CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

IRINJALAKUDA, THRISSUR - PIN 680 125

DEGREE OF
MASTER OF SCIENCE
(CHOICE BASED CREDIT AND SEMESTER SYSTEM)

UNDER THE

FACULTY OF SCIENCE

SYLLABUS

(FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2014 – 15 ONWARDS)

BOARD OF STUDIES IN ENVIRONMENTAL SCIENCE (PG)

IRINJALAKUDA, THRISSUR - PIN
680 125 KERALA, 673 635, INDIA
JULY, 2014

CHRIST COLLEGE
(AUTONOMOUS)

M Sc -Environmental Sciences
Under CUCSS Pattern

Syllabus/Course Structure

2014 Admission onwards

SYLLABUS / COURSE STRUCTURE AT A GLANCE

Semester	Course No.	Course Title	Credit
I (Core)	ES 1C 01	Physical Processes in the Environment	4
	ES 1C 02	Energy and Environment	4
	ES 1C 03	Environmental Impact and Risk Assessment	4
	ES1C 04	Environmental Pollution and Pollution Abatement	4
	ES 1C 05	Practical I - Physical and chemical analysis of soil and water	2
	ES 1C 06	Practical II- Physical environmental analysis	2
Total credits for the first semester			**20**
II (Core)	ES 2C 07	Fundamentals of Environmental Engineering	4
	ES 2C 08	Environmental Microbiology	4
	ES 2C 09	GIS, Remote Sensing, System Analysis and Modeling	4
	ES 2C 10	Environmental Toxicology and Biochemistry	4
	ES 2C 11	Practical III - Geoinformatics	2
	ES 2C 12	Practical IV - Environmental Chemistry & Environmental Biology	2
Total credits for the second semester			**20**
III (Core and Elective)	ES 3C 13	Biodiversity and Conservation	4
	ES 3C 14	Wastes and Waste Management	4
	ES 3C 15	Biostatistics, Quantitative Methods & Eco-informatics	4
	ES 3E 16	Ecosystems and Global Climate Change	4
	ES 3C 17	Practical V- Microbiology & Statistical techniques	2
	ES 3C 18	Practical VI – Biodiversity	2
Total credits for the third semester			**20**
IV(Core)	ES 4C 19	Project/Dissertation	8
IV (Elective papers) (Four paper to be selected)	ES 4E 20	Environment, Occupational Health & Safety	2
	ES 4E 21	Remedial Mathematics	2
	ES 4E 22	Hydrology and Water Resources	2
	ES 4E 23	Indian Environmental Law	2
	ES 4E 24	Environmental Disaster Management	2
	ES 4E 25	Current Environmental Issues in India	2
	ES 4E 26	Wildlife and Avian Biology	2
	ES 4E 27	Environmental Economics	2
Total credits for the fourth semester			**16**
Total for Semesters 1, 2, 3 and 4			***76***
External Practical Examinations are conducted at the end of Second and Fourth semester only Practical Examination for Practical I and Practical II as one paper, Practical III and Practical IV as another paper will be conducted at the end of the second semester, and Practical Examination for Practical V and Practical VI as one paper will be conducted at the end of the fourth semester only'			

CORE SUBJECTS – COURSE CONTENTS

SEMESTER - I

ES 1C 01: Physical Processes in the Environment

Module I: Sun-Earth System: planetary motion and seasons; Solar radiation - global distribution, effect of atmosphere - scattering, absorption and reflection, greenhouse Effect; Structure of Atmosphere and Atmospheric Circulation; General circulation of the atmosphere and Indian Monsoons; General Circulation of Oceans; Winds and surface circulation, causes of ocean currents, characteristics of convergence, divergence, upwelling and sinking of ocean waters; Deep-sea circulation, Thermohaline conveyor belt

Module II: Thermodynamics, Atmospheric Stability: Composition of dry air and atmospheric water vapor content; Potential temperature, virtual temperature, isothermal and adiabatic processes; Stable, unstable and neutral equilibriums, Inversions; Atmospheric Boundary Layer - depth, structure, diurnal variations and their significance in pollutant dispersion.

Module III: Clouds and Precipitation: Cloud formation and classification, Aerosols, condensation and ice nuclei, droplet growth - curvature and solute effects, precipitation mechanisms; Weather and Climate - Climatic zones, continental & maritime climates; Climate change and variability, Natural and anthropogenic causes of climate change, El Nino and ENSO events

Module IV: Properties and Structure of the Earth: Crust, mantle, core, earth's magnetic field; Recycling of the Lithosphere - the rock cycle, weathering (physical, chemical and biological) and erosion, sedimentation, metamorphism; Rock types - Igneous, metamorphic and sedimentary rocks; Concept of plate tectonics and continental drift; Geological time-scales.

Module V: Global water balance: hydrological cycle, relationship of surface, groundwater and stream-flow, Stream hydrograph; Groundwater - aquifers; Groundwater exploitation and management

Suggested Readings

1) Mike R Leeder, Marta Pérez-Arlucea (2006) Physical Processes in Earth and Environmental Sciences, Blackwell publishers

2) Peter Smithson, Kenneth Addison, Kenneth Atkinson (2012) Fundamentals of the Physical Environment, Rutledge
3) John Monteith and Mike Unsworth (2006), The Atmosphere and Ocean - A Physical Introduction (3rd Edition), Neil Wells, John Wiley & Sons, NY
4) R G Barry and R J Chorley, (1997) Atmosphere, Weather and Climate (6th Edition), Methuen, London
5) H M Saxena (2006) Environmental Studies, Rawat Publications
6) Roger Del Moral and Lawrence R Walker (2007) Environmental Disasters, Natural Recovery and Human Responses, Cambridge
7) Patrick L Abbot (2002) Natural disasters, Tata McGraw Hill
8) Fred G Bell (1998) Environmental Geology - Principles and Practice, Blackwell Science Publishers, London

ES 1C 02: Energy and Environment

Module I Energy basics: Laws of Thermodynamics; Forms and types of energy; Energy resources classification - perpetual, renewable and non - renewable; conventional and non conventional; secondary energy sources; sun as source of energy, nature of its radiation, thermal dynamics of earth system, solar constant, distribution of solar radiation across various atmospheric levels, ecologically important radiations, energy flow in Ecosystems.

Module II Non-renewable energy resources: Coal, oil, natural gas, heavy radioactive elements; formation of fossil fuels in the geological time scale, India's non- renewable energy reserves and usage pattern; world's energy reserves and consumption; Non-renewable energy usage and limitations, role of fossil fuels in modern economy, environmental impacts of fossil fuels exploitation and utilization.

Module IIIRenewable energy resources: Biomass, wind, hydroelectric, ocean, geothermal; Secondary energy resources - electricity, hydrogen; Alternate energy resources; Renewable energy usage, limitations and scope; modern techniques for energy resource recovery using Microbes, solar collectors, photovoltaics, solar ponds, nuclear-fission and fusion, magneto-hydrodynamic power (MHD), and biomass gasification.

Module IV: Nuclear energy generation and environmental safety: radioactivity from nuclear reactors, fuel processing and radioactive waste, hazards related to power plants, dose from environment and nuclear radiations, pathways analysis and dose assessment, radioactivity risk assessment, criterion for safe exposure.

Module V Energy production and impacts on environment: degradation of air, water and land; Important Multipurpose power projects and environmental issues in India; Energy use pattern in different parts of the world and its impact on the environment; energy utilization in urban and rural contexts; Sustainable Energy management, problems and solutions; Energy crisis and challenges of energy transformation; energy conservation measures for sustainable development.

