M.Sc. Environment Science and Management

Master of Science

PROGRAM STRUCTURE AND SYLLABUS
2019-20 ADMISSIONS ONWARDS

(UNDER MAHATMA GANDHI UNIVERSITY PGCSS REGULATIONS 2019)

EXPERT COMMITEE IN ENVIRONMENTAL SCIENCE
MAHATMA GANDHI UNIVERSITY

2019

THE EXPERT COMMITEE IN ENVIRONMENTAL SCIENCES

Chairman: **Prof. (Dr.) E.V. Ramasamy**, Dean, Faculty of Environmental and Atmospheric Sciences, Director, School of Environmental Sciences, Mahatma Gandhi University

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2. Dr. Baiju K.R. Associate Professor, School of Environmental Sciences, MGU
3. Dr. Mahesh Mohan, Assistant Professor, School of Environmental Sciences, MGU
4. Dr. Sylas V.P. Assistant Professor, School of Environmental Sciences, MGU
5. Mr. Sajithkumar K.J, Guest Lecturer, Department of Environmental Sciences, Sree Sankara College, Kalady
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Contents

M.Sc. Environment Science and Management Degree Program
(Mahatma Gandhi University Regulations PGCSS2019 from 2019-20 Academic Year)

1. Aim of the Program

The programme aims to provide an integrated knowledge of diverse disciplines and training on various theoretical and applied aspects of environmental science and management. The course content keeps abreast with the latest developments in the area of study. The students have to do a full time institutional or industrial training/ project work for four to five months, enabling them to have valuable hands on experience in the real world. The theory, practical, project work and training activities of this programme pave the students to acquire knowledge, skill and expertise on specified subjects along with the integrated knowledge of all relevant disciplines. This provides them to have theoretical and professional competency in planning, decision making and execution of any activity in the field of environment management with the primary aim of sustainable development.

The students of this programme equip themselves to fit for a wide range of opportunities available in research institutions, public and private organizations/ industries, NGO's and consultancy firms in areas of environmental analysis, resource management, environmental planning, pollution monitoring and control, environmental biotechnology, environmental toxicology, waste and hazard management, EIA, EMS, conservation of nature and bio-resources, remote sensing, GIS, forest and wildlife management, etc., and also for research in various disciplines of environmental science.

2. Eligibility for Admissions

B.Sc Degree in any one of the science subjects (Botany/Zoology/Chemistry/Physics/EnvironmentalScience/EnvironmentManagement/Microbiology /Biotechnology/Biochemistry/Agriculture/Horticulture/Forestry/any branch of Life Science/Geology/Geography) or an equivalent examination or an engineering degree in Civil/Mechanical/Chemical/ Environmental branch with an aggregate of 55% marks in the optional.

3. Medium of Instruction and Assessment: English
4. Faculty under which the Degree is Awarded: This programme is carried out under the faculty of Environment and Atmospheric Science

5. Specializations offered, if any: No

6. Note on compliance with the UGC Minimum Standards for the conduct and award of Post Graduate Degrees

7. THE PROGRAM STRUCTURE

Course Code	Title of the Course	Type of the Course	Hours per week	Credits
FIRST SEMESTER				
ES010101	Ecology and Biodiversity Conservation	Core	3	4
ES010102	Environmental Geosciences	Core	3	4
ES010103	Environmental Chemistry, Instrumentation and Analytical Techniques	Core	3	4
ES010104	Environmental Pollution and Management	Core	3	4
ES010105	Research Methodology and Statistics	Core	3	3
ES010106	Laboratory Course Part 1	Core	10	5
SECOND SEMESTER				
ES010201	Eco Toxicology and Occupational Health Hazards Management	Core	3	4
ES010202	Environmental Microbiology	Core	3	4
ES010203	Introduction to Geo-informatics	Core	3	3
ES010204	Environmental Laws, Education and Policies	Core	3	4
ES010205	Laboratory Course Part 2	Core	10	5
THIRD SEMESTER				
ES010301	Environmental Engineering	Core	3	4
ES010302	Environmental Planning and Resource Management	Core	3	4
ES010303	Laboratory Course Part 3	Core	10	5
Elective 1			3	4
Elective 2			3	3
FOURTH SEMESTER				
ES010401	Environmental Biotechnology and Waste Management	Core	3	3
Elective 3			3	3
ES010403	Project Work (Report/Thesis)	Core		5
ES010404	Comprehensive Viva Voce	Core		5

