Jawaharlal Nehru University
School of Environmental Sciences

M.Phil. Programme

Common Courses (2 Credits Each)

Semester–I	
Package-A (Any Two Courses to be Opted)	**Package-B (Any Two Courses to be Opted)**
ES-651 Ecosystem Processes	ES-586 Environmental Management
ES-652 Earth Processes	ES-654 Analytical Techniques
ES-653 Atmospheric Processes	ES-655 Statistical Methods

Optional Courses (3 Credits Each)

Area–I	
Semester-I	**Semester-II**
ES-605 Mathematical Ecology	ES-628 Advance Topics in Bioelectronics
ES-608 Some Physics Based Techniques in Environmental Research	ES-640 Diffusion and Transport of Air Pollutants
ES-609 Topics in Non-Linear Differential Equations and System Analysis	ES-642 Aerosol Physics
ES-637 Air Pollution Meteorology	ES-671 Mathematical Modelling
	ES-674 Energy Use and Environmental Implications
Area–II	
Semester-I	**Semester-II**
ES-610 Geological Oceanography	ES-612 Geochemistry of Mineral Deposits
ES-638 Water Resources	ES-618 Environmental Geology
ES-644 Geochemical Cycles	ES-629 Recent Sediments
ES-611 High Temperature Geochemistry	ES-661 Remote Sensing Applications in Geosciences
	ES-666 Glaciofluvial Sediments
	ES-673 Soil Geochemistry
Area–III	
Semester-I	**Semester-II**
	ES-616 Water Pollution
	ES-617 Soil Pollution and Solid Waste Management
	ES-632 Air Pollution
	ES-639 Limnology
	ES-675 Chemical Speciation in Aquatic Systems
Area–IV	
Semester-I	**Semester-II**
ES-621 Environmental Toxicology	ES-619 Environmental and Occupational Health
ES-684 Advances in Molecular Biology	ES-622 Cell and Environment
ES-677 Environmental Physiology	ES-624 Man and Tropical Forest Ecosystem Function
ES-678 Rehabilitation Ecology	ES-636 Molecular and Radiation Biophysics
	ES-643 Air Pollution and Plants
* Credit requirement for Common Courses is 8	
** Credit requirement for Optional Courses is 9	
*** Credit in respect of Dissertation is 7	

The Optional Courses offered in either semester depending on the availability of faculty.

M.Phil. Programme – Course Contents

Package A (Common Courses)

Course No.: ES-651 Ecosystem Processes (CKV) Credits: 2

Ecosystem organization and homeostasis: Succession, Stability and Diversity.

Primary Production: Processes and factors affecting it in different kinds of systems.

Trophic Dynamics: Trophic webs, Autotrophic vs. hetrotrophic systems; Energy Flows and Efficiencies; Hydrological Cycle, Carbon Cycle; Nitrogen Cycle; Sedimentary Cycles (including S&P); Disruption of Biogeochemical Cycles and its consequences; Perturbation, Disturbance and Stress; Responses of Ecosystems (Land, Water, Marine) to deforestation, fire, pollution, ecological invasions; Rural vs. Urban systems; Restoration of Degraded Ecosystems.

Course No.: ES-653 Atmospheric Processes (BPM/VKJ) Credits: 2

Structure and composition of the atmosphere – weather elements. Potential temperature, dry and moist adiabatic lapse rates. Stability in the atmosphere, T-Phi diagram, mixing heights.

Moisture variables, Virtual temperature, Condensation and Precipitation, Clouds and their classification. Heat balance of the earth-atmosphere system.

Fundamental Forces – Equations of motion on a rotating earth. Winds, wind roses and wind profiles. Divergence and Vertical motion. Rossby, Richardon, Reynolds and Froude Numbers. Turbulent diffusion equation – Eddy transport of heat, mass and momentum. Bjerkness circulation theorem and applications. General circulation, monsoons. Jet streams and tropical cyclones. Climate change and Climate models.

Course No.: ES-652 Earth Processes (SM) Credits: 2

Objectives: To understand the origin and evolution of the Earth's crust and its fluid envelope, the processes that shape its surface and the linkages among the solid earth, fluid envelope and the biosphere.

Contents: Primary differentiations of the earth and the formation of its core, mantle, crust, atmosphere and hydrosphere, plate tectonics and the formation of oceans, continents and mountains, weathering and soil formation, erosion, transport and deposition of sediments by rivers, wind and glaciers, geological processes and ocean margins and land-ocean interaction; biogeochemical cycling of elements.

Package B (Common Courses)

Course No.: ES-655 Statistical Methods (JSR) Credits: 2

Probability distributions and their properties, Normal, Poisson, Binomial distributions, Sampling and tests of significance – Student t-distribution, F-distribution, X^2 distribution, Correlation and Regression, Linear Regression, Multivariate Analysis. Analysis of variance – F-test, Non-parameter statistics.

