M.Sc. ENVIRONMENTAL SCIENCE
SYLLABUS BASED ON THE SEMESTER SYSTEM

The primary objective of National Environmental Policy is "to protect and manage the country`s environmental assets such that their capacity to sustain development is unimpaired and to ensure that future generations are able to enjoy the magnificent environmental endowment". To attain this major objective, the country needs well-trained practitioners; demands are expected to grow in the related fields of Environmental Science. To help meet these demands, the Uttarakhand Technical University, Dehra Dun, offers students the opportunity to undertake an MSc Environmental Science. The aim of this Programme is to provide a thorough, stimulating and practical postgraduate education and give participants a sound basic knowledge of the relevant aspects of Environmental Science and its related specialist areas. Students will acquire appropriate analytical skills for flexibility of approach in environmental decision-making, thus graduating with expertise highly valued by employers. The graduates of the specialist Programme will be fully equipped to seek employment or improve their proficiency in government ministries, environmental planning consultancies, environmental agencies, local authorities, utilities and non-governmental organizations locally as well as regionally. Increasingly, business is being required to demonstrate management of environmental and social issues along with traditional financial performance. The focus of attention has also been moving towards the service and public sectors that, because of their large numbers as well as their high numbers of employees, account for a very significant proportion of environmental degradation. Particular attention is directed towards reduction of air, land and water pollution, together with the need for urban, natural habitat and coastal zone management. Concomitant with these has been growing public awareness of the interaction between development actions and their environmental consequences. No doubt, consistent calls are being made for human health, amenity and ecological concerns to be explicitly considered in development decisions.

The aim of this MSc EVS programme is on training that enables the student to embrace the concept of better quality of life for a sustainable future.

The aims can be summarised as follows:

- adopt an integrated approach by focusing on planning resource use efficiently and equitably, analyzing objectively pollution control strategies, and minimizing environmental impact utilizing the tools of environmental auditing and environmental and ecological impact assessment;
- emphasise the complex interrelationships between, on the one hand, a rising material standard of living with the consequence of increased product consumption and hence resources, and on the other hand, increased and more stringent environmental legislation to reduce and control industrial pollution;
- provide the skills of critical awareness, analysis, evaluation and assessment for efficient environmental decision-making and management; and
- provide training in the design, conduct, analysis and interpretation of an independent research project to MSc level.

ELIGIBILITY REQUIREMENTS (QUALIFYING EXAMINATION)

Candidates who have passed B.Sc. (Hons.)/B.Sc. (10+2+3) or BE/B.Tech. with a minimum of 50% marks (equivalent GPA with a minimum 50% aggregate at 10 & 10+2 levels) shall be considered for admission to M.Sc. Course in Environmental Science.

FIRST SEMESTER (Theory Papers)		
Subject Code	**Subject Name**	**Max. Marks**
ES101	**Introduction to Environmental Science**	**60**
ES102	**Environmental Chemistry**	**60**
ES103	**Environmental Biology**	**60**
ES104	**Ecosystem Dynamics**	**60**
ES105	**Statistical methods and computer applications in environmental science**	**60**
FIRST SEMESTER (Practical Papers)		
	Practical I (based on paper ES 101, ES 102, ES 103)	**75**
	Practical II (based on paper ES 104, ES 105)	**75**
	Internal Assessment	**250 (50 X 5 = 250)**
	Total marks of M. Sc. First Semester	**700**

SECOND SEMESTER (Theory Papers)		
Subject Code	**Subject Name**	**Max. Marks**
ES201	**ANALYTICAL TECHNIQUES**	**60**
ES202	**WATER AND WASTE WATER TECHNOLOGIES**	**60**
ES203	**TREATMENT TECHNOLOGIES FOR MUNICIPAL SOLIDS HAZARDOUS AND BIOMEDICAL WASTES**	**60**
ES204	**ECOHYDROLOGY**	**60**
ES 205	**ENVIRONMENTAL IMPACT ASSESSMENT**	**60**
SECOND SEMESTER (Practical Papers)		
	Practical-I (based on paper ES 201, ES 202, ES 203)	**75**
	Practical-II (based on paper ES 204, ES 205)	**75**
	Internal Assessment	**250 (40 X 5 = 250)**
	Total marks of M. Sc. Second Semester	**700**