Elective Group-A			
Sl No	Course Code	Title of the Course	Credits
1	ES800301	Environmental impact assessment and Audit	4
2	ES800302	Environmental Economics and Sustainable Development	3
3	ES800403	Disaster Management	3
Elective Group-B			
Sl No	Course Code	Title of the Course	Credits

1	ES810301	Green Chemistry and Nanotechnology	4
2	ES810302	Natural and Anthropogenic Disasters	3
3	ES810403	Climate Change and Governance	3

FIRST SEMESTER COURSES

ES010101	Ecology and Biodiversity Conservation
ES010102	Environmental Geosciences
ES010103	Environmental Chemistry, Instrumentation and analytical techniques
ES010104	Environmental Pollution and Management
ES010105	Research methodology and statistics
ES010106	Laboratory Course Part1

COURSE CODE- ES010101
ECOLOGY AND BIODIVERSITY CONSERVATION

Number of Hours - Week: 3 **Credits: 4**

Course Outcome

The Course enables the students to:

1. Understand the concepts of ecology and environment
2. Study the structure, organization and processes in ecosystem
3. Understand the structural and functional aspects of a population as an ecological unit
4. Explain the concept of biological community, changes and interactions within community.
5. Understand conservation biology, its need and methods.
6. Explain the concept of ecology and relevance of environmental science.
7. Develop skill on applied aspects of ecology including mathematical or conceptual model of population or community dynamics to analyse the various factors of population growth and regulation

Unit 1 Introduction

1.1. Basic concepts of Environment
1.2. Definition, principles and scope of Environmental Science
1.3. Multidisciplinary approach
1.4. Basic concepts - Science, Matter and Energy
1.5. Global environmental issues – an introduction

Unit 2 Environmental Ecology

2.1. Definition-History of Ecology-Subdivisions of ecology (Autecology and Synecology)-Ecology and other subjects (Relationship)-
2.2. Fundamental ecological variables (Matter, light, Time, Space & Diversity)-Ecology and environment management:- Holistic approach, Gaia Hypothesis
2.3. Ecosystems-Definition –classification: Terrestrial: Biomes; Aquatic-lentic-lotic-Fresh and marine water
2.4. Components of Ecosystem-Structure-function and size of ecosystem
2.5. Nutrient cycles-Energy Flow- Biogeochemical cycles-Trophic relations-Food chain, Food-web and Ecological pyramids-- Productivity and ecological efficiencies
2.6. Biogeography:-Definition and history-Classification of Biogeography zones-Phytogeography:-Floristic regions of the World and India-Zoogeography:-Zoogeographical regions of the World and India
2.7. Comparative Ecosystem Ecology-Structure, Function and Characteristics of Forests and Tundras (Temperature & Tropical Forests, Arctic and Alpine Forests), Deserts (Arid and Semi-Arid), Grassland and Savannas, Coastal and Marine, Coral Reefs, Wetlands (Lakes, Rivers, Estuaries, etc.), Mangroves, (Through Assignments and Seminars)

Unit 3 Population Ecology

3.1. Definition-Structure and measurements:-Density-Growth-Natality-Mortality-Population dispersal and distribution-Population growth:-Factors affecting population-Carrying capacity-Population Regulation- Strategies of species survivability (r- selection and k- selection)

3.2. Population Genetics:-Mendelian population-Gene frequency-Gene pool and genetic drift-Hardy- Weinberg-equilibrium-Change in Gene Frequencies- Ecotypes and other related terms

