DEPARTMENT OF ENVIRONMENTAL SCIENCES
SCHOOL OF EARTH SYSTEM SCIENCES
UNIVERSITY OF KERALA

Syllabi of M.Sc. Programme
Environmental Sciences

(Under Credit and Semester System w.e.f. 2017 Admissions)

Department of Environmental Sciences
School of Earth System Sciences
University of Kerala

PROGRAMME OBJECTIVES

- Students are trained to acquire a broad base of knowledge of environmental systems, including the Earth's atmosphere, hydrosphere, lithosphere, and biosphere.
- The program trains the students to solve fundamental problems in environmental science and engineering.
- The program helps to study the environmental and technological issues in the management and control of air, soil and water pollution and also help to acquire knowledge to conduct Environmental Impact Assessment studies and advanced technical skills in remote sensing and GIS.
- The course places emphasis not only on individual student development but also involves team-working and presentations to develop your interpersonal skills.
- The Department also offers elective course for the Semester India Programme (SIP) co-ordinated by the Centre for International Academics in the University.
- This post graduate course will enable the candidate to take up roles as environmental analysts (remote sensing and GIS) and environmental mangers with an emphasis on environmental monitoring and pollution control.
- This programme will prepare the students for a career in the government bodies (central and state pollution control boards, department of climate change), industrial sectors, contract laboratories, academia, or for entry into M.Phil/ Ph.Dprogrammes.

Structure of the Programme

Sem. No.	Course Code	Name of the Course	Number of Credits
I	Core Courses		
	ENS-C-411	Environmental Biology and Ecosystem Dynamics	4
	ENS-C-412	Environmental Toxicology	4
	ENS-C-413	Environmental Chemistry	4
	Internal Elective		
	ENS-E-414	Biochemistry and Nanobiology	3
II	Core Courses		
	ENS-C- 421	Environmental Techniques	4
	ENS-C- 422	Environmental Microbiology	4
	ENS-C- 423	Environmental Geology	4
	ENS-C- 424	Environmental Meteorology and Climate Change	3
III	Core Courses		
	ENS-C- 431	Environmental Genetics and Biotechnology	4
	ENS-C- 432	Natural Resources and Energy Management	4
	ENS-C- 433	Environmental Impact Assessment and Disaster Management	4
	ENS-C- 434	Field Study	3
IV	Core Courses		
	ENS-C- 441	Environmental Engineering and Pollution Control	4
	ENS-C- 442	Environmental Economics and Policies	4
	ENS-C- 443	Remote Sensing and GIS	4
	ENS-D- 444	Dissertation	6
Extra Departmental Elective Courses			
I	ENS-X- 411	Disaster Management	2
II	ENS-X- 421	Environmental Health Perspectives	2
III	ENS-X- 431	Waste Management Techniques	2

Semester : I
Course code : ENS-C-411
Course Title : ENVIRONMENTAL BIOLOGY AND ECOSYSTEM DYNAMICS
Credits : 4

AIM: The course aims at exposing the students from non-biology background to the variousaspects of ecosystem structure and functions. Also the course enables the students to understand the fundamental and applied aspects of environmental biology and ecosystem functioning.

OBJECTIVES: The course is designed to gain understanding of the structural andfunctional aspects of ecosystems. The course introduces the students to topics related to biomes and habitats, ecosystem dynamics, evolution of ecosystems, ecological interactions, population dynamics and limiting factors of the environment.

COURSE CONTENT

MODULE I: Concept and scope of Environmental Science, Environmental Biology, ecosphere and biosphere; ecological factors and variables. Biomes and Habitats : Classification of biomes– Terrestrial biomes–tundra, taiga,grassland, desert, evergreen and deciduous forests, tropical rain forests and their characteristics– flora and fauna. Classification of aquatic habitats – fresh water : ponds, rivers, lakes, wetlands– their characteristics, flora and fauna; marine habitats – pelagic, benthic, inter-tidal, estuarine, Mangroves – their characteristics, flora and fauna.

MODULE II: Ecosystem dynamics: Introduction - Concept, characteristics, kinds and structure,ecosystem functioning – food chain, food web, ecological pyramids of numbers, biomass, energy, inverted pyramids, ecological energetics – energy flow, ecological efficiency.

MODULE III: Development and evolution of ecosystems–biogeochemical cycles–gaseous andsedimentary cycles, food chain, food-web, ecotone, edge effects, ecological niche and ecosystem stability.

MODULE IV: Ecological interactions - Neutralism, symbiosis, commensalism, mutualism, antagonism, antibiosis, parasitism, predatism, competition – intra-specific and inter-specific,Ecological and environmental significance of interactions.

MODULE V: Population dynamics–concept of population, population growth–density, natality,mortality and growth curves, life curves, age structure, function and equilibrium; populationregulation – biotic potential and environmental resistances; Factors of population regulation –

density dependent and density independent; population crash and carrying capacity; the laws ofpopulation growth.

Module VI: Limiting factors of environment: Concept of limiting factors, laws of limiting factors–laws of minimum and tolerance, combined concept of limiting factors, Earth's carrying capacity.Ecoinformatics : concepts and principles.

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- http://complexitylabs.io/ecosystem-dynamics/
- http://www.tern.org.au/Eco-informatics-pg17733.html
- http://www.uwyo.edu/wygisc/ecoinformatics_initiative/
- https://earthobservatory.nasa.gov/Experiments/Biome/
- https://utmsi.utexas.edu/research/ecosystem-dynamics
- https://www.nationalgeographic.org/encyclopedia/biome/
- https://www2.estrellamountain.edu/faculty/farabee/biobk/BioBookcommecosys.html

Semester : I
Course code : ENS-C-412
Course Title : ENVIRONMENTAL TOXICOLOGY
Credits : 4

AIM: The course aims at providing students with an advanced, multi-disciplinary and currentunderstanding of the effects of chemicals on human and environmental health. The course has been specifically designed to equip students with the skills to critically evaluate and understand chemical hazards, as well as making informed decisions in terms of potential health risks for both humans and wildlife.

OBJECTIVES: The course gives an overview of the distribution of pollutants in theenvironment, their entry, movement, storage and transformation within the environment. It aspires to assess the impact of chemicals not only on individuals but also on populations and whole ecosystems.

COURSE CONTENT

MODULE I: Toxicants in the Environment: History of toxicants - Principles of toxicology– toxicantsand toxicity, factors affecting toxic substances in the environment, their types – degradable and non-degradable; sources and entry routes.

MODULE II: Eco-toxicology: Introduction to eco-toxicology - Ecosystem influence on the fate andtransport of toxicants, Transport of toxicants by air and water; Transport through food- chain: bio-transformation and bio-magnification; Influence of ecological factors on the effects of toxicology.

MODULE III: Environmental fate of pollutants - Global dispersion of toxic substances-dispersion and circulating mechanisms of pollutants.

Acute and chronic toxicity; Lethal and sub-lethal doses - Analysis of NOEL, LD50 andMLD. Dose-response relationship, Detoxification in human body - detoxification mechanisms, organs of detoxification. Carcinogens, mutagens and teratogens. Toxicity testing procedures.

MODULE IV: Man and Environmental Toxins - Routes of toxicants to human body-inhalation, skinabsorption, oral, injection. ADME – adsorption, distribution, metabolism and excretion. Response to toxin exposures – dose-response relationship, frequency and cumulative response.

MODULE V: Chemical toxicology - Toxic chemicals in the Environment. Impact of Toxic chemicals onenzymes - biochemical effect of arsenic, cadmium, lead, mercury, carbon monoxide, nitrogen oxides, sulphur dioxide and cyanide.