THIRD SEMESTER (Theory Papers)		
Subject Code	**Subject Name**	**Max. Marks**
ES301	**ENVIRONMENTAL POLICY & LEGISLATION**	**60**
ES302	**IPR & BIOSAFETY**	**60**

ES 303	**ECOTOXICOLOGY, INDUSTRIAL HYGIENE AND OCCUPATIONAL HEALTH**	**60**
ES304	**ENVIRONMENTAL POLLUTION, ASSESSMENT & MONITORING**	**60**
ES 305	**ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT**	**60**
		60
THIRD SEMESTER (Practical Papers)		
	Practical-I (based on paper ES 301, ES 302, ES 303)	**75**
	Practical-II (based on paper ES 304, ES 304)	**75**
	Internal Assessment	**250 (40 X 5 = 250)**
	Total marks of M. Sc. Third Semester	**700**

FOURTH SEMESTER		
Subject Code	**Subject Name**	**Max. Marks**
ES 401	**PROJECT WORK**	**450**
	Total marks of M. Sc. Fourth Semester	**450**

CONTENTS

SEMESTER - I

ES 101: INTRODUCTION TO ENVIRONMENTAL SCIENCE
ES 102 : ENVIRONMENTAL CHEMISTRY
ES 103: ENVIRONMENTAL BIOLOGY
ES 104 :ECOSYSTEM DYNAMICS
ES 105:STATISTICAL METHODS AND COMPUTER APPLICATIONS IN ENVIRONMENTAL SCIENCE

SEMESTER – II

ES201: ANALYTICAL TECHNIQUES
ES202: WATER AND WASTE WATER TECHNOLOGIES
ES203: TREATMENT TECHNOLOGIES FOR MUNICIPAL SOLIDS HAZARDOUS AND BIOMEDICAL WASTES
ES204 : ECOHYDROLOGY
ES 205: ENVIRONMENTAL IMPACT ASSESSMENT

SEMESTER – III

ES301:ENVIRONMENTAL POLICY & LEGISLATION
ES302:IPR & BIOSAFETY
ES 303: ECOTOXICOLOGY, INDUSTRIAL HYGIENE AND OCCUPATIONAL HEALTH
ES304:ENVIRONMENTAL POLLUTION, ASSESSMENT & MONITORING
ES 305:ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT

SEMESTER – IV

ES 401: PROJECT WORK

SEMESTER - I

ES 101: INTRODUCTION TO ENVIRONMENTAL SCIENCE

Unit 1:

Definition, Principles and Scope of Environmental Science.
Evolution of environment, Physicochemical and Biological Characteristics of environment, Geographical classification and zones.
Earth, Man and Environment, bio-diversity in situ and ex situ biodiversity conservation.

Unit 2:

Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere, Mass and energy transfer across various interfaces.
First and second laws of thermodynamics, heat transfer processes, Biochemical cycles, gaseous and sedimentary turnover rate and turnover item, Hydrological cycle, Carbon cycle, Nitrogen cycle, Sulphur cycle, Phosphorus cycle, nutrient budget, main impact on nutrient cycle.

Unit 3:

General relationship between landscape, biomes and climate. Climates of India, Indian monsoon, Drought, Tropical cyclones and western disturbances.
Atmosphere stability and instability, temperature inversion and mixing heights, heat balance of the earth- atmosphere system, global climate change.

Unit 4:

Human Ecology - Population growth, age structure, equilibrium level, size and distribution, natality, morbidity, mortality.
Natural Resources- conservation and sustainable development.Environmental ethics.

ES 102 : ENVIRONMENTAL CHEMISTRY

Unit 1: Concept and scope of Environmental Chemistry
Basic Concepts : Stochiometry, Gibb's energy, Chemical Potential, chemical equilibrium, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radio nuclides. Significant chemical process- photosynthesis, fermentation and biodegradation.
Unit 2: Classification of elements: Chemical speciation, chemistry of corrosion, metabolic, neurotoxic and carcinogenic compounds.
Chemistry of air: Particles, ions and radicals in the atmosphere, chemical and photochemical reactions, oxygen and ozone chemistry, greenhouse effect, oxygen, carbon and nitrogen cycles