3.3.Human Population:-Historical overview-Characteristics of human population growth-Exponential growth-Age-Sex distribution-Trends in human population growth

Unit 4 Community Ecology

4.1. Concepts of Community- Community gradients (Ecotone, Edge Effect, Continnum Concept)

4.2. Primary production in Terrestrial and Aquatic Communities-Productivity measurements.

4.3. Ecological Succession-Kinds of Succession (Hydrarch and Xerarch)

4.4. Community Organization: Ecological Niche-.Interactions between species:Competition-Predation-Mutualism-Commensalism-Parasitism-Allelepathy

4.5. Stress Ecology and Adaptation

Unit 5 Applied Ecology

5.1. Estimating Abundance:-Mark and Recapture Method -Quadrat and Line Transect's-Distance and Removal Methods-Trapping and Collection techniques-Census technique for Avifauna and Wildlife

5.2. Species Diversity measures:-Species richness-Species Heterogenecity (Simpson's Indices, Shannon-Wiener Indices)-Vegetational Profile assessments- Taxonomy and Biosystematics

5.3. Eco-informatics-concepts and principles

Unit 6 Concept of Biodiversity Conservation

6.1. Biodiversity: An introduction- Definition- Types of biodiversity- Composition and levels of biodiversity- Biodiversity Hotspots

6.2. Biodiversity depletion-causes and consequences

6.3. Recent International, National and Regional Biodiversity Initiatives (CBD, Global Biodiversity Strategy, National Biodiversity Action Plans, Biodiversity Registries)

6.4. Conservation of Biodiversity

6.5. Biodiversity with special reference to Kerala

Unit 7: Conservation Biology-

7.1. Introduction-Origin, concepts and definition of conservation biology

7.2. Fitness and Viability of Population:-Minimum Viable Population-Heterozygocity and Fitness-Pattern of Diversity and Rarity, including Endemism-Habitat Fragmentation and its effects

7.3. Community processes:-Community Stability and Structure- Co-adaptation and co-evolution (plant and animal interactions-basic concepts only)-Keystone Species and Dominant species-Infectious diseases and conservation biology-Conservation of Habitats-Threats and management of habitats-Theory and practice of conservation (basics only)-

Restoration, reclamation and regeneration of habitats (measures and steps introduction only)

Recommended Readings

1. Brewer R(1994), The Sccience of Ecology, saunders College Publishing, New York
2. Chapman J. L and Reiss M J (1992), Ecology-Principles and Applications, Cambridge University Press, Cambridge
3. Colin R, Townsend, Michael Begon and John L Harper (2012), Essentials of Ecology, third edn, Blackwell publishing
4. Rana.S.V.S.(2005)Essentials of Ecology and Environmental Science,Prentice Hall of India,New Delhi.
5. Heywood V H(Ed)(1995), Global Biodiversity Assessment (UNEP), Cambridge University Press, Cambridge
6. Krebs C J (1989), Ecological methodology, Harper Collins Pub. New York
7. Maxted N, B V Ford-Lloyd and J G Hawkes (ED) (1997). Plant Genetic Conservation- The in situ approach. Chapman & Hall, Madras
8. Michael Hutchings, Davis Gibson, Richard Bardgett and Mark Rees (2011), Journal of Ecology, Vol 99, ISI Journal Citation Reports @ Ranking
9. Michael P (1990), Ecological methods for laboratory and Field Investigations, Tata McGraw Hill Publishing Company Limited, New Delhi.
10. Mukherjee B (1996), Environmental Biology, Tata McGraw- Hill Pub. Co. Ltd, New Delhi
11. Nayar, M P (1996). Hot spots of Endemic Plants of India, Nepal and Bhutan. TBGRI, Trivandrum
12. .Odum E P (1971), Fundamentals of Ecology, W B Saunders Company, Philadelphia
13. .Odum E P (1983), Basic Ecology, Saunders College Publishing, Philadelphia
14. Dash M.C (2001)Fundamentals of Ecology,Tata McGraw-Hill Publishing Company Limited,New Delhi.
15. Rajagopalan.R.(2005)Environmental Studies,Oxford University Press,New Delhi.