Reading material:- 1) Principles of Biometry Charles M. Woolf (D. Van Nostrand Company, Inc.)
2) Statistics Murray R.Spiegel and Larry J.Stephens (Schaum's Outlines)
3) Statistical Methods Snedecor ,G.W and Cochran

Course No.: ES-654 Analytical Techniques (KD) Credits: 2

Objectives: To introduce the students to the principles of various analytical techniques commonly used in environmental research and to provide lab training in any one technique by way of a small project, if possible.

Contents:

1. Particle size analysis.
2. X-ray, diffraction in mineral/particulate identification.
3. Chemical analysis by spectrometric and – spectrophotometric methods.
4. Chromatographic techniques.
5. Water, chemistry.
6. Ultrasonography.
7. DHA-based methods in biological analysis.
8. Remote Sensing.

Course No.: ES-491 Environmental Impact Analyses (PSK) Credits: 2

Concept of holistic Environment, its physical, chemical, biological components, the socio-economic and cultural dimensions of environment, concepts of carrying capacity and global commons.

Human activities and impacts: local, regional and global; short-term and long-term impacts on Environment.

Origin and development of EIA, National environmental policy and statutory requirements of EIA; objectives of EIA.

Methodology of EIA; scoping, categorization and evaluation criteria; prediction and assessment of impact, interactions between environmental components and impacts.

Alternate strategies and mitigation measures, environmental monitoring and audit.

Case Studies: Urban development, water resources development, thermal and atomic energy projects, mining projects petrochemical projects.

Area-I (Optional Courses)

Course No.: ES-605 Mathematical Ecology (LKP) Credits: 3

Models of population growth: deterministic models, non-linear relationships; leslie matrix model; difference equation models; stochastic model.

Interacting population: Lotka-Volterra model; competition: exclusion principle; prey-predator system; certain exact results; pertubative solution; some useful mathematical and graph techniques. Modified Lotka-Volterra models. Modified Lotka-Volterra models. Gauss-Witt model. Some exactly solvable models. Stability analysis for ecosystems; Routh-Hur-witz criteria; Liapunov method and related techniques.

Multispecies ecosystem and communities; general discussion; energy flow considerations in an ecosystem; elementary aspects of systems analysis for ecosystems.

Evaluation: Problem Sets/Quizzes (at least two) : 30%
Mid Semester Exam. : 30%
End Semester Exam. : 40%

Course No.: ES-608 Some Physics Based Techniques in Environmental Research (JB) Credits: 3

Ultrasound: Characteristics of ultrasonic fields and their production and measurement. Piezoelectric transduction and ultrasonic field configuration. Non-linear ultrasonic fields composition, dependence of ultrasound absorption in critical binary liquid systems. Particle coagulation by means of ultrasound, ultrasonic temperature measurement.

Acoustic Radar, measurement of Acoustic Non-linearity parameter of sea water.

Laser Applications: Laser light transmission through the atmosphere, molecular absorption and particle scattering, techniques for detection of molecular pollutants, by absorption of Laser radiation. Remote monitoring capabilities of Laser systems, single and double ended systems. LIDAR, Raman LIDAR, Resonance

LIDAR.

Microwaves: Environmental aspects of microwave radiation, microwave decomposition of toxic vapour stimulants, effect of radio frequency electrical seed treatment, radio frequency electrical fields for stored grain insect control, electromagnetic energy for insect control.

Electrical detection of airborne particulate using surface ionization techniques, submicron and centimicron particulate detection, Characteristics of Electromagnetic precipitation of fuel oil ash.

Evaluation: Mid Semester Exam. : 30%
Lab. Work : 30%
End Semester Exam. : 40%

Course No.: ES-609 Topics in Non-linear Differential Equations and System Analysis (LKP/JSR/GPM) **Credits: 3**

Autonomous systems; phase plane phenomena; critical points and stability; limits cycles; Liapunov analysis. Examples from non-linear mechanics; conservative and non-conservative systems. Periodic solutions; Poincare-Bendixon Theorem. Approximation methods; Krylov-Bogliubov method; Describing function method.

First order systems and their mathematical properties; second order systems; microscopic system theory and transfer analysis; the convolution integral; the Fourier, Laplace and other transforms; stability of systems.

Course No.: ES-628 Advance Topics in Bioelectronics (JB) **Credits: 3**

Bio-electrodes; the electrode-electrolyte interface electrode impedance, surface electrodes, sub-integumental and intracellular electrodes.