Unit 3: Chemistry of Water: Physical chemistry of Seawater, complexation in natural and wastewater. Concept of DO, BOD, COD and threshold number, physicochemical basis of redox potential, electro-chemical theory of corrosion, role of water in environment. Chemistry of Lithosphere: Chemical composition of earth, metals, minerals, fossil fuels and soils.
Unit 4: Heavy metals -Lead, Arsenic, Mercury, Cadmium, Selenium and Chromium. Chemistry of cleaning agents - Soap, detergents and bleaching agents. Chemistry of gaseous, liquid and solid fuels - gasoline and additives, antiknock agents, lubricants and greases, fossil fuels, firewood, biogas. Chemistry of Pollutants: CFC, Pesticides, weedicides and fungicides.
Unit 5: Analytical methods e.g. Gas Chromatography, HPLC, Atomic Absorption Spectrometry, Polarography, Fluorometry, Neutron Activation Analysis, Ion selective electrodes, UV and visible spectroscopy.

ES 103: ENVIRONMENTAL BIOLOGY
Unit 1: Definition, Principles and Scope. Biotic and abiotic factors of environment.
Principle and concept of ecosystem : wetland, pond, forest, river, grassland and estuary ecosystems. producers, consumers, decomposers.
Homeostasis of environment- primary productivity, C3 and C4 pathways and significance, second law of thermodynamics and energy flow; Trophic structure, food chain , food web ; Ecological pyramids and ecosystem energetics; wetland ecosystem.
Unit 2: Population dynamics : Definition, population density, Natality, Mortality, Age structure, Growth pattern, Fluctuation and equilibrium, Biotic potentials, population dispersion. Density dependent and density independent factors of population regulation. Community: Definitions, characteristics, diversity, dominance, structure, stratification, periodicity, fluctuation within community, interdependence, Ecotone and Edge effect, Ecological Niche and Equivalents, Ecotype, Ecophene and Ecological indicator, Ecological succession.
Unit 3: Common flora and fauna in India: Aquatic – Phytoplankton, Zooplankton and Macrophytes, Terrestrial – forests. Endangered, rare and threatened species with special reference to Uttarakhand and North East India.
Unit 4: Biodiversity and its conservation: Definition, Hotspots of Biodiversity, Strategies for Biodiversity conservation, National Parks and Sanctuaries, Gene pool. Microflora of Atmosphere; Air sampling techniques, identification of aeroallergens, Air borne diseases and allergies.

ES 104: ECOSYSTEM DYNAMICS
Unit 1: History and scope of Ecology; Concept of ecosystem, food webs and population stability,Trophic levels. Solar energy and the atmosphere, photosynthesis and respiration, Energy flow through the biosphere, Feedback and control.
Unit 2: Population dynamics, some biological growth curves, Carrying capacity, biological resistance, population growth curves.
Human population growth, Age structure, population pyramids, fertility, momentum of population growth, population control.
Unit 3: Food production; Human food requirements, proteins, Food chain losses, Food from land and sea, increasing yield, pesticides – their effects on non target organisms, Effects on predator – prey relationship.

Unit 4: Biological conservation, types of forests in India, causes of forest degradation, problems of deforestation, Gene pool conservation. Principle of life, Biosphere, Biomes and aquatic life zones, Genome. Ecosystem stability, imbalances in the ecosystem, Human impact on ecosystem.
Unit 5: Food production; Human food requirements, proteins, Food chain losses, Food from land and sea, increasing yield, pesticides – their effects on non target organisms, Effects on predator – prey relationship.Biological conservation, types of forests in India, causes of forest degradation, problems of deforestation, Gene pool conservation.

