# Master of Science - Environmental Science & Management

## Syllabus - First Semester

### ECOLOGY AND ECOSYSTEM DYNAMICS

**Course Code: ENV4101** **Credit Units: 03**

**Course Objective:**
The course will lead the students through different levels of the living world starting from ecological principles, parameters and analytics to organisms, continuing through populations and introducing finally communities and ecological succession. Structure, function and process of ecological sciences are main components of this course.

**Course Contents:**

**MODULE-I: Ecosystem:** Earth as a life support system, components and organization, limiting factors, Laws of limiting factors – Liebig's law of minimum, Shelford's law of tolerance, adaptation, habitat and niche, Keystone species, population parameters - structure, growth regulation, interactions between populations, life history strategies (r and k species), the concept of carrying capacity; Growth Model (Prey-Predator, Lotka- Voltera, Leslie's matrix model).

**MODULE-II: Ecosystem analysis:** Synecology, species area relations, methods of sampling, community coefficients, association analysis, cluster analysis, gradient analysis, vegetation mapping, ecological succession, succession models and concept of climax, Human Population Dynamics, Human Ecology.

**MODULE-III: Framework of ecosystem:** Structure and function of ecosystems, productivity, decomposition, energy flow, ecological efficiency, global pattern of productivity, biogeochemical cycling (pool, fluxes and residence time), major biomes of India and the world, ecosystem services: scope, application, model and case studies.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Odum, Eugene P., and Gary W. Barrett. 2007. Fundamentals of Ecology, 5th edition, Thomson Brooks /Cole
- Primack, Richard B. 2010.Essentials of Conservation Biology, 5th edition. Sinauer Associates, Sunderland, Ma.USA
- Ecology and field biology - R.L. Smith

- Begon, M., Townsend, C. R., and Harper, J. L. *Ecology from Individuals to Ecosystems*. Wiley-Blackwell, USA. 2005.

# EARTH SYSTEM SCIENCES

**Course Code: ENV4102** **Credit Units: 03**

**Course Objective:**
The purpose of the course is to develop a holistic understanding of earth as a system. It attempts to illustrate the reasons for why things happen in nature, the way they happen and how humans have adapted and influenced the natural processes. The course will have application in ecosystem management, conservation and understanding of environmental hazards through in-depth understanding of earth process. It provides vital inputs to grasp the concept of sustainable development in context of global and regional level.

**Course Contents:**
**MODULE - I:** The Universe: concepts and origin, the solar system, planets-origin, shape and size of the Earth - structure and composition of Earth's interior and surface, Plate-tectonic processes**,** weathering and erosional processes, Earth processes, geological cycle, tectonic cycle, rock cycle, hydrological cycle.

**MODULE- II: Soil science:** Soil: types, composition, and formation, soil origin, texture, horizons and profile, soils of the world and India, soil analysis: moisture and pH determination, organic content determination (Walkly Black method) and iron content analysis, soil conservation, India's agriculture (types, irrigation, cropping pattern, green revolution and food security), land use planning in India, .

**MODULE-III: Marine environment:** Coastal environment, coastal erosion and stabilization, relief of the ocean floor, origin and composition of sea water, temperature and salinity of ocean water, vertical and horizontal distribution of temp and salinity, movements of ocean water, waves and tides, types of tides, ocean currents, major ocean currents, sea level changes and its impact on coastal areas. Environmental setting of India**:** Structure and relief, drainage system and watersheds, mechanism of Indian monsoon and rainfall patterns, floods and droughts.

**Examination Scheme:**

| **Components** | **A** | **CT** | **HA** | **EE** |
|---|---|---|---|---|
| **Weightage (%)** | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination

***Books Suggested:***


- Carla Montgomery (2011) Environmental Geology, McGrew Hill, Ryerson
- Edward A. Keller ($9^{th}$edition) Environmental Geology, Prentice Hall, USA
- Tom Garrison (2011) Essential of Oceanography, Brooks/Cole CENGAGE learning.
- Press F. &Siever R. Understanding Earth $4^{th}$edition, W. H. Freeman; 4 edition (July 17,2003)

# ENVIRONMENTAL BIOLOGY

**Course Code: ENV4103** **Credit Units: 02**

**Course Objective:**
The purpose of the course is to focus on the contribution of microbial ecology in the management, restoration and sustainability of the biosphere. The role of microbial communities in ecosystem both in natural and managed ecosystems and their influence on environmental quality and sustainability will be discussed in detail. The objective of the course would be to review the role of microbial communities and their processes in order to conserve and restore the ecosystem

**Course Contents:**
**MODULE- I: Environmental biochemistry:** Proteins -biologically important proteins, biological functions of proteins, Nucleic acids – DNA, RNA, biological functions of nucleic acids, biochemical degradation of pollutants, bioconversion of pollutants.

**MODULE- II: Environmental Microbiology:** Concept and definition, microbes in agriculture - biological nitrogen fixation, bio-fertilizers, mycorrhiza, food microbiology - micro-organisms of food, microbes in food production, food spoilage, food poisoning and its prevention, Classification, characteristics, occurrence, and ecological significance of microorganisms, photoautotrophs, chemolithotrophs, organotrophs, parasites and their environmental significance, soil microorganisms and their interactions relative to soil fertility, microbial toxins, viral, bacterial and fungal diseases of plants and their effects on ecosystem, Photosynthesis, Respiration.

**MODULE-III: Microbial Process & Applications:** Microflora of atmosphere - sampling techniques, identification of aeroallergens, airborne diseases and allergies, microbes and pollution abatement, Environmental biotechnology: introduction, genetic engineering and its applications, Gene-Bank, Tissue culture, Fermentation, Enzyme technology.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***
- Fundamentals of Ecology: E. P. Odum
- Botany: A. C. Dutta; Oxford University Press, Calcutta
- Aquatic Ecosystems: Kumar, A P H Pub
- Microbiology 6th ed: Purohit, Agrobios
- Global environmental Biotechnology: D. L. Wise
- Methods in Biotechnology: Hans Peter Schmauder

# CHEMISTRY OF ENVIRONMENT

**Course Code: ENV4109** **Credit Units: 03**

**Course Objective:**
The course is designed to make the student understand various aspects of chemistry which are significant to environmental science and get knowledge of various analytical techniques required for research. An understanding about various types of pollution their control measures and emerging trends will also be achieved. The course will also give an idea about impacts of pollution on the environment and health.

**Course Contents:**
**MODULE - I: Environmental chemistry:** Concept and scope, basic understanding of thermodynamics of environment, Gibb's free energy, chemical potential, phase equilibrium, stochiometry, acid base reactions, solubility product, solubility of gases in water, the carbonate system, solutions: normality, molality and molarity, expressing concentrations.

**MODULE - II: Air chemistry:** Chemical composition of atmosphere, *particles, ions and radicals,* formation of inorganic and organic particulate matter, photochemistry of atmosphere, chemistry of oxygen and ozone, aerosols, photochemical smog, and acid rain.

**MODULE-III: Water and soil chemistry:** Properties of water**,** water quality parameters: Physical, Chemical & Biological parameters, DO, BOD, COD, salinity, pH, Electrical Conductivity, Oxidation-reduction potential (ORP), composition of seawater and physico -chemical speciation in oceans, pesticides in water.
Chemical composition of lithosphere, water and air in soil, inorganic and organic components in the soil, *Cation exchange capacity of soil,* acid, base and ion-exchange reactions in the soil and soil acidity.

**MODULE- IV: Toxic chemicals chemistry:** Biochemical aspects of arsenic, cadmium, lead, mercury, carbon monoxide, O3, PAN, pesticides, insecticides**,** and MIC, carcinogens in the air, PAH's, PCB's, dioxin and dibenzo furans, chemistry of hydrocarbon decay, and green chemistry.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Masters G.M. (2004) Introduction to Environmental Engineering and Science, 2nd Edition, Pearson Education.
- Buell P. and Girard J. (2002) Chemistry Fundamentals: An Environmental Perspective (2nd edition), Jones & Bartlett Publishers.
- Cunningham W.P. and Cunningham M.A. (2007) Principles of Environmental Science: Inquiry and Applications, Tata McGraw-Hill.
- Miller G.T. (2001) Environmental Science, (eighth edition), Brooks/Cole.
- Pepper I.L., Gerba C.P. and Brusseau M.L. (2006) Environmental and Pollution Science, (2nd edition) Academic Press.
- Fundamentals of Environmental Chemistry:-Stanley E. Manahan.