Transducers: Transducers for mechanical input, temperature transducers, transducers for electrical input and optical transducers. Bio-electric amplifiers; general requirements for bio-electric amplifiers. Amplifier circuits, feed back in amplifier.

Non-invasive techniques; Biomedical applications of electrical impedance measurements.

Electrical field and electrical impedance plenthysmograph. Bio-telemetry; radio telemetry services single and multi-channel telemetry circuits.

Recording and display system: factors influencing the fidelity of a recorder, slow speed moving coil recorders, servo- assisted moving coil recorders, X-Y recorders, magnetic taperecorder, frequency modulated recorders.

Evaluation: Mid Semester : 30%
Lab. Work : 30%
End Semester : 40%

Course No.: ES-637 Air Pollution Meteorology (BPM) **Credits: 3**

Meteorological Fundamentals. Adiabatic Diagram. Effects of Meteorological parameters on Transport and Diffusion, Pollutant Concentration variation. Influence of Topography on Transport and Diffusion. Equation of state and conversion of concentrations. Meteorological roses.

Principles of Turbulence and Diffusion, Introduction to Turbulence and Diffusion Theory, The Generalised Gaussian Diffusion Equation, Atmospheric Diffusion computations. Effective Stack Height.

Air Pollution Climatology, Interrelationship between Meteorology and Air Pollution, Urban Effects upon Meteorological Parameters. Atmospheric Turbidity, Atmospheric Chemistry of Air Pollution. Natural Removal Processes in the Atmosphere. Analysis of Air Quality Cycles.

Meteorological Instruments and their exposure, Applications of Meteorology to Air pollution Potential. Air Pollution surveys. Site Selection for a Potential Source, Atmospheric Tracers and Urban Diffusion Experiments, Meteorological models for Urban Areas. Sources of Meteorological data.

Course No.: ES-640 Diffusion and Transport of Air Pollution (BPM) Credits: 3

Micrometeorology fundamentals, variation of wind, temperature and water vapour in the lower layers of the atmosphere Energy and moisture balances. Flux-profile relationships.

Estimation of Atmospheric Dispersion-Diffusion equations-Effects of stability-Estimation of vertical and horizontal dispersion-Evaluation of wind speed-accuracy of estimates-calculation of maximum ground level Concentrations-Estimates of Deposition.

Effective height of emission and maximum Concentration-Estimates of required stack heights Effect of evaporative cooling-Effect of aerodynamic downwash-effect of gravity.

Concentrations in an Inversion-Break up fumigation, plume trapping-concentrations at ground level compared to concentrations at the level of Effective stack height from elevated continuous sources-total dosage from a finite release-Cross wind integrated Concentration-Estimation of Concentrations for sampling times longer than a few minutes-Estimation of seasonal or annual average concentrations at a receptor from a single pollutant source. Meteorological conditions associated with maximum ground-level concentrations-Concentration at a receptor point from several sources-Instaneous sources-Relation to other Diffusion equations.

Urban air Pollution models-different types their accuracies and Transport models.

Air quality standards, Emission standards-Industrial Meteorology and Maximising the Dilution capacity of the atmosphere.

Effects of air Pollution on man and materials-Environmental Impact Assessment studies related to air Pollution and in siting industries.

Course No.: ES-642 Aerosol Physics (VKJ) Credits: 3

Introduction and definitions; morphological properties of aerosols, shape, size structure, mean and median diameter. Praticle size distributions; Fluid properties; Reynold's number, drag, viscous motion, stokes law; Particle Kinetices, settling, acceleration, declaration, impaction, centrifugation, respirable sampling, isokinetic sampling. Particle diffusion.

Aerosol charging mechanisms, electrostatic field controlled aerosol kineticte s, condensation, evaporation and growth, coagulation of particles. Optical properties, extinction, diffraction, Rayleigh and Mie scattering, Approximations of Mie theory and its applications.

Lab. work: Credit
Evaluation: Sessionals and Lab. Work : 20% each
Mid Semester : 30%
End Semester : 30%

Course No.: ES-671 Mathematical Modelling (LKP/JSR/GPM) Credits: 3

Aim: To introduce students to mathematical modelling in areas relevant to Environmental Sciences.

Contents: The need for modelling. Brief review of standard models from Physics and Chemistry.

Modelling Methodology: Setting up of the model, parameter estimation, verification, validation, sensitivity analysis. Mathematical Methods: Matrices, numerical methods for solving of O.D.E.'s, Data analysis. Time series analysis.

Examples to illustrate the above will be chosen from amongst atmospheric sciences, ecology, biology. These would include Energy Balance Climate Models, Tropical Cyclones, Population Dynamics, Lake Ecosystems, Modelling of diseases like Diabetes, Models for Evolution.