ES 105: STATISTICAL METHODS AND COMPUTER APPLICATIONS IN ENVIRONMENTAL SCIENCE
Unit 1: Basic Statistics: Measures of Central Tendency and Dispersion, Frequency Distributions, Moments, Matrices, Simultaneous linear equations.
Probability Rules : Theory and Distributions, Normal, Binomial, Poisson and Lognormal distributions.
Unit 2: Sampling and Test of Significance: Student's t- distribution, F distributions, Chi Square distribution, Error theory and applications.
Analysis of Variance, Hypothesis Testing: F-test, t- test, Fisher's least significance difference test and application.
Unit3: Correlation and Regression, Simple (linear) and multivariate analysis and their applications.
Non–parametric Statistics: Contingency tables, Comparing sets of normal data and ordinal data, Correlation methods and applications.
Partial Correlation and Multiple Regression, Trend Surfaces, Cluster Analysis and discriminant analysis, Principal component analysis, Factor analysis, Time series analysis, power spectrum analysis.
Unit 4: Environmental System Analysis : Approaches to development of models, validation and forecasting, Models of Population growth and interactions- Lotka–Volterra model, Leslie's matrix model, point source stream pollution model, box model, Gaussian plume model.
Environmental Statistics: Scope and significance, national and international developments.
Unit 5: Computer techniques: Structure, function, capabilities and limitations of a computer, Types of computer, Computer languages and soft wares currently available, Basics of word processing and data base management techniques.
Introduction to scientific programming in PASCAL / BASIC / FOXPRO, writing of simple programs to apply some elementary statistical techniques to environmental data, Elementary environmental modeling.

Semester II

ES201: Analytical Techniques
Unit I
Basic Techniques
Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques
Spectroscopy Techniques
UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy

Unit II

Chromatography Techniques

TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity

Electrophoretic techniques

Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Unit III

Centrifugation

Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge -Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods

Unit IV

Radioactivity

Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay

Unit V

Advanced Techniques

Protein crystallization; Theory and methods; API-electrospray and MALDI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis.

Texts/References

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H.Freeman & Company, San Fransisco, 1982.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.
3. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
4. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
5. Selected readings from Methods in Enzymology, Academic Press.

ES202 Water and waste water technologies

Unit I

Water microbiology and analytical tools in assessment of water pollution

Overview of standards of water in relation to public health - Detection and control of micro-organisms in environmental fresh water, in source and drinking water; Potable and nonpotable water; Methods of water sampling for pollution analysis; Biosensors - types and applications in environmental pollution detection and monitoring; Biological treatment: stabilization pond, aerated lagoon, activated sludge process, trickling filter anaerobic treatment.

Water Pollution

Principal forms of Water Pollutants and their sources; Pollution of stream, lakes and phenomenon of eutrophication; Water pollution monitoring and water quality standards; Ocean pollution – oil pollution; Ground water pollution and its control; Water pollution prevention

Unit II

Water Pollution Monitoring

Methods of monitoring; Biological methods; Detection methods for DO, BOD, Pathogen monitoring by heterotrophic plate count; Multiple tube method; Membrane filtration methods; Other emerging techniques such as enzyme detection, hybridization, PCR, Gene probe technology etc.; Strategies for controlling pathogen transfer; Chemical methods- Detection methods for COD, pH, alkalinity, TSS, TDS, Total organic carbon, oil, grease etc.; Biosensors of pollution

Unit III

Effluent treatment systems

Sewage and waste water treatments systems; Primary, secondary and tertiary treatments; Measurement of treatment efficiencies; Biological treatments - aerobic versus anaerobic treatments; Environmental pollution control- Bioremediation, Bioaugmentation and Biostimulation; Biofilms in treatment of waste water; Biofilm development and biofilm Kinetics; Aerobic Biofilms; Bioreactors for waste water treatments; Reactors types and design; Reactors in series; Development and optimization of membrane bioreactor process for use in sanitary and industrial sewage treatment.

Unit IV

Removal of specific pollution

Physicochemical characteristics and treatment strategies for effluent generated by Distillary and fermentation industry; Fertilizers and pesticide manufacturing industries; Dyes and dye intermediate producing industries and textile industries; Paper and pulp industries; Tanneries; Pharmaceuticals; Thermal power plants; Food and dairy industries; Iron and steel industries; Organic solvents; Chlorinated minerals and inorganic chemical industries and petrochemicals; Biotechnological application of hazardous waste management of water; Use of microbial systems; Phytoremediation: Waste water treatment using aquatic plants; Root zone treatment; Development of new biocatalysts to be applied in waste water biotechnology.