Suggested Readings

1) Robert A Ristinen and Jack P Kraushaar (2005), Energy and the Environment, Wiley
2) Walters C (1986), Adaptive Management of Renewable Resources, Macmillan Publishing Company, New York
3) John C Sawhill H and Richard C (1986), Energy Conservation: Successes and Failures, Brookings InstitutionPress
4) Joan S (1992), Getting to Know about Energy: In School and Society, Falmer Press
5) Elliot David (2003), Energy, Society and Environment, Technology for a Sustainable Future, Rutledge
6) Gilbert M Masters (1997), Introduction to Environmental Engineering and Science (2nd Edition), Prentice Hall
7) John C Sawhill H and Richard C (1986), Energy Conservation: Successes and Failures, Brookings Institution Press
8) Widell J W, Weir A D (1986), Renewable Energy Resources, E & F N Spon Limited, London
9) Joan S (1992), Getting to Know about Energy: In School and Society, Falmer Press
10) IDRC (1993), AGENDA 21: Green Paths to the Future, International Development Research Centre, Ottawa

ES 1C 03: Environmental Impact & Risk Assessment

Module I: Basics of EIA and RA: Concept of EIA, Evolution of EIA, EIA practice in India, EIA Notifications 1992, 1994, 1997 2009; Other related Notifications; Project Screening in EIA, defining and examining scope, objectives and alternatives in EIA Projects, project planning and processes, baseline information, Impact prediction, decision making; cumulative impact assessments, strategic impact assessments.

Module II: Types of EIA: Rapid EIA, comprehensive EIA, strategic EIA, data collection, ecological impacts, environmental impacts (Air, water, Land Noise),

socioeconomic and cultural Impacts, health impacts, prediction of impacts; methodologies, cost benefit analysis, Environmental Management Plan (EMP).

Module III: Environmental Impact Statements: Preparation and contents of Environmental Impact Statements; Reviewing EIA/EIS; Use of EIA in Public participation and decision making; EIA in Sustainable development

Module IV: EIA case studies: Mining projects, hydroelectric projects, nuclear power projects, thermal power projects, refineries, cement, metallurgy

Module V: Environmental Risk Assessment and Management: Perceived risks, real risks, hazard identification, hazard characterization, hazard accounting, health risk assessment, risk management, modeling tools in risk assessment; Modeling and simulation; Risk Assessment Methods, Comparative Ranking of Risks, Guidelines for Comparison; case studies.

Suggested Readings

1) Asit K Biswas and S B C Agarwala (1992) Environmental Impact Assessment for Developing Countries, Butterworth-Heinemann Limited
2) Glenn W Suter II (2006), Ecological Risk Assessment (Second Edition), CRC Press
3) Dennis J Paustenbach (2002), Human and Ecological Risk Assessment: Theory and Practice, Wiley-Interscience
4) Shrivastava A K (2003), Environmental Impact Assessment, APH Publishing Corporation, NewDelhi
5) Abbasi S A and D S Arya (2004), Environmental Impact Assessment, Discovery Publishing House, New Delhi
6) Kukarni VS, SN Kaul, RK Trivedi (2002), A Hand book of Environmental Impact Assessment, Scientific Publishers, Jodhpur
7) Maria Rosario (2000), Perspectives on Strategic Environmental Assessment, Edited Lewis Publishers, USA
8) Susan L Cutter (1999), Environmental risks and hazards, Prentice-Hall India
9) Glasson J, Therivel R, Chadwick A (1994), Introduction to environmental impact assessment- Principles and procedures, process, Practice and prospects, Research Press, Delhi
10) Petts Judith (1999), Handbook of environmental impact assessment (Vol. 1), Blackwell
Science

ES 1C 04: Environmental Pollution and Pollution Abatement

Module I: Environmental pollutions: Pollutions - physical, chemical and biological; radio nuclides, Electromagnetic radiations, Electro-smog, noise and light pollution; sources - industrial, commercial, domestic etc.; Industrial process and their pollution potentials - mining, smelting, cement production, petroleum refining, thermal power plants, pulp and paper, tannery, dairy, textile dyeing and bleaching.

Module II: Water Pollution: Physical and chemical properties of water; pollution of water resources, types and sources, solids and turbidity, alkalinity, acidity, salinity, hardness, nutrients, fluoride, heavy metals, organic pollutants, oxygen demanding wastes, (COD, BOD), Persistent organic pollutants (DDT, PCBs, PAHs, Dioxin) etc.

Module III: Air pollution: Particulate matter - respirable and irrespirable, inorganic and organic species in PM; gaseous pollutants (CO, SOx, NOx), secondary air pollutants, organic air pollutants, volatile organic pollutants; Green house gases and climate change, Acidic Deposition, Tran boundary air pollution; Meteorological factors affecting air pollutants, diffusion, turbulence and transportation, plume rise and stability conditions, Wind Roses; Effects of pollutants on human beings, plants, animals, materials and climate; Ambient air quality standards.

Module IV: Soil pollution: Macro and micro pollutants in soil, heavy metals, radio-nuclides, agrochemical pollutants (fertilizers, pesticides, animal wastes), industrial wastes (oil drilling, coal fired power plants, mining), Municipal solid wastes, Biomedical wastes.

Module V: Pollution Monitoring methods and pollution abatement: Air quality monitoring techniques - high volume air samplers, stack samplers, measurement of PM, gaseous pollutants; Water, soil and biological sample analysis for parameters such as dissolved and suspended solids, BOD, COD, turbidity, hardness, chloride, phosphate, Sulphate, nitrogen compounds, heavy metals, pesticides, oil and grease etc; techniques for pollution abatement - management of emissions, effluents and solid wastes, recycling, reduction etc; Policies for Controlling Air and Water pollution, Disposal of Toxic and Hazardous Waste-Standards.

Suggested Readings

1) Marquita K Hill (2004), Understanding environmental Pollution (Second edition), Cambridge University Press, New Delhi
2) S E Manahan (2004), Environmental Chemistry, Lewis Publishers
3) I A Mirsal (2004), Soil Pollution, Springer Publications
4) Bailey R A etal (2005) Chemistry of the environment, Academic Press

5) D W Connell (1997), Basic Concepts of Environmental Chemistry, Lewis Publishers, New York
6) APHA / AWWA (1992) Standard methods for the Examination of water and waste water, 18th edition, American Public Health Association, American Water Works Association, Water Environment Federation, Washington
7) David H F Linn, Bela G Liptak (2000) Air Pollution, Lewis Publishers.
8) Shilpa Shyam, H N Verma, S K Bhargava (2006), Air Pollution and its impact on plant Growth, New India Publishing Agency

ES 1C 05 Practical - I: Physical and chemical analysis of soil and water

- Sample preparation methods
- Types & calibration of standards for soil & water analysis
- Familiarity with instrumental techniques for basic Chemical analysis: pH Meter, chromatography, spectrophotometer, fluorometry
- Chemical analysis of water & waste water:
- Analyses of wastes & solids
- Estimation of physico-chemical properties of water: Turbidity, Light penetration, Conductivity, Total suspended solids, Alkalinity, Hardness, Dissolved oxygen, BOD, COD, pH, etc
- Analysis of water quality on Tri-linear diagram
- Evaluation of hydrologic parameters; catchment delineation and water balance
- Analysis of biological materials

ES 1C 06 Practical - II: Physical environmental analysis

- Air & Gas analysis
- Ambient Air Quality monitoring - SPM, RPM, Sulphur dioxide, Nitrogen dioxide.
- Wind Rose Analysis
- Climogram Analysis
- Identification & Classification of important rocks
- Interpretation of geological maps

SEMESTER – II

ES 2C 07: Fundamentals of Environmental Engineering

Module I: Introduction to Environmental Engineering: Concepts, characteristics of environmental engineering, civil engineering and environmental engineering, ecological principles and environmental engineering, public and environmental health; ethics in environmental engineering; concepts of industrial ecology and its applicability in environmental engineering

Module II: Environmental engineering and Water pollution: Sources of water pollution, pollutant dynamics in environment, aquatic ecology, self purification; measurement of water pollution, parameters, water pollution treatment (primary, secondary and tertiary, biological, constructed wetlands), reduction, reuse and recycling techniques

Module III: Environmental engineering and Solid waste: Solid waste characterization, dynamics of wastes in environment, management of solid waste (end of the pipeline techniques, management at the origin) and disposal of wastes; reduction, reuse and recycling techniques.

Module IV: Environmental engineering and Air pollution: Air pollution characterization, pollutant dynamics in environment, management of air pollution (end of the pipeline techniques, management at the origin) and disposal of wastes; reduction, reuse and recycling techniques.