MODULE VI: Environmental Health - Concept and scope, global and regional perspectives, basicrequirements for healthy environment, environmental quality, human exposure and health impact, Environmental diseases - Asbestosis, silicosis, siderosis, asthma, fluorosis and allergies.Epidemiological issues -malaria, kalaazar, water borne diseases.

REFERENCES

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- https://link.springer.com/journal/10646
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- https://www.journals.elsevier.com/toxicology
- https://www.journals.elsevier.com/toxicology/most-downloaded-articles

Semester : I
Course code : ENS-C-413
Course Title : ENVIRONMENTAL CHEMISTRY
Credits : 4

AIM: The course aims to equip the students with an understanding of the nature, reactivity, andenvironmental fates of toxic organic chemicals, pollution due to pesticides, options for natural and green insecticides; an understanding of the chemistry of the stratospheric and tropospheric processes. Major environmental issues are discussed such as ozone depletion, greenhouse effect, anthropogenic climate change, and air pollution. Upon successful completion of this course, students will be able to, recognize the importance of environmental changes, and demonstrate an understanding of theoretical and practical environmental issues.

OBJECTIVES: The overall goal of this course is to develop an understanding of chemicals and their effects on the environment, and to gain an understanding of the fundamental chemical processes that are central to a range of important environmental problems and to utilize this knowledge in making critical evaluations of these problems. Some laboratory experiments were also conducted.

COURSE CONTENT

MODULE I: Introduction - Concept and Scope of Environmental Chemistry, Major environmentalsegments. Natural cycles of the environment - Hydrological cycle, Carbon cycle, Oxygen cycle, Nitrogen cycle, Phosphorous cycle, Sulphur cycle.

MODULE II: Atmosphere - Composition of the atmosphere, Regions of the atmosphere, Earth's radiation balance. Particles, radicals and ions in the atmosphere.Stratospheric chemistry – Oxygen and ozone chemistry, Green house effect/ global warming, chlorofluoroarbons, Ozone depletion, Minimizing future emissions of green house gases.Tropospheric chemistry - The

principle of reactivity in the troposphere, The tropospheric oxidation of methane, Photochemical smog, Rain , snow and fog chemistry, Formation and composition of acid rain, Atmospheric aerosols, Oxidation of atmospheric SO_2. Chemistry of urban and indoor atmosphere.

MODULE III: Hydrosphere - Water resources, Global distribution of water, Gases in water, Organicmatter in water. Physical chemistry and composition of sea water and fresh water on land. pH,pE and pH- pE diagrams of selected elements. Complexation in natural water and waste water.

MODULE IV: Lithosphere - Weathering of rocks- physical, chemical and biological processes. Factorscontrolling the formation of soil, soil profile and classification of soil. Composition of soil-organic and inorganic components in soil, water and air in soil. Micro and macro nutrients, nitrogen pathways and NPK in soil. Acid base and ion exchange reactions in soil.

MODULE V: Toxic organic chemicals and heavy metals - Pesticides- classification, degradation,pollution due to pesticides.Organochlorine pesticides - structure and chemistry, DDT, bioaccumulation and biomagnification. Organophosphates and carbamate insecticides - structure and chemistry, Natural and Green insecticides -sources, target insects. Integrated Pest Management. Heavy metals - Speciation and toxicity of heavy metals, Bioaccumulation of heavy metals.Non pesticide Toxic Organic Compounds of Environmental concern - Dioxins, Furans,Polychlorinated Biphenyls (PCBs), Polynuclear Aromatic Hydrocarbons (PAHs) - sources, structure, health impacts. Concept of green chemistry.

MODULE VI: Radioactivity and Nuclear Energy - Types of radiation, Units of radioactivity, Detectionand measurements of radioactivity, Radioactive nucleus decay, Radon from U 238 decay sequence, Health threat from environmental radiation. Fission and Fusion Reactors, The future of fission based nuclear power, Nuclear accidents and environmental impacts.

REFERENCES

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- https://www.nature.com/
- https://www.nrdc.org/issues

Semester : I
Course code : ENS-E-414
Course Title : BIOCHEMISTRY AND NANOBIOLOGY
Credits : 3

AIM: The aim of the course is to give the importance of biomolecules in different biochemicalprocesses in living organisms. The most important objective of the study of nanobiology involve applying nano-tools to relevant environmental/biological problems and refining these applications. The course help the student to acquire knowledge on the function of biomolecules and also to know the nanotechnology based drinking water and waste water treatment methods.

OBJECTIVES: The course gives a detailed description of the structure of importantbiomolecules- carbohydrates, lipids, proteins and nucleic acids. Also describes the bioenergetics, role of free radicals in biological systems. The nanobiology emphasizes on the interactions of biological systems with natural and engineered nanomaterials and the environmental applications of nano-materials.

COURSE CONTENT

MODULE I: Chemical structure of biologically important macromolecules - Nucleotides andnucleic acids, covalent polynucleotide structure, double helical structure of DNA, properties of DNA, amino acids, peptides and proteins, covalent structure of proteins- secondary structure, tertiary and quaternary structure. Major classes of carbohydrates and their structure. Storage and structural lipids.

MODULE II: Intra and intermolecular interactions - ionic covalent and hydrogen bonds, vandervaal's forces. Polar and non-polar compounds, polyelectrolytes.

MODULE III: Bioenergetics and thermodynamics - Concept of free energy and entropy, enthalpy,standard free energy change.

MODULE IV: Free radicals in Biological systems - Oxygen as a free radical in the auto-oxidation offats, antioxidants.

MODULE V: Definition of nanoscience, nanotechnology and nanobiology, diffusion

inmembranes and cells.Interactions of biological systems with natural and engineered nanomaterials, Molecular nanotechnology - Scanning probe microscopy, Atomic Force Microscopy and Scanning Tunnelling Microscopy. DNA microarray - principle and applications.

MODULE VI: Nanodots – Biological Applications. Quantum Devices - Carbon Nanotubes.Nanoparticles in pharmaceutical and medicinal field, biomedical applications of nanoparticles, Health risks of nanoparticles.Nanomaterials- Environmental applications Zerovalent iron nanoparticles, titaniumdioxide, silver nanoparticles - nanomembrane process,nanosorbants- mesoporous silica-ground water remediation; airpurifier-nanophotocatalysis,nanocoating- corrosion prevention, nanosolar thermal absorber,nano technology based drinking water and waste watertreatment.

REFERENCES

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- http://www.aspbs.com/nanomed.htm
- http://www.nanooze.org/articles/nanobiology-and-nanomedicine/
- https://www.grc.nasa.gov/www/k-12/airplane/thermo.html
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Semester : II
Course code : ENS-C-421
Course Title : ENVIRONMENTAL TECHNIQUES
Credits : 4

AIM: Environmental analysis is a very important part of decision making. This comprises theprocesses which scan, monitor, analyze, and forecasts the variables of the environment. The course is designed to provide a clear knowledge about the principle and working of various analytical technique used in the environmental analysis to the students so that they can work with these tools effectively.

OBJECTIVES: Many analytical techniques such as spectroscopy, microscopy,electrochemical analysis, separation techniques such as chromatography etc. are now widely used in the environmental analysis. Knowing the principle and instrumentation and working of these instruments is very important. This course gives a clear idea about the principles, instrumentation and working of various analytical instruments used in the qualitative and quantitative environmental analysis.

COURSE CONTENT

MODULE I: Sampling of air, water, soil and sediments - Preservation, storage and processing.Biostatistics- Introduction, Frequency distribution, Diagrammatic representations.Measures of Central tendency – Mean - arithmetic, geometric and harmonic mean, Median, Mode. Measures of Dispersion - Range, Standard deviation, Mean deviation, Quartile deviation; Variance, Skewness, Kurtosis, Normal, Binomial and Poisson distribution. Correlation, Regression. Tests of significance – F and Chi-square (X^2) tests.Microscopy and related techniques - Principles of light and electron microscopes, different types and their applications.