Texts/References

1. Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney, Manual of Environmental Microbiology, 2nd edition, ASM Press. 2001.
2. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
3. Foin, Ecological Systems and the Environment – I
4. D.L. Wise, Biotreatment Systems, Volume II.
5. Mizrahi & Wezel, Advances in Biotechnological Process
6. Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Environmental Microbiology, Academic Press, 2000.
7. Martin Alexander, Biodegradation and Bioremediation, 2nd Edition, Academic Press, 1999.
8. Gabriel Bitton, Wastewater Microbiology, 2nd Edition. Wiley-Liss; 2nd Edition, 1999.

ES203 Treatment Technologies for Municipal solids Hazardous and Biomedical wastes

Unit I

Bioremediation, Biotransformation and Biodegradation

Bioremediation; *In situ* and *Ex situ* bioremediation; Constrains and priorities of bioremediation; Evaluating Bioremediation; Bioremediation of VOCs.

Biodegradation; Factors affecting process of biodegradation; Methods in determining biodegradability; Contaminant availability for biodegradation.

Xenobiotics; Persistence and biomagnification of xenobiotic molecules; Microbial interactions with xenobiotics; Phase I and Phase II reactions; Cyt P 450 mediated reactions; Use of microbes (bacteria and fungi) and plants in biodegradation and Biotransformation.

Unit II

Solid waste management of municipal and biomedical waste

Basic aspects of solid waste management; Current practices in India; Aerobic and anaerobic treatments of solid wastes; Composting; Vermiculture; Biogas generation; Comparison of aerobic and anaerobic methods; Treatment of hazardous wastes; Origin, sources and treatment strategies for polychlorinated biphenyls, pesticides, toxic pollutants, polymers, Textile chemical residues etc.; Biomedical wastes, Types of biomedical wastes; Hazards caused by biomedical wastes; Treatment strategies for biomedical wastes.

Unit III

Heavy metal and oil spill bioremediation

Sources of heavy metal pollution; Microbial interactions with inorganic pollutants - Microbial metal resistance; Microbial transformation; Accumulation and concentration of metals; Biosorption - Biotechnology and heavy metal pollution; Oil field microbiology; Improved oil recovery; Biotechnology and oil spills; Hydrocarbon degradation

Unit IV

Environmental impacts on agriculture

Biodegradation of agricultural chemicals; GM crops and their impact on environment; Biological nitrogen fixation; Phosphate solubilization; Biofertilizers; Biological control of insect pests; Role of biopesticides/insecticides; Biocontrol of plant pathogens; Integrated pest management-practical implementation; Ecology and IPM.

Unit V

Biotechnology for management of resources

Need for management of resources; Role of environmental biotechnology in management of resources; Reclamation of wasteland; Biomass production; Biogas and biofuel production; Development of environmentally friendly processes such as integrated waste management.

Texts/References

1. Bruce Rittman, Perry L. McCarty, Environmental Biotechnology: Principles and Applications, 2nd edition, McGraw-Hill, 2000.
2. Milton Wainwright, An Introduction to Environmental Biotechnology, Kluwer Academic Publishers, Boston. Hardbound, 1999.
3. K.G. Mukerji, B.P. Chamola, Rajeev K. Upadhyay, Biotechnological Approaches in Biocontrol of Plant Pathogens, Kluwer Academic/Plenum Publishers. Hardbound, 1999.
4. Martin Alexander, Biodegradation and Bioremediation, 2nd edition, Academic Press, 1999.
5. M.N.V. Prasad, Kazimierz Strzalka, Physiology and Biochemistry of Metal Toxicity and Tolerance in Plants, Kluwer Academic Publishers, Dordrecht Hardbound, 2002.

ES 204: ECOHYDROLOGY

Unit 1: Introduction: The hydrologic cycle, Inventory of Earth's water. Precipitation : Various forms of precipitation, interpretation of precipitation data Evaporation and evapo-transpiration: meteorological factors, transpiration, methods of estimating evaporation from land surface using Penman's equation.
Unit 2: Infiltration and percolation: Infiltration capacity of soil, Factors influencing infiltration capacity, methods of determining infiltration capacity.Interaction of vegetation, land use, topography, climate, runoff and sediment yield. Basic concepts of floodplain hydrology, wetland hydrology, forest hydrology and mountain hydrology
Unit 3: Erosion by water of hill slopes and river banks. Ground water recharging and rain water harvesting. Runoff : Duration of runoff, flow rating curves-their determination, adjustment and extension, catchment characteristics and their effects on runoff, climatic factors.
Unit 4: Ground water: The occurrence of ground water, factors of influence, ground water flow, abstraction of ground water. Hydrological forecasting: Frequency analysis, Probability of the N-year event, series of events, Probability plotting, cyclical nature of hydrological phenomena. Ecohydrology of the Brahmaputra basin

