DEPARTMENT OF ENVIRONMENTAL SCIENCES
UNIVERSITY OF KERALA

SYLLABUS

(WITH EFFECT FROM JUNE 2013)

POST GRADUATE PROGRAMME IN ENVIRONMENTAL SCIENCES

M.Sc. ENVIRONMENTAL SCIENCES

Sl.No.	Paper code	Title of the paper	No. of hours per week			Credits
SEMESTER I			L	T	P	
1	ENS 511	Environmental Biology and Ecosystem Synamics	3	1	2	4
2	ENS 512	Environmental Toxicology	4	1	0	4
3	ENS 513	Environmental Chemistry	3	1	2	4
SEMESTER II						
4	ENS 521	Environmental Techniques	3	1	2	4
5	ENS 522	Environmental Microbiology	3	1	2	4
6	ENS 523	Environmental Geology	3	1	2	4
7	ENS 524	Environmental Meteorology and Climate Change	3	1	0	3
SEMESTER III						
8	ENS 531	Environmental Genetics and Biotechnology	4	1	0	4
9	ENS 532	Natural Resources and Energy Management	4	1	0	4
10	ENS 533	Environmental Impact Assessment and Disaster Management	4	1	0	4
11	ENS 534	Field Study			6	3
SEMESTER IV						
12	ENS 541	Environmental Engineering and Pollution control	4	1	0	4
13	ENS 542	Environmental Economics and Policies	4	1	0	4
14	ENS 543	Remote Sensing and GIS	3	1	2	4
15	ENS 544	Project work			12	6
Elective Courses						
Department Elective						
16	ENS 501	Biochemistry and Nanobiology	3	0	0	3
Extra Department Elective						
17	ENS 51 A	Disaster Management	1	0	0	1
18	ENS 52 A	Environmental Health Perspectives	2	0	0	2
19	ENS 53 A	Waste Management Techniques	1	0	0	1

AIM AND SCOPE OF THE POST GRADUATE PROGRAMME IN ENVIRONMENTAL SCIENCES

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. 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.

Career prospects

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/ PhD programmes.

I SEMESTER – CORE COURSES

ENS. 511. ENVIRONMENTAL BIOLOGY AND ECOSYSTEM DYNAMICS

Credits: 4

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

COURSE DESCRIPTION: The course is framed into 8 modules including the structural and functional aspects of ecosystems. Fundamental aspects are designed in the first module. Further modules include topics related to biomes and habitats, ecosystem dynamics, evolution of ecosystems, ecological interactions, population dynamics and limiting factors of the environment. The last module is on the applied aspects of ecology i.e. ecoinformatics. The practical part of the course includes both field and laboratory observations. The experiments are identification of terrestrial and aquatic fauna and flora; estimation of primary productivity and community studies by quadrat and line transect method.

Module 1. Introduction : Concept and scope of Environmental Science; concept of Environmental Biology, ecosphere and biosphere; ecological factors and variables.

(6 hrs)

Module 2. 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.

(14 hrs)

Module 3. 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.

(8 hrs)

Module 4. Development and evolution of ecosystems – biogeochemical cycles – gaseous and sedimentary cycles, food chain, food-web, ecotone, edge effects, ecological niche and ecosystem stability.

(8 hrs)

Module 5. Ecological interactions : Neutralism, symbiosis, commensalism, mutualism, antagonism, antibiosis, parasitism, predatism, competition – intra-specific and inter- specific; Ecological and environmental significance of interactions.

(8 hrs)

Module 6. Population dynamics – concept of population, population growth – density, natality, mortality and growth curves, life curves, age structure, function and equilibrium; population regulation – biotic potential and environmental resistances; Factors of population regulation – density dependent and density independent; population crash and carrying capacity; the laws of population growth.

(10 hrs)

Module 7. 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.

(10 hrs)

Module 8. Ecoinformatics : concepts and principles.

(2 hrs)

PRACTICALS

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.

Recommended Readings:

1. Botkin, Daniel B. 2011. Environmental Science: Earth as a Living Planet, John Wiley and Sons, New Delhi.
2. Chapman,J.L. and Re is s,M . J . 2005. Ecology P rin cip l e s a n d Ap p licat io n s , Cambridge University Press, London.
3. Dash,M.C. 1994. Fundamentals of Ecology, Tata McGraHill, New Delhi
4. Gunther,O. 1998 Environmental Information Systems. Berlin, New York, Springer.
5. Miller G.Taylor and Scott Spoolman. 2011. Essentials of Ecology, Brooks/ColeLearning, USA.
6. Odum,E.P. 1971. Fundamentals of Ecology, W.B.Saunders Company, Philadelphia.
7. Sharma.P.O. 1996. Environmental Biology, Rastogi Publications, Meerut.
8. Verma.P.S. and V.K.Agarwal. 1985. Principles of Ecology. S.Chand and Company, New Delhi.

ENS. 512. ENVIRONMENTAL TOXICOLOGY

Credits: 4

AIM: The course aims at providing students with an advanced, multi-disciplinary and current understanding 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.

COURSE DESCRIPTION: The course includes the details of distribution of pollutants in the environment, 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.

Module 1. Toxicants in the Environment: History of toxicants - Principles of toxicology – toxicants and toxicity, factors affecting toxic substances in the environment, their types – degradable and non-degradable; sources and entry routes.

(12 hrs)

Module 2. Eco-toxicology: Introduction to eco-toxicology; Eco-system influence on the fate and transport 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.

(14 hrs)

Module 3. Environmental fate of pollutants: Global dispersion of toxic substances – dispersion and circulating mechanisms of pollutants.

(6 hrs)

Module 4. Acute and chronic toxicity; Lethal and sub-lethal doses; Analysis of NOEL, LD50 and MLD; Dose-response relationship; Detoxification in human body – detoxification mechanisms – organs of detoxification. Carcinogens, mutagens and teratogens; Toxicity testing procedures.

(14 hrs)

Module 5. Man and Environmental Toxins : Routes of toxicants to human body – inhalation, skin absorption, oral, injection; ADME – adsorption, distribution, metabolism and excretion; Response to toxin exposures – dose-response relationship, frequency and cumulative response.

(8 hrs)

Module 6. Chemical toxicology : Toxic chemicals in the Environment; Impact of Toxic chemicals on enzymes; biochemical effect of arsenic, cadmium, lead, mercury, carbon monoxide, nitrogen oxides, sulphur dioxide and cyanide.

(8 hrs)

Module 7. Environmental Health: Concept and scope; global and regional perspectives; basic requirements for healthy environment; environmental quality, human exposure and health impact; Environmental diseases : Asbestosis, silicosis, synopsis, asthma, fluorosis and allergis, epidemiological issues – Malaria, Kala azar, water borne diseases.

(18 hrs)

Recommended Readings:

1. Calow.P. 1994. Handbook of Ecotoxicology. Blackwell Scientific Publications, London
2. Chatterji,M., M.Munasinghe and R.Ganguly. 1998. Environment and Health in Devloping Countries. A.P.H.Publishing House, New Delhi.
3. Forbes,V.E. and T.L.Forbes. 1994. Ecotoxicology in Theory and Practice. Chapman & Hall, London.
4. Hayes, W.A. 2001. Principles and Methods of Toxicology, CRC, USA.
5. Jacobson-Kram,D. 2006. Toxicological testing handbook: Principles, Applications and Data Interpretation, Taylor and Francis, New York.
6. Klaassen,C.D. and Watkins,J.B. 2003. Essentials of Toxicology, McGraw-Hill Professional, New Delhi.
7. Levin,S.A. and M.A.Harwell, J.R.Kelley and K.D.Kemball. 1989. Ecotoxicology: Problems and Approaches. Springer-Verlag, New York.
8. Manahan,S.E. 2000. Environmental Chemistry, Lewis Publishers, New York.
9. Pery,G. 1980. Introduction to Environmental Toxicology, Elsevier, Amsterdam.
10. Walker,C.H., R.M.Sibly, S.P.Hopkin and D.B.Peakall. 2012. Principles of Ecotoxicology, CRC Press, New York.
11. Wright,D.A. and Welbourn,P. 2002. Environmental Toxicology, Cambridge University Press, London.