MODULE II: Titrimetry - General theory, Classification of reactions in titrimetry, Acid-base titrationindicators, Acidity, Alkalinity. Environmental applications of titrimetric analysis. Principle and determination - Free CO_2, Organic carbon, DO, BOD, COD, Organic carbon in soil.Complexometric titrations - EDTA titrations, Metal ion indicators, Permanent andtemporary hardness. Determination of hardness in water. Determination of Ca and Mg in soil. Estimation of CO_2, SO_2, NO_2 in air.Gravimetric Analysis - Principle, stoichiometry of gravimetric reactions, formation andproperties of precipitates, precipitation from homogeneous solution, nucleation, organic precipitations, applications of gravimetric analysis.Sedimentation -Centrifuge - types and applications.Density gradient methods. Electrophoresis - theory, classification and applications.

MODULE III: Chromatographic methods - Definition and theory of chromatographic

separation, classification and types of chromatography. Planar chromatography – thin layer and paper chromatography.Liquid chromatography – HPLC - instrumentation and applications, Gel permeation chromatography. Gas chromatography – instrumentation, types of detectors – FID, TCD, ECD. GCMS – advantages.

MODULE IV: Colourimetry and Spectrophotometry – Principle, interaction of electromagneticspectrum with matter. Beer-Lambert's Law. Spectrophotometers – types and applications. NDIR, NMR, ESR, Rotational diffusion and Flow birefringence – CD, ORD.Turbidimetry, Nephelometry-Principle, Instrumentation and applications.Emission Spectroscopy - Elementary idea of emission spectroscopy, introduction,elementary theory, instrumentation, types of flames, interferences. Flame photometer - factors affecting flame photometry, applications to qualitative and quantitative analysis, limitations.**IV-b.**Fluorimetry - Fluorescence and Phosphorescence. Theory of fluorescence andphosphorescence, quantum yield, factors affecting fluorescence and phosphorescence, Fluorometer and Spectrofluorometers, instrumentation, applications.

MODULE V: Electro-analytical Methods - Fundamentals, Electrochemical cells, Solution structure,Potential in electro analytical cells, Nernst equation. Potentiometry - Introduction, Reference electrodes, Indicator electrodes, Ion selective electrodes and their applications in chemical analysis.Instrumentation and measurement of cell unit.Direct potentiometry, Potentiometric titration, Applications. Elementary idea of Stripping voltammetry. Polarography - Direct current polarography, basic principle, instrumentationapplications of polarography to inorganic and organic compounds.Amperometric titrations.

MODULE VI: Radiometric Analysis - Types of radiation, radioactive decay, decay rates, laws ofradioactive decay, half life, determination of radioactivity. Neutron Activation Analysis-Principle, theory and instrumentation, applications in environmental analysis. Isotopic Dilution Analysis-Principle, theory, instrumentation and applications.

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- https://www.intechopen.com/books/imaging-and-radioanalytical-techniques-in-interdisciplinary-research-fundamentals-and-cutting-edge-applications/
- https://www.khanacademy.org/test-prep/mcat/chemical-processes/separations-purifications/a/principles-of-chromatography
- https://www.saylor.org/site/wp-content/uploads/2012/07/Chapter911.pdf

Semester : II
Course Code : ENS-C- 422
Course Title : ENVIRONMENTAL MICROBIOLOGY
Credits: 4

AIM: The course aims at imparting an understanding on the basic and applied aspects ofenvironmental microbiology and providing a comprehensive insight into the importance of microbes as key players in the various functions of the environment and also in degradation of wastes.

OBJECTIVES: The course is designed to provide a comprehensive introduction to both fundamental andapplied aspects of environmental microbiology. The course will provide information on microbial evolution and classification, microbial ecology and diversity, metagenomics, microbial interactions, microbial degradation of pesticides and recalcitrant compounds, food and industrial microbiology, medical environmental microbiology, biomining and microbial genetic engineering.

COURSE CONTENT

MODULE I: Scope and importance of microorganisms; Major groups of microorganisms:Microbial evolution and classification – nutrition, growth, metabolism, regulation, reproduction, mutation.

MODULE II: Microbial ecology and diversity - microbiology of soil, air, water and sediments.Microbes in extreme environments, space microbiology. Culture dependent and culture independent methods of microbial diversity analysis .Metagenomics -PCR, DGGE,

FISH, FAME analysis, gene amplification, sequencing, molecular phylogeny and SIP (stable isotope probing) techniques, DNA barcoding, microbial database.

MODULE III: Microbial interactions: microbe and microbe; microbe vs plants; microbe vs animals;Geo-microbiology - role of microorganisms in biogeochemical cycling of elements – carbon, nitrogen, sulphur, phosphorus and iron cycles.Biomining - microbial leaching of low grade mineral ores; molecular probes fororganisms in mines and mine tailings.

MODULE IV: Role of microorganisms in the degradation of natural and manmade compounds recalcitrant chemicals, Persistent Organic Pollutants (POPs).Microbial pathways and enzymes involved in degradation of organic and inorganic pollutants.

MODULE V: Food and industrial microbiology - Food spoilage–causes and preservation, fermented foods, dairy products. Industrial uses of bacteria, yeast and fungi.Basic techniques in microbial genetic engineering–gene cloning, introduction ofcloned genes into new hosts using plasmids and phage vector systems, expression of genes in new host, Genetically modified organisms (GMOs) and their environmental implications.

MODULE VI: Medical Environmental Microbiology - Ecology of infectious agents and diseases;vector-borne diseases – malaria, plagues; Food and water-borne diseases – cholera, typhoid,emerging diseases; airborne infections: bacterial and fungal. Microbial fertilizers and pesticides.

REFERENCES

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- https://www.sciencedaily.com/

Semester : II
Course Code : ENS-C- 423
Course Title : ENVIRONMENTAL GEOLOGY
Credits : 4

AIM: This course aims at providing students with improved understanding of the physical earth, geological processes, geological resources and environmental geology. Specifically, this will help to use of geologic information to solve conflicts in environmental science, to minimize environmental degradation, and to maximize the beneficial results of using our natural and modified environments.

OBJECTIVES: The various modules in this course will provide students with a broad spectrum of environmental and geosciences subjects to facilitate greater awareness of the interactions among the different components of the earth, various geological processes and phenomenon occurring on earth etc. The awareness covers topics like minerals, rocks, soils, groundwater resources, natural hazards, isotope hydrology and its applications etc.

COURSE CONTENT

MODULE I: Introduction - Origin and evolution of the earth, geological time scale. Plate tectonics - sea floor spreading and continental drift. Forces acting on the surface of the earth-tectonic and diastrophic forces.

MODULE II: Minerals and Rocks - Definition of mineral, physical properties of minerals, brief overview of formation, forms, textures, structures, classification of igneous, sedimentary and metamorphic rocks. Overview of important mineral resources and fossil fuels of India. Environmental impacts of mining and various mitigatory measures. Study of interior of earth - crust, mantle and core. Geothermal energy.Soil - Chemical and mineralogical composition, physical properties of soil -texture, bulk density, permeability. Chemical properties - cation exchange capacity, pH. Soil erosion-types, causes and remedial measures.

MODULE III: Natural hazards - Earthquakes- causes, effects, distribution and prediction. Volcanoes-types, products of volcanic eruption and its environmental impact. Landslides-slope stability, factors affecting slope stability, causes and prevention of landslides. Brief note on tsunami. Coastal erosion- causes, processes and protective measures.