Module V: Environmental engineering and physical pollution: Physical pollution (noise, radiation, light), pollutant dynamics in environment, management of physical pollution (end of the pipeline techniques, management at the origin) and control techniques

Suggested readings

9) Gilbert M Masters (1997), Introduction to Environmental Engineering and Science (2nd Edition), Prentice Hall
10) Allan Brimicombe (2003), GIS, Environmental modeling and engineering, Taylor & Francis, London
3) Ruth F Weiner and Robin Matthews (2007), Environmental Engineering (4th Edition), Butterworth – Heinemann
4) Glenn O Schwab, Delmar D Fangmeier, William J Elliot and Richard K Frevert (1992), Soil and Water Conservation Engineering, John Wiley& Sons

5) Vesilind P Aarne (1997), Introduction to environmental engineering, PWS Publishing Company, Boston
6) Stanley E Manahan (1999), Industrial Ecology: Environmental Chemistry and Hazardous Waste (1 edition), CRC Press
7) Robert U Ayres, Leslie Ayres (Editors) (2002) A Handbook of Industrial Ecology, Edward Elgar Publishing Limited
8) George Tchobanoglous, Franklin L Burton and H David Stensel (2003), Waste water engineering - treatment and re-use (4th Edition), , Metcalf & Eddy Inc, Tata McGraw Hill, New Delhi

ES 2C 08: Environmental Microbiology

Module I: Introduction to environmental microbiology: History and scope; microbial diversity and taxonomy; Methods in Taxonomy of Bacteria, Achaea and Fungi, Morphological Methods, Chemotaxonomy, Genetic Methods; Eukaryotes and prokaryotes; Aerobic, microaerophilic, facultative anaerobic and obligate anaerobic microbes; Microbial community interactions (competition, antibiosis, predation etc.) in environment

Module II: Viruses: General properties of viruses; Bacteriophages - classification; Viruses of eukaryotes, animal and plant viruses, reproduction, cytocidal infection and cell damage; Persistent, latent and slow virus infection; Insect and insect borne viruses; Viroids and prions; Viruses of fungi, algae and protozoans

Module III: Bacteria: Characterization - phenotypic, genotypic and serological; Autotrophic and heterotrophic metabolism, basic energy yielding mechanisms, Bacterial nutrition, nutrient requirements, nutrient uptake; growth curve, measurement of growth

Module IV: Fungi, microalgae and Protozoans: Fungi - classification, distribution, structure, nutrition and metabolism, reproduction, characteristics of fungal division; Protozoans - classification, distribution, importance, morphology, nutrition, encystment and excystment, reproduction; Microalgae - Basic concepts, distribution, structure, nutrition, reproduction, characteristics, classification

Module V: Microbial Ecology: Foundations of microbial ecology and microbial interactions; Microbial growth in natural environment, growth limitation by environmental factors; Methods in environmental microbiology -

Examination of microbial communities as complex assemblages, microbial community structure; General perspectives on microbial communities in aquatic environment, terrestrial systems, plants and animals

Suggested Readings

1) Mitchell Ralph (Editor) (1992), Environmental Microbiology, John Wiley and Sons
2) Pepper Ian L, Charles P Gerba, Terry J Gentry, and Raina M Maier (2011), Environmental Microbiology, Academic press
3) Atlas Ronald M and Richard Bartha (1997) Microbial Ecology: Fundamentals and Applications (4th Edition), Benjamin Cummings
4) McArthur J (2006), Microbial Ecology - An Evolutionary Approach, Academic Press
5) Pommerville Jeffrey C (2007), Alcamo's Fundamentals of Microbiology, Jones & Bartlett Publishers
6) Michael T Madigan, John M Martinko, Paul V Dunlap and David P Clark (2003) Brock Biology of Microorganisms (10th Edition), San Francisco, Pearson/Benjamin Cummings
7) Prescott, LM, JP Harley and DA Klein (2005) Microbiology (6th Edition), McGraw - Hill

ES 2C 09: GIS, Remote Sensing, Systems Analysis and Modelling

Module I: Introduction to GIS & Remote sensing: Principles of remote sensing & GIS; Spectra of Environmental Components; Satellites in remote sensing and GIS; Remote sensing and GIS applications on Ocean, Atmosphere, Land, Geology, Water Resources (Ground water and Surface water); Sun-earth cosmic connection to understand environment of the Earth

Module II: Applications of Remote sensing and GIS in early warnings: Tsunami, Earthquake, Snowfall, Global warming, Forest fire, Landslide, Land-subsidence; Use of LANDSAT, SPOT, IRS ERS, RADARSAT and Extra terrestrial satellite data by using ERDAS, ARCGIS, ERMAPPER, IDRISI ENVI and S+ software for solving the Environmental problems; Free and Open softwares in GIS application

Module III: Spatial Data Analysis: Data attributes and spatial topology; Geographical datasets and data management; Digital Elevation Models

(DEMs), GIS analysis and queries, Surface analysis, Raster data and analysis, Data quality and errors, GIS map output; Data Acquisition, Image preprocessing and correction methods: Distortions, sharpening, smoothing, geometric transforms, image compression; system model, Principal Component analysis, mosaic and subsets, image information extraction.

Module IV: Image enhancement: Frequency filters, Digital image Classification and advanced classification techniques, Terrain analysis and Fly simulation, Change detection Analysis, Image arithmetic operations, Vegetation Indices; Cryosphere, Disaster, Defense studies; softwares in Remote sensing and GIS to solve Environmental problems including Groundwater Exploration, Rainwater Harvesting, Biomass analysis and its relationship with Geo-resource evaluation.

Module V: System Analysis & Modelling: Definitions and concepts of system, sub-system, variables and parameters; Linear vs. non-linear models; Non-linear forecasting; Prey-predator systems, Environmental systems; Time series analysis, simulation; Types of systems: Open and cybernetic systems, feedback; Ecosystem as a cybernetic system; Critical points of a system; stability of critical points; limitations of modeling; Models in Ecosystem Analysis, Synthesis and forecasting: statistical regression approach, differential equation approach and computational approaches, Lotka-Voltera model. Air and water quality modeling, water shed models; Introduction to computational technology: Fuzzy logic; artificial neural networks; Genetic algorithms; Evolutionary algorithm, Natural Distributionfunctions

Suggested Readings

1) Lillesand T M and Kiefer T W (2004), Remote Sensing and Image Interpretation, John Wiley and Sons, NJ, USA
2) Sabins Floyd F Jr (1978), Remote Sensing: Principles and Interpretation, WH Freeman and Company, NY
3) Kang-tsung Chang (2003), Introduction to Geographic Information Systems, Tata McGraw Hill Edition, New Delhi
4) Daplyn P, Cropley J, Treagust and Gordon A (1994) The use of Geographical Information Systems in Socio-economic Studies, The Natural Resources Institute
5) James B Campbell (2007), Introduction to Remote Sensing, The Guilford Press (4th edition), NY, USA

6) John R Jensen (1996), Remote Sensing of the Environment: An Earth Resource Perspective (2nd Edition), Prentice Hall Series in Geographic Information Science.
7) John A Richards and Xiuping Jia (2005), Remote Sensing Digital Image Analysis: An Introduction, Springer, Germany
8) Ian Heywood, Sarah Cornelius and Steve Carver (1999), An Introduction to Geographical Information Systems, Longman Pub group, UK
9) Grant WE, Pederson EK and Sendra LM (1997), Ecology and Natural Resource Management: Systems Analysis and Simulation, John Wiley, New York
10) Jorgensen S E (Editor) (2000), Handbook of Ecosystem Theories and Management, Series: Environmental & Ecological (Math) Modeling, CRC Press
11) Allan Brimicombe (2003), GIS, Environmental modeling and engineering, Taylor & Francis, London
12) Finwright John and Mulligan, Mark (Editor) (2004), Environmental Modelling: Finding simplicity in complexity, John Wiley, New York
13) Iyengar Sitharama S (1998), Computer Modeling and simulations of complex biological systems, CRC Press
14) Westervelt James (2001), Simulation modeling for watershed management, Springer
15) Skidmore S and Wore B (1992), Introducing systems analysis, BPB publications
16) Awad EM (1992), Systems analysis and design, Galgotia publications
17) Hawryszkiewycz IT (1989), Introduction to systems analysis and design, Prentice Hall India
18) Law AM and Kelton David W (1991), Simulation modelling and analysis, Series in Industrial Engineering and Management Science, McGraw Hill
19) Kingsland SE (1985), Modeling nature, episodes in the history of population ecology, University of Chicago
20) Zannetti P (1990), Air pollution modeling, theories computational methods and available softwares, Van Nostrand Rheinhold, New York