ENS. 513. ENVIRONMENTAL CHEMISTRY

Credits: 4

AIM : The course aims to equip the students with an understanding of the nature, reactivity, and environmental 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.

COURSE DESCRIPTION: Environmental Chemistry is a highly interdisciplinary field that focuses on the chemical processes influencing the composition and chemical speciation of different spheres of Earth System i.e Atmosphere, hydrosphere and lithosphere. 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.

Module 1. Introduction: Concept and Scope of Environmental Chemistry, Major environmental segments. Natural cycles of the environment: Hydrological cycle, Carbon cycle, Oxygen cycle, Nitrogen cycle, Phosphorous cycle, Sulphur cycle.

(12 hrs)

Module 2. 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, Minimising future emissions of Green House Gases.

(10 hrs)

Module 3. Tropospheric chemistry: The principle of reactivity in the troposphere, The troposheric oxidation of methane, Photochemical Smog, Rain , snow and fog chemistry, formation and

composition of acid rain, Atmospheric aerosols, Oxidation of atmospheric SO2. Chemistry of urban and indoor atmosphere.

(8 hrs)

Module 4. Hydrosphere: Water resources, global distribution of water, gases in water, organic matter 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.

(8 hrs)

Module 5. Lithosphere: Weathering of rocks- physical, chemical and biological processes. Factors controlling 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.

(10 hrs)

Module 6. 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.

(12 hrs)

Module 7. 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.

(8 hrs)

Module 8. Radioactivity and Nuclear Energy: Types of radiation, Units of radioactivity, Detection and 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.

(12 hrs)

PRACTICALS

1. Toxicology tests (LC50)
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, NO3, PO4, in water; Determination of potability of water using coagulant demand, chlorine demand and residual chlorine.
8. Analysis of heavy metals and pesticides.

Recommended Readings:

1. Arnikar.H.J (1995). Essentials of Nuclear Chemistry.New Age International, New Delhi.
2. Baird,C and Cann, M (2005). Environmental Chemistry. W.H.Freeman and Company, New York (Pub).
3. Dara.S.S. (1993). A Text Book of Environmental Chemistry and Pollution Control.S. Chand, New Delhi.
4. Hamir S. Rathor. (2012). Pesticides: Evaluation of Environmental Pollutionby CRC Press
5. Lenihan, J.M.A and Fletcher W.W. (1976). Energy resources and the Environment. Academic Press.
6. Manahan.S.E.(1999). Environmental Chemistry. Lewis Publishers.USA.
7. Santra.S.C.(2004). Environmental Sciences. New Central Book Agency, Kolkata.
8. Thomous S. Spiro and William M. Stiglicini, (2002). Chemistry of the Environment, Prentice Hall of India Pvt. Ltd.

II SEMESTER– CORE COURSES

NS 521 ENVIRONMENTAL TECHNIQUES

Credits: 4

AIM: Environmental analysis is a very important part of decision making. This comprises the processes 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.

COURSE DESCRIPTION: 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. The course is divided into fourteen modules which include sampling methods and analysis techniques of samples using various methods like microscopy, chromatography, spectroscopy, radiometry, electro analytical methods etc. It also deals with the analysis of data using various statistical parameters. Along with the theory classes, practicals are also provided to the students based on various analytical methods discussed in the theory part.

Module 1. Sampling of air, water, soil and sediments - Preservation, storage and processing.

(4 hrs)

Module 2. Microscopy and related techniques: Principles of light and electron microscopes;

different types and their applications.

(6 hrs)

Module 3. Titrimetry: General Theory, Classification of reactions in titrimetry, Acid-base titration indicators, Acidity, Alkalinity. Environmental applications of titrimetric analysis. Principle and determination - Free CO2, Organic carbon, DO, BOD, COD, Organic carbon in soil.

(6 hrs)

Module 4. Complexometric titrations: EDTA titrations, Metal ion indicators, Permanent and temporary hardness. Determination of Hardness in water. Determination of Ca and Mg in soil. Estimation of CO_2, SO_2, NO_2 in air.

(6 hrs)

Module 5. Gravimetric Analysis: Principle, Stoichiometry of gravimetric reactions, formation and properties of precipitates, precipitation from homogeneous solution, nucleation, organic precipitations, applications of gravimetric analysis.

(4 hrs)

Module 6. Sedimentation: centrifuge - types and applications; density gradient methods; Electrophoresis : theory, classification and applications.

(4 hrs)

Module 7. 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.

(6 hrs)

Module 8. Colourimetry and Spectrophotometry: Principle – interaction of electromagnetic spectrum 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.

(6 hrs)

Module 9. 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.

(6 hrs)

Module 10. Fluorimetry: Fluorescence and Phosphorescence. Theory of fluorescence and phosphorescence, quantum yield, factors affecting fluorescence and phosphorescence, Fluorometer and Spectrofluorometers, instrumentation, applications.

(6 hrs)

Module 11. Electroanalytical 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.

(6 hrs)

Module 12. Polarography: Direct current polarography, basic principle, instrumentation applications of polarography to inorganic and organic compounds, elementary idea of stripping voltammetry, amperometric titrations.

(6 hrs)

Module 13. Radiometric Analysis: Types of radiation, radioactive decay, decay rates, Laws of radioactive 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.

(6 hrs)

Module 14. 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 (χ^2) tests.

(8 hrs)

PRACTICALS

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

Recommended Readings:

1. Allen J. Bard and Lafrry R. Faulkner, Electrochemical Methods,2nd Ed., John Wiley & Sons (2001).
2. APHA. 2012. Standard Method for the Examination of Water and Waste water, Washington, D.C.
3. Christian G.D. (2000), Analytical Chemistry, 6thed, John Wiley & Sons
4. De.A.K. 1994. Environmental Chemistry. New Age International Ltd. New Delhi
5. Eving G.W. (1985). Instrumental Methods of Chemical Analysis, 5th Ed.,,Mc-Graw Hill Book Company.
6. Radojecic M. and Bashkin V.N. (2007). Practical Environmental Analysis. RSC Publishing, Cambridge.
7. Skoog D.A., F.J. Holler and Nieman, (2003). Principles of Instrumental Methods, 5th Ed.,Thomson Asia Pvt. Ltd., Singapore.
8. Vogel A.I.(1999). Textbook of Quantitative Chemical Analysis, 5th Ed., Addison Wesley Longman Singaporepte Ltd.
9. Willard, Merritt, Dean, and Settle, (1986). Instrumental Methods of Analysis, 7th Ed., C B S Publishers & Distributors.

ENS. 522. ENVIRONMENTAL MICROBIOLOGY

Credits: 4

AIM: The course aims at imparting an understanding on the basic and applied aspects of environmental 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.

COURSE DESCRIPTION: The course is designed as 9 modules covering both fundamental and applied aspects of environmental microbiology. 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 are the various topics included in the course. Laboratory practicals include sterilization techniques, culture media preparations, isolation and culturing techniques, staining and microbial counting techniques.

Module 1. Scope and importance of microorganisms; Major groups of microorganisms: Microbial evolution and classification – nutrition – growth – metabolism and regulation; reproduction, mutation.

(5 hrs)

Module 2. Microbial ecology and diversity: microbiology of soil, air, water and sediments; microbes in industry; Microbes in extreme environments; Space microbiology.

(5 hrs)

Module 3. Metagenomics : Environmental genomics, ecogenomics or community genomics– PCR, DGGE, FISH, FAME analysis, gene amplification, sequencing, molecular phylogeny and SIP (stable isotope probing) techniques; DNA barcoding; microbial database.

(7 hrs)

Module 4. Microbial interactions : microbe and microbe; microbe vs plants; microbe vs animals; Geomicrobiology - role of microorganisms in biogeochemical cycling of elements – carbon, nitrogen, sulphur, phosphorus and iron cycles.