# ENVIRONMENTAL PHYSICS & ENERGY

**Course Code: ENV4110** **Credit Units: 03**

**Course Objective:**
The aim of this course is to facilitate the students with the concepts of energy and various renewable and non-renewable resources. A general idea of the production and utilization scenario with respect to energy resources and its impact on environment will be dealt with. The significance of energy in Indian scenario and possible alternatives would be overviewed with a brief study of policy prospective of energy sectors.

**Course Contents:**
**MODULE-I: Environmental Physics:** Thermodynamics: Energy, Entropy Laws, Heat Transfer, Thermal conductivity, diffusivity. Fourier's equation for heat conduction - its solution for rectilinear and radial (spherical and cylindrical) flow of heat Matter and Energy Exchange, Heat and Air Pollution, Basic assumptions of kinetic theory, Ideal gas approximation, deduction of perfect gas laws. Maxwell's distribution law (both in terms of velocity and energy), Black- Body Radiation, Energy Budget of Earth and associated process i.e. Green house effect

**MODULE-II: Energy sources: conventional:** Conventional sources: fossil fuels (coal, oil and gases): reserves, classification, basic geology and environmental impact of production and consumption of fossil fuels, hydrocarbons: formation, reserves, production, refining and transport of petroleum products.

**MODULE- III: Energy sources: new/renewable:** Production, consumption and potential: Nuclear energy: chemistry, feasible material, nuclear reactors, nuclear fuel cycle and environmental issues, Solar Spectrum, radiation and energy balance of earth, solar thermal energy, solar photovoltaic, hydroelectricity, tidal power, wind energy, wave energy, geothermal energy, OTEC, fuel cell (hydrogen fuel cell, metal hydrate fuel cell, microbial fuel cell), current potential, achievements and future prospects of renewable energy, Biogas and biodiesel, Energy conservation policies.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Tiwari, G.N. and M. K. Ghosal. 2005. Renewable Energy Resources: Basic Principles and Application, NarosaPublishing.
- Ginley, David S., and David Cahen. 2011. Fundamentals of Materials for Energy and Environmental Sustainability. Cambridge.
- Master, Gilbert M. 2004.Renewables and Efficient Electric Power Systems. John Wiley and Sons.
- Boyle, Godfrey. 2004. Renewable Energy, 2nd Edition. Oxford University Press.
- Twidell, I. John and Tony Weir. 2007. Renewable Energy Resources. Taylor and Francis Group.

# BASIC MATHEMATICS

**Course Code: ENV4111** **Credit Units: 02**

**Course Objective:**
The basic purpose of the course is to teach basic mathematics for its application in a broad range of environmental science subfields. Derivatives and integrals, ordinary and partial differential equations, and linear and non- linear algebraic equations are the various topics to be taught.

**Course Contents:**
**Module I: Algebra**
Partial Fractions - Binomial, Exponential and logarithmic Series (without Proof) -Summation -Simple problems.

**Module II: Theory of equations**
Polynomial Equations with real Coefficients - Irrational roots - Complex roots- Transformation of equation by increasing or decreasing roots by a constant - Reciprocal equations - Newton's method to find a root approximately - Simple problems.

**Module III: Matrices**
Symmetric - Skew-Symmetric - Orthogonal and Unitary matrices - Rank of a matrix -Consistency of equations - Eigen roots and eigen vectors - Cayley-Hamilton theorem (without proof)-Verification and computation of inverse matrix.

**Module IV: Trigonometry**
Expansions of sin θ, cos θ, tan θ in terms of θ - Hyperbolic and inverse hyperbolic functions - Logarithms of complex numbers.

**Module V: Differential calculus**
n-th derivatives - Leibnitz theorem (without proof) and applications – Jacobians -Concepts of polar co-ordinates-Curvature and radius of curvature in Cartesian co-ordinates.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Mackenzie A. (2005) Mathematics and Statistics for Life Scientists, Taylor & Francis, New York.
- Parkhurst D.F. (2006) Introduction to Applied Mathematics for Environmental Science, Springer, New York.

# ANALYTICAL LABORATORY-I

**Course Code: ENV4107** **Credit Units: 03**

1. Determination of minimum size of quadrat for community study.
2. Determination of density, frequency, abundance, and dominance of plant species using quadrat method.
3. Calculation of the Importance Value Index (IVI) of species.
4. Identification of soil texture - clay, sand, and loamy.
5. Study of hand specimens of rock samples.
6. Determination of hardness (Ca, Mg, and total) and alkalinity of water.
7. Determination of total dissolved solids (TDS) in wastewater
8. Determination of residual chlorine in water sample.
9. Determination of Dissolved Oxygen (DO) of wastewater.
10. Determination of Biological Oxygen Demand (BOD) of wastewater.
11. Determination of Chemical Oxygen Demand (COD) of wastewater.
12. Visit of wastewater treatment plant to understand various unit operations.

**Examination Scheme:**

| IA | | | | EE | |
|---|---|---|---|---|---|
| **A** | **PR** | **LR** | **V** | **PR** | **V** |
| 5 | 10 | 10 | 5 | 35 | 35 |

Note: IA –Internal Assessment, EE- External Exam, PR- Performance, LR – Lab Record, V – Viva.

***Books Suggested:***


- Misra, R. (1968) Ecology Workbook, Oxford &IBH Publications Co., New Delhi.
- American Public Health Association (2012) Standard Methods for Examination of Water and Wastewater, APHA, AWWA, WPCF, American Public Health Association Inc., Springfield, New York.
- Maiti, S.K. (2003) Hand Book of Methods in Environmental Studies, Vol. I & II, ABD Publishers, Jaipur.

# TERM PAPER / SEMINAR

**Course Code: ENV4131** **Credit Units: 01**

**Objectives:**
The objective of this course is to judge the understanding as well as application of the knowledge gained by the students. The aim of the term paper/ seminar is to provide the students with an opportunity to further enhance their knowledge in a sector of their choice by undertaking examination and analysis of various aspects of environmental issues at a level commensurate with the learning outcomes of the various courses taken up by them in the ongoing semester.

A term paper/ seminar is primarily a record of intelligent reading in several sources on a particular subject. The students will choose the topic at the beginning of the session in consultation with the faculty assigned.

***Guidelines:***
a) Choosing the topic: contemporary issue and will be given by the department
b) Finding relevant materials
c) Presentation: before the commencement of Semester examinations
d) Response to queries
e) Submission of the write-up

Presentation of the seminar will be of 30 min maximum (25 min presentation and rest question answer session)

**Examination Scheme:**

| Organisationand relevance of content | Literature Review | Bibliography | Presentation | Response to the queries | Total |
|---|---|---|---|---|---|
| 30 | 10 | 10 | 40 | 10 | **100** |

# Syllabus – Second Semester

## POLLUTION CONTROL AND MANAGEMENT

**Course Code: ENV4201** **Credit Units: 03**

**Course Objective:**
The course aims at giving detailed knowledge about different pollution control and management strategies. The course will also deals with the sources of pollution in air, soil, water, soil and also noise and their impact onthe environment and health.

**Course Contents:**
**MODULE - I: Air pollution and control:** Air pollution: types of pollutants, sources and effects, Basic air pollution modeling i.e. Gaussian Plume Model, Box Model, ambient air quality standards, wind rose, pollution control alternative measures, downstream pollution control device: particulate matter control: control methods and devices: wall collection devices - gravity settlers, centrifugal separators, electrostatic precipitators, dividing collection devices - surface filters, depth filters, scrubbers, gaseous contaminants control - absorption, adsorption, combustion and condensation.

**MODULE - II: Waste Water Treatment:** Water pollution: types of pollutants, sources and effects, water quality standards, volume and strength reduction, segregation, reuse, recycle, neutralization, equalization, proportioning, physical methods: sedimentation, coagulation and flocculation, filtration, sludge dewatering, chemical methods: disinfection, removal of hardness, fluoride, arsenic, chromium, iron and manganese, removal of nitrogen and phosphorus, biochemical methods: aerobic and anaerobic treatment, septic tank, Imhoff tank, oxidation ponds, aerobic lagoons.