MODULE IV: Earth's surface processes - erosion, transportation and deposition of earth'smaterials by streams, wind and glaciers.Glaciers - physical and chemical aspects, recession of Himalayan glaciers,glaciers as an index of climate change.

MODULE V: Ecohydrology - Definition and concept of eco-hydrology. Hydrologic cycle andhydrologic budget, inventory of the earth's water, global water balance. Drainage basin – definition, characteristics, drainage pattern, stream classification and ordering.Use of topographic maps and environmental geologic maps in environmentalstudies.

MODULE VI: Groundwater - Source, occurrence and movement of groundwater. Definition of watertable, water table fluctuations- environmental influences, fluctuations due to evapo-transpiration, meteorological phenomena, urbanization. Geologic formations as aquifer, aquitard, aquiclude. Quality criteria of groundwater for drinking and irrigation purpose, groundwater contamination, groundwater recharging and rain water harvesting. Isotope Hydrology- Definition and classification of isotopes- stable andunstable (radioactive) isotopes, environmental (natural) and artificial isotopes. Isotopes of H2, O2, N2, S. Isotopic composition of water. Expression of environmental stableisotopes. Application of Isotopic Techniques in Hydrology - use of radioactive isotopes in determination of origin and age of groundwater, groundwater recharge. Use of environmental stable isotopes for determining surface water and groundwater interconnection. Discrimination of water pollution due to nitrate, phosphate, sulphate. Stalinization of water resources.

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Semester : II
Course code : ENS-C-424
Course Title : ENVIRONMENTAL METEOROLOGY AND CLIMATE CHANGE
Credits : 3

AIM: The course imparts an understanding in the basic concept of Environmental Meteorologyand to educate the students about the new concept of climate change. The course also provides the scientific background for research and other careers across a broad spectrum of meteorology-related science, focusing particularly on the links between the atmosphere and the land surface environment.

OBJECTIVES: This course has two major themes. The first theme deals withenvironmental meteorology and the second theme covers Climate Change. In the first theme, four modules are there and emphasis is placed on fundamentals of meteorology, description and measurement of climatic parameters, micrometeorology and pollution meteorology. Also introduce students to fundamental principle of meteorological instrumentation and measurements. This will provide the students with the scientific background for research and other careers across a broad spectrum of meteorology-related science, focusing particularly on the links between the atmosphere and the land surface environment.In the second theme, the climatology refers to the fundamentals of climatology, boundary layer climates, pollution climatology, the phenomenon of climate change with emphasis on India.

COURSE CONTENT

MODULE I: Fundamentals of Meteorology - Motions of the earth and seasons. Earth-sunrelationship. Insolation and its latitudinal and seasonal variation.

MODULE II: Air temperature- warming and cooling of air near ground, measurement oftemperature. Humidity- expressions of humidity, measurement of humidity.Clouds-classification and types. Precipitation- process, types of precipitation, measurement of

precipitation-recording, non-recording, radar, satellite,estimation of precipitation, averaging techniques- thiessen polygon and isohyets. Wind - forces affecting wind, types of wind and measurement of wind.

MODULE III: Micrometeorology - applications to vegetated surfaces, urban areas, humanbeings and animals, impact on the physiology of plants and animals, stress induced changes.

MODULE IV: Pollution meteorology - Application of metorological principles to transport anddiffusion of pollutants. Diffusion and turbulence, mixing height. Effect of meteorological factors on air pollution, size and structure of plume, dispersion of air pollutants - Gaussian model, reaction of pollutants in air forming smog, PAN, Acid rain.Pollution Climatology - Preliminary concepts of climate change,Seasons in India,Monsoons, El nino and ENSO, Enhanced greenhouse effect - global warming, GHGs in the atmosphere, Effects of global warming.

MODULE V: Climatology - Elements of weather and climate, climatic controls, energy balancein atmosphere, elementary ideas about weather systems, climatic classifications, climates in India, monsoons of India.Boundary layer climates-effects of topography, energy and mass exchange,climates of vegetated surface, urban climatology.Science of Climate Change - Drivers of climate change- Greenhouse gases,aerosols - reflective and black carbon, land use changes. Energy balance, feed-back processes in climate system, concepts of global warming potential (GWP), radiative forcing.

MODULE VI: Climate change scenarios of India - impact of climate change on agriculture,forest, water resources, monsoon system of India.

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Semester : III
Course code : ENS-C- 431
Course Title : ENVIRONMENTAL GENETICS AND BIOTECHNOLOGY
Credits : 4

AIM: The study of environmental genetics gives the details of interaction between genetics andthe environment. And the course on environmental biotechnology helps to educate the students about the recent concepts of biotechnology and can acquire knowledge for using the biological systems for remediation of contaminated environments and for eco-friendly processes.

OBJECTIVE: The environmental genetics course gives the details of expression ofgenetic information, mutation and environmental mutagens. The chemical and physical mutagenic agents and their effects on DNA are emphasized. Principles of evolutionary genetics and population genetics are also included in the course module. Environmental Biotechnology course introduces the student the applications of biotechnology in environmental monitoring, waste management and pollution abatement, biodiversity conservation and bioenergy production.

COURSE CONTENT

MODULE I: Introduction, Central dogma of molecular genetics, Experiments to show DNA as thegenetic material, DNA replication, change the sequence of DNA, Genes and chromosomes a gene codes for a single polypeptide, recombination occurs by physical exchange of DNA, Nature of Genetic code.

Mutation and Environmental mutagens: Occurrence, kinds of Mutation, spontaneous andinduced mutation, Mutagens, detection of mutation, Lethal mutations, Phenotypic effects of mutation, Mutation rate, Significance & Practical applications of Mutation. Molecular basis of Mutation, mutagenic agents - physical, chemical, biological, Effect on genetic material, Repair mechanisms.

MODULE II: Expression of genetic information: from transcription to translation, The Relationshipbetween genes and protein, The basic process, Transcription and RNA Processing in Eukaryotic Cells, Encoding genetic information, Decoding the codons: the role of transfer RNAs, Inhibitors of transcription and translation.Chromosomal variation in Number & Structure Euploidy, Non-disjunction &Aneuploidy, Aneuploid segregation in plants, Aneuploidy in

Human, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Chromosomal Mosaics, Polytene chromosomes, Deletion, Duplication, Inversion, Translocation, Position Effect, Centromeric& Non-centromeric breaks in chromosomes, Genetic hazards.

MODULE III: Population Genetics and Evolution: Synthetic theory of Evolution– Lamarckianevolution theory, Darwin's theory of evolution, Neo-Darwinism, modern synthesis theory of evolution, Macroevolution & Microevolution. Chromosomal aberrations & evolution. Principles of Evolutionary Genetics: A brief history of evolutionary genetics, Epistasis and the conversion of genetic variances.

MODULE IV: Environmental Biotechnology - Definition, principles, scope. Role of biotechnology inbiodiversity conservation, utilization of biodiversity, biotechnology vs biodiversity.Biotechnology and energy production - Bioenergy, Biofuel, biodiesel, Biohydrogen.Bioenergy from wastes.Ecofriendly products - Biopolymers and bioplastics.

MODULE V: Biotechnology for environmental protection and pollution prevention. Applications in solid waste management – biocomposting, biomethanationBiotechnology for wastewater treatment - Microbial processes in wastewatertreatment, microbial biofilm and wastewater treatment, secondary treatment systems, nutrient removal through biomass production, applications in tannery, distillery and food industries. Biotechnology for air pollution abatement and odour control – deodorizationprocess – bioscrubbers, biobeds, biotrickling filters.