(8 hrs)

Module 5. Role of microorganisms in the degradation of natural and manmade compounds – pesticides, recalcitrant chemicals, Persistent Organic Pollutants (POPs); Bioremediation – concept, principles and applications; types - insitu, exsitu; microbes involved; rhizoremediation, phycoremediation.

(8 hrs)

Module 6. Food and industrial microbiology : Food spoilage – causes and preservation; fermented foods, dairy products; industrial uses of bacteria, yeast and fungi.

(7 hrs)

Module 7. 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.

(7 hrs)

Module 8. .Biomining : microbial leaching of low grade mineral ores; molecular probes for organisms in mines and mine tailings.

(5 hrs)

Module 9. Basic techniques in microbial genetic engineering – gene cloning, introduction of cloned genes into new hosts using plasmids and phage vector systems; expression of genes in new host, Genetically modified organisms (GMOs) and their environmental implications.

(8 hrs)

PRACTICALS

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.

Recommended Readings :

1. Atlas. R.M. 1995. Principles of Microbiology. Mosby Year Book Inc. Missouri
2. Dubey,S.K. 2013. Microbial Ecology. Wisdom Press, New Delhi
3. Mitcehll.R. 1992. Environmental Microbiology. Wiley, New York
4. Patrick K.Jjemba. 2004. Environmental Microbiology : Principles and Applications. Science Publishes, USA.
5. Pelczar,Jr. M.J., E.C.S.Chan and N.R.Krieg. 1993. Microbiology Tata Mc.Graw Hill Publishing Company Ltd. New York.
6. Powar,C.B. and Daginawala.H.F. 1988. General Microbiology Vol.I and II. Himalaya Publishing House, Bombay.
7. Sanat Takore. 201. Soil Microbiology. Wisdom Press, New Delhi.
8. Stanier.R.Y. et al. 1993. General Microbiology. The Macmillan Press Ltd. London.

ENS 523 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 landuse, to minimize environmental degradation, and to maximize the beneficial results of using our natural and modified environments.

COURSE DESCRIPTION: 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. Included in environmental geology studies are such topics likesoils, rocks, mineral and groundwater resources, landslides, earthquakes etc.Isotope hydrology and its applications also included.

Module 1. 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.

(6 hrs)

Module 2. 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. Geothermal energy.

(12 hrs)

Module 3. Study of the interior of earth- crust, mantle and core.

(2 hrs)

Module 4. 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.

(8 hrs)

Module 5. Earth's surface processes: Erosion, transportation and deposition of earth's materials by streams, wind and glaciers.

(4 hrs)

Module 6. 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.

(4 hrs)

Module 7. Glaciers: physical and chemical aspects, recession of Himalayan glaciers, glaciers as an index of climate change.

(3 hrs)

Module 8. Ecohydrology: Definition and concept of eco-hydrology; hydrologic cycle and hydrologic budget, inventory of the earth's water, global water balance; drainage basin– definition, characteristics; drainage pattern, stream classification and ordering.

(5 hrs)

Module 9. Groundwater: Source, occurrence and movement of groundwater; water table; geologic formations as aquifer; aquitard, aquiclude; quality criteria of groundwater for drinking and irrigation purpose; groundwater contamination; water table fluctuations- environmental influences, fluctuations due to evapotranspiration, fluctuations due to meteorological phenomena, urbanization; groundwater recharging and rain water harvesting.

(7 hrs)

Module 10. Isotope Hydrology: Definition and classification of isotopes- stable and unstable (radioactive) isotopes, environmental (natural) and artificial isotopes. Isotopes of H2, O2, N2, S. Isotopic composition of water. Expression of environmental stable

isotopes. 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; salinization of water resources.

(6 hrs)

Module 11. Use of topographic maps and environmental geologic maps in environmental studies.

(3 hrs)

PRACTICALS

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.

Recommended Readings:

1. Burbank, D.W. & Anderson, R.S. 2012. Tectonic Geomorphology. Wiley and Blackwell Publications, a John Wiley and Sons, Ltd.
2. Clark, I.D and Fritz, P., 1997. Environmental Isotopes in Hydrogeology. Lewis publishers, New York. 328p.
3. Duggal, K.N. and Soni, J.P. 1996. Elements of water resource engineering New Age International Publisher.
4. Guitierrez, M. 2013. Geomorphology, CRC press.
5. Huddart, D. & Stot, T. 2010. Earth Environment-Past, Present and future, Wiley

and Blackwell Publications, A John Wiley and Sons, Ltd.

6. IAEA, 1981. Stable Isotope Hydrology- Deuterium and Oxygen-18 in the water cycle. Tech. Reports series: IAEA, Vienna: 303p.

7. Read, H.H. Rutley's Elements of Mineralogy. John Wiley and Sons, New York.
8. Reghunath, H.M.1996. Hydrology – Principles, analysis and design New Age International Publisher.
9. Singh, V.P. 1994. Elementary Hydrology. Prentice-Hall of India.
10. Strahler, A.N. and Strahler,A.H. 1987. Physical Geography.
11. Strahler, A.V. and Strahler,A.A. 1973. Environmental Geoscience, Wiley International.
12. Todd, D.K. and Mays, L.W. 2005. Ground Water Hydrology. Wiley India Private Limited. 236p.
13. Tyrell, G.W. 1948. Principles of Petrology.

ENS. 524. ENVIRONMENTAL METEOROLOGY AND CLIMATE CHANGE

Credits. 3

AIM: The course impart an understanding in the basic concept of Environmental Meteorology and 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.

COURSE DESCRIPTION: This course has two major themes. The first theme deals with environmental 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.

Module 1. Fundamentals of Meteorology: Motions of the earth and seasons. Earth-sun relationship. Insolation and its latitudinal and seasonal variation.

(3 hrs)

Module 2. Air temperature- warming and cooling of air near ground, measurement of temperature; 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.

(8 hrs)

Module 3. Micrometeorology : applications to vegetated surfaces, urban areas, human beings and animals, impact on the physiology of plants and animals; stress induced changes.

(4 hrs)

Module 4. Pollution meteorology : Application of metorological principles to transport and diffusion 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.

(8 hrs)

Module 5. Climatology : Elements of weather and climate, climatic controls, energy balance in atmospheric; elementary ideas about weather systems, climatic classifications; climates in India; monsoons of India.

(8 hrs)

Module 6. Boundary layer climates – effects of topography, energy and mass exchange, climates of vegetated surface, urban climatology.

(7 hrs)

Module 7. 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.

(7 hrs)

Module 8. 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.

(8 hrs)

Module 9. Climate change scenarios of India: impact of climate change on agriculture, forest, water resources, monsoon system of India.

(5 hrs)

Recommended Readings :

1. Arya,S.P. 1999. Air Pollution Meteorology and Dispersion, Oxford University Press, London.

2. Barry,R.G. and R.J.Shorty. Atmosphere, Weather and Climate.

3. Berry.F.M. E.Bollay and N.R.Beers. Hand Book of Meteorology.
4. Bryers H.R. (1974) General Meteorology, McGraw-Hill.

5.Finlayson-Pitts. 1986. Atmospheric chemisty Fundamental and ExperimentalTechniques, John Wiley and Sons, New Delhi.

6. Hess,S.L. 1959. Introduction to Theoritical Meteorology, Holt Renehart and Winston, New York.

7. Pal Arya. S. 1988. Introduction to Micrometeorology . Academic Press.

8. Rajan,C.K. and P.A.Menon. Climates of Kerala, Classic Printers, Cochin.

III SEMESTER– CORE COURSES

ENS. 531. ENVIRONMENTAL GENETICS AND BIOTECHNOLOGY

Credits: 4

AIM: The study of environmental genetics gives the details of interaction between genetics and the 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.

COURSE DESCRIPTION: The environmental genetics course gives the details of expression of genetic 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 includes 9 modules. Biotechnology and biodiversity, biotechnology in waste management and pollution abatement, biotechnology and bioenergy are the various topics of the course.

Module 1. Introduction, Central dogma of molecular genetics, Experiments to show DNA as the genetic 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.