ES 205: ENVIRONMENTAL IMPACT ASSESSMENT
Unit 1: Concept of environmental impact analysis: Concept of environment and environmental Impact, Nexus between development and environment, Measurement of impact – physical, social, economical, natural; Concept of significant effect, consideration of significant effect; Short term versus long term effect; Environmental impact factors and area consideration.
Socioeconomic Impact Analysis (SIA): Types of socioeconomic impact, basic steps in SIA, Analysis of public services and facilities impacts; Fiscal impact analysis; Analysis of social impacts; Impacts of economic profile of the community.
Unit 2: Air quality impact analysis (AQIA): Typical considerations and factors; Pollution sources, atmosphere interactions; Air pollution effects; Air quality modeling; Legal aspects; Assessment methodology; Mitigation procedures; Case studies – Highway and Power Plants.
Noise Impact Analysis (NIA): Nature of sound, Environmental noise problem, sound power and sound intensity; Decibels and levels, sound propagation and attenuation; Effect of noise on people; Noise scale and rating methods, estimating transportation noise impact, examples of impact assessment.
Unit 3: Energy Impact Analysis (EnIA): Types of energy and distribution; Energy sources; Importance of energy impact analysis; Energy inventory, supply demand scenario; Energy conservation; Energy alternatives; Energy inventory data; energy conservation.
Water Quality Impact Analysis (WQIA): Water quality criteria and standards, Environmental setting; Water quality impact by project type; Water quality modeling.
Vegetation and Wild Life Impact Analysis (VWLIA): Biological concepts and terms; Assessment topics, mitigation measures, alternatives, assessment methodologies; Example of biotic assessment.
Unit 4: Framework of Environmental Assessment: Description of environmental setting; Prediction and assessment of impact on air, water, noise and biological environment; Prediction and assessment of impact on the cultural and socio-economic environment; Methods of impact analysis; Public participation in environmental decision making,

Environmental ethics, Integration and Optimization criteria for Multipurpose Development Projects, Environmental auditing.

Unit 5: Impact Assessment Methodologies: Determination of impact importance, development of value functions; Examples of total impact evaluation.

Role of GIS in EIA base line study; risk assessment, risk management, comparison of alternatives.

Case studies: River valley projects, thermal power plants, mining projects, oil refineries and petrochemicals, paper mills and cement industries.

III SEMESTER

ES301:Environmental Policy & Legislation

Unit I

International Environmental Policies

Nature of Environmental Policies; Stockholm Conference(1972); Rio Conference (UNCED)(1992); Merits of the Conference (Agenda 21); Failures of the Conference.

International Agreements and Treaties:

Concept of agreement and treaty; Need of international agreements and treaties; Johanesburg treaty; GAAT and Environment; CITES; Montreal Protocol

Unit II

National Policy on Environment:

National Committee on Environment and Planning (NCEP); Tiwari committee; Establishment of MoEF; National Forest Policy; National Water Policy and National Energy Policy; CPCB and SPCBs.

Constitutional provisions for Environmental Protection:

Historical Background of constitutional provisions; Article 14, 15, 19, 21, 32, 39, 47, Article 48(A), 49, 51A(g) as fundamental duties of citizen and directive principles of state policy, Article 243, 243(G) and (W); Art. 246, 248 and other articles related to Environment; Writ provisions for the protection of environment.

Unit III

National Environmental Legislation related to water, air, mining etc.

The Water(Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; Aims, objectives and major contents and Sec. 12 of Mining Act, 1952.

National Legislation on Forest, Wildlife etc.

The Forest (conservation) Act, 1980; The Wildlife (Protection) Act, 1972; The Biodiversity (Protection) Act, 2002; Aims, objectives and major contents with ammendments.