**MODULE - III: Soil and noise pollution control:** Soil contaminants: organic and inorganic (including heavy metals): sources and fate, control and abatement of contamination, bioremediation by microorganisms, phytoremediation, factors affecting uptake of contaminants, Noise pollution: sources and effects, SEL, $L_{Aeq,T}$, $L_{90}$, $L_{10}$, SIL, noise control: source reduction, control along the source-receiver pathway, receiver protection, assessing and predicting noise.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Manahan S.E. (2000) Fundamentals of Environmental Chemistry, CRC Press.
- Brady N.C. (2007) The Nature and Properties of Soil, Thirteenth edition, Prentice-Hall India.
- EcrenfelderW. (1990) Industrial Pollution Control, McGraw Hill Int. Ed.
- Pepper I.L., Gerba C.P. and Brusseau M.L. (2006) Environmental and Pollution Science, Academic Press.
- Harrison R.M. (2001) Pollution: Causes, Effects and Control, Fourth Edition, Royal Society of Chemistry.
- Nevers N.D. (2000) Air Pollution Control Engineering, McGraw Hill Int.

# ENVIRONMENTAL ANALYSIS: TOOLS AND TECHNIQUES

**Course Code: ENV4204** **Credit Units: 03**

**Course Objective:**

The purpose of the course is to develop analytical skills required for environmental monitoring. The students will become familiar with various physical, chemical and biological parameters involved in water, air and soil research. They would also be able to follow various standard protocols used in environmental analysis. With the theoretical knowledge they would also be able to develop their skills to use contemporary tools and techniques required for environmental impact assessment.

**Course Contents:**

**MODULE- I: Introduction:** Sampling techniques, basic concept of quantitative analysis (titrimetry, gravimetry, colourimetry), Measurement of Concentration; solution; principles of spectrophotometry, Lambert-Beer relationship, spectrophotometry, atomic spectroscopy, Microscopy; simple, compound and electron microscope.

**MODULE- II: Air pollution analysis:** Ambient air sampling and monitoring: aerosols (SPM and RSPM) and gaseous pollutants: Oxides of sulphur (SOX), nitrogen (NOX), $H_2S$, $O_3$, $NH_3$, $CO_2$, CO, hydrocarbons (HC's).

**MODULE- III: Instrumental methods of analysis:** Chromatography, Gas chromatography (GC), Atomic absorption/emission spectrophotometry, Gas liquid chromatography (GLC), High performance liquid chromatography (HPLC), electrophoresis, X-ray fluorescence, X-ray diffraction, and flame photometry, Fourier Transform Infrared Spectroscopy (FTIR).

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- APHA (1980), Standard Methods for the Examination of Water and Wastewater Published by American Public Health Association, 15thed.
- Laboratory Analytical Techniques Series (LATS), published by CPCB.

# ATMOSPHERIC SCIENCE AND CLIMATE CHANGE

**Course Code: ENV4209** **Credit Units: 03**

**Course Objective:**
This course would make the students familiar with the dynamics of earth and the factors governing the climate-weather system. Knowledge of various components of climatic system and their interaction with atmosphere/hydrosphere/lithosphere would further create curiosity among the students about the climate system modeling and climatic vulnerability. Focus will be given on mitigation and adaptive measures at international and national platform.

**Course Contents:**
**MODULE - I: Climatology and meteorology:** Radiation budget and balance, solar constant, lapse rate and stability, cycle, mechanism of wind development, fundamental forces (pressure gradient, centrifugal, gravity, and coriolis), surface wind and upper air circulation: jet stream, planetary circulations.

**MODULE - II: Global climate system:** Components of climate system and their interactions (atmosphere, ocean, sea, ice, land surface), feedback mechanism, weather systems: extreme weather events, western disturbances, Indian ocean dipole, El Niño-Southern Oscillation, madden-julian oscillation and Indian monsoon.

**MODULE - III: Climate change:** Natural variability vs. anthropogenic forcing to climate system, climate sensitivity, paleoclimatology and measurement techniques (tree rings and ice core analysis), climate system modeling (circulation models),green house gases and global warming, concept of vulnerability, impact and adaptation, sectoral vulnerabilities, impacts and adaptation.

**MODULE - IV: Contemporary Issues:** International efforts and policy framework- IPCC, UNFCCC, Kyoto protocol, India's national policy framework for climate change (sectoral aspects), CDM project cycle and modalities, procedures and global carbon market (carbon trade), $CO_2$ sequestration, forests and other sinks in India-opportunities and concerns, linking climate change mitigation and adaptation.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

**Books Suggested:**


- James R.H. An Introduction to Dynamic Meteorology, International Geophysics Series.
- IPCC (2001 & 2007) Working Group I Report "The Physical Basis of Climate change"
- Atmospheric Thermodynamics by Bohren and Albrecht.
- Marshall J. and Plumb R.A. (2001) Atmosphere, Ocean and Climate, Elsevier, Amsterdam.
- Oliver J.E. and Hidore J.J. (2008) Climatology: An Atmospheric Science, Prentice Hall.
- Peake S. and Smith J. (2009) Climate Change from Science to Sustainability, Oxford Publications.
- Cole B., 7th Ed. (2002) Meteorology Today: An Introduction to Weather, Climate, and the Environment–Ahrens, CD.

# GEOINFORMATICS FOR ENVIRONMENTAL MANAGEMENT

**Course Code: ENV4210** **Credit Units: 03**

**Course Objective:**
This course will develop the skills of students in the field of GIS and remote sensing. It will also give the basic concepts of remote sensing and principles associated with image acquisition and image processing. The role of GIS as a tool in environmental management and knowledge of GPS will be facilitated. This course will also look into the application of remote sensing/GIS in database generation and environmental management.

**Course Contents:**
**MODULE- I: Fundamentals of remote sensing:** Map: definition, types, scale and projections, remote sensing: introduction, scope and components, electromagnetic spectrum, its characteristics and interaction with atmosphere and earth surface, spectral signature, albedo, atmospheric windows, platforms, sensors and type of scanning systems
Aerial photography, elements of visual image interpretation, multispectral remote sensing, microwave remote sensing, basics of visual image processing (interpretation, converging evidence), digital image processing: rectification, enhancements, classification - unsupervised, supervised, hybrid, and accuracy assessment.

**MODULE- II: Geographic information system (GIS):** Geographic information system: introduction, definition and components, functional elements: data in GIS, raster and vector data structure, data input methods: keyboard entry, manual digitizing, scanning and automatic digitizing, accuracy, precision and resolution, consistency, completeness. Basics, satellite generation, positioning services, GPS details and integration, coordinate systems.

**MODULE- III: Remote sensing and GIS - application in environmental management:** National initiatives (NNRMS/NRDMS, ISRO-DOS), techniques and applications of remote sensing in forest cover/ type mapping, degradation, biomass estimation, habitat analysis, biodiversity characterization, environmental monitoring, geo-hazard assessment water resources (flow direction and accumulation), use of GIS and remote sensing.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Dutta A (2001) Biodiversity and Ecosystem Conservation. Kalyani Publisher, Kolkata.
- Jha LK (1997) Natural Resource Management. APH Publishing Corporation, New Delhi.
- Nalini KS (1993) Environmental Resources and Management, Anmol Publishers. Owen OS &Chiras DD (1995) Natural Resources Conservation. Prentice Hall India.

# STATISTICAL TOOLS AND RESEARCH METHODOLOGY

**Course Code: ENV4211** **Credit Units: 02**

**Course Objective:**
The course aims to address the issues related to acquisition and analysis of environmental data and use of statistics in solving them. An overview of extracting information and analysis of data through various statistical tools and techniques will be made. The students would be familiar with designing systems and various models. A preliminary introduction to fundamental concepts of research would make them understand the intricacies of writing and proposing research ideas and hypotheses.

**Course Contents:**
**MODULE- I: Introduction:** Basic elements and tools of statistical analysis, measurement of central tendency, measures of dispersion: absolute and relative measures, range, standard deviation, variance, quartile deviation, coefficient of variability, skewness, kurtosis, probability: probability distribution functions and their applications, data sampling, sampling locations, times, distributions and types, sampling theory.

**MODULE- II: Statistical methods:** Hypothesis testing, significance and correlation, correlation coefficients, linear models and regressions: multiple regressions, distribution- normal, t and chi square test, test of hypothesis and significance, analysis of variance, computer-based modeling: linear, regression, validation and forecasting, difference among means: F-test: 1 way ANOVA, F-test: 2 ways ANOVA.

