposition.
5. Soil microorganisms and their interactions. Biofertilizers, and soil borne plant pathogens.

### UNIT-III

6. Role of microorganisms in cycling of Carbon, Nitrogen, Phosphorus and sulphur.
7. 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-IV

8. Biogenic pollution; microbial toxins, air-borne microbes, spread of microbes through air and water.
9. Microbial damage of crops. Brief account of fungal, bacterial and viral diseases of crop plants.

### UNIT-V

10. Bioenergy from solid organic wastes. Production of biogas, and organic manure. Production of single cell protein.
11. Biodegradation of xenobiotic, recalcitrant compounds. Biological detoxification of toxic substances.

## **PRACTICALS**

1. Preparation of slants and plates.
2. Staining and microscopic study of fungi and bacteria.
3. Estimation of bacterial populations by plate count method.
4. Estimation of microbial population by MPN methods.
5. Measurement of size of microbes by micrometry.
6. Detection of fecal contamination of water.

**LIST OF BOOKS SUGGESTED**

1. Microbiology: fundamentals and applications Atlas, R.M., 1984, Macmillan Publishing Co., New York.
2. Microbiology - An Environmental Perspective Paul Edmonds, 1978, Macmillan Publishing Co., New York.
3. Microbiology. Mitchell, R., 1974, Prentice-Hall, London.
4. Microbial Ecology. Alexander, M., 1971, John Wiley & Sons, Inc., New York.
5. Introduction to Soil Microbiology, Alexander, M., 1977, John Wiley & Sons, Inc., New York.
6. Principles of Microbial Ecology. Brock, T., 1966, Prentice-Hall - Englewood Cliffs, New Jersey.
7. General Microbiology. Schlegel, N.G., 1986, Cambridge University Press, UK.
8. Industrial Microbiology. Ross, F.C., 1986, Second Ed., Charles E. Merrill Publishing Co., Columbus.
9. Biological field and laboratory methods for measuring the quality of surface water and effluents, Weber, C.I., 1973, EPA-670/4-73, Ohio.

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

(for the students admitted during 2013-2014 onwards)

### 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. Multispectral data analysis.

### UNIT-III

5. Image processing methods for feature extraction : Aerial Photographs; Visible, infrared and microwave data; Digital data storage and retrieval.
6. Applications of remote sensing in environment monitoring; resource assessment and management; and disaster management.

### UNIT-IV

7. Introduction, definition and Terminology of GIS. GIS categories, components, and fundamentals. Theoretical framework of GIS; Data collection, data inputs and output;
8. GIS types : Raster GIS; Vector GIS; feature based GIS mapping. GIS spatial analysis; Computational Analysis Methods (CAM); Visual Analysis Methods (VAM).

### UNIT-V

9. GIS data storage, manipulation and analysis. Integrated analysis of spectral and attribute data. GIS analysis functions.
10. Applications of GIS in Risk assessment, Pollution monitoring; Resource management; Urban development, Aquatic resource evaluation and Forest fire control.

## **REFERENCES**

1. Remote Sensing and its Applications by LRA Narayan Universities Press (India) Ltd., (1999).
2. Remote Sensing and Geographical Information Systems by M.Anji Reddy (2001), B.S. Publications, Hyderabad.
3. Elements of Photo-grammetry by Paul, Wolf.
4. Elements of Photogrammetry by K.K.Rampal.
5. Principles and Applications of Photogeology by Shiv Pandey.
6. Remote Sensing and Image Interpretation by T.M.Lillesand and

R.W.Kiefer.

7. Remote Sessing in Hydrology by E.T.Engman and R.J. Curney.
8. Geographic information systems - A Management Perspective by Stan Aronoff.
9. Geographic Information Systems - David Martin.



**ES 3.1 : ENVIRONMENTAL BIOTECHNOLOGY**

(for the students admitted during 2013-2014 onwards)

**UNIT-I**

1. Introduction : Scope, importance and applications.
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.

**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. Biofilms and Biocatalysts.
11. Production of biodegradable plastics.

**UNIT-V**

12. Vermicomposting and composting.
13. Bioremediation and ecorestoration.
14. Biotechnology and IPR; TRIPS, Patents.

**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. Immobilisation of microbes.

**LIST OF BOOKS SUGGESTED**

1. Gupta, P.K. 1995. Elements of Biotechnology, Rastosi Co.
2. Casida, 1994. Industrial Microbiology, Wiley Eastern Publishers.
3. Bilgrami, K.S. and A.K. Pandey, 1992. Introduction to Biotechnology. CBS Publishers & Distributors, Delhi.
4. Jogdand, S.N. 1995. Environmental Biotechnology, Himalaya Publishing House, Bombay.