MODULE VI: Bioremediation – types, principles.Biodegradation of persistent organic pollutants, enzymescatalyzing biodegradation, pathways of degradation, molecular aspects of biodegradation.Biomonitoring - Biosenors, biochips. Biosurfactants – microbial production and their role in bioremediation.Microbial transformation of heavy metals - heavy metal tolerance, metal-microbeinteractions, immobilization and transformation of metals. Applications in metal removal - Bioleaching and biomining. Environmental impacts of genetically modified organisms.

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Semester : III
Course code : ENS-C- 432
Course Title : NATURAL RESOURCES AND ENERGY MANAGEMENT
Credits : 4

AIM: This course aims to equip students with the necessary knowledge and skills in the areas ofnatural resources, and energy management. In particular, the course caters to the rising demand from the public and private sectors for environmental managers in the field of energy, environment and sustainability. Based on such knowledge gain in this course, the students can develop innovative and creative solutions to various energy and environmental problems.

OBJECTIVES: This course provides a broad overview of natural resources and energymanagement. The interdisciplinary nature of this course allows students to learn about conservation, protection and management of variety of natural resources. Principles and practices for sustainably managing natural resources i.e. soil, water, forests, biodiversity are taught. Different sources of energy production systems and their environmental impacts; broad comprehension of alternative fuels, bioenergy and their production methodologies are also included in the course syllabus so that the students can appreciate the importance of energy efficiency and energy conservation strategy for sustainable environment.

COURSE CONTENT

MODULE I: Natural Resources : concept and major types of natural resources, land resources;land use and land cover, land use change, drivers of land use change, impact of land use change on environment.

MODULE II: Soil and mineral resources : overview of major soil types and mineral deposits inIndia with special reference to Kerala, Environmental effects of mining; acidic, alkaline and saline soils – reclamation techniques.

MODULE III:Forest resource : over view of major forest types in India with specialreference to Kerala – their characteristics; Social forestry – multipurpose tree species (MPTs), Nitrogen fixing Tree species (NFTs) – characteristics; community participation; pattern of planting; eco-restoration of eroded hill slopes and degraded Jhum land.Agroforestry - origin and definition, types; Tree and crop management,models for hill farming – three tier system, contour-tree-greenhedge-crop farming system; Role of forests in carbon sequestration.

MODULE IV: Biodiversity : Introduction, levels, importance; Organisms–evolution anddistribution in space and time; hotspots of biodiversity, gene pool, climate and its impact on biodiversity; diversity of flora and fauna; Threats to biodiversity : Endangered, endemic species and threatened species; IUCN threatened species of plants and animals; Red data book.Biodiversity conservation: Convergence and divergence in species; sustainableexploitation; strategies for conservation; global agreements and national concerns; RAMSAR sites, CBD, quarantine regulations; Biodiversity Act, IPRs, Biopiracy – cause and effect; Protection of wildlife – role of WWF, WCU, CITES, TRAFFIC, Wildlife Protection Act.

MODULE V: Water resource : Distribution and extent-global, national and regional; waterresources types – surface water, ground water; water availability and uses, freshwater shortages, impact of climate change on freshwater resources, Management and conservation of water resources.Watershed management: Concept, Objectives, planning and measures; Landuse planning for watershed management; Water harvesting and recycling; Flood control and watershed management; Socio-economic aspects of watershed management.

MODULE VI: Energy and Environment : Human energy requirement, energy use pattern indifferent parts of the world and its impact on the environment; energy use pattern in India, sources of energy and their classification; Fossil fuels – classification, composition; energy content of coal, petroleum and natural gas; exploration/ mining.Bioenergy : Biomass composition and types; conversion processes; biogasproduction – anaerobic digestion, Energy from wastes; Nuclear energy : Fission and Fusion, Nuclear fuels - Refining, enrichment, fuel fabrication and fuel cycle; Solar energy : Harnessing of solar energy, solar collectors and concentrators, solar electricity generation, solar heaters, dryers, cookers – photo-voltaics; solar energy utilization in India; Wind energy : Wind power, harnessing of wind energy, power generation – wind mills; wind energy potential in India; Geothermal energy, Wave & Tidal power.Alternative fuels: Gasoline, Natural Gas and Propane, Oxygenated fuels,Biofuels,Hydrogen.

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Semester : III
Course code : ENS-C- 433
Course Title :ENVIRONMENTAL IMPACT ASSESSMENT ANDDISASTER MANAGEMENT
Credit : 4

AIM: The course on Environmental Impact Assessment enables the student to judge whether or not a particular developmental project would require an EIA; how such an assessment be produced, what steps would be needed to undertake a baseline survey, how impacts might be mitigated and monitored. The disaster management modules will improve the scientific knowledge among

students about various natural and man- made disasters through the teaching of policies, programs, administrative actions and operations undertaken. This will train them to cope with different disaster management activities like preparedness, prevention and thereby to reduce or avoid the human, physical, and economic losses suffered by individuals, by the society, and by the country at large.

OBJECTIVES: The first objectives to make the student aware of the process of assessing the potential impacts of major developmental projects (actions) on the environment- known worldwide as Environmental Impact Assessment (EIA). This is seen globally as major tool to help deliver sustainable development. The second objective is to get an awareness regarding the disaster management with reference to the policies, programs, administrative actions and operations undertaken to address a natural or man-made disaster through preparedness, mitigation, response and recovery.

COURSE CONTENT

MODULE I: Environmental Impact Assessment (EIA) - Definition, purpose and characteristics ofEIA, global evolution of EIA, participants in EIA process, stages of EIA, types of EIA. Environmental inventory. Baseline data on EIA- environmental data, project data and project alternative data. Measurement of impact– physical, social, economic, natural. Public-participation in environmental decision making, Framework of Environmental Assessment, Description of environmental setting, Environmental impact factors and area consideration. Environmental Impact Statement (EIS) and Environmental Management Plan (EMP).

MODULEII: Environmental Impact Analysis - Impact identification and methods of impactidentification- adhoc method, checklist, matrix, network, overlay and index methods. Impact prediction and predictive methodologies, impact evaluation (assessment) and impact mitigation.

MODULE III: Basic steps for the impact identification, prediction and assessment of air, water,noise, vegetation and wildlife environment with case studies.EIA in India - An overview of history, current procedures, practices and guidelines.EIA of water resource projects, industries, mining and quarrying, highway construction, tourism developments.

MODULE IV: Basic Concept of Disaster- Definition of hazard, vulnerability, risk, disaster. Causative factors of disaster, Classification of disasters. Hazard Mitigation - Identification of hazard prone belts, hazard zonation and risk assessment, risk reduction in vulnerable areas, developing warning systems, forecasting, emergency preparedness, education and training activities, planning for rescue and relief works.

MODULE V: Disaster Management - Definition of disaster management, components of disaster management cycle - crisis management & risk management. Crisis management- quick response and relief, recovery, development. Risk management- risk identification and risk assessment, risk reduction- preparedness, prevention and mitigation, risk transfer. Disaster management- actand policy. Important sectors in disaster management-health and medical care, communications, insurance, social work, NGO's, media, fire services, police and paramilitary services, armed forces etc. Levels of disasters in India.

MODULE VI: Natural Hazards - earthquakes, tsunami, volcanoes, floods, landslides, avalanche,cyclone, drought, fire – causes, perception, mitigation and management.Man-made hazards -Hazards due to dams and reservoirs, nuclear power plants,industrial hazards, occupational hazards, mitigation measures.Environmental health hazard and risk assessment: biological, chemical, physical and psychological health hazard; health risk assessment and management.

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Semester : III
Course code : ENS-C- 434
Course Title :FIELD STUDY
Credits : 3

AIM : Environmental Science employs an interdisciplinary approach, teaching students how to meet the challenges of creating a safe and healthy environment and how to recognize and control the effects of pollution and environmental stress on ecosystems.