**MODULE-III: System Analysis & Research methodology:** Mathematical models-deterministic and stochastic, generation of environmental data, stochastic processes in environment, approaches to development of model, linear simple and multiple regression model, validation and forecasting, Prospective of research, sample proposals, framing a statement of the problem (objective), background to the study, literature survey (previous study and gap in study so far), methodology of research and pitfalls.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- John J. Schiller, Seymour Lipschutz, Schaum's Outline of Probability and Statistics, 4th Edition, Tata McGraw-Hill Education.
- Manly (2001) Statistics for environmental science and management, Chapman and Hall /CRC.
- Wayne, R. Ott (1995). Environmental Statistics and Data Analysis, CRC Press.
- Shaefer S.J. and Theodore L. (2007) Probability and Statistics Applications for Environmental Science, CRC Press, Boca Raton, FL.
- Csuros M. (1997) Environmental Sampling and Analysis, Lab Manual, Lewis Publishers, Boca Raton, FL.
- Strunk W. and White E.B. (1999). The Elements of Style, Longman; 4thEdition.

# ANALYTICAL LABORATORY-II

**Course Code: ENV4212** **Credit Units: 03**

1. Study of toposheet for geographic information and spatial data types.
2. Description of base map with attributes and image data.
3. Data entry and preparations (input, editing and attributing)
4. Element of Image Interpretation, Image enhancement, Image registration and Georeferencing.
5. Image classifications for land use/ land cover using ERDAS, PCI Geomatica and ENVI.
6. GIS Software, introduction to open source GIS
7. Thin layer paper chromatography analysis of organic compounds.
8. Determination of SPM and RSPM in ambient air by high volume sampler.
9. Monitoring of Air Quality Parameters using Sun Photometer.
10. Sampling and measurement of black carbon in the ambient air.
11. Soil analysis: pH, organic carbon, moisture, water holding capacity, and nutrients.

**Examination Scheme:**

| IA | | | | EE | |
|---|---|---|---|---|---|
| **A** | **PR** | **LR** | **V** | **PR** | **V** |
| 5 | 10 | 10 | 5 | 35 | 35 |

Note: IA –Internal Assessment, EE- External Exam, PR- Performance, LR – Lab Record, V – Viva.

***Book Suggested:***


- Shryock, H.S. (1976) *Themethods and Materials of Demography*, Academic Press, New York.
- Gurumani, N. (2006) *Research Methodology for Biological Sciences*, MJP Publishers, Chennai.

# PROJECT (FIELD SURVEY)

**Course Code: ENV4232** **Credit Units: 02**

**Objectives:**
The aim of the project is to provide the students with an opportunity to explore the natural environment for enhancing their knowledge and understanding about various components of environment, human interaction and impact. The project may involve field visits to various places i.e. forested area, natural landscape, pond, lake, river, dam, wastewater treatment plant etc. The project can be defined as a scholarly inquiry into a problem or issues, involving a systematic approach to gathering and analysis of information / data, leading to production of a structured report. The student will need to submit a report in the end.

***Guidelines for Report:***
a) Title: It will be given by student
b) Introduction: about the particular site/habitat.
c) Observations and significance
d) Presentation and queries
e) Submission of the report

Presentation of the report will be of 15 min maximum (10 min presentation and rest question answer session)

**Examination Scheme:**

| Organisationand relevance of content | Introduction | Bibliography | Presentation | Response to the queries | Total |
|---|---|---|---|---|---|
| 30 | 10 | 10 | 40 | 10 | **100** |

# Syllabus – Third Semester

## ENVIRONMENTAL CONSERVATION & SUSTAINABLE DEVELOPMENT

**Course Code: ENV4301** **Credit Units: 03**

**Course Objective:**
The paper aims at providing insight into human dimension of development and management of natural resources. An understanding of perspectives in analyzing constraints and opportunities for sustainable development would be attempted at alongwith an introduction to basic conservation methodologies. An approach towards the challenges encountered for sustainability would also be looked at to enable the students focus on complex relationships between social, economic and environmental processes.

**Course Contents:**
**MODULE - I: Introduction:** Natural resources: classification and concept, forest resources: distribution, deforestation, carbon sequestration, impacts of mining and dams, water resources:, mineral resources, energy resources, food resources: world food problem, modern agriculture and environment, land resources: land degradation, landslides, soil erosion and desertification.

**MODULE - II: Biodiversity:** Definition, levels and gradients of biodiversity, values and significance of biodiversity, threats to biodiversity: habitat fragmentation, pollution, exotic/invasive species etc., and hotspots of biodiversity, Red data book and IUCN categorization.

**MODULE- III: Resource conservation:** Definition and meaning, material substitution, product life extension, recycling, biodiversity conservation (in-situ and ex-situ), conservation of fossil fuel, forest management: social, agro- and urban forestry, ecotourism, grassland management, coastal zone management, mangroves and coral reefs significance and conservation, wasteland and their reclamation: formation and reclamation of USAR, alkaline and saline soils.

**MODULE IV: Sustainable development & Social Issues:** Definitions & Principles of Sustainable Development; Brundtland Commission Report, Agenda 21, Millennium Development Goal, Challenges to sustainable development; Agriculture, Population & Food Security, Public Health and Nutrition, Education, Natural Resources (Forests, Energy, Water), Climate Change Public policy (community participation and participatory learning), economics and policy coherence.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Lillisand, Thomas, Ralph W. Kiefer and Jonathan Chipman. 2007. Remote Sensing and Image Interpretation. Wiley India.
- Jensen, John R. 2004. Introductory Digital Image Processing: A Remote Sensing Perspective. Prentice Hall.
- Burrough, P.A. and McDonnell, R.A. (1998) Principles of geographical information systems. Oxford

University Press, Oxford, 327pp.
- Jensen J.R. (2000) Remote Sensing of the Environment: An Earth Resource Perspective, Prentice Hall, ISBN 0-13- 489733-1.
- World Commission on Environment and Development (1987) Our Common Future, Oxford, OUP.
- UN Millennium Project (2005) Innovation: Applying Knowledge in Development, Science, Technology and Innovation Task Force Report.
- UN Millennium Project (2005) Investing in Development: A Practical Plan to Achieve the Millennium Development Goals, Overview.

# WATER RESOURCES MANAGEMENT

**Course Code: ENV4313** **Credit Units: 03**

**Course Objective:**
The course is designed to make the students aware about the availability and assessment of water resources along with various terminologies associated. An understanding about the need to conserve water has to be made. An approach to watershed development and various principles, common guidelines and policies will be overviewed.

**Course Contents:**
**MODULE-I: Introduction:** World water inventory, global water balance and Indian scenario, hydrologic cycle, precipitation: process and types, runoff: components, water yield, flood and its estimation and control, aquifers (confined and unconfined), quality and quantity of ground water and its usefulness in water supply, rainwater harvesting and groundwater recharge.

**MODULE-II: Water in ecosystem:** Agriculture and water, soil moisture, irrigation system and its environmental impacts, crop water management, agro-climatic zonation and crop planning (reference to India), drought and its management-causes and impacts, water conservation practices for deserts, wetlands: definition, processes, functions and management, hydrologic conditions and water budget, wetland conservation: Ramsar convention, definition, management objectives and strategy.

**MODULE-III: Watershed management:** Introduction, concepts and principles, water balance approach, water budgeting, physical, meteorological and hydrological component of watershed, land-use and land-cover classification, resource appraisal, water and soil conservation measures: (a) drain-line treatment; (b) area treatment, watershed as unit of sustainable development, selection of plant species for plantation, organic farming and organic fertilizers, watershed development in India.

**MODULE-IV: Water conservation, conflicts and challenges:** Water crisis, water footprint, atmosphere continuum (SPAC), water use efficiency (WUE), water auditing, water treatment, recycling and reuse, water sharing and conflicts, current water issues in India: Narmada Dam, Tehri, Almetti Dam, SardarSarovar, Interlinking of rivers and river basin management.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Patra K.C. (2011) Hydrology and Water Resources Engineering, Narosa Publishing House.
- Subramanya K. (2004) Engineering Hydrology, Tata McGraw-Hill, New Delhi.
- Sharda V.N., Sikka A.K. and Juyal G.P. (2006) Participatory Integrated Watershed Management: A Field Manual, Central Soil and Water Conservation Research and Training Institute, 218, KaulagarhRoad,Dehradun.
- Tideman E.M. (1999) Watershed Management–Guidelines for Indian Conditions, Omega Scientific Publishers, New Delhi.
- Black P.E. (1996) Watershed Hydrology, Lewis Publishers.
- Developing the Environment Problems and Management –C.J. Barrow.
- JainS.K.,Agarwal P.K.andSinghV.P.(2007)HydrologyandWaterResourcesofIndia,Springer,TheNetherlands.
- Common Guidelines for Watershed Development Projects (2008) Government of India.