ES 2C 10: Environmental Toxicology and Biochemistry

Module I. Ecotoxicology as a synthetic Science: major classes of environmental pollutants - inorganic, heavy Metals, organics, organometalics, radioactive isotopes, gases; Routes of entry into ecosystems - surface waters, land, atmosphere; long-range

movement and global transport of pollutants; Fate of pollutants in ecosystems - biotransformation, bioaccumulation and biomagnification

Module II: Toxicity Testing: Test organisms used in Bioassays; Definition of toxicity, case studies (As, Hg problems); Concept of Dosimetry - lethal, sub-lethal and chronic tests, dose response curves, LC50, MATC-NOEC, brief statistical methodology; toxicant effects - cellular, organismic, population and Ecosystem-Level effects, global effects

Module III: Biochemical effects of environmental contaminants: environmental carcinogens, mutagens, asbestos, hormone mimics; Biomarkers and bio-indicators; metabolic impacts; biochemical parameters - enzymes, metabolites, structural changes, biosynthesis and catabolism of proteins, lipids, carbohydrates and nucleic acids, toxic response of different tissues and organelles, tissue specificity

Module IV: Toxicology, Epidemiology and environmental health: hazardous wastes, untreated sewage, automobile exhausts, industrial effluents, industrial emissions into atmosphere, agricultural run-off of pesticides; epidemiological techniques to assess health impacts

Module V: Environmental contamination related diseases: Water pollution related diseases (Gastroenteritis, Hepatitis etc.); air pollution related diseases (allergies, respiratory diseases); food-borne diseases (Food poisoning, parasites etc); Vector born diseases; Environmental changes and vector borne diseases, environmental radiation related morbidity and mortality

Suggested Readings

1) Newman MC, Lawrence CA, and Unger MA (2002), Ecotoxicology: Fundamentals of Ecotoxicology (2nd Edition), CRC Press, Boca Raton, Florida
2) Walker CH, Hopkin SP, Sibly RM and Peakall DB (2001), Principles of Ecotoxicology (2nd Edition), Taylor & Francis, London
3) Moore GS (2002), Living with the Earth: concepts in Environmental Health Science (2nd Edition), Lewis publishers, Michigan
4) Brian Alloway, Jose Centeno, Robert Finkelman, Ron Fuge, Ulf Lindh, Pauline Smedley, Olle Selinus (Editors) (2005), Essential of Medical Geology; Elsevier Academic Press
5) Hayes A W (1988) Principles and methods of toxicology (2nd edition), Raven press, New York

6) Stewart C P and Stolman A (1960) Toxicology (Vol-I), Academic press, New York
7) David A Wright and Pamela Wellborn (2002), Environmental Toxicology (1st edition), Cambridge Environmental Chemistry Series, Cambridge University Press

ES 2C 11 Practical III: Geoinformatics

- Simulations based on various environmental models
- Measurement of species diversity (calculation of Diversity Indices from data collected on plant species in a natural vegetation
- Computer lab:
- Introduction to computational techniques
- Introduction to ArcGIS Desktop and Erdas Imagine
- Working with GPS Device
- Creating Geodatabase
- Editing spatial data
- Editing attribute data
- Image Enhancement and Filtering Techniques
- Image Subset and Image Mosaic
- Image Classification
- Unsupervised and supervised Classification
- Map Creation
- Case study of making an EIA on any of the following;
- A proposed Chemical factory /Oil refinery /airport /Tiles industry /Electronic city /Residential complex etc.

ES 2C 12 Practical IV: Environmental Chemistry & Environmental Biology

Environment Chemistry

- Unit 1: Different type of sampling techniques – grab sampling, composite sampling. Measurement of water quality parameters Colour, turbidity, temperature, conductivity, acidity and alkalinity. Sample

preparation methods: Types and calibration of standards for soil & water analysis. Chemical analysis of water & wastewater; Analyses of wastes & solids; Air & gas analysis; Analysis of biological materials. Familiarity with instrumental techniques for basic Chemical analysis: chromatography, spectrophotometer, fluorometry

- Unit 2: Estimation of Dissolved solids, free carbon dioxide, free chlorine, calcium and magnesium, (EDTA method) Iron and manganese (colourimetric method) nitrate and nitrite (titrimetric/colourimetric method), Sulphate (titrimetric/gravimetric method), sulphide (titrimetric method), fluoride (ion selective electrode/colourimetric method), chromium and lead (colourimetric method) and mercury.

- Unit 3. Estimation of a) BOD, COD an DO, b) Detergents (colourimetric method), c) Oil and grease in water.

Suggested Readings:

1. Vogel's Textbook of Quantitative Chemical Analysis – 5th Edition (1989) ELBS.
2. Water Pollution by B.K. Sharma and H. Kaur. 2nd Edition (1997-98), Krishna Prakashan Media
(P) Ltd. Merrut.
3. Essential Environmental Science – Methods and Techniques. Ed. Simon Watts and Lind say Halliwell (1196), Routledge, London.
4. APHA (1998), standards methods for the examination of water and waste water, 20th edition, Washington DC.

Environmental Biology

- Unit .1. Ecological Methods: a) Estimation of Frequency, density, biomass, coverage and Importance Value Index (IVI), for grasslands using quadrat, transect and point quadrat methods, b) Estimation of frequency, density, biomass, coverage and Importance Value Index (IVI) for a midland ecosystem using quadrat, transect and point quadrat methods, and c)Vegetation analysis for (i) association-2 x 2 contingency table and X2 test; (ii) Correlation (iii) non-randomness (iv) diversity – Shamon & Wiener's Diversity Index.

- Unit.2. Analysis of Phytoplanktons in an Aquatic Ecosystem: a) Preservation and identification – Lucky's drop method; Haemocytometer method, b) Primary Production – Biomass method; chlorophyll estimation; Gaarder & Gran's method.
- Unit.3. Routine Methods of Microbiological Examination of Potable Water: Sample collection; Standard Plate Count (SPC); Probable

Number (MPN) of coilforms; MPN for faecal coilforms, calculation of MPN; Gram staining; Comparison of a well water and sewage water sample for bacterial ogical Drinking Water Quality as per BIS & WHO Standards.

- Unit.4. Sampling and estimation: a) Sampling – Techniques, Frequency estimation; Density estimation, b) Biomass & Productivity estimation, and c) Chlorophyllestimation.

Suggested Readings:

1) Trivedy, R.K., Goel, P.K. & Trisal, C.L. Practical Methods in Ecology and Environmental Science. Environmental Publications, Karad, India, 1987, 340 pp.
2) Richard J. Schmitz, Introduction to Water Pollution Biology. Gulf Publishing Company, Houston, Texas, 1996.
3) Patrick R. Dugan, Biochemical Ecology of Water pollution. Plenum Publishing Corporation, 1975.
4) APHA, Standard Methods for the Examination of Water and Wastewater. 16th Edn., American Public Health Association, Washington, D.C.,1995

SEMESTER – III

ES 3C 13: Biodiversity and Conservation

Module I: Natural resources: Ecological concepts related to natural resources, matter, energy; renewable and non-renewable resources; soil, water, plants, animals etc. Wetlands, water bodies, forests; ecosystems services etc. Biodiversity concepts and patterns: Organic Evolution through geological time scale; Microbial diversity, Plant diversity, Soil biodiversity; Levels of Biodiversity: Community diversity (alpha, beta and gamma biodiversity), Gradients of Biodiversity (latitudinal, insular)

Module II: Biodiversity - scales: Ecosystems diversity - biomes, mangroves, coral reefs, wetlands and terrestrial diversity; Species diversity - richness and evenness; Genetic diversity: sub species, breeds, race, varieties and forms; benefits from biodiversity - direct and indirect benefits, Ecosystems services, Bio-prospecting; Biodiversity hotspots and their characteristics

Module III: Threats to Biodiversity: Habitat loss and fragmentation; disturbance and pollution; introduction of exotic species; extinction of species; human intervention and biodiversity loss: global environmental changes, land in water use changes; national and international programmes for biodiversity conservation; biodiversity convention and biodiversity Act, IPRs

Module IV: Biodiversity conservation: Conservation movements - International and National; Ecologically relevant parameters (viable population, minimum dynamic area, effective population size, metapopulations); reproductive parameters in conservation (breeding habitats, mating systems, inbreeding depression, genetic bottlenecks, genetic constraints); IUCN categories - endangered, threatened, vulnerable species; Red data book and related documentation; threatened plants and animals of India, ecosystem people and traditional conservation mechanisms

Module V: Ex-situ / in-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; In-vitro Conservation – germ plasm and gene Bank; tissue culture - pollen and spore bank, DNA bank; Wildlife values and eco-tourism, wildlife distribution in India, problems in wildlife protection, organizations involved in conservation (WWF, WCU, CITES, TRAFFIC etc), Wildlife Protection Act 1972; In-situ conservation: sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots.