COURSE CODE- ES010102
ENVIRONMENTAL GEOSCIENCES

Number of Hours / Week: 3 **Credits: 4**

Course Outcome:

The Course enables the students to:

1. Give a basic understanding of the various physical or abiotic environment systems
2. Describe the composition of different physical systems
3. Outline the features of earth, land, water, soil and oceans
4. Explain the importance of climate and weather to the global and regional environment
5. Define and elucidate the various terms related to the physical environment
6. Explain the basics of Earth systems its processes and Landforms
7. Distinguish various Plate tectonic processes and resultant Features
8. Distinguish the major land forms formed by the action of various geological agents

Unit 1 Earth and its Process

1.1 Origin, evolution and structure of Universe and solar system
1.2 The Earth in relation to the Universe-Origin, evolution, and structure of the earth -Origin of ocean, atmosphere and lithosphere
1.3 Geological Time Scale
1.4 Introduction to geodynamics-Continental drift -Sea floor spreading-Plate tectonics-Isostacy
1.5 Origin and evolution of biosphere and life -Origin of life evolution
1.6 Mineralogy-Minerals- Atomic Structure, Chemical Composition and Physical Properties of major rock forming minerals-quartz, feldspars, micas, amphibole, pyroxene, olivine, garnet
1.7 Rocks- Classification-igneous-sedimentary –metamorphic-Rock cycle-Mineralogy and texture of major rocks-basalt, gabbro, granite, charnockite, khondalite, gneiss, sandstone, shale, limestone.-Structures in rocks-strike, dip, fold, fault, joints
1.8 Biogeography- Definition and history- Classification of Biogeographic zones-Phytogeography-Floristic regions of the World and India- Zoogeography- Zoogeographical regions of the World and India

Unit 2 Introduction to Physical Systems

2.1 Biosphere and its divisions-Atmosphere-Lithosphere-Hydrosphere
2.2 Solar radiation -Absorption-Scattering-Reflection
2.3 Atmosphere-Stratification- Pressure gradient
2.4 Thermodynamics of atmosphere-Lapse Rate-Atmospheric stability (Stable, Unstable, & Neutral Equilibria)-Inversions-Spatial and temporal ranges of variation in temperature
2.5 General circulation of air:-Ferrel's law and Corioli's effect-Global air circulation system and heat transport from equator to poles- Heat budget
2.6 Wind-Formation-Classification
2.7 Clouds-Formation-Classification-Aerosols-Condensation nuclei-Precipitation mechanism-Cloud seeding

Unit 3 Weather and Climate

3.1 Definitions and scope of Climatology
3.2 Weather and climate
3.3 Components of Climate system
3.4 Classification of Climate-Koeppen's classification and Thornthwaite's scheme-Climatic types and zones
3.5 Climate of India-Indian Monsoon (onset of Monsoon and retreat of monsoon, rain bearing systems, Break in the monsoon, MONEX)-Climatic regions of India
3.6 Oceanic and Continental influence (Air- Sea interaction)
3.7 Global climatic phenomena-El Nino & La Nina
3.8 Climate Change-Causes and factors-Global actions on climate change-Effect of climate change in ecosystems
3.9 Weather and Climate monitoring equipment (Familiarization only)
3.10 Meteorological data collection and analysis (Rainfall, Evaporation, Temperature, Relative humidity, wind speed, wind direction, Wind-rose etc)
3.11 Applied Meteorology-influence of Weather and Climate on agriculture- Heat Islands-Influence of meteorological factors on air pollutants (Diffusion, Turbulence, Transportation, and Plume rise and stability conditions)