Course No.: ES-674 Energy Use and Environmental Implications (AKA\VKJ) Credits: 3

Physical view of energy; a brief history of energy consumption pattern; thermodynamic concepts; energy, entropy and useful works; biophysics of energy and flow through ecosystems; energy and economic efficiencies.

Simple models for energy resources; renewable, non-renewable; energy converters.
Environmental impact of energy use; energy intensities, environmental damage potential. Greenhouse forcing contribution (GFC) and greenhouse warming potential (GWP), evaluation of greenhouse index.

Risk assessment of energy use coal, oil, natural gas, nuclear and biofuels.

Energy outlook for the future.

Area-II (Optional Courses)

Course No.: ES-610 Title: Geological Oceanography (VA) Credits: 3

Introduction: History of oceanic exploration; tools and techniques of marine exploration, seismic reflection and refraction; gravity and magnetics, coring; dredging, etc., physiographic provinces of the ocean, passive and active continental margins; sedimentary processes on the continental margins and deep oceans, role of gravity flow in deep sea sedimentation; global tectonics, the concept of plate tectonics and associated phenomenon, drift and orogeny; mineral resources of the ocean.

Evaluation: Sessional : 30%
Mid Semester : 30%
End Semester : 40%

Course No.: ES-612 Geochemistry of Mineral Deposits (VR) Credits: 3

Crustal abundances of elements and mineral resources classification, major and trace chemistry of ore minerals; physical chemistry of ore magmas and ore solutions.

Relation between petrogenesis and ore genesis in magnetic rocks. Geochemistry and genesis of magnetic sulfide and oxide ores, volcanogenic sulfide and gold ores, sedimentary sulfide and oxide ores; geological and geochemical exploration of precious, base and ferrous metals deposits.

Geology and geochemistry of ore bearing igneous rocks in India.

Evaluation: Mid Term : 30%
Quizzes : 30%
Final Exam. : 40%

Course No.: ES-618 Environmental Geology (VS) Credits: 3

Evolution of oceans and atmosphere through geological time, changes in the composition of sedimentary rocks, factors affecting chemistry of earth materials through time, rate processes and methods of estimating rates in various time scales, modern processes, weathering, erosion, darning of rivers and perturbation in natural rate processes, land use pattern, mining of urban activities, health aspects of geochemistry in modern environment. Waste disposal and groundwater contamination, human activity, and long-term geological/global change.

Evaluation: Mid Term : 40%
End Semester : 40%
Term Paper : 20%

Course No.: ES-629 Recent Sediments (VA) Credits: 3

Nature and spatial distribution of recent sediments; clastic, chemical and biogenic sediments; dynamics of sediment motion in fluvial, lacustrine, estuarine and ocean environments; basin characteristics and factor affecting sediment yield in the catchment area; processes of accretion and denudation and resulting land forms; problems associated with situation of river channels and lakes, etc., sediments as a source and sink of pollutants.

Evaluation: Sessional : 30%

Mid Term : 30%
End Term : 40%

Course No.: ES-638 Water Resources (SIH) Credits: 3

Introduction: The hydrologic cycle. Inventory of Earth's water, properties of water, Darcy's law, fundamental Equations of groundwater flow.

Surface Water Resources: Rainfall, infiltration, evapotranspiration and runoff, springs, lakes, etc.

Groundwater Resources: Rock properties affecting groundwater, vertical distribution of groundwater, Zone of Saturation, Geologic formations as aquifers, type of aquifers and groundwater basin.

Environmental Influences on Water Resources: Surface and groundwater resources of Arid and Semi-arid regions, snowmelt hydrology from glaciers, fluctuations due to evapotransipiration, fluctuations due to tides, urbanisation. Concept of basin management and basin management by conjunctive use. Recent developments in surface and groundwater resources monitoring.

Evaluation: Sessiona : 30%
Mid Term : 30%
End Term : 40%

Course No.: ES-644 Geochemical Cycles (VS) Credits: 3

Chemistry of natural waters, physical chemistry of dissolved materials in water, Eh, pH and stability diagrams, basic concept of cycling through time, concept of reservoirs, fluxes and transfer of materials, steady and non-steady state models, global cycling of elements, rates of erosion, disturbance in the cycling due to anthropogenic impact, case studies of geochemical cycles for selected elements such as Hg, Al, F, etc., hydrological systems and distribution of materials through various sub-systems, Nutrient, Toxic metals and Biogeochemical Cycles.

Evaluation: Mid Term : 40%
End Semester : 40%
Term Paper : 20%

Course No.: ES-661 Remote Sensing Applications in Geosciences (SM) Credits: 3

Mineral/Oil Exploration: Identification and mapping of host Tock, structure, anomalies (Structural, Lapographical, drainage, etc.). Landforms, etc., and integration with geological, geophysical, geochemical and geobotanical data.