Suggested Readings

11) Daly GC (Ed) (1997), Nature's Services: Societal Dependence on Natural Ecosystems, Island Press, Washington DC
12) Dobson AP (1996), Conservation and Biodiversity, Scientific American Library, New York
13) Gaston K J and J I Spicer (1998), Biodiversity - an Introduction, Blackwell Science, London
14) Groom bridge B, and M Jenkins (2000), Global Biodiversity: Earth's Living Resources in the 21st Century, World Conservation Press, Cambridge, UK
15) IUCN (2004), Red list of threatened species - a global species assessment, IUCN, Gland, Switzerland

16)Loreau M, and P Inchausti (2002), Biodiversity and Ecosystem functioning: Synthesis and Perspectives, Oxford University Press, Oxford
17)Primack RB (2002), Essentials of Conservation Biology (3rd Edition), Sinauer Associates, Sunderland, SA
18)Pawar SN, RB Patil and SA Salunkhe (2005), Environmental Movements in India: Strategies and Practices, Rawat publications, Jaipur
19)Wilson Edward O (1993), Diversity of Life, Harvard University Press, Cambridge, MA
20)Walters C (1986), Adaptive Management of Renewable Resources, Macmillan Publishing Company, New York
21)Craig J R, Vaughan D J and Skinner B J (1996), Resources of the Earth: origin, use, and environmental impact (2nd Edition), Prentice Hall
22) Klee G A (1991), Conservation of natural resources, Prentice Hall
23)Owen O S, Chiras DD, Reganold JP (1998), Natural resource conservation - management for a sustainable future (7th Edition), Prentice Hall
24)Abiud Kaswamila (Editor) (2012), Sustainable Natural Resources Management, InTechOpen
25)Francois Ramade (1981) Ecology of Natural Resources, John Wiley & Sons Inc
26)Zilberman David, Goetz Renan and Garrido, Alberto (Editors) Natural Resource Management and Policy, Springer
27)Perman R, Yue Ma and McGilvray J (1997) Natural Resource and Environmental Economics, Longman Scientific & Technical
28)Mohan Munasinghe (1997), Environmental Economic and Natural Resource Management in Developing Countries, World Bank
29)Khanna LS and A N Chaturvedi (2000), Handbook of Forestry, Khanna Bandhu publications, Delhi
30) Dwivedi A P (1993), Forestry in India, Surya publications, Dehra Dun
31)Richard Welford (Editor) 1999, Corporate Environmental Management – Systems and strategies, University press (India) limited, Hyderabad
32)Forest L Reinhadt (2000), Down to Earth - Applying Business principles to Environmental Management, Harvard Business school press, Massachusetts

ES 3C 14: Waste and Waste Management

Module I: Wastes: Definition, types (solid and liquid), sources, characteristics; waste generation rates: Indian and International scenario; municipal wastes, agricultural wastes, sewage sludge, industrial wastes and

mining wastes, hazardous wastes, biomedical waste, management of solid waste, waste treatment methods (Incineration, pyrolysis); concepts of waste reduction, recycling and reuse; energy recovery, environmental impacts of wastes.

Module II: Solid wastes: Source, categories, generation rates; Waste management approaches (collection, segregation and transport of solid wastes); handling wastes at source, domestic, municipal solid wastes; recycling of wastes and waste minimization techniques; solid waste processing technologies, mechanical and thermal volume reduction; biological and chemical techniques for energy and other resource recovery; Treatment methods (composting, incineration, pyrolysis, sanitary landfills); Waste disposal in landfills (site selection, design, and operation of sanitary landfills, secure landfills and landfill bioreactors); leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation).

Module III: Hazardous wastes: Definition, sources and characteristics: Hazardous waste categorization, generation, collection, transport, treatment and disposal: Biomedical wastes - type, collection, segregation at source, and treatment methods; Nuclear waste - quantity of generation, treatment and management options; Legislation on management and handling of municipal solid wastes, bio-medical wastes and hazardous wastes

Module IV: Wastewater and its treatment: Water as a scarce natural resource, sources of water pollution; Wastewater treatment, anaerobic, aerobic process, methanogenesis, bioreactors, cell and protein (enzyme) immobilization techniques; Treatment schemes for waste water, dairy, distillery, tannery, sugar, antibiotic industries

Module V: Vermicomposting and vermitechnology: Introduction to the concepts; waste biomass resources, utilization of organic manure; waste and earthworms, vermicomposting - the concept, advantages and phases; case studies / success stories in India for management of different types of solid wastes.

Suggested reading

1) Rao CS, Environmental Pollution Control Engineering, Wiley Eastern Limited, New Delhi
2) Sharma BK, Environmental Chemistry, Goel Publishing House, Meerut
3) Jogdanand SN, Environmental Biotechnology: Industrial Pollution Management. Himalaya Publishing House, India
4) Santra SC, Environmental Science (4th or Revised Edition), New Central Book Agency, Calcutta
5) Dey AK, Environmental Chemistry, Wiley Eastern India Limited, New Delhi
6) Timmy Katyal, Masatada Satake (1989), Environmental Pollution, Anmol Publications,India
7) L K Wand et al (edited), Handbook of industrial and hazardous wastes treatment, Marcel Dekker, New York
8) Gilbert M Masters (1997), Introduction to Environmental Engineering and Science (2nd Edition), Prentice Hall
9) Lawrence K Wang, Yung-Tse Hung, Howard H Lo, Constantine Yapijakis, Kathleen Hung Li (Eds.) (2005), Handbook of Industrial and hazardous wastes treatment (Second Edition), Marcal Dekker Inc
10) J C Crittenden Et al (2005), Water Treatment - Principles and Design (Second Edition), John Wiley & Sons
11) Gilbert M Masters (1997), Introduction to Environmental Engineering and Science (2nd Edition), Prentice Hall
12) Robert U Ayres, Leslie Ayres (Editors) (2002) A Handbook of Industrial Ecology, Edward Elgar Publishing Limited

ES 3C 15: Bio-statistics, Quantitative Methods & Ecoinformatics

Module I: Data classification and Tabulation: Numerical Description of Data: Mean, Median, Mode, Quantiles, Standard Deviation, Kurtosis and Skewness, Variance, Coefficient of Variation, Random Variables, Discrete and Continuous variable, Expected Value, Variance; Population Mean, Population Variance; Limit Theorems: Central Limit Theorem, Strong Law of Large Number, Weak Law of Large Number

Module II: Data distributions and transformations: Normal, Binomial, Poisson, logarithmic distributions; Basic probability and statistics, probability fundamentals, computation and laws of probability, fundamentals of inference; probability theory, sample space and events, axioms of probability, conditional probability, independent events, Bayes' Formula; Data analysis: Simple linear regression and correlation, Linear Regression Models, Least Squares method, estimating equations; Tests

of hypothesis; non-parametric and parametric tests, Chi -square, t and F test; ANOVA; Estimation theory, unbiased estimator, confidence Interval; softwares for data analysis, Excel, SPSS, Minitab and R