## **ES 3.2 : ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND MANAGEMENT SYSTEMS (EMS)**

(for the students admitted during 2013-2014 onwards)

### **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. Public participation and preparation of Environmental decision making.
6. Preparation of Environmental Management Plan: Criteria for selection of Environmental Factors; Factor importance coefficient; Alternatives.

### **UNIT-IV**

7. EMS : ISO 9000 and 14000 guidelines, standards and certification procedures.
8. Risk assessment and emergency 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; preaudit activities; activities at the site; post audit activities; problems encountered during the audit.

### **PRACTICALS**

1. Site mapping.
2. Location of different units of an industry within the site.
5. Guidelines and preparation of questionnaire.
6. Preparation of questionnaire for Environmet 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 Copany.
5. Bindu N. Lohani, 1984. Environmental Quality Management. EmSeries, South Asian Publishers, New Delhi.
6. Alan Gilpin, 1995. Environmental Impact Assessment. Cambriedge 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**

(for the students admitted during 2013-2014 onwards)

**UNIT-I**

1. Introduction : Scope and Objectives. Importance of rules and regulations. Development of comprehensive Policy Acts - NEPA, 1969 - Salient features.  
Development of Environmental Legislation in India.  
Constitutional Provisions of Environment Protection.
2. Water Pollution (Prevention and Control) Act, 1974.  
(as amended upto 1988).
3. Air Pollution (Prevention and Control) Act, 1981.

**UNIT-II**

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

**UNIT-III**

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

**UNIT-IV**

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

**UNIT-V**

14. Enforcement of laws, rules and regulations. Powers and responsibilities of CPCB and SPCB's.
15. Creation of environmental awareness through environmental education; role of media, Government and non-governmental organisations.

**PRACTICALS**

1. Adoption of some villages to create awareness & to amelrate facility on Protection acts and policies on environmental issues.
2. Case studies ; Ganga pollution case, Tehri dam case, Mathura refinery case, Bhopal gas leak case.

**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**

(for the students admitted during 2013-2014 onwards)

**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. Bio-transformation of toxicants: Biotransformation sites,
7. Nature of enzymes and reactions. Factors effecting Biotransformation of xenobiotics.

**UNIT-IV**

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

**UNIT-V**

9. Biological Monitoring of Toxic chemicals; Methods and objectives of Exposure monitoring, Food-chain as a source of toxic chemical exposure. Bio-Chemical markers.
10. Biomedical aspects of Environmental Toxicology : Physico-chemical and physiological variables influencing the toxicity of chemicals, public health. Side effects of medicines on human beings; the skin, blood, respiratory system and liver; long term and short-term effects.

**PRACTICALS**

1. Effect of pesticides on fish, insects and earth worms.
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 dont's 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. Dikshithl, 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 Environmetal Audit.



**NON - CORE**  
**ES 3.7: ENVIRONMENT AND SOCIAL ISSUES**  
(for the students admitted during 2013-2014 onwards)

Unit – I

1. Environmental Ethics: Issues and possible solutions
2. Resettlement and Rehabilitation of people, problems and concerns
3. Consumerism and waste products

Unit - II

4. Environmental Health and urbanization.
5. Rainwater harvesting and watersheds management
6. Population growth and Environmental quality

Unit - III

7. Human rights related to Environmental Quality
8. Women and natural resources conservation
9. Solid waste Management in cities and impacts on Environmental quality

Unit - IV

10. Wasteland reclamation
11. Environmental movements in India
12. Eco-Tourism

Unit - V

13. Role of public in Environmental protection
14. Governmental Agencies on Environmental Protection.
15. Green Bench, Green Tribunals, Green Products, Green farming, Eco-labeling ISO-9000, ISO-14000, OSHAs and Safety, Health and Environment (SHE), Green Jobs.

**ES 4.1: INDUSTRIAL POLLUTION : MONITORING AND MANAGEMENT**

(for the students admitted during 2013-2014 onwards)

**UNIT-I**

1. Classification of Industries based on environmental impacts.  
Criteria for selection of site for establishment of industry.  
EIA; preproduction 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) Agribased 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

**UNIT-V**

7. Environment monitoring and management of --
  - (a) Petro-chemical industries
  - (b) Steel plants
  - (c) Paper and Pulp industry

**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.

**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**

(for the students admitted during 2013-2014 onwards)

**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.
6. Design criteria for a secure landfill and incineration.

**UNIT-III**

7. Handling and Management of biomedical waste.
8. Handling and Management of Hazardous Waste.
9. Disposal of nuclear waste.