(6 hrs)

Module 2. Mutation and Environmental mutagens: Occurrence, kinds of Mutation, spontaneous & induced 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.

(10 hrs)

Module 3. Expression of genetic information: from transcription to translation, The Relationship between 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.

(8 hrs)

Module 4. 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.

(8 hrs)

Module 5. Population Genetics and Evolution: Synthetic theory of Evolution – Lamarckian evolution 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.

(8 hrs)

Module 6. Environmental Biotechnology : Definition, principles, scope – role of biotechnology in environmental protection; Biotechnology and biodiversity conservation ex situ; utilization of biodiversity; biotechnology vs biodiversity.

(3 hrs)

Module 7. Bioremediation : Principle, types, Microbial, phyco-, zoo- and phytoremediation; biodegradation of organic pollutants : aerobic, anaerobic, cometabolic; Biofertilizers and biopesticides : types; production and role in IPM; genetically engineered organisms – Bt toxin gene.

(5 hrs)

Module 8. Biotechnology for solid waste management : sanitary landfilling; Biocomposting – aerobic, anaerobic; vermicomposting; Biomethanation.

(4 hrs)

Module 9. Biotechnology for wastewater treatment : Microbial processes in wastewater treatment; microbial biofilm and wastewater treatment; secondary treatment systems; nutrient removal through biomass production; applications in tannery, distillery and food industries.

(6 hrs)

Module 10. Biotechnology for air pollution abatement and odour control : deodorization process – bioscrubbers, biobeds, biotrickling filters.

(5 hrs)

Module 11. Biodegradation of persistent organic pollutants : microbial adaptations; enzymes catalyzing biodegradation; pathways of degradation; molecular aspects of biodegradation; Biosenors, biochips, biosurfactants – microbial production and their role in bioremediation.

(7 hrs)

Module 12. Microbial transformation of heavy metals : heavy metal tolerance; metal-microbe interactions; immobilization and transformation of metals; genetic aspects of resistance; applications in metal removal; Bioleaching and biomining.

(6 hrs)

Module 13. Bioenergy - Biofuel and biodiesel : biogas, butanol, biodiesel, ethanol, biohydrogen; bioenergy from wastes; Ecofriendly products : Biopolymers and bioplastics.

(4 hrs)

Recommended Readings:

1. Agarwal,S.K. 1998. Environmental Biotechnology. APH Publishing corporation, New Delhi
2. Baker.K.H. and D.S.Herson. 1994. Bioremediation. McGraw Hill Inc. New York.
3. Hoffmann, A.A. (1993). Evolutionary Genetics and Environmental Stress. Oxford University Press.
4. Jogdand.S.N. 1995. Environmental Biotechnology-Industrial Pollution Management. Himalaya Publishing House, Bombay.

5. Lehninger, A.L. 1998. Principles of Biochemistry. C.B.S Publishers & Distributors. Delhi.

6. Pradipta Kumar Mohapatra. 2006. Text Book of Environmental Biotechnology. I.K International Publishing House Pvt. Ltd. New Delhi.

7. RamKumar. 2000. Environmental Biodegradation. Sarup and Sons, New Delhi.

8. Reza Marandi and Ali Shaeri. 2009. Environmental Biotechnology. SBS Publishers and Distributors Pvt. Ltd. New Delhi.

9. Rick Lewis.1998. Human Genetics - Concepts and Applications- 3rd Edition.

10. Strick Berger. 1996. Genetics. Prentice Hall of India, New Delhi.

ENS. 532. NATURAL RESOURCES AND ENERGY MANAGEMENT

Credits: 4

AIM: This course aims to equip students with the necessary knowledge and skills in the areas of natural 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.

COURSE DESCRIPTION: This course provides a broad overview of natural resources and energy management. 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.

Module 1. 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.

(7 hrs)

Module 2. Soil and mineral resources : overview of major soil types and mineral deposits in India with special reference to Kerala, Environmental effects of mining; acidic, alkaline and saline soils – reclamation techniques.

(7 hrs)

Module 3. Forest resource : over view of major forest types in India with special reference to kerala and Kerala – their characteristics; Social forestry – multipurpose tree species (MPTs), Nitrogen fixing Tree species (NFTs) – characteristics; community participation; pattern of planting; ecorestoration of eroded hill slopes and degraded Jhum land.

(10 hrs)

Module 4. 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.

(7 hrs)

Module 5. Biodiversity : Introduction, levels, importance; Organisms – evolution and distribution 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.

(8 hrs)

Module 6. Biodiversity conservation: Convergence and divergence in species; sustainable exploitation; 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.

(8 hrs)

Module 7. Water resource : Distribution and extent-global, national and regional; water resources types – surface water, ground water; water availability and uses, freshwater shortages, impact of climate change on freshwater resources, Management and conservation of water resources.

(7 hrs)

Module 8. Watershed management: Concept, Objectives, planning and measures; Land use planning for watershed management; Water harvesting and recycling; Flood control and watershed management; Socio-economic aspects of watershed management.

(7 hrs)

Module 9. Energy and Environment : Human energy requirement, energy use pattern in different 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.

(7 hrs)

Module 10. Bioenergy : Biomass composition and types; conversion processes; biogas production – 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.

(9 hrs)

Module 11. Alternative fuels: Gasoline, Natural Gas and Propane, Oxygenated fuels, Biofuels,

Hydrogen.

(3 hrs)

Recommended Readings:

1. Abbasi,S. 1997. Wetlands of India: Ecology and threats; Discovery Publishing House, New Delhi

2. Biswas,A.K. 2007. Water resources : Environmental Planning, Management and Development, McGraw-Hill, New Delhi.

3. Boyle,G., Bob Everett and J.Ramage. 2003. Energy System and Sustainability, Oxford University Press, New York.

4. Daniel,D. Chiras and Reganold,John,P. 2009. Natural Resource Conservation: Management for a Sustainable Future, Addison Wesley, Boston.

5. Dwidei,A.P. 2003. A text book of Silviculture. International Book Distributors,

Dehradun.

6. FaiFUng, C, and Ana Lopez, Mark eds. 2011. Modelling the impact of climate change on water resources, Wiley Blackwell.

7. Ghosh,S.K. and Singh,R. 2003. Social Forestry and Forest Management, Global Vision Publication, New Delhi.

8. Jha,L.K. 1995. Advances in Agroforestry, APH Publication Corporation, New Delhi.

9. Kesler,P. 2002. Mineral Resources : Economics and Environment, CBS Publishers and Distributors, New Delhi.

10. Rajora Rajesh. 1998. Integrated Watershed Management : A field Manual for Equitable, Productive and Sustainable Development, Rawat Publications, Jaipur.

11. Sudhakara Reddy, B.P.Balachandra. 2006. Energy, Environment and Development, Narosa Publishing House Pvt. Ltd., New Delhi.

12. Thapar,S.D. 1975. India's Forest Resources, Macmillan India, New Delhi.

ENS 533 ENVIRONMENTAL IMPACT ASSESSMENT AND DISASTER MANAGEMENT

Credits: 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.

COURSE DESCRIPTION: This course has two major themes. The first theme which is discussed in five modules, examines 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 theme deals with the Disaster Management refers to the policies, programs, administrative actions and operations undertaken to address a natural or man-made disaster through preparedness, mitigation, response and recovery.

Module 1. Environmental Impact Assessment (EIA): Definition, purpose and characteristics of EIA; 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).

(10 hrs)

Module 2. Environmental Impact Analysis: Impact identification and methods of impact identification- adhoc method, checklist, matrix, network, overlay and index methods; impact prediction and predictive methodologies, impact evaluation (assessment) and impact mitigation.

(8 hrs)

Module 3. Basic steps for the impact identification, prediction and assessment of air, water, noise, vegetation and wildlife environment with case studies.

(6 hrs)

Module 4. EIA in India: An overview of history, current procedures, practices and guidelines.

(4 hrs)

Module 5. EIA of water resource projects, industries, mining and quarrying, highway construction, tourism developments.