Unit 4 Geomorphology

4.1 Geomorphology: an introduction
4.2 River(River formation, erosion, transportation and deposition)-Slope process(Flows, Fall, Slides, Subsidence etc.)-watershed ,Drainage pattern and their significance
4.3 Coastal Geomorphology (Formation of lakes, Backwaters & Estuaries)
4.4 Water-Hydrological cycle-Global water balance-Types of water- The surface water-Relationship of surface and ground water-Ground water-Origin, Movement and Storage-Hydrological classification of water bearing formations
4.5 Geomorphology of India and Kerala

Unit 5 Oceanography

5.1 Oceans: an introduction
5.2 Marine resources(physical,biological and marine energy resources)
5.3 Productivity of Oceans
5.4 Ocean circulation
5.5 Coastal protection methods (Conventional & environment friendly)
5.6 Tides and tidal environment-Tidal inlets-Bays-Lagoons-Estuaries

Recommended Readings

1. Barry, R G and Chorley R J (1998). Atmosphere, weather and Climate (7th Edn). Routledge, London
2. Brady N C (1996) The Nature and Properties of Soil (10th Edn). Prentice hall of India Pvt. Ltd, New Delhi
3. Clark J R (1995) Coastal Zone Management- Hand Book, CRC –Lewis Publishers
4. Critchfield H J (1997) General Climatology (4th Edn) Prentice hall of India Pvt. Ltd, New Delhi
5. Das P K(1995) The Monsoons (3rd Edn) National Book Trust India, New Delhi

6. Emiliani C (1997) Planet Earth-Cosmology, Geology
7. John E Oliver & John J Hidor (2003)Climatology An Atmospheric Science, Pearson Education.
8. Holmes A (1965) Principles of Physical Geology, FLBS
9. Kale V S Gupta A (2001) Introduction to Geomorphology. Orient Longman Ltd Hyderabad
10. Kale V S (2010) Reprnt. Introduction to Geomorphology
11. Menon P A (1995) Our Weather National Book Trust India, New Delhi
12. Misra S P & Pandey S N, Essential Environmental Studies (2010), Ane Books PVt Ltd.
13. Mohapatra (2011), Reprnt .Text Book of Physical Geology
14. Mukerjee P K (2010) A Text Book of Geology, The World Press Pvt Ltd
15. Park C (1997) The Environment –Principles and Applications. Routledge, London
16. Pinet P R (1992) Oceanography- An Introduction to Planet Oceanus. West Publishing Company, New York
17. Raghunath H.M(1996),Hydrology Principles Analysis,Design,New Age International Publishers
18. Siddhartha K(1999),Oceanography A Brief Introduction,Kisalaya Publications PVT Ltd
19. Siddhartha K (2005), Atmosphere, Weather and Climate, Kisalaya Publications PVT Ltd
20. Suresh Lal(2004),Watershed Development,Management and technology,Mangal Deep Publications
21. Strahler A N and Strahler A H (1973) Environmental Geoscience – Interaction Between Natural Systems and Man. Hamilton Publishing Company, Santa Barbara, California
22. Todd D K (1995) Ground Water Hydrology (2nd Edn) John Wiley & Sons New York.
23. Tom Garrison,Oceanography,Wadsworth Publishing Company

COURSE CODE- ES010103
ENVIRONMENTAL CHEMISTRY, INSTRUMENTATION AND ANALYTICAL TECHNIQUES

Number of Hours / Week: 3 **Credits: 4**

Course Outcome

The Course enables the students to:

1. Review some of the fundamental concepts of chemistry
2. Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
3. Apply basic chemical concepts to analyse chemical processes involved in different environmental problems (air, water & soil)
4. Discuss local and global environmental issues
5. Explain gravimetric, volumetric, spectroscopic and Chromatographic analysis
6. Understand the basic principles of Analytical Techniques and instrumentation
7. Basic principles of Green chemistry, Green techniques and tools
8. Describe the applications of green chemistry

Unit 1 Fundamental Concepts (Basic understanding only)

1.1 Chemical equations and Stoichiometry, Concept of Normality, molarity, molality, molecular weight, equivalent weight, Avogadro hypothesis, isotopes, oxidation, reduction, oxidation number.