OBJECTIVES: Field study focuses on a particular locale and/or environmental issue to study the various ways in which biological, chemical, geological, and human factors interact. It is compulsory that each student must visit at least 2 natural sites, 2 research and development institutions and 2 industries/ factories anywhere in India. By visiting various environmentally relevant areas, industries and institutions, students can learn how to integrate and apply knowledge from the appropriate areas of basic science, economics, and policy to address problems caused by ecosystem degradation and from physical alteration of the environment. Students have to prepare a report on the field visit discussing about the importance of the visited area and the knowledge they derived from the visit and submit the report with photographs.

Semester : IV
Course code : ENS-C-441
Course Title : ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL
Credits : 4

AIM: The course aims to acquire knowledge on the technology and principles behind theprocesses and techniques related to the reduction of emissions to air, land and water and the effects of pollution. Also Engineering solutions to major environmental problems will be explored.

OBJECTIVES: The course helps to understand the main causes of water pollution,different

sources of water pollution and their characteristics and harmful effects. The course deals with detailed description of the methods of treatment of waste water, the need of establishing different water quality standards and details of drinking and surface water quality standards.

COURSE CONTENT

MODULE I: Air Pollution - Atmospheric pollution, Classification of air pollutants, Sources of airpollution, Impacts of ozone layer depletion, Chlorofluorocarbons, Effects of air pollution on human health, Sampling of aerosols, Sampling and analysis of particulates and gaseous pollutants, Ambient air quality and emission standards, Air pollution indices, Air Act legislation and regulations, Removal of gaseous pollutants. Particulate emission control,bioscrubbers, biofilters. Indoor air pollution- effects of air pollutants on animals and humans, Indoor air quality. Noise Pollution - Sources, measurement, health impacts, effects and control.

MODULE II: Water Pollution - Types of water pollution, water pollutants, sources and storagesof water -ground water and surface water, and consequences of water pollution. Ecological and biological effects of domestic, industrial and agricultural wastes on water bodies. Responses of plants and animals to changes in physico-chemical characteristics. River Action plans. Biological monitoring of water pollution. Sampling, physical, chemical and bacteriological analysis of water, water quality standards. Control and prevention of water pollution. State and Central pollution control boards, Tolerance limits and specifications, Thermal pollution- sources, causes, effects and control.

MODULE III: Water treatment - Quality of water, Standards of raw and treated water, Objectivesof waste water treatment, Wastewater collection and treatment principles: sewerage system, storm water collection, combined sewer overflow design, Unit processes for waste water treatment- septic tanks. Primary treatment: preliminary treatment such as bar screen, gritchamber, coagulation and flocculation, giltration and sedimentation tank methods. Secondarytreatment - design principles- activated sludge, trickling filters, oxidation ponds. Tertiary/ advanced treatment - Removal of toxic compounds and refractory organics, removal of dissolved inorganic substances, Ion exchange methods, Electrodialysis, Softening of water-Reverse osmosis, nitrogen and phosphorus removal. Disinfection of water, Sludge treatment and disposal. Conventional methods of effluent treatment. Water pollution management and control. General and specific pollution control with respect to a few chemical industries such as tanneries, textile, fertilizer and electroplating industries.

MODULE IV: Water Quality Modelling: Formulations for water quality modeling-MODFLOW.Discharge Monitoring Report (DMR) Pollutant Loading Tool – AQUATOX.

MODULE V: Soil Pollution - Physical and chemical properties of soil, Soil microorganisms and

theirfunctions, Wastes and pollutants in soil, Pesticides and their effects on soil components, residual toxicity, and pollution. Different kinds of synthetic fertilizers and their interactions with soil components. Industrial effluents of different kinds, their interactions with soil components. Changes in characteristics of soil by waste disposal. Toxic heavy metals. Trace element analysis in soil. Control of soil pollution: sanitary and secured landfills. Remediation of contaminated soils.

MODULE VI: Radioactive Pollution - Radionuclides- sources, types of radiation, effects onhumans, exposure standards, control measures.

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Semester : IV
Course code : ENS-C-442
Course Title : ENVIRONMENTAL ECONOMICS AND POLICIES
Credits : 4

AIM: The course is designed to give comprehensive insight into the economics of pollution andclimate change and to educate the students on various aspects of environmental auditing. It also imparts knowledge about environmental laws, regulations and policies of India and International Environmental laws.

OBJECTIVES: The course is structured to introduce the student to various aspects ofenvironmental economics, auditing, management and policies. It provides the student the theory and analytical tools to explore the economic dimensions of natural resources, to understand how the environment is valued. The course helps the student to understand how to use natural resources efficiently and also explore various policies for possible solutions and ensure sustainable development.

COURSE CONTENT

MODULE I: Economy and the Environment - Nature and scope of Environmental economics;economics and ecology; Economics of Natural Resources exploitation – methods of valuation of environmental costs and benefits, market value approach of environmental costs and benefits. Economics of Pollution - optimum level of pollution.

MODULE II: Economics of climate change - Clean Technology - Imperatives of clean technologyin the context of mitigation and adaptation measures. CDM concept, CDM scenario in India, CDM projects sector-wise, National Action Plan on Climate Change, sustainable habitat, concept of Green architecture. Carbon trading, carbon credits, Carbon sequestration, Carbon Foot-print.Issues of Energy security, Food Security and Social security.

MODULE III: Environmental Auditing and Management - Objectives, frequency and criteria audit team,Environmental appraisal, accounting and environmental audit. Environmental guidelines for siting of industry, Green Balance Sheet (GBS), Environmental Management - Concept and scope, systems and approaches,standards – international and national - eco-mark, green funding and taxes, trade and environmental management - Intellectual Property Rights – Scheme of labelling of environmentally friendly products (eco-mark), Public Liability Insurance

Act, 1991. Environmental Management and ISO Certification: Environmental Management Systems (EMS), ISO 14000 (EMS).

MODULE IV: Environmental policy in Ancient India–Medieval India, British India duringpost independent era, Environmental History of India.National Environmental Policy and Regulatory framework - Rules andregulations of Central and State Government and Pollution Control Boards for Environmental Protection, public policy strategies in pollution control.International and National Conservation agencies.Major environmental movements in India – Chipko movement, Appiko movement; Narmada dam, Tehri Dam.

MODULE V: International Environmental Laws : Evolution and development ofInternational Environmental Laws with reference to Stockholm conference, Nairobi Declaration, Rio Conference, Rio+5 and Rio+10, etc.Global environmental issues and International Laws to control global warming, climate change, ozone depletion, acid rains, hazardous wastes.Role of UN authorities in protection of global environment, convention on biodiversity.

Environmental Laws in India: Legal, administrative and constitutionalprovisions for environmental protection in India, Constitutional and Statutory laws in India, statutory protection of human environment – Factories act of 1948, Motor Vehicle Act, Indian Forest act of 1927, the mines and minerals act of 1957, Hazardous Waste Legislation for pollution abatement, Anti Pollution Acts – The Water Act, 1974, The Air Act 1981, The Environment Protection Act, 1986, The national environment appellate authority act of 1997, The wildlife protection act 1972; The forest conservation act of 1980, Biodiversity Act 2002.

MODULE VI: Sustainable Development - Concept and growth of the idea, indications ofsustainability, models of sustainable development, sustainable development scenario – global, national; sustainable agriculture.Ecotourism - Definition, concept and principles, types of ecotourists, Scopefor ecotourism in Kerala, India, Benefits of ecotourism.Environmental Ethics - Concept of Environmental Ethics, philosophies ofbiocentrism and ecocentrism, application of ethics to environmental issues, eastern and western philosophical traditions/ religious treatises on the relationships between humans, animals and natural environment. Ecofeminism-Environmental equity and justice.Environmental Education - Meaning and scope–principles andobjectives, environmental awareness strategies, formal and non-formal education; action plans.