# ECO-TOXICOLOGY, HEALTH AND SAFETY

**Course Code: ENV4314** **Credit Units: 03**

**Course Objective:**
Development of knowledge and skills to reinforce the attitudes and behaviors required for safe and environmentally sound work habits. Another aspect of eco-toxicology would deal with effects of various toxic materials posing adverse environmental health. A brief overview of industrial hazards and safety management will keep the students updated about occupational health.

**Course Contents:**
**MODULE-I: Overview of environmental health:** Public exposure from industrial sources, hazards by industry, major chemical contaminants at workplace, industrial environmental accidents, Hospital Waste Management.

**MODULE-II: Eco-toxicology:** Toxicity: case studies (F, As, Hg etc.), entry, movement and fate (biotransformation, bioaccumulation and biomagnifications) of pollutants in ecosystems, natural toxins: animal toxins, snake venoms, plant toxins, metals, pesticides, POPs: portals of entry and toxic effects, chromosome damage, gene mutation, factors influencing toxicity, environmental carcinogenesis: chemical carcinogenesis, organic carcinogens, metal carcinogens, occupational cancer, toxicity testing, test organisms used in bioassays, coliform bacteria count and MPN method, dose response curves, $LC_{50}$,$LD_{50}$.

**MODULE- III: Industrial safety:** Public health, personal hygiene, food adulterants, diseases (deficiency, infection, pollution, occupational and communicable) prevention and control, management of hygiene in public places, occupational health and safety, hazards - physical, chemical and biological, industrial safety standards and regulations, accidents - prevention and control, good manufacturing practices (GMP) and good laboratory management practices (GLP), OSHA & NIOSHA.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Handbook of Environmental Health and Safety – principle and practices (Vol. II):H. Koren; LewisPublishers
- Basic Environmental Health (2001): AnnaleeYassi, TordKjellstr"om, Theo de Kok, TeeGuidotti.
- Environmental Health: Monroe T.Morgan.
- Newman, M.C, Lawrence, C.A., and Unger. M.A., 2002. Ecotoxicology: Fundamentals of Ecotoxicology, $2^{nd}$Ed., CRC
- Press, Boca Raton, Florida.
- Walker, C.H., Hopkin, S.P., Sibly, R.M., and Peakall, D.B. 2001. Principles of Ecotoxicology. 2nd Ed. Taylor & Francis, London.
- Stanely E. Manahan.1992.Toxicological chemistry. Lewis Publishers

# WASTE MANAGEMENT & VALORIZATION

**Course Code: ENV4315** **Credit Units: 02**

**Course Objective:**
The course would comprise of general introduction and various components of solid waste. It would cover the characterization, collection, treatment and disposal techniques and related environmental issues. Students would be conceptualized with the onsite vs. offsite waste management as well as integrated waste management.

**Course Contents:**
**MODULE - I: Introduction:** Sources, characterization, and chemical composition of solid and hazardous wastes, legal, health and environmental issues for solid and hazardous waste management, integrated waste management strategy: reduce, recover/ reuse and recycling, hazard identification, risk characterization, and exposure assessment.

**MODULE - II: Waste management:** Methods of waste collection, storage and transportation, treatment and disposal techniques for solid waste - landfill, landfill operation and maintenance, composting, advantages and limitation of composting techniques, vermin-composting, autoclaving, microwaving, incineration, Pyrolysis, biogas plant**,** Landfill gas emission and methane recovery Leachate collection and treatment, techniques of hazardous waste treatment and safe disposal, nuclear and e-waste management.

**Module III: Waste valorization from residues:** Biomass & Bio-oils**:** Environmental & economic aspects; Bio-alcohols from microorganisms & agricultural waste, Clean technologies concepts for the biological conversion of wastes- aerobic and anaerobic; Municipal solid waste management by composting.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Batstone R., Smith J.E. (Jr.) and Wilson D. (1989),The Safe Disposal of Hazardous Wastes-the Special Needs and Problems of Developing Countries, The World Bank Technical Paper No. 93, Vol. I, II and III, Washington, DC, The World Bank.
- Central Public Health and Environmental Engineering Organization (CPHEEO) (2000) Manual on Municipal Solid Waste Management, New Delhi, Controller of Publications.
- Freeman H.M. (1988) Standard Handbook of Hazardous Waste Treatment and Disposal, New York, Mc Graw-Hill.
- SW-846 (1980) Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Washington, DC, USEPA, Available at http://www.epa.gov/epawaste/ hazard/test methods/sw846/index.htm.
- Tchobanoglous G., TheisenH. and Vigil S. (1993) Integrated Solid Waste Management: Engineering Principles and Management Issues, New York, McGraw-Hill.
- Vesilind P.A., Worrell W.A. and Reinhart D.R. (2001) Solid Waste Engineering, Australia, CL-Engineering.
- Ramachandra, T. V. (2011) Management of Municipal Solid Waste. TERI Press, New Delhi

# ENVIRONMENTAL ECONOMICS

**Course Code: ENV4317** **Credit Units: 02**

**Course Objective:**
Economics and environment must be completely integrated in decision making and law making processes and there should be an effort to increase understanding of intriguing policy problems. Environmental and resource economics makes use of ideas and tools developed in other branches of economics to make significant contribution to valuation techniques, design of policy instruments for pollution control and management of commons.

**Course Contents:**
**MODULE-I: Introduction:** Integration of environment and economics, basics of welfare economics: producer and consumer surplus, market failure, pareto optimality, cost-benefit analysis and valuation: discounting, principles and estimation of cost-benefit, methods of valuation: physical linkage, hypothetical behavioral and stated preferences methods, observed behavioral or revealed preferences methods, selected concepts in econometrics.

**MODULE II: Resource Economics:** Renewable and non-renewable resources, the resource allocation problem and management. Hotelling's rule, exhaustible energy resources, stock pollutants, risk and uncertainty; economics of forestry, fisheries, minerals and climate economics.

**MODULE-III: Economics & Environmental Policy:** Command and control versus incentives and subsidies - available policy options, regulating pollution through standards: pigouvian fees and marketable permits, porter's hypothesis, economic growth and the environment: environmental kuznets' curve.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

**Books Suggested:**


- Bhattacharya, R.N. (Ed.), 2001, Environmental Economics: An Indian Perspective, O.U.P.
- Kadekodi, G.K., (Ed.), 2004, Environmental Economics & Practice, O.U.P.
- Harris, J.M. 2006. Environmental and Natural Resource Economics: A Contemporary Approach, 2nd edition. Houghton Mifflin.
- Conrad J.M. (1999) Resource Economics, Cambridge University Press.
- Hanley N., Shogren J.F. and White B. (1997) Environmental Economics in Theory and Practice, Oxford and London, Oxford University Press and Macmillan.

# ANALYTICAL LABORATORY-III

**Course Code: ENV4316** **Credit Units: 03**

1. Use of microscope: bacterial morphology and staining methods.
2. Biological examination of water: algae and bacteria
3. Isolation of fungi from environmental samples
4. Standard plate count
5. Bacterial water quality: Measuring quality of water by using coli form organisms (MPN method and membrane filter).
6. Estimation of sugars, proteins, lipids.
7. Water analysis: Maximum Probable Number (of Bacteria), E.coli
8. Experiments related to Microbiological analysis of waste water MPN, Total and Faecal coliforms [in potable water], and other organisms.
9. Process and analysis of biological composting and vermicomposting.

**Examination Scheme:**

| IA | | | | EE | |
|---|---|---|---|---|---|
| **A** | **PR** | **LR** | **V** | **PR** | **V** |
| 5 | 10 | 10 | 5 | 35 | 35 |

Note: IA –Internal Assessment, EE- External Exam, PR- Performance, LR – Lab Record, V – Viva.

***Book Suggested:***


- Gurumani, N. (2006) *Research Methodology for Biological Sciences*, MJP Publishers, Chennai.
- Jacobson-Kram, D. (2006) *Toxicological Testing Handbook: Principles, Applications and Data Interpretation.*
- Taylor & Francis, New York.
- Gurumani, N. (2006) *An introduction to Biostatistics*, MJP Publishers, Chennai.
- Murugesan, A.G. and Rajakumari. C. (2006) *Environmental Science and Biotechnology*, MJP Publishers, Chennai.