1.2 Solutions- types; ionization, primary and secondary standards- preparations, calculations of concentrations of solutions using specific gravities and molecular weights, units of concentrations of solutions- inter conversions. Colligative properties, ionic product of water, pH and pOH, buffer solutions

1.3 Chemical Kinetics: Control of reaction/First, second and zero order reactions

1.4 Thermodynamics- Laws of thermodynamics, reversible and irreversible processes, thermodynamic functions, exothermic and endothermic reactions, spontaneous and non-spontaneous reactions. Order and molecularity of a reaction, basic kinetic laws- zero, first, second , pseudo- order reactions, determination of rate constants, common ion effect, ionic product of water.

1.5 Concept of Energy, enthalpy, entropy/Gibbs energy and chemical potential, Laws of mass action; Chemical equilibria/Acid-base equilibria/Redox reactions and redox potential/ Radionuclide's, solubility products

1.6 Unsaturated and saturated hydrocarbons

Unit 2 Chemistry of Air, Water and Soil

2.1 Chemistry of Air- History of evolution of the earth's atmosphere-Role of chemical constituents in atmospheric processes (water, COx, NOx, SOx, O2 & Ozone)-Ozone layer- Chemistry of the Ozone layer- Ozone depletion and the chemicals that cause ozone depletion-Greenhouse gases and greenhouse effect-Photochemical smog- Origin and Occurrence, Oxidizing and reducing smog- Ecological effects- Acid rain and its ecological effects

2.2 Chemistry of Water-Composition and structure of pure water-Physical properties of water and aqueous solutions-Solubility of solids, liquids and gases in water- Chemical reactions and equilibria in water–carbonate equilibria, metal ion equilibria, redox equilibria- Natural organic components in water- Concepts of DO, BOD and COD

2.3 Chemistry of Soil-Introduction -Weathering and pedogenesis -Factors of soil formation - Development of soil profile-Structure of Soil- Gross composition-Texture and structure, method of analysis of texture (International pipette method)-Organic and inorganic components of soil-Physico-Chemical characteristics of soil- Ion-exchange and adsorption processes in the soil- Soil quality parameters and assessment-Classificaton of types of soil (Reference to India and Kerala)-Fate of chemicals in the soil

Unit 3 Analytical Techniques and Instrumentation – I (Principles and application)

3.1 Gravimetric Methods - Principle and application of gravimetric methods in determination of total, dissolved, suspended, volatile and fixed solids present in water and waste water.

3.2 Estimation of moisture content of soil, phytomass, compost and vermi-compost using moisture balance

3.3 Volumetric Methods- Importance of volumetric analysis-Standardization of reagents using volumetric titrations

3.4 Electrochemical Methods- pH meters – Glass and Reference electrodes- Ion selective electrodes- Electrical conductivity measurements: Conductivity Meters

3.5 Photometric methods- Nephelometry and Turbidometry- Spectrophotometry- Optical design of filter photometer, single beam spectrophotometer, double beam – UV – Visible – Spectrophotometer- Flame photometry (FP)

3.6 Atomic Absorption Spectrophotometry (AAS)- X-ray Fluorescence - X-ray Diffraction

3.7 Dosimetry - Geiger Muller Counter- Scintillation counter

Unit 4 Analytical Techniques and instrumentation-II (Principles and application)

4.1 Chromatography- Paper chromatography- Thin layer chromatography- Column chromatography- Gas liquid chromatography- GC-MS- High Performance Liquid Chromatography (HPLC)

4.2 Electrophoresis- Gel electrophoresis- Immuno electrophoresis (ELISA, Blotting Techniques, RFLP, etc)

4.3 Microscopy- Light microscope, Bright field, Dark field, Phase contrast and Fluorescent microscope- Electron Microscopy – Transmission Electron Microscope (TEM) and Scanning Electron Microscopy (SEM)