**UNIT-IV**

10. Handling and Management of Municipal Solid Waste (MSW).
11. Disposal and Treatment of biodegradable waste - composting, vermicomposting and biomethanization.

**UNIT-V**

12. Problems of disposal of sludge from effluent treatment plants (ETP's), combined effluent treatment plants (CETP's) and sewage treatment plants (STP's).
13. Disposal of fly-ash from thermal power plants.
14. Management of plastic waste and synthetic polymers.

**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. Active participation in waste minimization programmes.
4. 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 INDUSTRIAL SAFETY**

(for the students admitted during 2013-2014 onwards)

### **THEORY :**

#### **Unit I : Workplace Hazards:**

Nature and types of work places – type of hazards. Hazards in mining activities. Hazards in the fertilizer industry, petroleum refinery and organic chemical factories; Metallurgical, pulp and paper industry, tanneries; paints, dyeing of fabrics; coke ovens, pesticide industries; glass, ceramics and cement industries; alcohol and sugar industries.

#### **Unit II**

Control of Hazards and Accidents due to fire explosion and natural causes in : Thermal power plants, steel and metallurgical industries, atomic power plants, steam boilers, mining industry and mechanical workshops.

#### **Unit III: Safety in Process Plants:**

Disaster mitigation and control: industrial lay out , arrangement of equipments; machinery and utilities.

Personal Protective Equipments: types of personal protective equipments.

Industrial Hygiene: Principles, health and safety ergonomics.

Safety monitoring and Safety Information Systems.

#### **Unit IV:**

Plant and Personnel Safety: illumination, ventilation, working at elevated places, electrical conditions, shop and factory floors, overhead equipments handling- checklists for plant maintenance – guarding of moving machinery.

Safety Administration: Safety committee; safety councils – safety education-communicating safety message. First aid-principles, methods and training.

#### **Unit V :**

Accident Investigation: Classification of accidents – steps of investigation – accident reports – analysis of accidents – causes, remedies – rehabilitation of workers.

Legal Aspects of Industrial Safety – safety measures in factories act, mines act, pollution control acts for water, air, and land, child labour and women employee acts.

Technique of operation review – systems safety for high potential accidents – on site, offsite emergency plans.

### **PRACTICALS:**

1. Industrial visits
2. Preparation of site maps and industrial layouts with regard to approach to accident sites
3. Checklists of personal protective equipments
4. Preparation of on-site emergency plans
5. Preparation of accident reports
6. Preparation of rehabilitation plans
7. Assessment of safety adequacy in the industry
8. Assessment of women employees' safety in the industry

9. First Aid Methods.
10. Preparation of Safety Information Manual.

### Reference Books:

1. Industrial Safety. Rolland P. Blake II Ed., Prentice Hall Inc. New York. 1953.
2. Chemical Hazards of the work place, Procter Hughes and Fischman. JB Lippincoff Co., Philadelphia (1978).
3. Industrial Safety Handbook W. Handley Mc-Graw Hill, London.
4. Protecting personnel at hazardous waste sites. SP Levine. Martin Butterworth Publishers, London. 1985.
5. Controlling in-plant air borne contaminants. John D. Constance, Marcel Dekker Inc. New York.
6. Techniques of safety management, Dan Paterson II Ed., McGraw Hill – Kogakusha. New Delhi. 1978.

## ES 4.4 : ECO FRIENDLY TECHNOLOGIES

(for the students admitted during 2013-2014 onwards)

### UNIT-I

**Renewable Energy sources as eco friendly technologies;** Generate electricity, heat, or fuel for use within the establishment from:

- Wind (Aeolic) Energy
- Geothermal Energy
- Ocean (Tidal) Energy
- Hydropower
- Biomass
- Solar Power
- Land Fill Gas (LFG)
- Municipal Solid Waste (MSW)