Groundwater Exploration: Mapping of landforms, tithology, structure, landuse. Soil, drainage, etc., and integration with available geophysical, hydrological and hydrogeological data.

Engineering Geological Applications: Utility of remote sensing data for selecting sites/areas for dams, bridges, buildings, etc. Remote sensing data for alignment of railway line, roads, tunnels, pipelines, etc.

Study of landslide prone areas and earthquakes. Environmental Geology: Impact of mining, quarrying, reservoirs on environment.

Practicals

Preparation of Groundwater potential Zone maps using remote sensing data.

Preparation of Waterlogged and Salinity infested areas. Study of impact of mining, quarrying and reservoirs on environment.

Course No.: ES-666 Glacio-Fluvial Sediments (SIH) Credits: 3

Introduction: The alpni sediment system, dimensions of the system (a) Spatial context (b) Temporal context.

Sediment transfer process – Characteristics of the sediment system, model of the debris transfer.

Hydrogeomorphology of proglacial areas – Fluvial form and process, fluvial land form.
Glacial sediment transfer – Englacial and supraglacial sediment – The glacier as a transport system, sedimentological characteristics of glacial debris, the role of englacial sediments in the formation of sypraglacial moraines.

Subglacial sediment system – Thyermal conditions, abrasion, subglacial water channels.

Fluvial sediment transfer – Hydro-climatic conditions of glaciers, water balance and mass balance of glaciers, melt process of glacier surface, characteristics of glacier runoff, supra and subglacial drainage.

Solutes – Environment and water chemistry, atmospheric contribution, phase change in exchange, sub-glacial weathering, dissolved load discharge relationship and the origin of solutes.

Suspended sediments – Method of monitoring, yield, relationship between suspended sediment concentration and discharge, proglacial sediment sources and sinks.

Application and implications – Erosion estimation and its denudational implications, sediment budget and its monitoring.

Evaluation: Seasonal : 30%
Mid Term : 30%
End Semester : 40%

Course No.: ES-611 High Temperature Geochemistry (VR) Credits: 3

Introduction to Geochemistry – Atomic properties, periodic table; geochemical properties of transition metal ions, rare earth elements ions, large ions lithophile elements; pressure-temperature dependence of geochemicals properties, solid solution in minerals-principles of chemical substitution; thermodynamics of solid solution formation, application of mineral solid solution in petrogenesis. Geological phase diagrams. Interpretation of phase diagrams; discussion of specific ternary and quaternary phase diagrams of geological importance. Chemical reaction and trace element geochemistry. Heterogeneous equilibrium and distribution of elements in minerals; thermodynamics of trace element substitution, application of trace element geochemistry in petrogenesis and ore genesis.

Evaluation: Quizzes : 30%
Hid Term : 30%
End Semester : 40%

Course No.: ES-673 Soil Geochemistry (VR) Credits: 3

Objective: To understand the chemistry of weathering of rock-forming minerals and soil formations, the influence of cenozoic geologic and climatic factors in soil formation and distribution and the relationship between soil geochemistry and soil fertility.

Contents: Structure and chemistry of clay minerals; chemical weathering of rock-forming minerals, cenozoic orogeny, topography, climate and organisms on weathering rates, soil formation and distribution; mobility of nutrient and trace elements during soil genesis; pedogenic evolution and inherent soil fertility; paleosols and past climate; effects of modern agriculture on soil geochemistry.

Evaluation: Sessionals : 20%
Hid Term : 30%
End Term : 50%

Area-III (Optional Courses)

Course No.: ES-616 Water Pollution (DKB) Credits: 3

Water chemistry and ecological aspects of Water Pollution. Type, sources and consequences of Water Pollution.

Waste water and its treatment, origins and characteristics of liquid industrial effluents discharged in the water body, chemical and bacteriological sampling and analysis, water quality criteria and standards; health effects of Water Pollution; instrumental methods of analysis, for example, AA, ASV, GLC, etc., Water Pollution control and case study; lab. work.

Evaluation: Mid Term : 30%
Term Paper : 30%
End Semester : 40%

Course No.: ES-617 Soil Pollution and Solid Haste Management (AKB) Credits: 3

Physico-chemical, mineralogical and biological properties of soil. Soil organic matter. Micro-organisms of soil. Decomposition of organic matter in soil. Pollution and residual toxicity from the application of insecticides, fungicides, weedicides and synthetic fertilizers.

Sources and nature of solid wastes; their characterisation and classification. Methods of dispersal and management of solid wastes. Recycling of waste materials. Interactions between industrial effluents and soils; soil contamination with radionuclides.