(10 hrs)

Module 6. Basic Concept of Disaster- Definition of hazard, vulnerability, risk, disaster. Causative factors of disaster. Classification of disasters.

(3 hrs)

Module 7. 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.

(5 hrs)

Module 8. Disaster Management: Definition of disaster management; components of disaster management cycle- crisis management & risk management. Crisis management- quick response & relief, recovery, development. Risk management- risk identification and risk assessment, risk reduction- preparedness, prevention and mitigation, risk transfer. Disaster management- act and policy.

(5 hrs)

Module 9. 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.

(5 hrs)

Module 10. Natural Hazards: earthquakes, tsunami, volcanoes, floods, landslides, avalanche, cyclone, drought, fire – causes, perception, mitigation and management.

(10 hrs)

Module 11. Man-made hazards: Hazards due to dams and reservoirs, nuclear power plants, industrial hazards, occupational hazards, mitigation measures.

(10 hrs)

Module 12. Environmental health hazard and risk assessment: biological, chemical, physical and psychological health hazard; health risk assessment and management.

(4 hrs)

Recommended Readings:

1. Bregman, J.I. and Mackenthum, K.M. 1992. Environmental impact statements. Chelsia Michigan: Lewis.
2. Calow, P. 1997. Handbook of environmental risk assessment and management. Oxford: Blackwell Science.
3. Canter, W. Larry. 1996. Environmental impact assessment. McGraw-Hill International editions. 660p.
4. Fortlage, C. 1990. Environmental assessment: a practical guide. Aldershot: Gower
5. Geological Hazards- A Source Book on Hazards and Disasters. Kushy, T. M., Green wood Press, Westport, Conn. London.
6. Glasson, J; Therivel, R and Chadwick, Al. 1999. Introduction to environmental impact assessment. UCL Press. 496p.
7. Gupta and Harsh, K. 2003. Disaster Management, Universities Press (India) Pvt. Ltd.
8. Hamele Hubert, 1988. A major impact. Naturopa, 59, 5-7.

9. Hunter Collin and Green Howard, 1995. Tourism and the environment. A Sustainable relationship. London. Routledge.

10. Jha and Kumar, M. 2010. Natural and Anthropogenic Disasters; Vulnerability, Preparedness and Mitigation, Springer.

11. Morris, P and Therivel, R. 1995. Methods of environmental impact assessment. London. UCL press.

12. Munn, R.E.1979. Environmental impact assessment: principles and procedures, 2nd Edn. New York: Wiley.

13. Singh, K . K . &. Singh, A . K . 2010. Natural a n d m a n m a d e d i s a s t e r s : vulnerability, preparedness and mitigation, Vol(1&2), M.D. publications. Pvt. Ltd. New Delhi.

14. Strahler, A.N. and Strahler, A.H. 1973. Environmental Geoscience – Interaction between natural systems and man: -Santa Barbara, California, Hamilton Publishing.

15. Talwar, A.K. & Juneja, S. 2009. Flood Disaster Management, Commonwealth publishers, New Delhi.

16. Vaidya, K.S. 1987.Environmental Geology, Tata McGraw-Hill Publishers.

17. White, G.F. (ed.) Natural hazards – local, national, global: Oxford University

Press.

ENS.534. FIELD STUDY

Credits: 3

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.

AIM AND DESCRIPTION: 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.

IV SEMESTER– CORE COURSES

ENS541 ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL

Credits: 4

AIM: The course aims to acquire knowledge on the technology and principles behind the processes 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.

COURSE DESCRIPTION: 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.

Module 1. Air Pollution: Atmospheric pollution, classification of air pollutants, sources of air pollution, 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; bioscrubers, biofilters. Indoor air pollution- effects of air pollutants on animals and humans, Indoor air quality. Noise Pollution: Sources, measurement, Health impacts, effects and control.

(15 hrs)

Module 2. Water Pollution: Types of water pollution, water pollutants, sources and storages of 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.

(15 hrs)

Module 3. Water treatment: Quality of water, standards of raw and treated water, objectives of 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, grit chamber, coagulation and flocculation, giltration and sedimentation tank methods. Secondary treatment: 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.

(22 hrs)

Module 4. Water Quality Modelling: Formulations for water quality modelling- MODFLOW. Discharge Monitoring Report (DMR) Pollutant Loading Tool – AQUATOX.

(8 hrs)

Module 5. Soil Pollution: Physical and chemical properties of soil, Soil microorganisms and their functions, 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.

(15 hrs)

Module 6. Radioactive Pollution: Radionuclides- sources, types of radiation, effects on humans, exposure standards, control measures.

(5 hrs)

Recommended Readings:

1. Gilbert M. Masters (1998). Introduction to Environmental Engineering and Science 3rd ed. Prentice Hall of India Pvt. Ltd.
2. Jarry A. Nathanson (2003). Basic Environmental Technology, 4th Ed., Prentice Hall of India Pvt. Ltd.
3. Mahajan S.P. (1998). Pollution control in process industries, Tata McGraw Hill, New Delhi.
4. Metcalf & Eddy (2003).Wastewater engineering: Treatment, Disposal, Reuse, 4th edition. Tata McGraw Hill, New Delhi.
5. Nicholas P. Cherimisinoff (2001). Biotechnology for Waste and wastewater treatment, Prentice Hall of India Pvt. Ltd.
6. Nylie C. Brady (1996).The Nature and Properties of Soil, 10th Ed., Prentice Hall of India Pvt. Ltd.
7. Parsons, S.A. and Jefferson, B. (2006). Introduction to potable water treatment processes, Blackwell Publishing.
8. Rao, C.S. (1995). Environmental Pollution Control Engineering, 3rd Ed., Wiley Eastern Ltd. New Age International Pvt. Ltd.
9. Raymond W. Miller and Roy L. Donalvee (1997). Soils in Our Environment, 7th Ed, Prentice Hall of India Pvt. Ltd.
10. Sharma.B.K. (2001). Water Pollution. Goel Pub. House. Meerut.
11. Wadhwa Y. (2009). Air Pollution: Causes and Control. Cyber Tech Publications, New Delhi.
12. Luyben, W. L. Process Modeling Simulation and Controls for Chemical Engineers, Mc. Graw Hill Book Co.

ENS 542 ENVIRONMENTAL ECONOMICS AND POLICIES

Credits: 4

AIM: The course is designed to give comprehensive insight into the economics of pollution and climate 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.

COURSE DESCRIPTION: The course is framed in 13 modules including various aspects of environmental economics, auditing, management and policies. Economy of the environment and climate change, environmental auditing, environmental history, environmental management, National and International environmental laws and policies, sustainable development, ecotourism, environmental ethics and environmental education are the important topics discussed in this course.

Module 1. 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.

(5 hrs)

Module 2. Economics of climate change : Clean Technology: Imperatives of clean technology in 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 Footprint. Issues of Energy security, Food Security and Social security.

(7 hrs)

Module 3. Environmental auditing: Objectives, frequency and criteria audit team, Environmental appraisal, accounting and environmental audit. Environmental guidelines for siting of industry, Green Balance Sheet (GBS), Status of compliance of mandatory and voluntary requirements for industries.

(4 hrs)

Module 4. Environmental policy in Ancient India – Medieval India, British India during post independent era; Environmental History of India.

(3 hrs)

Module 5. National Environmental Policy and Regulatory framework : Rules and regulations of Central and State Government and Pollution Control Boards for Environmental Protection; Environmental policy 2006, Environmental policy resolution, legislation, public policy strategies in pollution control; International and National Conservation agencies.

(6 hrs)

Module 6. 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 labeling of environmentally friendly products (eco-mark), Public Liability Insurance Act, 1991; Environmental Management and ISO Certification: Environmental Management Systems (EMS), ISO 14000 (EMS). Components of Environmental Management System-Objectives, Policies, Implementation and Review.

(9 hrs)

Module 7. International Environmental Laws : Evolution and development of International 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, ozone depletion, acid rains, hazardous wastes; role of UN authorities in protection of global environment; convention on biodiversity; convention on climate change, Kyoto Protocol.