Module III: Data representation: Frequency distribution, cross tabulation and pivot tables; graphs and charts, construction of bar, pie charts, line charts; best fit curves; use of software for data analysis / graph / reports, Excel / SPSS / R. Multivariate statistical techniques: Introductions to Factor analysis, principal component analysis, discriminant analysis, cluster analysis, and correspondence analysis

Module III: Introduction to Database Management System (DBMS): Introduction to Linux / open source platforms with basic commands; Data Structures in eco-informatics; Database Design, Structured Query Language; Designing Databases for eco-informatics; Data warehouse, Data mining, Data Mart; Web Applications Development in eco- informatics: Introduction to Internet, protocols, WWW, URL, Web Site, Web Browser, Web Server, Application Server, Database Server, Internet & Database Connectivity

Module IV: Mathematical models and computational tools for eco-informatics: Introduction to Artificial Neural Networks; Probabilistic models; Likelihood and maximum likelihood algorithms and their applications in eco-informatics; Pattern Discovery, Association and Classification; Eco- informatics applications in Natural Resources Management, wildlife conservation and management, habitat suitability studies, habitat modeling, in study of anthropogenic pressures on environment such as industrialization, urbanization and other threats

Suggested Readings

1)Ludwig J A and James F Reynolds (1988), Statistical Ecology, John Wiley & Sons

2)Gupta SP (2004), Statistical Methods, Sultan Chand & Sons New Delhi

3)Robert R Sokal and F James Rohlf (1994), Biometry: the principles and practices of statistics in biological research (3rd edition), W H Freeman

4)Zar Jerrold H (1999), Biostatistical analysis, Person Education, New Delhi

5)Bowerman Bruce L, Richard T O'Connell and Michael L Hand (2001), Business statistics in Practice, McGraw-Hill Irwin

6)Harry Frank and Steven C Altheon (1994), Statistics - Concepts and applications, Cambridge

7)Frederick E Croxton, Dudley J Cowden and Sidney Klein (1979), Applied General Statistics, Prentice Hall India

8)Richard I Levin and David S Rubin (1997), Statistics for Management (7th Edition), Prentice Hall.

9)Digby PGN and RA Kempton (1991), Multivariate analysis of ecological communities, Chapman and Hall, London

10) Friedrich Recknagel (Editor) (2005), Ecological Informatics - Scope, Techniques and Applications, Springer

11) Stefano Ceri and Giuseppe Pelagatti (2000), Distributed Databases: Principles and Systems, Universities Press

12) Jan L Harrington (2000), Object Oriented Database Design Clearly Explained, Harcourt

13) Elmasri Ramez and Navathe, Shamkant B (2000), Fundamentals of Database Systems, Pearson

14) Longley PA, Goodchild MF, Maguire DJ and Rhind DW (2005), Geographic Information Systems and Science (2nd edition), Wiley

15) Zeiler Michael (2002), Modeling Our World, The ESRI Guide to Geodatabase Design, Environmental Systems Research Institute Inc, California, USA

16) Mitchell A (1999), The ESRI Guide to GIS Analysis Volume 1: Geographical Patterns and Relationships, Environmental Systems Research Institute Inc, California, USA

17) Noel Cressie (1991), Statistics for Spatial Data, John Wiley & Sons

18) Lillisand TM, R W Kiefer and Chipman (2004), Remote sensing and image interpretation (5th edition), John Wiley & Sons, New York

ES 3C 16: Ecosystems and Global Climate Change

Module I: Earth Systems: Earth's geological history and development and evolution of the earth systems; Gaia Hypothesis; Introductions to various systems - Atmosphere, Hydrosphere, Lithosphere, Biosphere and their linkages, types of ecosystems

Module II: Atmosphere, oceans and climate: Basic atmospheric properties, climatic controls, Climatic classifications and variability; Movement in the atmosphere, global scale, regional scale, local scale; Oceans: General circulation patterns; Air- Sea interactions; role of the oceans on climate

Module III: Global Energy balance: Source, transfer, distribution; Energy balance of the atmosphere; Wind, stability and turbulence; Monsoons; El Nino, Southern Oscillations, cyclones

Module IV: climate and its changes: Records of climate change (glacial cycles, ocean sediments, corals, tree rings); Human Impacts on climate, Causes and consequences of Global warming, Greenhouse effect, Global and regional trends in greenhouse gas emissions; Sea level rise; role of oceans and forests as carbon sinks; Ozone depletion- stratospheric ozone shield, Ozone hole;

Module V: Impacts of Climate change: Effects on organisms including humans; effects on ecosystems and productivity; species distribution ranges; spread of diseases; Extinction risk for temperature-sensitive species; UV effects; Climate change and Policies, Montreal Protocol, Kyoto Protocol, Carbon trading, clean development mechanisms

Suggested readings

1) Barry R G (2003), Atmosphere, weather and climate, Rutledge Press, UK
2) Critchfield Howard J (1998), General climatology, Prentice Hall India, New Delhi

3) Firor J, and J E Jacobsen (2002), The crowded greenhouse: population, climate change and creating a sustainable world, Yale University Press
4) Glantz M H (2003), Climate Affairs: a primer, Island Press
5) Harvey D (2000), Climate and Global Climate Change, Prentice Hall
6) Kump LR, Kasting JF and Carne R G (2004), The Earth System (3rd Edition), Prentice-Hall
7) Inter governmental Panel of Climate Change (IPCC) Reports

ES 3C 17: Practical – V: Microbiology & Statistical techniques

- Statistical data analysis using software applications
- Preparation of charts, graphs and reports
- Basic techniques in Microbiology
- Coliforms as indicators of faecal pollution- Enumeration and identification of Coli form (fecal and non-fecal) using MPN method in surface waters
- Identification of a few fungal species in vegetation soils and mycelia culture

ES 3C 18: Practical – VI: Biodiversity

- Biodiversity sampling
- Estimation of population size
- Estimation of biomass – destructive and non-destructive methods
- Estimation of species richness - Fish, Reptilian, Avian, Mammalian
- Diversity indices
- Similarity coefficients
- Report on the visits to water treatment, waste water treatment and sewage treatment
  plants
- Report on the visits to Air pollution monitoring station; making flow sheets.
- Viva-Voce based on the above reports.

SEMESTER - IV

ES 4C 19: Project/Dissertation

Project / dissertation would be based on an original work done by the student on a topic related to environmental sciences

Viva-Voce based on the above two project reports.

ES 4E 20: Environment, Occupational Health & Safety

Module I: Environmental Health and Safety: Concept of Environment, health and safety; Diseases through pollution; Management to control diseases; Occupational Health, Health and Safety Considerations; Environmental Health and Human Society

Module II: Environmental Health and Occupational Hygiene: Basis of environment and occupational health, biological monitoring (e.g. BEI), Occupational Hygiene, Preventive Measures; Occupational Health & Safety Management System, OHSAS – 18000.

Module III: Pollution, radiation and Industrial Hazards: Types and effects of pollution and radiations on human body, Measurement and detection of radiation intensity; Measurement and disposal of wastes, radioactive waste; Industrial noise, measurement, sources, control, effects of noise on human and environmental health; air pollutants, effect of different gases and particulate matter, acid fumes, smoke, fog on environmental and human health; Vibration - effects, measurement and control measures

Module IV: Health problems in different types of industries: Construction, textile, steel and food processing, tanneries, Cement, Thermal and nuclear power plants, pharmaceuticals; Occupational Health and Safety considerations in Waste Treatment Plants

Module V: Safety and Health Management: Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety; Ergonomics, Introduction, Definition, Objectives, Advantages; Ergonomics Hazards, Musculoskeletal Disorders and Cumulative Trauma Disorders; Importance of Industrial safety, role of safety department, Safety committee and Function

Suggested readings

33) A J Rowland and Paul Cooper (1983), Environment and Health, Edward Arnold Publishers Ltd, Basic Concepts of Environmental Health – NIH Publication No. 80-1254, 1980
34) Encyclopedia of Occupational Health & Safety (Vol 1 & 2, 3rd Revised Edition), International Labour Organization
35) R K Jain and Sunil S Rao (2006), Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi
36) Slote L, Handbook of Occupational Safety and Health, John Willey and Sons, New York

ES 4E 21: Remedial Mathematics

Module I: Number system in mathematics: Rational numbers, geometric interpretation of rational numbers, irrational numbers, whole numbers, integers, real numbers, prime numbers, concept of infinity