Evaluation: Lab. Mid Term Test : 30%
Term Paper : 30%
End Semester Test : 40%

Course No.: ES-632 Air Pollution (PSK) Credits: 3

Meteorological and topographical effects on air movements, fuel and atmospheric Pollutants; sources and diffusion of SO_2, CO, NOx smoke, Particulates and heavy metals in air. Sampling techniques; analysis of different gases and solid particulates, effects of air Pollution on human health, control techniques, air quality criteria and case study.

Lab. Work

Evaluation: Mid Term : 30%
Term Paper : 30%
End Semester : 40%

Course No.: ES-639 Limnology (BG) Credits: 3

Definition, scope, and history, types of freshwater bodies lentic, lotic; Physicochemical properties of water; Morphometry and water movement; Light in water; Heat budget of water bodies; Oxygen and other dissolved gases; Sediments, Sediment-water interface and redox potential; Nitrogen in water; Phosphorus, Sulphur, Calcium and other nutrients; Heavy metals and organic compounds in water; Life in water: Phytoplankton, periphyton, zooplankton, fish, benthic organisms and Macrophytes; Microbiology of freshwaters; Primary and Secondary production, Production Processes and factors influencing them; Food-chain dynamics and energetics; Detritus and Carbon cycle; Comparative study of lentic and lotic ecosystems; Estuarine ecosystem; Land-water interactions; Applied Limnology; Water Pollution, Eutrophication; Wastewater treatment, Water quality management and modelling; Aquaculture; Water quality standards; Monitoring water quality; Methods of water and waste-water analysis.

Practicals: Field and laboratory investigations: about 15 exercises.

Evaluation: Mid Semester Test : 30%
End Semester Test : 40%
Report of Field/Lab. : 30%
Work, Other Assignment

Course No.: ES-675 Chemical Speciation in Aquatic Systems (DKB) Credits: 3

Chemical processes in the aquatic environment with respect to chemical nature of water; sources, pathways and reservoirs of contaminants in aquatic systems.

Heavy metals in aquatic systems, species distribution in non-marine and marine waters and conditions governing them, metal pollution assessment from speciation analysis, (speciation and toxicity of metals).
Coordination compounds, relationship between toxicity and structure, determination of species distribution. Organometallic and organometalloidal compounds, structure-toxicity-relationships, species distribution organic chemicals in aquatic systems, specific groups and their fate in water bodies, prioritisation and hazard assessment of toxic organics, impact on aquatic biota. Analytical methodologies for chemical speciation studies, chemical modelling of aquatic systems. Radionuclides in the aquatic environment, their behaviour and bioavailability.

Area-IV (Optional Courses)

Course No.: ES-619 Human Phipiology and Occupational Health (JDS) Credits: 3

Dimension and definitions of Environmental and Occupational Health. The man-environment relationship; Health hazard in the Environment, Environmental Health Management; Occupational and Industrial Health Management; Modernisation and Health Policies, Field survey methodologies with epidemiological and biostatistical analysis. Occupational exposures with case and cohort studies; Population dynamics and health effects on migrants; Health Ecology, Psychosocial and behavioural patterns of good health.

Field Work: Case study based on data collected from a medical institution, work place or socially relevant health programme.

Evaluation: Field Work/Other Assignment : 30%
Mid Semester Test : 30%
End Semester Test : 40%

Course No.: ES-621 Environmental Toxicology (RS) Credits: 3

Introduction: Environmental Toxicology, Economic Toxicology and Forenssic toxicology-dose response relationships, frequency response and cumulative response; statistical concepts LD 50's – potency versus toxicity, margin of safety-concepts of hypersensitivity and hyposensitivity. Biological factors that influence toxicity; chemical factors that influence toxicity, chemical factors that influence toxicity influence of route of administration abnormal response to chemicals; basis of selective toxicity; laboratory determination of toxicity of chemicals.

Animal management in Toxicological Evaluation: Animal extrapolation; Eco-Toxicology.

Besides, a detailed study of the following topics will be made on heavy metals: (1) Properties and occurrence (2) Production (3) Industrial uses (4) Metabolism and Physiology (5) Toxicology (6) Prophylaxis (7) Therapy.

Aluminium, antimony arsenic, barium, beryllium, bismuth, cadmium, chromium, cobalt, copper, lead, magnesium, manganese, mercury, molybdenum, nickel, platinum, rubidium, silver, tin and zinc.

In addition, toxic effects of insecticides and other pollutants will be studied on humans and other mammals.

Evaluation: Assignment : 30%
Mid Semester Exam. : 30%
End Semester Exam. : 40%

Course No.: ES-622 Cell and Environment (KD) Credits: 3

Introduction to Cell and its micro-environment, cellular interaction with pollutants at the biomacromolecular level and its reflection on the gene expression, cell behaviour and cell signalling.