(8 hrs)

Module 8. Environmental Laws in India: Legal, administrative and constitutional provisions 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.

(10 hrs)

Module 9. Transnational environmental policy – Indus river basin, the Ganga-Brahmaputra river basin systems; Major environmental movements in India – Chipko movement, Appiko movement; Narmada dam, Tehri Dam, Almetti Dam.

(6 hrs)

Module 10. Sustainable Development : Concept and growth of the idea, indications of sustainability, models of sustainable development, sustainable development scenario – global, national; sustainable agriculture.

(6 hrs)

Module 11. Ecotourism : Definition, concept and principles; types of ecotourists; Scope for ecotourism in Kerala, India; Benefits of ecotourism.

(4 hrs)

Module 12. Environmental Ethics : Concept of Environmental Ethics, philosophies of biocentrism 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.

8 hrs)

Module 13. Environmental Education : Meaning and scope – principles and objectives; environmental awareness strategies; formal and non-formal education; action plans.

(4 hrs)

Recommended Readings:

1. Boero.G. and A.Silberston. 1995. Environmental Economics. St.Martins Press, Inc.,New York.

2. Divan, Sand Rosencranz.A. 2001. Environmental Law and Policy in India. Oxford University Press, New Delhi.

3. Environmental Law and Policy in India, Shyam Dian and Armin Rosencrany. 2001. Oxford University Press, New Delhi.

4. Environmental Law in India. Gurdeep Singh. 2005. Mc Millan, New Delhi.

5. Ian Hodge. 1995. Environmental Economics – A textbook. Sterling Publishers, Pvt. Ltd. New Delhi.

6. ISO 14004 – Environmental Management Systems : General guidelines on principles, systems and supporting techniques (International Organization for Standardization – Switzerland).

7. Karpagam,M. 1993. Environmental Economics- A textbook. Sterling Publishers, Pvt. Ltd. New Delhi.

8. Misra.R.P. 1995. Environmental Ethics. Concept Publishing Company, New Delhi.

9. Mridula and N.Datt. 1993. Ecology and Tourism. Universal Publishers Distribution, Delhi.

10. Perman,R., Y.Ma and J.McGilvray. 1996. Natural Resource and Environmental Economics. Longman Singapore Publishers Ltd. Singapore.

11. Srivastava,D.C. 2005. Readings in Environmental Ethics: Multidisciplinary Perspectives, Rawat Publications, Jaipur.

ENS 543 REMOTE SENSING AND GIS

Credits: 4

AIM: Students can gain experience in the applications of remote sensing and GIS to solving problems 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.

COURSE DESCRIPTION: This course provides students an understanding of the basic concepts of remote 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, photogrammetry, 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.

Module 1. 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 and generation of sensor data - data analysis. Active and Passive Remote Sensing; Special features of remote sensing.

(5 hrs)

Module 2. Aerial Remote Sensing: advantages of aerial remote sensing, elements of photographic 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.

(6 hrs)

Module 3. Photogrammetry: Geometric characteristics of aerial photographs, scale of photographs, stereo models; principles of stereophotos, relief displacement, parallax and measurement of height and slope, convergence and evidence, aerial mosaics, orthophotos, photogrammetric instruments.

(6 hrs)

Module 4. Types of Sensors: Sensors, Platforms and Scanners; Principle of scanner and CCD 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.

(8 hrs)

Module 5. Satellite Remote Sensing: advantages of satellite remote sensing; types of satellite 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.

(7 hrs)

Module 6. Digital Image Processing: Digital Image formats; file structures, Image Rectification and Restoration, Image enhancement, Image classification – supervised, unsupervised, ground truth data and training set manipulation; data merging.

(6 hrs)

Module 7.Geographical Information System (GIS): Introduction: definition, historical evolution, components, basic principles; Data models: vector and raster data; spatial and

non-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; Bhuvan Geoportal.

(9 hrs)

Module 8. Global Positioning System (GPS): System segments, GPS satellite signals, GPS error sources, calculating locations, differential GPS and GPS in differential mode; applications of GPS in environmental studies. IRNSS GPS.

(5 hrs)

Module 9. Application of Remote Sensing and GIS: Applications in forestry and wildlife management; monitoring of land use/land cover; soil and agriculture; water resources; urban planning; disaster management; health studies.

(8 hrs)

PRACTICALS

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 photogeologic maps
8. Map digitization and analysis.

Recommended Readings:

1. Abbassi, Er. T. & Abbassi, S.A. 2010. Remote sensing, GIS and Wetland management, Discovery publishing house, Pvt. Ltd.

2. Agaral, N.K. 2004. Essentials of GPS, Spatial Networks Pvt. Ltd. Hyderabad.
3. Anji Reddi, M. 2000. Remote Sensing and geographical Information System.
4. Chang Kang-Tsung. 2002. Introduction to Geographic Information Systems. Tata McGraw Hill.
5. Chrisman and Nicholas. 1997. Exploring Geographic Information Systems, John Wiley & Sons.
6. Clarke, K.C. 1997. Getting started with Geographical Information System. Prentice Hall, New Jersey.
7. Cracknell, A. P. & Varotsos, C. A. 2012.Remote sensing and atmospheric ozone-Human activities versus natural variabililty, Springer, published in association with Praxis Publishing, Chichetser, UK.
8. Demers, Michael No. 1996. Fundamentals of Geographic Information Systems. John Wiley & Sons.
9. Fisher Peter. 1995. Innovations in GIS 2. Taylor and Francis, New York.
10. Heywood, I. An introduction to GIS, Pearson.
11. Jain, A. 2005. Sensors and Environmental Applications of Remote Sensing. A.A. Balkeme Publishers.
12. Jensen, J.R. Remote Sensing of the Environment – An Earth Resource Perspective. Pearson Education.
13. Jhanwar, M.L and Chouhan, I.S. 1998. Remote Sensing and Photogrammetry – Principles and Applications.
14. Kolay, A.K. 2009. Remote sensing & assessment of soil resources, Atlantic, New Delhi.
15. Lillesand, T. M. and Kiefer, R. W. 1987.Remote Sensing and Image Interpretation. John Wiley and Sons, New York.
16. Martin,D. Geographic Information Systems:, Routledge, N.Y. 17. Narayan.L.R.A. 1999. Remote Sensing and its applications. Universities.
17. Stephen Wise. 2002. GIS basics, Taylor and Francis, New York.

ENS 544 PROJECT WORK

Credits: 4

AIM: The project work is formulated to take the students deep in the field of research in various 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.

DESCRIPTION: To carry out the project work, students have to find a problem which is environmentally 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.

ELECTIVES

DEPARTMENT ELECTIVE

ENS. 501. BIOCHEMISTRY AND NANOBIOLOGY

Credits: 3

AIM: The aim of the course is to give the importance of biomolecules in different biochemical processes in living organisms. The most important objective of the study of nanobiology involve applying nanotools 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.

COURSE DESCRIPTION: The course gives a detailed description of the structure of important biomolecules- carbohydrates, lipids, proteins and nucleic acids. Also describes the bioenergetics, role of free radicals in biological systems. The nanobiology is the subject that has only emerged very recently.. This section of the course emphasizes on the interactions of biological systems with natural and engineered nanomaterials and the environmental applications of nanomaterials.

Module 1. Chemical structure of biologically important macromolecules: Nucleotides and nucleic 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.

(10 hrs)

Module 2. Intra and intermolecular interactions: ionic covalent and hydrogen bonds, vander vaal's forces. Polar and non-polar compounds, polyelectrolytes.

(6 hrs)

Module 3. Bioenergetics and thermodynamics: Concept of free energy and entropy, enthalpy, standard free energy change.

(4 hrs)

Module 4. Free radicals in Biological systems: Oxygen as a free radical in the auto-oxidation of fats, antioxidants.

(6 hrs)

Module 5. Definition of nanoscience, nanotechnology and nanobiology; diffusion in membranes and cells.