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- http://www.epa.vic.gov.au/our-work/environmental-auditing
- http://www.investopedia.com/terms/e/environmental-economics.asp
- http://www.legalservicesindia.com/article/article/environmental-laws-and-constitutional-provisions-in-india-1926-1.html
- http://www.undp.org/content/undp/en/home/sustainable-development-goals.html
- https://link.springer.com/referenceworkentry/10.1007%2F1-4020-4494-1_116
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Semester : IV
Course code : ENS-C-443
Course Title : REMOTE SENSING AND GIS
Credits : 4

AIM: Students can gain experience in the applications of remote sensing and GIS to solvingproblems in the various branches of environmental sciences. Students will able to apply their knowledge and skills in spatial science to collect, map, analyze and present information about the physical environment. The knowledge and skills acquired through this course train students for careers in the private, public, and nonprofit sectors where there is an increasing demand for professionals with advanced technical skills in remote sensing and GIS are required to organize and analyze environmental data.

OBJECTIVES:This course provides students an understanding of the basic concepts ofremote sensing and Geographical Information Systems (GIS) techniques and the applications of these techniques in various branches of environmental sciences. The course is designed for students with diverse backgrounds who desire training in the use of remote sensing and GIS in environmental and natural resource analysis and management. The course is organized into two parts. The first part focuses on the theories underlying basic processes in remote sensing, aerial and satellite remote sensing, photo-grammetry, sensors and digital image processing. Students will be taught processing of satellite images, and how data from various satellite platforms are used in the environmental sciences. The second component of the course focuses on the GIS, where the structure and format of GIS data, data input and transformation, spatial analysis are taught. In addition, students will gain an understanding of the recent advances in GIS such as WebGIS, Open Geospatial Consortium (OGC), and data portals commonly used in remote sensing and GIS.

COURSE CONTENT

MODULE I: Concepts and Foundation of Remote Sensing - Basic processes in remote sensing-data acquisition - energy sources and radiation principles, propagation of energy through atmosphere, energy interaction with earth's surface features, retransmission of energy into the atmosphere, generation of sensor data , data analysis. Active and Passive Remote Sensing, Special features of remote sensing.

MODULE II: Aerial Remote Sensing - advantages of aerial remote sensing, elements ofphotographic systems - films, aerial cameras, filters. Classification of aerial photos and processes of aerial photos, elements of image interpretation, interpretation keys, interpretation of photographs and images for environmental analysis. Photogrammetry - Geometric characteristics of aerial photographs, scale ofphotographs, stereo models, principles of stereo-photos, relief displacement, parallax and measurement of height and slope, convergence and evidence, aerial mosaics, ortho-photos, photogrammetric instruments.

MODULE III: Types of Sensors -Sensors, Platforms and Scanners, Principle of scanner andCCD array, Thermal, Multispectral (MSS), Microwave, Lidar: Basic definition and principles, general characteristics, spectral resolution and interpretation, applications in environmental monitoring. Overview of hyperspectral remote sensing.

MODULE IV: Satellite Remote Sensing - advantages of satellite remote sensing, types ofsatellite orbits - polar and geostationary, Satellite characteristics - Orbit, swath, resolution, scale. Overview of satellites - Landsat, SPOT, IRS, NOAA, Cartosat, Oceansat, IKONOS,

QUICKBIRD, ERS, RADARSAT, INSAT satellites - their sensors, geometry, radiometry, orbital characteristics, data products and applications.

MODULE V: Digital Image Processing - Digital Image formats, file structures, ImageRectification and Restoration, Image enhancement, Image classification – supervised, unsupervised, ground truth data and training set manipulation, data merging.

MODULE VI:Geographical Information System (GIS) - definition, historicalevolution, components, basic principles. Data models - vector and raster data, spatial andnon-spatial data, Map projection, defining spatial relationships, Spatial Analysis, measurements, queries, buffering and neighbourhood functions, map overlay, network analysis, spatial interpolation – TIN, DEM, DSM. Advances in GIS – WebGIS, Open Geospatial Consortium (OGC), FOSS in GIS, Data mining,BhuvanGeoportal.Global Positioning System (GPS) - System segments, GPS satellite signals, GPSerror sources, calculating locations, differential GPS and GPS in differential mode, applications of GPS in environmental studies. IRNSS GPS.Application of Remote Sensing and GIS: Applications in forestry and wildlifemanagement; monitoring of land use/land cover; soil and agriculture; water resources; urban planning; disaster management; health studies.

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- Jhanwar, M.L and Chouhan, I.S. 1998. *Remote Sensing and Photogrammetry – Principles and Applications.*
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- www.bhuvan.nrsc.gov.in
- www.esri.com
- www.geospatialworld.net
- www.geospatialworld.net.
- www.ncgia.org
- www.nnrms.gov.in
- www.nrsc.gov.in
- www.surveyofindia.gov.in

Semester : IV
Course code : ENS-D-444
Course Title : DISSERTATION
Credits : 6

AIM: The project work is formulated to take the students deep in the field of research invarious fields of environmental sciences. In order to critically evaluate and make a solution to various environmental problems, proper analysis, data collection evaluation and gathering the information is necessary.

OBJECTIVES: To carry out the project work, students have to find a problem which isenvironmentally relevant. Based on that, students have to conduct independent research analysis under the supervision of a teacher, on current environmental problems. Laboratory and/or field work is required for completing the project work. The student has to submit the dissertation after the completion of the work and has to present the work using a power point presentation. Also they have to attend the viva-voce examination related to their project work.

EXTRA-DEPARTMENTAL ELECTIVE COURSES

Semester : I
Course code : ENS-X-411
Course Title : DISASTER MANAGEMENT
Credits : 2

AIM: The aim of this extra departmental elective is to improve the scientific knowledge amongstudents about various natural and man- made disasters through the teaching of policies, programs, administrative actions and operations undertaken. This will train them to cope with the different disaster management activities like preparedness, prevention and thereby to reduce or avoid the human, physical, and economic losses suffered by individuals, by the society, and by the country at large. Also train them to reduce their personal sufferings in connection with a disaster.

OBJECTIVES: Thevarious modules in the first part of this course deals with basic concept of disaster, components of disaster management cycle, sectors in disaster management, role of Remote Sensing and GIS in disaster management etc. The second part covers the causes, perception and management of various natural disasters like flood, earthquake, landslide, cyclone, coastal erosion etc.

COURSE CONTENT

MODULE I: Basic concept of disaster- definition of hazard, vulnerability, risk,disaster.Causative factors of disaster. Classification of disasters.

MODULE II: Disaster management:- definition of disaster management; components ofdisaster management cycle- crisis management & risk management. Crisis management-quick response & relief, recovery, development. Risk management- risk identification & risk reduction- preparedness, prevention and mitigation.

MODULE III: Important sectors in disaster management- health and medical care,communications, insurance, social work, NGO's, media, fire services, police and paramilitary services, armed forces etc.

MODULE IV: Role of Remote Sensing and GIS in disaster management.Levels of disasters in India.Survey and assessment of after-effects of a disaster.

MODULE V: Causes, perception, management of various natural disasters like flood, landslides,earthquakes, tsunami, coastal erosion, cyclones, volcanism, forest fire etc.