Module II: Sets, relations and functions, and matrices: notations and symbols, sets - complementary sets, union, intersection, relations and functions - product sets, relations and functions; matrices and functions -matrix notations, matrix algebra, applications

Module III: Differential and integral calculus: growth rate, differentiation, anti derivatives, integrals, integrations, second derivative, extremes, mean of continuous functions

Module IV: Probability: introduction, events, concept of probability, axioms of probability theory, conditional probabilities, counting, binomial distribution, Poisson distribution, continuous distribution

Module V: Functions of two or more independence variable: Introduction, partial derivatives, maxima and minima, partial differential equations; case studies

Suggested readings

1) Peter C. Foster (1999), Easy Mathematics for Biologists, CRC Press
2) Batschelet Edward (1979) Introduction to mathematics for life scientists, Sprinegr-verlag

3) Courant Richard, Herbert Robbins and Ian Stewart (1996), What is mathematics, Oxford University Press
4) Edward K Yeargers, James V Herod, Ronald W Shonkweiler (1996), An Introduction to the Mathematics of Biology, Birkhäuser Boston
5) Nicholas F Britton (2004), Essential Mathematical Biology (2nd edition), Springer
6) Murray JD (2002), Mathematical Biology: An Introduction (Third Edition), Springer
7) Sarah P Otto and Troy Day (2007), A Biologist's Guide to Mathematical Modeling in Ecology and Evolution, Princeton University Press

ES 4E22: Hydrology and Water Resources

Module I: Introduction to hydrology: Definition, History of hydrology, Branches of hydrology - Chemical hydrology, Eco-hydrology, Hydrogeology, hydro-informatics, hydrometeorology, isotope hydrology, surface hydrology

Module II: The hydrologic cycle: Structure and properties of water, Inventory of Earth's water; different process of hydrologic cycle - precipitation, Canopy interception, snow melt, run off , sub surface flow, infiltration, evaporation, transpiration, sublimation, advection,condensation

Module III: Surface water resources: precipitation, infiltration, water balance, Evapo-transpiration and runoff; Drainage basin, Surface water hydrology - rainfall and surface runoff relationship, runoff, runoff characteristics, open channel flow; Statistical analysis in hydrology, Probable maximum precipitation, hydrograph, flow duration curve, Flood frequency analysis and estimation, Water balance

Module IV: Groundwater resources: Rock properties affecting ground water, vertical distribution of ground water, zone of saturation; Darcy's law - permeability, transmissivity and storage coefficient; Viscous character of groundwater flow; Geologic formations as aquifers, type of aquifers; Distribution of water - local, regional and global; Ground water exploration.

Module V: Water resource management: Flood and flood plain management; Water-shed management, water harvesting and artificial recharge to ground water; water pollution and water treatment; Wetland and

riparian management; forest management and water resources; Issues concerned with river linking in India

Practical

- Hydrologic measurements: water budgeting, Precipitation -Rain (Rain gauge), Humidity (Sling psychrometer, thermo hydrograph), Evaporation (Evaporation pan), Transpiration, Evaluation of hydrologic parameters; catchment delineation and water balance, Hydrograph analysis.

Suggested readings

1) Aggarwal A (1991), Floods, Floodplains and Environmental Myths, Centre for Science and Environment, New Delhi
2) Andrew D Ward and Stanley Trimble (2004), Environmental Hydrology (2nd Edition), Lewis Publishers
3) Karanth KRC (1988), Ground Water: Exploration, Assessment and Development, Tata-McGraw Hill, New Delhi
4) Mahajan G (1989), Evaluation and Development of Groundwater, Ashish Publishing House, New Delhi
5) Rao KL (1982), India's water wealth, Orient Longman, Delhi
6) Subramaniam V (2002), Text Book of Environmental Science, Narosa Publishing House, Delhi
7) Timothy Davie (2003), Fundamentals of Hydrology, Rutledge, Taylor and Francis Group, UK
8) Todd DK (2004), Groundwater Hydrology, John Wiley & Sons Inc
9) Vijay P Singh (1995), Environmental Hydrology, Kluwer Academic Publications, The Netherlands
10) Wright RT and Nebel BJ (2002), Environmental Science: toward a sustainable future, Prentice Hall India Ltd, 8th Edition

ES 4E 23: Indian Environmental Laws

Module I: Environmental ethics: Concepts, Ethical theories, consequential theory, deontological theory, virtue ethics, situation ethics, feminist ethics, Illustration cases, DPGs, Bio-piracy, GMO, Stem cell research. Environment and constitution of India, Environmental legislature Machinery, Constitutional Status of Environment, Duty to Protect Environment

Module II: Major Indian Environment / conservation related acts: Introduction to Water (Prevention and Control of Pollution) Act - 1974, Water (Prevention and Control of Pollution) Cess Act -1974, Wildlife (Protection) Act -1972, Forest (Conservation) Act -1980, Air (Prevention and Control of Pollution) Act -1981, The Environment (Protection) Act -1986, The Public Liability Insurance Act - 1991

Module III: Laws on Water and air pollution Control: Powers of Central and State Pollution Control Boards, Prevention and Control of Water Pollution, Closure or Stoppage of Water and Electricity Supply, Power of Central / state Governments to supersede the respective Central / State Boards; Air Pollution Control Areas, pollution control strategies, Prohibition of Emission of Air Pollutants

Module IV: Environment (Protection) Act 1986: Powers of Central Government, Legal Regulation of Hazardous Substance, Hazardous Wastes (Management and Handing) Rules 1989, The Natural Environment Tribunal Act 1995, Legal Measures to Control Noise Pollution, solid waste management and handling rules-2000; Bio- medical wastes (Management and Handling) Rules 1999; Coastal Regulation Zone Notification-1991

Module V: International environmental treaties and conventions: Montreal Protocol, Earth Summit, Agenda 21, Biodiversity Act - 2002, Kyoto Protocol, Copenhagen Summit 2009, Millennium Development Goals, Basel convention

Suggested Readings

1) Gurdip Singh (2005), Environmental Law in India, Macmillan India Ltd, New Delhi
2) Bala Krishnamoorthy (2005), Environmental Management, Prentice Hall of India Private Limited, New Delhi
3) Agarwal SK (1997), Environmental Issues and themes, APH Publishing Corporation, New Delhi
4) John O Neil, R Kerry Turner and Ian J Bateman (Ed.) (2001), Environmental Ethics and philosophy, An Elgar Reference collection, USA
5) Trivedi RK, Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards (Vol I and II), Enviro Media
6) Jadhav H and Bhosale VM (1995), Environmental Protection and Laws, Himalaya Publishing House, Delhi

ES 4E 24: Environmental Disaster Management

Module I: Disaster Management System - Flood Damage Assessment, Environmental Impact Analysis, Transboundary Air Pollution, Site suitability assessment, Pollution Monitoring and Management, Vehicular Pollution Assessment, Prediction and Forecasting

Module II: Weather and climate: climate science, thermal inversion, heat island, natural hazards:volcanoes, Earth quake, tsunami, land slide, tornadoes, storms, Hurricane and flood.coastal erosion Air pollution: - sources and impacts, -Green house gases; global warming,acid rain, Enso:-el-nino; na-nino.climate change: Treatise and convention -ICCC.

Module III: Realms of Environment: Atmosphere, hydrosphere, lithosphere and Biosphere. Solar system, the Earths origin, age and internal constitution. Geological timescale. Overview of natural resources - Environmental problems faced by India and the world.Sustainable development-problems and perspectives.

Module IV: Forest protection and management: objectives and principles; Introduction to Silviculture,and silvicultural systems; forest protection- fire, injuries by exotic and noxious plants,animals,and Shifting cultivation; forest covermonitoring.

Module V: Hydrologic hazards: earthquake, acid rain, eutrophication, flood, landslides, salt-water intrusion, avalanches, drought, desertification. Urbanization stress and health; Water in relation to human health: case studies.