Biotransformation of environmental conaminants: Degradation, cytochrome P450 monooxygenase, detoxification: enzymatic basis, conjugation and related systems, Cytochrome P450 and its multiple forms, differential gene expression of cytochrome P450, induction, transcriptional and translational control at the diversity of pollutant biodegradation.

Chemical mutagenesis and carcinogenesis: Chemicals as caracinogens, metabolic activation, aryl hydroxylase,

epoxide formation, chemicals as promoters, DHA repair mechanism.

Carcinogenesis as multistep process: Cell matrix interaction, growth factors receptors, altered gene expression and induction of tumour metastasis and angiogenesis, genetic basis of chemical carcinogenesis concept of protoncogene and oncogene activation; Tumour suppressor genes.

Cell to cell signalling and environmental factor: Extra-cellular signals. Cell surface receptors, receptor and non-receptor kinases, nuclear translocation protein and signal transduction.

Course No.: ES-624 Man and Tropical Forest Ecosystem Function (PSR) Credits: 3

Ecosystem concept-Temporal and spatial dimensions; Sustainable development concept-Spatial and temporal dimensions. Forest ecosystem function: General characteristics; Global change and forest ecosystem -Climate change, -Biodiversity depletion -Biological invasion. Perturbations and forest ecosystem properties; Natural versus Human managed ecosystems; Complex agroecosystems of traditional societies. Structure and organization, stability and resilience; forest ecosystem function as related to social economic and cultural perceptions of traditional societies; Indicators of sustainable development; Rural ecosystem rehabilitation; Value of traditional science and technology for sustainable management of natural resources; People's perception of environment of environment and development and community participation; Why people's participation? Conceptual issues of Humans as part of ecosystem function.

Course No.: ES-636 Molecular and Radiation Biophysics (AKA) Credits: 3

Nature and scope of biophysics: Structure of animal and plant cells and sub-cellular organelles such as mitochondria, chloroplast, ribosomes. Biological macromolecules: Structures of nucleic acids, proteins, polysaccharides and lipids; ultrastructure studies-electron microscopy.

Radiation source: Spectral characteristics of atmosphere long wave and short wave radiation, radiation fluxes in natural environment, the ultraviolet region absorption and scattering, alpha, beta, gamma and x-radiation, cosmic radiation. Absorption of electromagnetic radiation and interaction with matter. Comparison of different ionizing radiations, radiation as environmental pollutant, radioisotopes, detection and measurement of radiation.

Biological effects of radiations: Effect of radiation at cellular levels-structural and functional changes, interaction with biological macromolecules, whole-body effect, genetic effect, individual versus population effects. Linear energy transfer (LET) and Relative Biological effectiveness (RBE).

Radiation as cancer causing and cancer healing agent: Molecular carcinogenesis, interaction of carcinogens/anti-cancer agents with DNA. RNA and Nucleoproteins, effect of radiation on the interaction and structure-activity relationship. Interaction of metals: with nucleic acids, nucleotides and other small biomolecules; metal ions as stabiliser or destabiliser of the DNA structure, detoxification-metabolic cycles for mercury in the aquatic environment, effect of mercury and methylmercury, chemical bonding.

Bio-membranes: Structure and function; membrane models, arguments for and against the different models; movement through membranes; diffusion. Osmosis, cell permeability, partition coefficient, movement of ions, sodium and potassium pumps, electrical transport properties of membranes, bulk transport, organelle membranes, nerve impulse through membranes, Donan equilibrium, free energy, Nernst equation.

Evaluation:

Sessionals	:	30%
Mid Term	:	30%
End Semester	:	40%

Course No.: ES-643 Air Pollution and Plants (CKV) Credits: 3

Introduction: Causes of air pollution, sources, primary (SPM, SO_2, NO_x, NH_3, HF, CL, Heavy metals) and secondary (VOC, O_3, Smog, PAN, Acid rain) air pollutants. Levels of air pollutant in India; Air pollution standards in India.

Units of Air pollutants, air Pollution threshold levels and injury

Nature of SPM, smoke and their effect on plants.

Sources of sulphur dioxide (natural, anthropogenic); importance of sulphur to plants; sulphur in biological molecules; methods of studying the effects of air pollutants on plants; types of fumigation systems. Effect of SO_2 on plants; morphological; root: shoot ratio; ultrastructural effects; effect on photosytnthesis, respiration and other biochemical events; role of free radical in causing plant injury; effect on reproductive system and pollen germination; Resistance to SO_2 effect.

Oxides of nitrogen, sources and their effect on plants; ammonia, sources and effect on plants; Acid rain-causes and effect on plants; pollutant combination and their effect on plants.