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- Singh, K.K. &. Singh, A.K. 2010. Natural and manmade disasters: vulnerability, preparedness and mitigation, Vol(1&2), M.D. publications. Pvt. Ltd. New Delhi.
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- http://www.ifrc.org/en/what-we-do/disaster-management/about-disaster-management/
- http://www.isro.gov.in/applications/disaster-management-support-programme
- http://www.ndmindia.nic.in/

Semester : II
Course code : ENS-X-421
Course Title : ENVIRONMENTAL HEALTH PERSPECTIVES
Credits : 2

AIM: The study aims to give awareness about the healthy interrelationships betweenpeople and the environment. Environmental health is concerned with controlling these causative agents and safeguarding the public's health and wellbeing. By knowing the health perspectives we can reduce the impacts of social health problem. The students will be able to lead a Improved quality of life, a more eco-friendly environment.

OBJECTIVES: The course gives the details of effects of pollutants on ecosystemand human health. Also discusses the diseases associated with environmental exposures. The determinants of health are genetic, medical care, lifestyle and environment. The causative agents of disease are physical, chemical and biological. Reactive oxygen species have been increasingly implicated in the pathogenesis of many diseases and important biological processes including carcinogenesis, atherosclerosis, aging, neurodegenerative diseases, and inflammatory disorders. The role of antioxidants in health and disease are also described. The course also gives the details of Environmental Health Impact Assessment.

COURSE CONTENT

MODULE I: Environmental Health: Definition, Basic Principles, Major EnvironmentalHealth Problems.Air pollution - Indoor and outdoor pollution, major air pollutants, Toxicchemicals in air. Indoor Air pollution -sources and health hazards. National ambient airquality standards.

MODULE II: Water Pollution - Sources of water pollutants and their health impacts.Standards for drinking water. Water borne diseases, Vector borne diseases, Drinking waterdisinfection methods - Carcinogenicity of disinfection by-products.

MODULE III: Soil Pollution: Sources of Soil pollutants and Soil borne diseases.

MODULE IV: Food contamination - Pesticide residues and Heavy metals in food, Food bornediseases and causative agents.

MODULE V: Radiation damage and health impacts: Sources of Radiations - Man maderadiations and Natural radiations, Radiation syndromes, Radiation effects.Occupational Pollution and Health hazards: Occupational exposure of workersto pollutants and health impacts.**Vb:**Climate change and Human health: Climate and chronic Respiratory Disease(CRD), Direct impacts of climate, Indirect impacts of climate.Antioxidants in Health and Disease - Auto-oxidation and Free radicals, Naturaland synthetic Antioxidants, Therapeutic benefits of antioxidants.Environmental Health Impact Assessment (EHIA) - Definition, Significance ofEHIA, Steps in EIA.

REFERENCES

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- Kemm, J; Parry, J and Palmer, S. (2004).Health Impact Assessment: Concepts, theory, techniques and applications, Oxford University Press, NewYork.
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- Park, K. (2005). Park's Text Book of Preventive and Social Medicine, 18th Edition. M/s. Banarsidas- Bhanot Publishers, Jabalpur.
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- http://www.who.int/phe/en/
- https://ehjournal.biomedcentral.com/
- https://www.cdc.gov/nceh/

Semester : III
Course code : ENS-X-431
Course Title : WASTE MANAGEMENT TECHNIQUES
Credits :2

AIM: The course aims to impart knowledge on the management of solid and liquid wastes frommunicipal and industrial sources and to teach the principles and applications of remedial measures viz., recycling, reuse and recovery from the wastes.

OBJECTIVES: The fundamentals concepts ofwaste management are included as the first module. Characteristics and management of waste water, solid wastes and hazardous wastes and waste management policies are the important topics discussed in this course.

COURSE CONTENT

MODULE I: Wastes and Management: Definition, concept.

MODULE II: Waste water: Nature and types; sources and characteristics; treatment methods– physical, chemical, biological and advanced treatment methods. Natural treatment systems-constructed wetlands, wastewater reclamation and reuse.

MODULE III: Solid wastes: types of wastes; collection, transportation, disposal, processing ofmunicipal solid wastes; Treatment methods: Incineration, land-filling, composting, vermin-composting.

MODULE IV: Hazardous wastes: Definition, source and characteristics; Management of medicaland hospital wastes, Nuclear and radioactive wastes – classification, sources and disposal; e-waste and their management.

MODULE V: Industrial wastes-management practices in pulp and paper, and tannery. Waste management policies; polluter pays principle; wealth from waste-compost, single cell protein; waste to energy – ethanol, biogas, hydrogen.

REFERENCES

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- Agarwal,S.K. 2005. Wealth from waste, APH Publishing corporation, New Delhi
- Bhatia,S.C. 2007. Solid and Hazardous Waste Management. Atlantic Publishers and Distributors, New Delhi
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- https://www.wm.com/us

PRACTICALS

Semester : I
Course code : ENS-P-411
Course Title : ENVIRONMENTAL BIOLOGY AND ECOSYSTEM DYNAMICS

1. Identification of fauna and flora (4 each) of terrestrial, freshwater and marine ecosystems.
2. Identification of phytoplankton and zooplankton (either freshwater or marine).
3. Qualitative estimation of phytoplankton by Lacky's Drop Method and Zooplankton by Sedgwick-Rafter Cell method.
4. Estimation of primary productivity – Light and dark bottle method – effects of depth and light.
5. Community study :quadrat method ; flora and fauna study by frequency, density and abundance – line transect method.

Semester : I
Course code : ENS-P-413
Course Title : ENVIRONMENTAL CHEMISTRY

1. Toxicology tests (LC_{50})
2. Estimation of starch
3. Estimation of aminoacids
4. Estimation of protein
5. Estimation of reducing sugars
6. Estimation of chlorophyll
7. Analysis of DO, BOD, COD, $NO_3$and PO_4in water, Determination of potability of water using coagulant demand, chlorine demand and residual chlorine.
8. Analysis of heavy metals and pesticides.

Semester : II
Course code : ENS-P-421
Course Title : ENVIRONMENTAL TECHNIQUES

1. Methods of sampling - water, air, soil/sediment
2. Physico-chemical parameters of water - salinity, pH, conductivity, free carbon dioxide, alkalinity, TDS, TSS, total hardness, turbidity,
3. Air characteristics – analysis of particulates (dust fall method) and gaseous components – oxides of carbon/ nitrogen/ sulphur
4. Estimation of organic carbon (titrimetric method), total nitrogen (Kjeldahl method)
5. Estimations using Flame photometry – Na and K.

6. Chromatographic techniques – Paper, Thin layer : amino acids, plant pigments
7. Calculation of mean, median, mode and standard deviation, chi-square, ANOVA, regression, correlation, tests of significance

Semester : II
Course code : ENS-P-422
Course Title : ENVIRONMENTAL MICROBIOLOGY

1. Sterilization techniques.
2. Culture media preparations.
3. Isolation techniques: serial dilution, plating.
4. Identification of bacteria and fungi: physiological and biochemical.
5. Staining – Simple and Gram's.
6. Microscopic counting of microbes using haemocytometer.
7. Measurement of microbes using ocular and stage micrometer.
8. Estimation of coliform bacteria in water by MPN method.

Semester : II
Course Code : ENS-P- 423
Course Title : ENVIRONMENTAL GEOLOGY

1. Megascopic identification of important rock bearing minerals.
2. Identification of diagnostic physical properties and naming the mineral.
3. Megascopic identification of important rocks – igneous, sedimentary and metamorphic rocks.
4. Brief description of the texture, structure and mineralogy of rock.

Semester : IV
Course code : ENS-P-443
Course Title : REMOTE SENSING AND GIS

1. Study of topographic maps- identification of scale, latitude and longitude
2. Study of various geomorphic and environmental features in the maps
3. Interpretation of aerial photos using stereoscopes
4. Identification of various geomorphic and environmental features and the preparation of various thematic maps
5. Interpretation of satellite imageries
6. Brief description of the important geomorphic and environmental features
7. Preparation of photo-geologic maps
8. Map digitization and analysis

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