### UNIT-II

**Energy Efficiency** of the following technologies or practices within the establishment:

- Cogeneration or Combined Heat and Power (CHP)
- Motor System Optimization (through capital spending, re-engineering or use of software such as Motor master+, etc.)
- Oxy-fuel Firing
- Isothermal melting process
- Server virtualization
- Energy efficient fume hoods
- LEED certified building
- Weatherization measures for existing construction
- [Energy conservation](#) is the utilization of devices that require smaller amounts of energy in order to reduce the consumption of electricity. Reducing the use of electricity causes less fossil fuel to be burned to provide that electricity

### UNIT –III

Use technologies or practices to reduce or eliminate the creation of waste materials as a result of your operations, including the following:

- Collecting and reusing or recycling waste materials created as a result of your establishment's operations
- Managing and/or recycling wastewater effluent (phytoremediation, bioremediation, land application, etc.)
- Composting solid waste
- Remanufacturing
- [waste management](#) is the purification, consumption, reuse, disposal and treatment of [solid waste](#) that is undertaken by the government or the ruling bodies of a city/town.

## UNIT-IV

### **Natural Resource Conservation**

- Managing land resources
- Managing storm water
- Conserving soil, water, or wildlife
- Practice of no-tillage or conservation tillage agriculture
- Organic agriculture
- Agro forestry or perm culture
- Implementing a paperless office or reducing paper usage and consumption

## UNIT-V

Water purification: The whole idea/concept of having dirt/germ/pollution free water flowing throughout the environment. Sewage is conceptually similar to water purification. Sewage treatments are very important as they purify water per levels of its pollution

Environmental remediation is the removal of pollutants or contaminants for the general protection of the environment. Biosensors: Definition, process and advantages of biosensors: Bio remediation- Phytoremediation to clean air, water and soils: bio fertilizers and Bio pesticides: Over usage of Synthetic substances in agriculture, their role in environment, adverse impacts



**M.Sc Environmental Sciences**  
**(for the students admitted during 2015-2016 onwards)**  
**SCHEME OF INSTRUCTION AND EXAMINATION**

Sl.No.	Title of the Paper	Number of Credits	Instruction of Theory hours	Instruction of Practical's (h)	Theory marks 70+30*	Practical marks 70+30*	Total marks
<b>I : SEMESTER</b>							
1	Paper I : ECOLOGICAL PRINCIPLES AND BIODIVERSITY CONSERVATION	4	5	3	100		100
2	Paper II : BIostatISTICS AND COMPUTER APPLICATIONS	4	5	3	100		100
3	Paper III : NATURAL RESOURCES CONSERVATION AND MANAGEMENT	4	5	3	100		100
4	Paper IV : ENVIRONMENTAL CHEMISTRY AND INSTRUMENTATION	4	5	3	100		100
5	Practical I	1				50	50
6	Practical II	1				50	50
	credits	18					<b>500</b>
<b>II : SEMESTER</b>							
7	Paper I : WATER POLLUTION, MONITORING AND MANAGEMENT	4	5	3	100		100
8	Paper II : ATMOSPHERIC POLLUTION, MONITORING AND CONTROL	4	5	3	100		100
9	Paper III : ENVIRONMENTAL MICROBIOLOGY	4	5	3	100		100
10	Paper IV : APPLICATIONS OF REMOTE SENSING AND GIS	4	5	3	100		100
11	Practical I	1				50	50
12	Practical II	1				50	50
13	Non-core Paper						
14	Project	14					300
	credits	32					<b>800</b>
<b>III: SEMESTER</b>							
15	Paper I : ENVIRONMENTAL BIOTECHNOLOGY	4	5	3	100		100
16	Paper II : EIA & EMS	4	5	3	100		100
17	Paper III : ENVIRONMENTAL PROTECTION, ACTS, LEGISLATIONS AND POLICIES	4	5	3	100		100
18	Paper IV : ENVIRONMENTAL TOXICOLOGY	4	5	3	100		100
19	Practical I	1				50	50
20	Practical II	1				50	50
21	Non-core Paper						
	credits	18					<b>500</b>
<b>IV SEMESTER</b>							
22	Paper I : INDUSTRIAL POLLUTION : MONITORING AND MANAGEMENT	4	5	3	100		100
23	Paper II : WASTE MANAGEMENT	4	5	3	100		100
24	Paper III : ENVIRONMENT AND INDUSTRIAL SAFETY	4	5	3	100		100
25	Paper IV: Eco Friendly Technologies	4			100		100
26	Practical I	1				50	50
27	Practical II	1				50	50
28	Project Work & Viva Voce	14			300		300
	credits	32					<b>800</b>
	<b>TOTAL</b>	100					2600

30% of theory and practical marks through internal assessment.