(6 hrs)

Module 6. 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

(10 hrs)

Module 7. Nanodots- Biological Applications – Quantum Devices - Carbon Nanotubes Nanoparticles in pharmaceutical and medicinal field, biomedical applications of nanoparticles; Health risks of nanoparticles.

(8 hrs)

Module 8. Nanomaterials- Environmental applications Zerovalent iron nanoparticles, titanium dioxide, silver nanoparticles - nanomembrane process; nanosorbants- mesoporous silica-ground water remediation; airpurifier-nano photocatalysis nanocoating- corrosion prevention; nanosolar thermal absorber; nano technology based drinking water and waste water treatment.

(10 hrs)

Recommended Readings:

1. C.N.R.Rao, A. Muller and A.K.Cheetham, 2004. The Chemistry of Nanomaterials, Wiley – VCH Verlag GmbH & Co.
2. Cao, G , 2004. Nanostructures & Nanomaterials: Synthesis, Properties & Applications , Imperial College Press.
3. David L. Nelson and Michael M. Cox. 2003. Lehninger Principles of Biochemistry. Macmillan Press Ltd. UK.
4. Eric E. Conn, Paul K. Stumpf, George Bruening and Roy H. Doi. 1995. Outlines of Biochemistry, John Wiley & Sons. Singapore.

5. Mark Wiesner and Jean-Yves Bottero, 2007 Environmental Nanotechnology, McGraw-Hill

6. Ott.J.B and Boerio-Goates,J. , 2000 Chemical Thermodynamics Advanced Application, Academic Press, San Diego, CA.

7. Shatkin,T.A. Nanotechnology : Health and Environmental Risks. 2013. CRC Press, Taylor and Fancis Group.

8. Wilson,M., K.Kannangara, G.Smith, M.Simmons and B.Raguse. 2005. Nanotechnology, Basic Science and Emerging Technologies. Overseas Press India Private Limited. New Delhi.

EXTRA-DEPARTMENTAL ELECTIVES

SEMESTER I

ENS.51A-DISASTER MANAGEMENT

Credit: 1

AIM: The aim of this extra departmental elective is to 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 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.

COURSE DESCRIPTION: This extra departmental elective course contains seven modules. The various 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.

Module 1. Basic concept of disaster- definition of hazard, vulnerability, risk,disaster. Causative factors of disaster. Classification of disasters.

(3 hrs)

Module 2. Disaster management:- definition of disaster management; components of disaster management cycle- crisis management & risk management. Crisis management-quick response & relief, recovery, development. Risk management- risk identification & risk reduction- preparedness, prevention and mitigation.

(5 hrs)

Module 3. 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.

(3 hrs)

Module 4. Role of Remote Sensing and GIS in disaster management.

(2 hrs)

Module 5. Levels of disasters in India.

(1 hr)

Module 6. Survey and assessment of after-effects of a disaster.

(1 hr)

Module 7. Causes, perception, management of various natural disasters like flood, landslides, earthquakes, tsunami, coastal erosion, cyclones, volcanism, forest fire etc.

(5 hrs)

Recommended Readings:

1. Jha and Kumar, M. 2010. Natural and Anthropogenic Disasters; Vulnerability, Preparedness and Mitigation, Springer.
2. 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.
3. Strahler, A.N. and Strahler, A.H. 1973. Environmental Geoscience – Interaction between natural systems and man: -Santa Barbara, California, Hamilton Publishing.
4. Talwar, A.K. & Juneja, S. 2009. Flood Disaster Management, Commonwealth publishers, New Delhi.
5. Vaidya, K.S. 1987.Environmental Geology, Tata McGraw-Hill Publishers.
6. White, G.F. (ed.) Natural hazards – local, national, global: Oxford University Press.

SEMESTER II

ENS. 52A. ENVIRONMENTAL HEALTH PERSPECTIVES

Credits: 2

AIM: The study aims to give awareness about the healthy interrelationships between people 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.

COURSE DESCRIPTION: The course gives the details of effects of pollutants on ecosystem and 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.

Module 1. Environmental Health: Definition, Basic Principles, Major Environmental

Health Problems.

(4 hrs)

Module 2. Air pollution: Indoor and outdoor pollution, major air pollutants, Toxic chemicals in air. Indoor Air pollution -sources and health hazards. National ambient air quality standards.

(4 hrs)

Module 3. Water Pollution: Sources of water pollutants and their health impacts. Standards for drinking water. Water borne diseases, Vector borne diseases, Drinking water disinfection methods - Carcinogenicity of disinfection by-products.

(6 hrs)

Module 4. Soil Pollution: Sources of Soil pollutants and Soil borne diseases.

(3 hrs)

Module 5: Food contamination: Pesticide residues and Heavy metals in food, Food borne diseases and causative agents.

(4 hrs)

Module 6. Radiation damage and health impacts: Sources of Radiations - Man made radiations and Natural radiations, Radiation syndromes, Radiation effects.

(4 hrs)

Module 7. Occupational Pollution and Health hazards: Occupational exposure of workers to pollutants and health impacts.

(4 hrs)

Module 8. Climate change and Human health: Climate and chronic Respiratory Disease (CRD), Direct impacts of climate, Indirect impacts of climate.

(4 hrs)

Module 9. Antioxidants in Health and Disease: Auto-oxidation and Free radicals, Natural and synthetic Antioxidants, Therapeutic benefits of antioxidants.

(3 hrs)

Module 10. Environmental Health Impact Assessment (EHIA) - Definition, Significance of EHIA, Steps in EIA.

(4 hrs)

Recommended Readings

1. Frank R.S.1999.The Science of Air – Concepts and Applications, 2nd Edition, CRC Press, London.

2. Kemm, J; Parry, J; Palmer, S (2004).Health Impact Assessment: Concepts, theory, techniques and applications, Oxford University Press, NewYork.

3. Pandey.K, Shukla.J.P and Trivedi.S.P (2005). Fundamentals of Toxicology. New Central Book Agency (P) Ltd., Kolkota.
4. Park.K. (2005). Park's Text Book of Preventive and Social Medicine, 18th Edition. M/s. Banarsidas- Bhanot Publishers, Jabalpur.
5. Paul.N. Cheremisionoff (1997). Health and Toxicology - Advances in Environmental Control Technology Series, Gulf Publishing Company, Texas, U.S.A.
6. Santra.S.C. (2004). Environmental Science. New Central Book Agency (P) Ltd. Kolkata.
7. Yashpal.W (2009). Air Pollution: Causes and Control. Cyber Tech Publications, New Delhi.

SEMESTER III

ENS 53 A WASTE MANAGEMENT TECHNIQUES

Credit: 1

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

COURSE DESCRIPTION: The course is designed into 5 modules. The fundamentals concepts of waste 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.

Module 1. Wastes and Management : Definition, concept.

(1 hr)

Module 2. Waste water : Nature and types; sources and characteristics; treatment methods – physical, chemical, biological and advanced treatment methods.

(4 hrs)

Module 3. Solid wastes : types of wastes; collection, transportation, disposal, processing of municipal solid wastes; Treatment methods : Incineration, landfilling, composting, vermicomposting.

(5 hrs)

Module 4. Hazardous wastes : Definition, source and characteristics; Management of medical and hospital wastes, Nuclear and radioactive wastes – classification, sources and disposal; e-waste and their management.

(5 hrs)

Module 5. Waste management policies; polluter pays principle; wealth from waste –

compost, single cell protein; waste to energy – ethanol, biogas, hydrogen.

(5 hrs)

Recommended Readings

1. Agarwal,S.K. 2005. Green Management, APH Publishing corporation, New Delhi.

2. Agarwal,S.K. 2005. Wealth from waste, APH Publishing corporation, New Delhi

3. Bhatia,S.C. 2007. Solid and Hazardous Waste Management. Atlantic Publishers and Distributors, New Delhi

4. Bide,A.D. and R.R.Sundaresan. 2001. Solid Waste Management: Collection, processing and disposal. INSDOC, New Delhi

5. Khan,M.K. 2004. Hospital waste Management: Principles and guidelines, Kanishka Publishers, New Delhi

6. Liu,D.H.F. and R.G.Liptak. 2000. Hazardous waste and solid waste. Lewis Publishers, New York.

7. Metcalf and Eddy. 1991. Waste Water Engineering – Treatment, Disposal and Reuse. McGraw Hill International Edition, New York.