Unit IV

Environmental Legislation related to CRZ & PIL

Concept and need of public interest litigation; Jurisdiction of High Courts and Supreme Court; Need of CRZ rules for regulation the activities in coastal zone; Statutory provisions in IPC and CrPC; Common law remedies for environmental safeguard; Environment related provisions in Public Liability Insurance Act.

Texts/References

1. Declaration of: The Stockholm Conference, Rio, Rio+5 and Rio+10
2. Anti-Pollution Acts (30 and Commentaries published theorem)
3. Constitution of India (referred articles from Part-III, Part-IV and Part-IV-A)
4. Pares Distn. Environmental Laws in India.
5. P. Leelakrishnan, Environmental and the last (Bullorthworths, Latold, edn.)

ES302 IPR & Biosafety

Unit I

Introduction to Intellectual Property

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS

Unit II

Concept of 'prior art'

Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation

Unit III

Basics of Patents

Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application

Unit IV

Patent filing and Infringement

Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US

Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives

Patent infringement- meaning, scope, litigation, case studies and examples

Unit V

Biosafety

Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

Important Links

http://www.w3.org/IPR/
http://www.wipo.int/portal/index.html.en
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
www.patentoffice.nic.in

www.iprlawindia.org/ - 31k - Cached - Similar page
http://www.cbd.int/biosafety/background.shtml
http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

ES 303: Ecotoxicology, industrial hygiene and occupational health
Unit 1: Origin and scope of Toxicology: Types of toxic substances, Drugs, Food additives, Industrial chemicals, Pesticides, Environmental pollutants, Natural toxins, Household poisons, xenobiotic chemicals. Toxicological evaluation: Dose response relationship, LD 50, LC 50, Toxicity testing –acute toxicity tests, Sub-acute and chronic toxicity tests, Heavy metal toxicity tests for lead, Mercury, Cadmium and Chromium.
Unit 2: Physiological aspects; Types of exposures, Absorption routes—skin, lung, gastro intestinal tracts, Distribution storage of toxins in tissues, plasmapritein, kidney, fat, bone and blood. Passage of toxicants across placenta. Detoxination and Excretion: Detoxination process, Urinary excretion, billiary, lung, gastrointestinal, Cerebrospinal fluid, milk, sweet and saliva.
Unit 3: Effects of toxic substances : Health impacts, Effects on fish – long term effects – chronic , carcinogenic, mutagenic and teratogenic effects – a few illustrations , Hydrocarbons, Halogenated hydrocarbons, Alcohols, Aldehydes, Ketones, Esteroxides, Amines, Nitrosoamines, Nitrate Alkaloids.
Unit 4: Occupational Health Criteria: Health problems in India due to dust, heat stresses, chemicals noises, toxic gases and metals. Measurement and control of occupational diseases, factory acts. Epidemiological issue (i.e. Goitre, Fluorosis, and Arsenic).

ES304:Environmental Pollution, Assessment & Monitoring
Unit I
Environmental Pollution
Concept of Environmental Pollution; Origin of pollution; Classification and nature of Environmental Pollutants; Major sources; Impacts of Environmental Pollution at local regional and global level.
Air pollution
Concept of air Pollution; Major air pollutants and their sources; Meteorological aspects of air pollution; Oxides of nitrogen and sulphur; Particulate matter; Air pollution standards; Indoor and outdoor air pollution; Vehicular air pollution; Air pollution episodes and disasters; Effects of air pollution on human health, animals, plants, material and climate; Formation of fog and photochemical smog and acid rain; Monitoring of air pollution; Control on release of smoke; Gaseous contaminants and odour; Control on release of particulate matter by using different control devices.
Unit II
Noise Pollution
Concept of noise; Sources of noise; Measurement of noise; Religious festival and noise; Standards of noise; Effects of noise on plants, animals and human beings; Control of noise at source; Industrial noise control; Prevention of public noise; Community noise control.
Radiation Pollution

Types and possible hazards of radioactive substances; Measurement of radiation intensity; Effects of radioactive waste pollution on environment and impact of radiation on life; Monitoring and control of radiation pollution.