Ozone: Formation, reactivity, destruction; effect of ozone on plants.

Bioindicators; APTI; concept of critical load, air pollution and crop plants; air pollution and forest decline; effect of air pollutant at ecosystem level (direct and indirect) air pollution and biodiversity.

Air pollution abatement by green plants and green belts.

Course No.: ES-656 Biotechnological Applications in Environmental Sciences (SB) Credits: 3

Fundamentals of Biotechnology: Purification and analysis of DNA. Commonly used vectors for gene-cloning and construction of gene libraries. Enzymes, reagents and strategies used in gene- cloning. The techniques of DNA hybridization. Expression of genes in new hosts. Nucleotide sequence analysis of DNA. DNA-probes as detection methods. DNA amplification by Polymerase Chain Reaction.

Application in Environmental science. Use of DNA probes for low-level detection of living matter in environmental samples. DHA-based taxonomy in the assessment of biodiversity. Cloning of useful gene products related to microbial degradation of waste products. Use of engineered microbes in leaching of metals from ores, detoxification of industrial wastes, production of ethanol Sand methane. Potential use of biotechnology in problems of soil reclamation and biological nitrogen fixation.

Practical demonstration of some techniques, DNA purification and gel electrophoresis, Detection and analysis of DNA by dot blots and southern blots. DNA hybridization. DNA sequencing. PCR amplification of DNA.

Course No.: ES-677 Environmental Physiology (JDS) Credits: 3

An introduction to the Principles of Physiological function and adoption, at the organ-to-whole animal level. Diversity of evolutionary and functional adaptations, in vertebrates and Comparative Animal Physiology. The General Adaptation Syndrome. The Biological Clock.

Environmental physiology with considerations of: Water metabolism, Buogancy and Osmotic balance; its Normonal regulation. Movement. Cellular, ciliary and physiology of muscle. Energy metabolism and body temperature changes; Thermo regulation and adaptation. Nomeostasis and Hibernation. Nutrition, food and physiology of digestion. Oxygen uptake from the Environment; respiration and metabolism. Circulation of body fluids, Peripheral and Central circulation. Evolution of Heart structure and function. Environmental Perception, Neurophysiology and Information Processing in sensory and Neroons system. Excitable membranes and nervous transmission. Sensory Physiology of mechanoareceptors, gravity and equilibrium and kinesthesia. Perception of sound, light, and chemostimulation. Neuroendocrinology, and Hormone action.

Applied Physiology and Human Physiological Adaptations. Cardio respiratory function. Higher Neural functions, sleep, Memory, Speech, Emotion and Behaviour. Immune cell responses, Immunity and Immunodeficiency, Neuroimmunomodulation.

Course No.: ES-678 Rehabilitation Ecology (KGS) Credits: 3

Land degradation and rehabilitation-global, regional and local importance of the subject. Causes and processes of land degradation: (a) Natural hazards as a cause of and degradation, (b) Population growth as a cause of land degradation, (c) Inappropriate agriculture as a cause of land degradation, (d) Inappropriate forestry as a cause of land degradation, (e) Mining, coal combustion residues and waste disposal as the causes of land degradation, (f) Socio-economic and policy factors promoting land degradation, (g) Ecosystem stability, sensitivity and resilience in relation to land degradation processes; Quantitative evaluation of land degradation problems:

(a) Evaluation of degradational problems at national, regional and global scale using geographic information system (GIS) technology, (b) Ecological, and economic indicators of ecosystem degradation-soil erosion, nutrient cycling, hydrological cycling, nutrient and water use efficiency, biodiversity, productivity, profitability, (c) rapid appraisal techniques; Concepts of ecological rehabilitation, reclamation and restoration; Rehabilitation-resource management-environmental conservation-sustainable development linkages. Ecological basis of ecosystem rehabilitation: (a) Reproductive strategies of plants, (b) Growth strategies of plants, (c) Nutrient/water uptake and use strategies, (d) Environmental controls on soil formation and ecosystem productivity, (e) Soil biology and fertility processes, (f) Plants-animals-microbes linkages. Socio-economic considerations in ecosystem rehabilitation: (a) Relationships between environmental, economic and social opportunities and constraints in rehabilitation, (b) Ecosystem rehabilitation imperatives in developing and developed world, (c) Institutional requirements for ecosystem rehabilitation, (d) Consideration of socio-cultural values in developing rehabilitation strategies, Logical framework of developing rehabilitation strategies-integrated consideration of physical, biological, technological, socio-economic and policy constraints and opportunities; Ecosystem rehabilitation-case studies; Ecosystem rehabilitation-research needs and priorities.

Evaluation: Mid Term : 30 marks
Tutorials : 20 marks
End Semester : 50 marks