SCHEME OF EXAMINATION

Regulations of Postgraduate programme (Credit and Semester System) of University of Kerala will be followed for the conduct of examinations of M.Sc. Environmental Sciences. The core course in Environmental Sciences consists of 4 semesters and carries 60 credits. The scheme of evaluation consists of Continuous Assessment (CA) and End Semester Assessment (ESA) for each course.

The total marks of each course shall be 100 irrespective of whether it is a 1 credit or 4 credit course. Out of this, 40 marks shall be allotted to CA and 60 marks to ESA. CA consists of four components. The allocation of marks for each component under CA shall be attendance/participation 5, mid-semester exam 15, assignment 10 and seminar/practical quiz viva/ record 10. Attendance of 75% is compulsory.

Evaluation of course No. ENS 534 is based on participation in study tour (50 marks), submission of tour report (20 marks), written (20 marks) and viva-voce (10 marks) examination. Evaluation of course No. ENS 544 is based on Project report (80 marks) and viva-voce examination (20 marks). The evaluation results of each course shall be indicated as percentage marks. The minimum required for successful completion of each course shall be 50%. There shall be a separate minimum of 40% marks for ESE of each course. The minimum number of credits required for successful completion of programme is 72 acquired through core and elective courses.

Programme duration	:	4 Semesters
I Semester	:	5 Months
Accumulated minimum credits		
For the successful completion of the programme	:	72 (60 + 12)
1 credit	:	1 hour lecture or 2-3 practicals per week

1 Course	:	Maximum 4 credits
Project	:	4-6 credits
Maximum credits for core courses	:	60 credits
Minimum credits for core courses	:	48 credits
Minimum attendance required	:	75 %

No student shall register for more than 24 credits and less than 16 credits per semester.

Evaluation

- Each end semester examination except the final semester, shall be conducted by the concerned Department for all the courses run in the Department.
- Evaluation at the end semester examination except final semester shall be done by constituting a board consisting of 2 examiners of whom one shall be the course instructor and the other external. The external examiner shall be from outside the University Department and shall be selected by the Head of the Department from a panel proposed by the respective departmental council and approved by the Vice- Chancellor.
- The teacher concerned shall prepare a set of three to five question papers for the end – semester examination of which one shall be chosen by the Head of the Department to be used in the examination
- The final semester examination alone shall be conducted by the University.

- The evaluation of the courses shall be made and the results shall be indicated as percentage marks. The percentage of marks obtained shall be rounded off to the nearest integral number. The minimum required for the successful completion of the course shall be 50%. There shall be a separate minimum of 40% marks for end semester examination for each course.

- The marks for internal assessment shall be 40% and the marks for end semester examination 60%. At the beginning of each course every teacher shall inform his/her students unambiguously the method he proposes to adopt for the continuous assessment. This must be approved by the Departmental Council. The allocation of marks for each component under continuous assessment shall be in the following proportion.

(a)	Attendance	: 5
(b)	Mid semester examination	: 15
(c)	Assignment	: 10
(d)	Seminar/ Test/ Quiz/ Viva/ Records	: 10
	Total	: 40

The allotment of marks for attendance shall be as follows:

<75%	-	0
75%	-	2.5
76-80	-	3
81-90	-	4
above 90	-	5

- The Head of the Department shall display students results within two weeks after the examination. To ensure transparency, the answer scripts shall be made available to the students for scrutiny and they can seek clarification from the teachers regarding the evaluation of scripts within 3 days of publishing the provisional results in the Department Notice Board. If any student has complaints about evaluation the same shall be submitted to the Head of the Department in writing within a week. The student will then be asked to meet the Departmental Council and after hearing the views of the students as well as the teachers who have done the evaluation, a consensus will be reached on the award of marks.

- The Department Council will prepare two copies each of the result sheets - including break-up for each semester and sessional categories - and send one copy to the University retaining the other copy in the Department.

- Every Instructor will be evaluated by the students before the end of the semester.

  The Head of the Department will arrange for this evaluation.

Mark Sheet

- The University under its seal shall issue to the students a mark sheet on completion of each semester.

The mark sheet shall contain the following:

1. The title of the course taken
2. The credits associated with the course

3. The marks in percent secured by the student for each course
4. The total credits earned by the student in the semester
5. The total credits earned by the student till that semester
6. The total marks in percent as cumulative weighted average of the student.

- To arrive at the cumulative weighted average of marks at the end of the semester, the product of the credits assigned to each course and the percentage of marks secured in the course is totaled over all the course and this total is divided by the sum of the credits of all courses. To obtain the final result at the end of all semesters, the same procedure is repeated except that the sum is taken over all the courses the student has taken in all the semester still then.

Distinction	-	80% and above
I Class	-	60% and above and but below 80%
II Class	-	50% and above but below 60%

For eg: The weighted average marks in percent for a student getting 90% in a 4 credit course, 80% in a two credit course, 70% in a 3 credit course and 60% in a 3 credit course will be

$$= \frac{(90 \times 4) + (80 \times 2) + (70 \times 3) + (60 \times 3)}{4 + 2 + 3 + 3}$$

$$= \frac{910}{12} \quad = 75.8 \quad = 76$$

- The mark sheet issued at the end of the final semester shall contain the details of all the courses taken which shall contain the details of all the courses taken which shall include the titles of the courses, the credits associated with each course, the marks and the final class in which the student is placed

- In the case of those who do not complete all the course components it will be indicated in the mark sheet as 'Not Completed'. However, students will be permitted to complete the course with the concurrence of the Head of the Department.

- Those who fail in a particular course shall be permitted to repeat the course after obtaining permission from the Head of the Department.

- To be eligible to continue in the P.G. Programme, a student must, apart from being registered for the minimum prescribed credits, secure a minimum average of 50% or higher. If he/she fails to achieve this in any semester he/she shall be placed on scholastic probation in the succeeding semester. If he/she fails to improve and secure an average of 50% marks by the end of the succeeding semester then he/she shall be asked to leave the programme.

STRUCTURE OF QUESTION PAPER FOR END SEMESTER EXAMINATION

Total marks	:	60
Time	:	3 Hours
Part A	:	(10x2 =20 marks)

Answer any ten questions out of twelve (Each question carries 2 marks)

Part B	:	(5x4 =20 marks)

Answer any four questions out of six (Each question carries 5 marks)

Part C	:	(2x10 =20 marks)

Answer any two questions out of three (Each question carries 10 marks)

MODEL QUESTION PAPER

First Semester M.Sc. (CSS) Degree Examination, March 2014
Branch: Environmental Sciences
ENS 511: Environmental Biology and Ecosystem Dynamics

Time : 3 Hours Max. Marks : 60

SECTION- A

Answer any ten Questions (10 x 2 = 20 Marks)

1. What are trophic levels ?
2. Explain the characteristics of a shoal forest.
3. Explain vivipary with suitable example?
4. What is biological invasion?
5. What is edge effect?
6. Explain ecological niche?
7. Define an energy pyramid?
8. What is carrying capacity?
9. Name any two biome.
10. Define endemic species.
11. Explain law of minimum.
12. What is biosphere?

SECTION – B

Answer any four Questions (4 x 5 = 20 Marks)

13. Explain the concepts and principles of ecological informatics.
14. What is Hardy-Weinbery equilibrium? What are the conditions necessary for the maintenance of this equilibrium in any population?
15. Write a short note on ecological successions.
16. Explain the structure and significance of tropical rain forest.
17. Describe various functions of wetland ecosystem.
18. Briefly explain the ecological pyramids

SECTION- C

Answer any two Questions (2 x 10 = 20 Marks)

19. What is biodiversity? Explain the significance and threats to biodiversity with a few examples.
20. Define speciation and comment on phyletic speciation and true speciation with suitable examples.
21. Explain various ecological interactions and its significance.