# ENVIRONMENTAL BIOTECHNOLOGY

**Course Code: ENV4309** **Credit Units: 03**

**Course Objective:**
Environmental biotechnology utilizes microorganisms to exploit biotic resources for environmental management practices. This management includes treatment of contaminated water and wastewater, clean up of industrial waste streams, and remediation of soils contaminated with hazardous and toxic chemicals and application of biotechnology in improvement of environment quality. Environmental biotechnology is essential to society and truly important as a technical discipline.

**Course Contents:**
**Module-I: Bioremediation and metagenomics:** Bioremediation: concept and types (natural and engineered): bio- attenuation, ex-situ and in-situ, bio-augmentation and bio-stimulation, advantages and disadvantages, bioremediation to control pollution e.g. solid waste, sewage, industrial effluents, heavy metals, radioactive substances and oil spill, Metagenomics: environmental and community genomics, the study of genetic material recovered directly from environmental samples and future applications in bioremediation, Genetically modified organisms (GMO's) and bio- safety.

**Module-II: Industrial biotechnology:** Maintenance of stock cultures, culture collection centers/microbial gene banks, inoculum build-up, industrial substrates, design of a bioreactor, batch and continuous fermentation and solid-substrate fermentations, immobilization technologies, microbial production of food (SCP), essential prerequisites for organisms to be used as SCP and as food and feed supplements, microbial transformation, accumulation and concentration of metals, metal leaching, extraction and future prospects, biosensors.

**Module-III: Applied biotechnology:** Practical aspects of genetic engineering with microorganisms from extreme environment: use of extremophilic microorganisms in waste treatment and methane production from agro industrial wastes, enzyme production: cellulase, proteases, amylases, alcohol and acetic acid production, biocomposting and biomining, alternate fuels: biofuels, sources and production.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- M.H. Fulekar (2005) Environmental Biotechnology Oxford IBH Publishingcooperation.
- Elements of biotechnology, 1995. P.K. Gupta Rastogi Co.
- Industrial Microbiology - Casida, Wiley Easternpublishers,1 994.
- Biodegradation and Bioremediation- Martin Alexander.
- Biotechnology-A new industrial revolution Prentis S. Orbis Publishing Ltd., London.
- Microbiology Davis, B>D., Dulbecco, R., Eisen, H.N and Ginsberg, H.S. Harper and Row Publishers, Singapore. 1992.
- Environmental Microbiology, 2000, Maier, R.M. Pepper, I.L and Gerba, C.P. Academic Press.
- Review articles published in current opinion in microbiology, microbiological reviews, Advances in Microbial physiology, Bacteriological reviews etc.

# ENVIRONMENTAL GEOLOGY

**Course Code: ENV4310** **Credit Units: 03**

**Course Objective:**
The course is designed to provide a clear knowledge of Earth as a system and the basic concepts influencing the processes and dynamics of Earth. It will also give an understanding of geological processes vis-à-vis the human influences and its implications.

**Course Contents:**
**MODULE - I: Earth processes and dynamics:** Distribution of elements in the solar system and the Earth, chemical differentiation and composition of the Earth, general concepts about geochemical cycles and mass balance, properties of elements, geochemical behavior of major elements, mass conservation of elements and isotopic fractionation, structure and composition of earth's interior and surface, rocks and minerals and associated processes, history of the earth's surface and geological timescale.

**MODULE-II: Earth tectonics and dynamics:** Concept of plate tectonics, sea-floor spreading and continental drift, geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs, origin of oceans, continents, mountains and rift valleys, earthquake and earthquake belts, volcanoes: types, products and distribution.

**MODULE - III: Processes of soil formation**: Types of soil, soil degradation and changing land use pattern, concepts of natural ecosystems on the Earth and their mutual inter-relations and interactions (atmosphere, hydrosphere, lithosphere and biosphere),environmental changes due to influence of human-dominated environment over nature-dominated system, concept of biodiversity.

**MODULE- IV:** Impact assessment of water availability, quality and contamination of surface water and groundwater, atmosphere and air pollution, soil contamination due to urbanization, industrialization and mining, basic tenets of environmental laws.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Seismotectonic Atlas. 2000. GSI Publication.
- Kellar, E. A. 2000. Environmental Geology. Prentice Hall, N. Jersey.
- Merritts, D., de Wet, A. and Menking, K. 1998. Environmental Geology: an earth system science approach. W.H. Freeman & Co., N.Y.
- Strahler, A.N. and Strahler, A.H. 1973. (Revised Ed.) Environmental Geoscience: interaction between natural systems and man. Hamilton Pub, USA.

# GREEN ENERGY

**Course Code: ENV4311** **Credit Units: 03**

**Course Objective:**
The purpose of this course is to provide a survey of the most important renewable energy resources, and the technologies for harnessing these within the framework of a broad range of simple to state-of the art advanced energy systems. After completion of the course, students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.

**Course Contents:**
**MODULE - I: Green Energy and sustainable development:** Clean/ green energy technologies, sustainable development, international agreements/conventions on energy and sustainability: UNFCC, nuclear energy: fission reactors, fission power and environment, fuel cells: hydrogen fuel cell, metal hydrate fuel cell, microbial fuel cell, renewable energy sources: solar, geothermal, tidal and wind energy, hydropower, ocean thermal energy conversion(OTEC),energy use pattern: India and global, renewable energy management in India.

**MODULE - II: Solar Energy:** Solar radiation: measurement and prediction, solar collectors: flat plate and concentrating collectors, solar heating of buildings, solar still, solar water heaters, solar driers, conversion of heat to mechanical energy, solar thermal power generation systems, solar photovoltaic: principle, types of solar cells and fabrication, photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping and power generation.

**MODULE-III: Energy from waste– bio-chemical conversion**: Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, anaerobic digestion, biogas production, land fill gas generation and utilization, present status of technologies for conversion of waste into energy, design of waste to energy plants for cities, small townships and villages.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, by Gary C. Young, ISBN: 9780470539675, Publisher: John Wiley & Sons, Publication Date: June2010.
- Recovering Energy from Waste Various Aspects Editors: Velma I. Grover and Vaneeta Grover, ISBN 978-1- 57808- 200-1;2002
- G. Evans, Biowaste and Biological Waste Treatment,2005
- Biogas from waste and renewable resources, by Dieter D. And Angelika S. Wiley-VchPublication2010.

# WASTE WATER TREATMENT

**Course Code: ENV4312** **Credit Units: 03**

**Course Objective:**

**Course Contents:**

**MODULE- I: Water pollutants:** Types and sources, generation and collection of wastewater, sewerage systems, quantities of sanitary wastes and storm water, carrying capacity of rivers.

**MODULE- II: Wastewater characteristics**: Waste quality parameters: physical, chemical and biological, water borne diseases, primary, secondary and tertiary treatment, physical unit processes: screening, commutation, grit removal, equalization, coagulation-flocculation, sedimentation, and disinfection.

**MODULE- III: Biological wastewater treatment systems:** Aerobic processes - activated sludge process and its modifications, trickling filter, RBC, anaerobic processes: suspended growth, attached growth, fluidized bed and sludge blanket systems, natural wastewater treatment systems: ponds and lagoons, phytoremediation, wetlands and root-zone systems, operation and design aspects.

**MODULE- IV: Advanced wastewater treatment:** Iron and manganese removal, colour and odour removal, activated carbon treatment, ion exchange, electro-dialysis, reverse osmosis and flouride management, nitrogen and phosphorus removal, heavy metals removal, oil and refractory organics removal, micro-screening, ultra-filtration, centrifugation, wastewater disposal standards, sludge digestion and handling, disposal of effluent and sludge.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

**Books Suggested:**


- Waste water engineering, treatment and reuse by Metcalf and eddy, fifth edition, Tata McGraw Hill.
- Garg, S.K., Environmental Engineering, Vol. I, Khanna Publications, 2001, New Delhi.
- Garg, S.K., Environmental Engineering, Vol. II, Khanna Publications, 2001, New Delhi.
- Mark J. Hammer and Mark J. Hammer Jr., Water and Waste Water Technology, Prentice Hall of India Pvt. Ltd., 1998, New Delhi.

# TERM PAPER/ SEMINAR (RESEARCH ARTICLE)

**Course Code: ENV4331** **Credit Units: 01**

**Objectives:**
The objective of this course is to judge the understanding as well as application of the knowledge gained by the students.