Unit III

Soil Pollution

Importance of soil; Concept of soil pollution; Soil acidity, saline and alkaline soil; Causes of soil salinity; Major soil types; Physical, chemical and biological methods of soil reclamation; Different causes of soil degradation; Chemical and metallic pollution of agricultural soil; Mining and soil pollution; Soil pollution and air quality; Control of soil pollution

Solid Waste

Concept of solid waste; Industrial solid waste; Domestic solid waste; Agricultural solid waste; Municipal solid waste; Major sources of solid wastes; Effects of solid waste generation on quality of air, water and public health; Technical approach for solid waste management; Disposal of organic and medical waste;

Recovery and recycling of metallic waste; Disposal of plastic waste and hazardous wastes.

Unit IV

Environmental Quality Assessment and Monitoring

What is environmental quality? Quality of environment for life on earth and man; Deterioration of environmental quality with reference to anthropogenic impact; Methods of assessment of environmental quality; Short term studies/surveys; Rapid assessment; Continuous short and long term monitoring

Environmental Impact Assessment (EIA)

Need of EIA; Scope and objectives; Types of environmental impacts; Steps involved in conducting the EIA Studies; Environmental Impact Assessment techniques-Ad-hoc method, checklist method, overlay mapping method, network method, simulation and modeling technique, matrix method, and system diagram technique; Merits and Demerits of EIA studies.

Unit V

Principles of Remote sensing, its applications in Environmental Monitoring

Principles and Basic concepts of Remote sensing; EMR & its interaction with matter; Aerial Photography: Types, Camera, Elements of photo interpretation (Aerial Photography/image recognition); Sensors & platforms; IRS satellites & their sensors; Application of remote sensing in environmental studies: landuse mapping, forest survey, habitat analysis, water management, drought monitoring and flood studies, wetland survey ; rainfall estimation, pollution studies, soil conservation and watershed management; Spectral response of vegetation and vegetation mapping.

Geographical Information System (GIS)

Geographical Information System (GIS): Basic principles, Techniques Application in Environmental Science.Types of Geographical Data; Data Structure; Vector and Raster data: their Advantages and Disadvantages; Input, verification, storage and out put of geographical data; Importance of Geographical Information System in environmental studies.

Global Positioning System (GPS): basic principles, Applications to environmental studies –Point source pollution, hazard monitoring and assessment.

Texts/References

1. S. Glassstone, D. Van Nastrand, Source book on atomic energy, 3rd Edition, Germany, 1967
2. M. Eisendbud, Environmental radioactivity, , Academic Press

3. E.D.Enger, B.E. Smith, Environmental Science- Astudy of Inter relationships, WCB Publication.

ES 305:ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT

Unit 1: Environmental Management: Concept, Approaches, methods and standards. Environmental Management of Resources -- Water, forest, biological, mineral and agricultural
Unit 2: Environmental management of chemical, mining and manufacturing industries – petroleum, coal, cement, paper, fertilizer.
Unit 3: Sources and generation of solid wastes, their characterization, chemical composition and classification. Methods of disposal and management of bio-medical wastes, Municipal solid wastes, hazardous wastes; recycling of wastes, waste minimization techniques.
Unit 4: Basic concepts of Environmental Economics , Environmental Auditing , Ecomark Sustainable development – concept, and growth of the idea, indicators of sustainability, models of sustainable development. Sustainable Development Scenario – global, national.
Unit 5: Current environmental issues in India, Context : Narmada Dam, Tehri Dam, Almetti Dam, Soil erosion, Formation and reclamation of usar, alkaline and saline soil. Waste lands and their reclamation. Desertification and its control Legal, administrative and constitutional provisions for environmental protection in India.

Semester IV
ES 404: PROJECT
Work on the project initiated in Semester III is to be completed with report submission by the end of semester IV. The students will increase their professional capacity to conduct original investigations and prepare a dissertation of 15,000 words. Research topics will be chosen and discussed at the end of the third semester and a suitable supervisor will be allocated. Initial work will focus upon an overview of the chosen topic, a literature review and the design of the methodology to be adopted. During Semester 4 students will undertake the necessary research and analysis, culminating in the writing of the dissertation. A wide variety of topics relevant to environmental science and its management will be available and students will be encouraged to suggest their own topics.
The project report will be submitted in the form of dissertation duly certified by the supervisor of the Department (Ph.D in the concerned subjects) and external guide may be from research institutes and Universities in India . The project will be presented for evaluation at the end of semester by external expert.