Suggested Readings

1) Nyle C Brady (1996), Nature and Properties of soil, Collier Macmillan International Editions
2) John,H.(2004).Global Warming: Complete Briefing.3rd Ed., Cambridge University Press
3) Nicholas, S. (2007).The Economics of Climate Change: The Stern Review. Cambridge University Press .
4) Andrew E. D. and Edward, A.P. (2006). The Science and Politics of Global Climate Change: A Guide to the Debate .Cambridge University Press .New York.

5) R N Muller and R L Donahue (1996), Soils in our environment, Pratier hall India
6) Aulay Mackenzie and Sonia R Virdee (2002) Ecology Instant Notes by, Viva Books Private Limited, NewDelhi
7) G Tyler Miller (????), Environmental Science, Thompson Brooks Cole
8) Chris Park (????), The Environment - Principles and Applications, Rutledge
9) Stanley E Manahan (????), Environmental Science and Technology, Taylor and Francis
10) G Tyler Miller (????), Living in the Environment

ES 4E 25: Current Environment Issues In India

Module I: Realms of Environment: Atmosphere, hydrosphere, lithosphere and Biosphere, Solar system, overview of natural resources; Environmental problems faced by India and the world; Sustainable development, concepts, problems and perspectives

Module II: Weather and climate: climate science, thermal inversion, heat island; natural hazards, volcanoes, Earth quake, tsunami, land slide, tornadoes, storms, Hurricane and flood; coastal erosion; Green house gases; global warming, acid rain, Enso, el-nino, la-nino, climate change, treatise and conventions

Module III: Environment, Forest and wildlife: Forests in India forest cover and types of forests, deforestation and conservation, biodiversity, wildlife- endangered and threatened species, Biosphere reserves, wet lands, mangroves and coral reefs, wildlife conservation in India, Illegal trade in wildlife – poaching; Recent measures for wildlife protection and conservation national heritage - UNESCO's World Heritage list

Module V: Social construction of environmental issues: anthropogenic pressure, conflicts and negotiation; Benefit-cost approach to environmental problems; Institutional mode of environmental planning- policy formulation and strategies

Module V: Environmental movements: History, People's movement for environmental conservation in India-Bishnoi Movement, Chipko Movement, Narmada Bachao Andolan, Apikko movement, Silent Valley Movement, Baliyapal, Silent valley movements, drivers for the

environmental movement, popular movements and people's participation

Suggested Readings

1) Guha Ramachandra and J Martinez Alier (2000), Varieties of Environmentalism, Oxford University Press, Delhi
2) Ramachandra Guha (2000), The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalaya, University of California Press
3) S K Agarwal (1997), Environmental Issues and themes, APH Publishing Corporation, New Delhi

ES 4E 26: Wildlife and Avian Biology

Module I: Wildlife and avian biology: Concepts, various taxa, domestic vs. wild, endemism, ecological, economic, ethical other significance of wild species; vertebrates and invertebrates

Module II: Biology and Taxonomy of certain wild species: Amphibians, fishes and reptiles - brief taxonomy; Extinct, threatened, endangered and endemic species - Population status, distribution, feeding and Breeding habits, major threats to their survival and conservational significance

Module III: Biology and Taxonomy of certain wild species: Aves - brief taxonomy; Extinct, threatened, endangered and endemic species; Population status, distribution, feeding and Breeding habits, major threats to their survival and conservational significance

Module IV: Biology and Taxonomy of certain wild species: Mammals - brief taxonomy; Extinct, threatened, endangered and endemic species; Population status, distribution, feeding and Breeding habits, major threats to their survival and conservational significance

Module V: Environmental Impact on Wildlife: Wildlife conservation and management; Anthropogenic pressures on wild fauna and flora; Habitat loss, Habitat fragmentation, industrialization, urbanization and other threats; extinctions (historical and recent); Risks faced by small populations, minimum viable population, population viability analysis, diagnosis of declines; Biodiversity hot spots, reserve design in theory

and practice; Wildlife diseases, and their management; Wildlife administration and legislation; Sanctuaries, national parks, biosphere reserves

Suggested Readings

1) Sutherland William J (2000), The conservation handbook - research, management and policy, Blackwell Science
2) Rajesh Gopal (1992), Fundamentals of wildlife management, Justice Home, Allahabad
3) Grzimek's Animal life Encyclopedia (1972)- Vol 1-13, Van Nostrand Reinhold Company
4) Giles R II (1994), Wildlife Management Techniques (3r Edition), Nataraj Publications, Dehra Dun
5) Esmond Harris and Jeanette Harris (1997), Wildlife conservation in managed woodlands and forests (2nd Edition), Research Studies Press and John Wiley & Sons
6) Ali Sálim and Ripley (1983) Handbook of birds of India and Pakistan (2nd Edition), Oxford University Press
7) Prater SH, The Book of Indian Animals, BNHS/Oxford
8) Alfred JRS, Das AK and Sanyal AK (1998), Faunal diversity in India, ZSI Calcutta
9) Daniel JC (2002), The book of Indian Reptiles and Amphibians, Oxford
10) Sálim Ali (2002), The book of Indian Birds (revised edition), BNHS & Oxford university press, New Delhi
11) Sharma B D (1999), Indian wildlife resources: Ecology and development, Daya publishing House, Delhi
12) Singh Samar (1987), Conserving India's Natural Heritage, Nataraj Publication
13) Aaron NM (1973), Wildlife ecology, WH Freeman Co, San Francisco, USA
14) Negi SS (1993), Biodiversity and its conservation in India, Indus Publishing Co, New Delhi
15) Caughley G and Gunn A (1996), Conservation biology in theory and practice, Blackwell
16) Soule ME (Ed) (1996), Conservation Biology, Sinauer Associates Inc, Massachusetts

ES 4E 27: Environmental Economics

Module I: Nexus Between Ecology and Economics - The Principle of Material Balance - Private versus Social Cost - Resilience - Entropy - Trade-Off

Between Economic Growth and Ecological Balance - Renewable and Non-Renewable Resources - Sustainable Development

Module II: Economic Theory for Resource Allocation Policy - Externalities - Economic Coordination and the Price System - Market Equilibrium Analysis in Natural Resource Economics - Pareto Efficiency' and the Market - Property Rights and Economic Efficiency - Limits to Growth - Technology versus Environment - Coase's Theorem - Simon Kuznets's Inverted 'U' Shaped Curve

Module III: Two Kinds of Environmentalism - Rich and Poor - Poverty and The Environment - Cross Cultural Environmental Ethics - The Merchandising of Biodiversity - Genetic Erosion - Peasant Struggle to Control Seeds - Farmers' Rights

Module IV: Economics of Pollution Control - Environmental Impact Assessment - Evaluation of Project and Programme – Benefit / Cost Analysis - Contingent Valuation Method - Measurement of Environmental Damages - Valuing Environmental Benefits: Hedonic Price Approach - Ecological Footprint Approach, Systems Approach

Module V: Renewable resources - Growth curves - the rate of exploitation - open access and Common Property solutions - exhaustible resources - monopoly and the rate of extraction - ecosystem services - Institutional approach to environment problems

Suggested Readings

1) Sengupta Ramprasad (2001), Ecology and economic - an approach to sustainable development, Oxford
2) Adiseshiah Malcolm S (editor) (1987), Economics of environment, Lancer International, India International Center, New Delhi
3) Pearce David W and R Kerry Turner (1990), Economics of Natural Resources and the Environment, Harvester wheat sheaf, New York
4) Seneca Joseph J and Michael K Taussig (1974), Environmental Economics, Prentice Hall, New Jersey
5) Kerr John M, K Marothia Dinesh, Katar Singh, C Ramasamy and R Bentley William (editors) (1997), National Resource Economics - Theory and application in India, Oxford & IBH publishing Co, New Delhi
6) Kolstad Charles D (2000), Environmental Economics, Oxford University Press, New York
7) Pearce David and Dominic Moran (1994), The Economic value of biodiversity, Earth scan

Scheme of Examination

Scheme of Examination should be under CUCSS Pattern. Pattern of questionpaper as follows:

- Short answer type- number 1 t0 14 (no choice) 14x1=14 weightage
- Paragraph type- number 15 to 24 (7 out of 10) 7x2=14 weightage
- Essay type- number 25 to 28 (2 out of 4) 2x4 = 8 weightage

(Total 36weightage)

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