The aim of the term paper/seminar is to provide the students with an opportunity to further enhance their knowledge in a sector of their choice by undertaking examination and analysis of various aspects of environmental issues at a level commensurate with the learning outcomes of the various courses taken up by them in the ongoing semester.
A term paper/ seminar is primarily a record of intelligent reading in several sources on a particular subject. The students will choose the topic at the beginning of the session in consultation with the faculty assigned.
A workshop is primarily an activity based academic event where the students practically obtain hands on experience on any aspect of their learning. The student will choose the option of workshop from amongst their concentration electives. The evaluation will be done by Board of examiners comprising of the faculties.

**Major Themes**

- Waste to energy
- Green building
- Disaster management
- Renewable energy
- Climate change and adaptation
- Remote sensing and GIS
- Wild life management
- Sustainable practices

These themes are merely indicative and other recent and relevant topics of study may be included.

**Guidelines for term paper/ seminar:**

- Choosing the topic: contemporary issue/ relevant study material will be given by the department
- The participants are expected to explore the topic in advance and take active part in the discussions
- Presentation: before the commencement of Semester examinations
- Group Activities have to be undertaken by students as guided by the trainer in a workshop.
- Response to queries
- Submitting a write up of at least 500 words about the learning outcome from the workshop/term paper.

Presentation of the seminar will be of 30 min maximum (25 min presentation and rest question answer session)

**Methodology**
The methodology followed at the workshop could be based on any one or more of the following methods:

- Case Study
- Simulation
- Business Planning
- Quiz
- Quality analysis &characterization
- Identification and preparation of materials

**Examination Scheme:**

| Organisation and relevance of content | Literature Review | Bibliography | Presentation | Response to the queries | Total |
|---|---|---|---|---|---|
| 30 | 10 | 10 | 40 | 10 | **100** |

# SUMMER INTERNSHIP EVALUATION

**Course Code: ENV4335** **Credit Units: 06**

**Methodology:**

Practical training is based on the theoretical subjects studied by the students. It can be arranged within the college or in any related industrial unit/ research organization. The students shall get a chance for practical exposure to various industrial processes, technical and experimental research skills. In case of on campus training the students will be given specific tasks which may be experimental or observation and analysis based i.e. analysis of water, air and soil, biodiversity analysis, short term project, data generation and analysis etc. On completion of the practical training the students are to present a report covering various aspects learnt by them and give a presentation of the same. The summer internship may further lead to Major project formulation for last semester.

**Examination Scheme:**

| Feedback from Industry | Training Report | Viva | Presentation | Total |
|---|---|---|---|---|
| **10** | **30** | **30** | **30** | **100** |

# Syllabus – Fourth Semester

## ENVIRONMENTAL LAW & ENVIRONMENTAL IMPACT ASSESSMENT

**Course Code: ENV4401** **Credit Units: 03**

**Course Objective:**
The students would be made aware with the ever becoming complex environmental management issues. They will also have an overview of Environment Impact Assessment and newer approaches related to it. This course aims to acquaint the students with an in-depth knowledge of laws and policies concerned with environmental protection. A brief outline of the efforts being done through global summits and laws implemented at national level would make the students familiar with basic knowledge of environmental law issues.

**Course Contents:**
**MODULE- I: Environmental Protection - issues and problems**: National Environmental Policy, provisions for environment protection in constitution of India; major environmental movements in India: Chipko movement, Narmada dam, Tehri dam, Almeti dam; Role of NGO's.

**MODULE-II: International Efforts:** UNEP, WWF, UNESCO, IGBP, IUCN, GEF, UNFCC, IPCC, Stockholm Conference on Human Environment (1972), Nairobi Declaration, Montreal Protocol(1987), Basel Convention (1989 and 1992), Earth summit at Rio de Janeiro (1992), Kyoto Protocol (1997), Earth summit at Johannesburg (2002), CBD.

**MODULE-III: Environmental Laws:** National Water Policy, Air Pollution Act (1981), Water Pollution Act(1974), Water Cess Act (1977), Environmental (Protection) Act (1986), Hazardous Wastes Management and Handling Rules(1989), Municipal Solid Waste (Management and Handling Rules) (2000), Public Liability Insurance Act (1991) and Rules(1991), Coastal Regulation Zones (CRZ) Rules (2011), Plastics Manufacture, Sale and Usage Rules(2011), Ecomark, Wildlife (Protection) Act(1972),Forest (Conservation) Act(1980), Biological Diversity Act(2002), Mining Act.

**MODULE - IV: Environmental impact assessment (EIA)**: Environmental impact statement (EIS), scope and types of environmental audit, environmental management plan (EMP), eco-management and audit scheme (EMAS), ISO standards. Environmental management plan (EMP), ISO standards, safety management system - EMS; Life Cycle Analysis (LCA) and its components.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Global Biodiversity - W.R. L.IUCN
- Shyam Divan and Armin Rosencranz, 2005, Environmental Law and Policy in India, Oxford University Press, New Delhi, 2005.
- Leelakrishnan. P, 2008, Environmental Law Case Book. Lexis Nexis, Butterworths.
- Mohanty. S. K., 2011, Environment and Pollution Law, Universal Law Publishing Co.Pvt.Ltd.

- Shastri S C, 2008, Environmental Law, (2nd Edn.), Eastern Book Company, Lucknow.
- Singh Gurdip, 2004, Environmental Law in India, Mcmillan and Co.
- ShantakumarS,2005 Introduction to Environmental Law, (2nd Edn.), Wadhwaand Company, Nagpur
- Sahasranaman P B, 2008 Handbook of Environmental Law in India, Oxford University Press(India).

# URBAN ECOSYSTEM AND INDUSTRIAL ECOLOGY

**Course Code: ENV4402** **Credit Units: 02**

**Course Objective:**
The pace of urban development has already brought irreparable changes in the environment posing a threat to biodiversity. The purpose of this course is to have an understanding of concepts and processes governing urbanization and its impact on natural resources. Moreover, students will be conceptualized about the scope of sustainability of urban space. Students will also be given an exposure about industrial systems and the strategies to emulate ecological systems for minimizing the waste production in industrial processes. The course would also discuss key issues involved with eco-industrial development and some cases from India.

**Course Contents:**
**MODULE- I: Urbanization:** Global and regional scenario of urbanization: factors and impact, population dynamics and push-pull factors, vegetative distributions in cities (green spaces), land use and GIS, urban green habitat, ecosystem services for cities. Hydrological effects of urbanization (water demand/wet land/ water conservation/waste water); climate resilient cities for sustainable urban habitat, integrating urban and environmental planning framework

**MODULE-II: Concepts of Industrial ecology:** origin, definition, environment and the anthrosphere, industrial systems, material resources, societal factors and environmental equity, Systems analysis, industrial metabolism, biological analogies; perspective on industrial ecology from India and other developing countries such as China and Brazil, with case studies.

**MODULE- III: Issues of eco-industrial development:** Components of an industrial ecosystem (Kalundborg example), industrial symbiosis, role of government, community, developers, management, evaluating the success of eco-industrial development, life cycle analysis and assessment: life cycle of products, processes and facilities.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

**Books Suggested:**


- Bourg D. and Erkman S., (edited) Perspectives on Industrial Ecology,46(2)(hardback).
- Jari N., Jürgen H.B., Guntenspergen G., Nancy E.M., Elmqvist T. and James P. (ed)(2011) Urban Ecology: Patterns, Processes and Applications, Oxford UniversityPress, New York, US.
- Allen A. and You N. (2002) Sustainable Urbanization: Bridging the Green and Brown Agendas, University College London, UK.
- Case Study of the Textile Industry in Tirupur (available at http://www.roionline.org/bookchapters.php?bid=1, accessed on 17 June2011).
- ErkmanS. and RamaswamyR. (2003) Applied Industrial Ecology – A New Platform for Planning Sustainable Societies, AICRA Publishers, Bangalore, India.
- Ayres R.U. (2004) On the Life Cycle Metaphor: Where Ecology and Economics Diverge, Ecological Economics, 48, 425-438.

# NATURAL HAZARDS AND DISASTER MANAGEMENT

**Course Code: ENV4403** **Credit Units: 02**

**Course Objective:**
This paper introduces the students to various environmental hazards, their causes, nature, preparedness and assessment of loss. It teaches them to model hazards and familiarizes with methods of management of disasters and consequently risk zonation.

**Course Contents:**
**MODULE-I: Introduction:** Disaster: nature and causes, climate change and disaster, hazard, risk, vulnerability, mitigation, natural hazard profile of India.

**MODULE- II: Natural and manmade hazards:** Hazards: classification, causes, impact and prediction, floods and droughts, mass wasting/ landslides, avalanche, nature and causes of volcanoes, and geographical distribution, manmade hazards: hazards due to dams/ reservoirs, nuclear power plants, industrial and occupational hazards, tropical cyclones and tsunami, sea level change and its impact on coastal areas

**MODULE-III: Disaster management cycle:** Mitigation: disaster risk reduction (DRR), the emergency operation plan (EOP), disaster preparedness: preventive measures, early warning system, response and recovery, impacts of disasters: health, physical and socio-economic.

**Examination Scheme:**

| Components | A | CT | HA | EE |
|---|---|---|---|---|
| Weightage (%) | 5 | 15 | 10 | 70 |

A: Attendance, CT: Class Test, HA: Home Assignment, EE: End Semester Examination;

***Books Suggested:***


- Tarbuck E. J. and LutgensF. K. (1996).An introduction to Physical Geology. Prentice Hall, New Jersey; ISBN 0-13- 371584-1.
- Kumar K. (1998). Course Material of "Foundation Course in Disaster Management" of School of Social Sciences - Indira Gandhi National Open University; ISBN 81-7605-236-X to ISBN 81-7605-248-X.
- Valdiya K. S. (1987).Environmental Geology (Indian Context). Tata-McGraw-Hill, New Delhi.
- Coates Donald R. (1985). Geology and Society. Chapman and Hall, NY.
- Keller Edward A. (1996).Environmental Geology. Prentice-Hall, NJ.
- Valdiya K. S. (2001). Geology, Environment and Society. University Press, Hyderabad.
- Kates, B.I& White, G.F The Environment as Hazards, oxford, New York, 1978.
- R.B. Singh (Ed) Disaster Management, Rawat Publication, New Delhi, 2000.
- H.K. Gupta (Ed) Disaster Management, Universities Press, India, 2003.
- Dr. Satender, Disaster Management in Hills, Concept Publishing Co., New Delhi, 2003.
- A.S. Arya Action Plan For Earthquake, Disaster, Mitigation in V.K. Sharma (Ed) Disaster Management IIPA Publication New Delhi,1994.
- R.K. Bhandani: An overview on Natural &Manmade Disaster & their Reduction, CSIR, New Delhi.
- M.C. Gupta Manuals on Natural Disaster management in India, National Centre for Disaster Management, IIPA, New Delhi,2001.

# RESEARCH BASED PROJECT WORK

**Course Code: ENV4437** **Credit Units: 12**

**GUIDELINES FOR PROJECT FILE AND PROJECT REPORT**

Research experience is a professional problem-solving activity and is equally significant as any other aspect of the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-the-art instrumentation.

Research is genuine exploration of the unknown that leads to new knowledge which often warrants publication. But whether or not the results of a research project are publishable, the project should be communicated in the form of a research report written by the student.

Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be critically analyzed by the faculty guide and corrected by the student at each stage.

**PROJECT FILE**

The Project File may be a very useful tool for undertaking an assignment along-with a normal semester, an exploratory study, sponsored projects, a project undertaken during summer period or any other period as per curricula where the researcher is working with a company/organization. The project/ assignment may also be a part of the bigger research agenda being pursued by a faculty/ institution/ department.

The Project File is the principal means by which the work carried out will be assessed and therefore great care should be taken in its preparation. This file may be considered in continuous assessment.

***In general, the File should be comprehensive and include:***

- A short account of the activities that were undertaken as part of the project;
- A statement about the extent to which the project has achieved its stated objectives;
- A statement about the outcomes of the evaluation and dissemination processes engaged in as part of the project;
- Any activities planned but not yet completed as part of the project, or as a future initiative directly resulting from the project;
- Any problems that have arisen and may be useful to document for future reference.

***PROJECT REPORT***

The Project Report is the final research report that the student prepares on the project assigned to him. In case of sponsored project the layout of the project could be as prescribed by the sponsoring organization. However, in other cases the following components should be included in the project report:

- ***Title or Cover Page***
  The title page should contain Project Title; Student's Name; Programme; Year and Semester and Name of the Faculty Guide.

- ***Acknowledgement(s)***
  Acknowledgment to any advisory or financial assistance received in the course of work may be given. It is incomplete without student's signature.

- ***Abstract***
  A good" Abstract" should be straight to the point; not too descriptive but fully informative. First paragraph should state what was accomplished with regard to the objectives. The abstract does not have to be an entire summary of theproject, but rather a concise summary of the scope and results of the project. It should not exceed more than 1000 words.

- ***Table of Contents***
  Titles and subtitles are to correspond exactly with those in the text.

- ***Introduction***
  Here a brief introduction to the problem that is central to the project and an outline of the structure of the rest of the report should be provided. The introduction should aim to catch the imagination of the reader, so excessive details should be avoided.

- ***Materials and Methods***
  This section should aim at experimental designs, materials used (wherever applicable). Methodology should be mentioned in detail including modifications undertaken, if any. It includes organization site(s), sample, instruments used with its validation, procedures followed and precautions.

- ***Results and Discussion***
  Present results, discuss and compare these with those from other workers, etc. In writing this section, emphasis should be laid on what has been performed and achieved in the course of the work, rather than discuss in detail what is readily available in text books. Avoid abrupt changes in contents from section to section and maintain a lucid flow throughout the thesis. An opening and closing paragraph in every chapter could be included to aid in smooth flow.

  Note that in writing the various sections, all figures and tables should as far as possible be next to the associated text, in the same orientation as the main text, numbered, and given appropriate titles or captions. All major equations should also be numbered and unless it is really necessary, do not write in "point" form.

  While presenting the results, write at length about the the various statistical tools used in the data interpretation. The result interpretation should be simple but full of data and statistical analysis. This data interpretation should be in congruence with the written objectives and the inferences should be drawn on data and not on impression. Avoid writing straight forward conclusion rather; it should lead to generalization of data on the chosen sample.

  Results and its discussion should be supporting/ contradicting with the previous research work in the given area. Usually one should not use more than two researches in either case of supporting or contradicting the present case of research.

- ***Conclusion(s) & Recommendations***
  A conclusion should be the final section in which the outcome of the work is mentioned briefly. Check that your work answers the following questions:
  - Did the research project meet its aims (check back to introduction for stated aims)?
  - What are the main findings of the research?

- Are there any recommendations?
- Do you have any conclusion on the research process itself?

- ***Implications for Future Research***
  This should bring out further prospects for the study either thrown open by the present work or with the purpose of making it more comprehensive.

- ***Appendices***
  The Appendices contain material which is of interest to the reader but not an integral part of the thesis and any problem that have arisen that may be useful to document for future reference.

- ***References***
  References should include papers, books etc. referred to in the body of the report. These should be written in the alphabetical order of the author's surname. The titles of journals preferably should not be abbreviated; if they are, abbreviations must comply with an internationally recognised system.

  ***Examples:***
  **For research article:**
  Voravuthikunchai, S.P., Lortheeranuwat, A., Ninrprom, T., Popaya, W., Pongpaichit, S., Supawita, T., Photocatalytic treatment of tannery wastewater for the removal of toxic compounds, Journal of Environmental Science and Technology,8 (1): 116-117 (2002).
  ***For book:***
  Kowalski, M., Biological wastewater treatment for pulp and paper industry, Wastewater Treatment (Eds. P.S. Nutman IBP), **7**: 63-67(1976).

  ***The Layout Guidelines for the Project File & Project Report:***

  - A4 size Paper
  - Font: Arial (10 points) or Times New Roman (12points)
  - Line spacing: 1.5
  - Top and bottom margins: 1 inch/ 2.5 cm; left and right margins: 1.25 inches/ 3cm

## *ASSESSMENT OF THE PROJECT FILE AND THE PROJECT REPORT*

Essentially, the assessment will be based on the quality of the report, the technical merit of the project and the project execution. Technical merit attempts to assess the quality and depth of the intellectual efforts put into the project. Project execution is concerned with assessing how much work has been put in.

The Project should fulfill the following ***assessment objectives:***

- Range of Research Methods used to obtain information
- Execution of Research
- Data Analysis (Analyze Quantitative/ Qualitative information)
- Quality Control
- Conclusions

***Assessment Scheme: Continuous Evaluation:***

40% (Based on punctuality, regularity of work, adherence to plan and methodology, refinements/mid-course corrections etc. as reflected in the Project File.)

***Final Evaluation:***

60% (Based on the Documentation in the file, Final report layout, analysis and results, achievement of objectives, presentation/ viva)

***It is recommended that the Final evaluation should be carried out by a panel of evaluators.***