4.4 Flow Cytometry-Micrometry-Microtechniques- Fixation, Sectioning, Histological and Histo-chemical staining

Unit 5 Green Chemistry

5.1. Introduction- Basic principles of green chemistry (12 principles)
5.2. Tools of green chemistry- green starting materials, green reagents, green ractions, green methodologies, green chemical products
5.3. Concept of green engineering
5.4. Applications of green chemistry- zero waste technology

Recommended Readings

1. APHA (1998) Standards Methods for the examination of water and Waste water, 20th Edn, Washington DC
2. Bailey R A et.al. (1978) Chemistry of the Environment, Academic Press, New York
3. Baird C (1999) Environmental Chemistry, W H Freeman & Co, New York.
4. Balram Pani (2007), Environmental Chemistry, I K International. New Delhi
5. Brady N C (1999) The Nature and Properties of Soils, Prentice- Hall of India Pvt Ltd, New Delhi
6. Clarson D, Soil and Water Analytical Methods, Agri Clinics and Research Centre, Kottayam
7. Dara S S,(2002), Environmental Chemistry and Pollution Control, S Chand and Company, New Delhi
8. De A K, (2008) Environmentaql Chemistry, New Age International, New Delhi
9. Gary D Christian, Analytical Chemistry, 4th edition, Wiley & Sons
10. GrayW V & Stephen J D (2000) Environmental Chemistry a Global Perspective, Oxford University Press, New York
11. .Harrison R M and De Mora S J (1996) Introductory Chemistry for the Environmental Sciences (2nd Edn), Cambridge University Press, Cambridge
12. Julian E Andrews etal (2004) An Introduction to Environmental Chemistry, Blackwell Publishing
13. Khopkar S M (1985) Basic Concepts of Analytical Chemistry. Wiley Eastern Ltd.,New Delhi
14. Manahan S E Environmental Chemistry, Williard Grant Press, Boston, Massachusetts, USA
15. Mendham J et.al(2002), Vogels Text Book of quantitative Chemical analysis, Pearson Education, Singapore.
16. Marr L L and Cresser M S (1983) Environmental Chemical Analysis, International Text Book Company (pub), New York
17. Mcride M B (1994) Environmental Chemistry of Soils, Oxford University Press, New York
18. Orlov D S (1992) Soil Chemistry. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi
19. Puri ,Sharma, Pathania, Principles of Physical chemisty, Vishal Publishing Corporation, Jalandhar
20. Purnima Sethi, V S Kulkarni ((2011) Environmental Chemistry
21. Ronald A Baily et.al Chemistry of the Environment, Academic Press, USA California

22. Rump H H and Krist H (1998) Laboratory Manual for the Water, Wastewater and Soil, VCH Publishers, New York
23. Rastogi R P, R R Misra, An Introduction to Chemical Thermo Dynamics, 6th edn, Vikas Publishinh House, New Delhi
24. Santra S C, Environmental Science, New Central Book Agency
25. Stanley E Manahan (2004) Environmental Chemistry CRC Press
26. Suchla G (Ed) (1987) Vogel's Qualitative Inorganic Chemistry, ELBS

COURSE CODE- ES010104

ENVIRONMENTAL POLLUTION AND MANAGEMENT

Number of Hours / Week: 3 **Credits: 4**

Course Outcome

The Course enables the students to:

1. Discuss local and global environmental issues
2. Identify and distinguish the sources and types of water, air, and soil pollution.
3. Articulate knowledge about impact and control measures of water, air, and soil pollution.
4. Describe environmental analysis for various water, air and soil quality parameters
5. Explain Fate and transport of pollutants and distinguish the regional and global impact of pollution
6. Describe various pollutions and waste management methods
7. Discuss the Historic pollution episodes

Unit 1 Environmental Concerns (Introduction)

5.1. Growing environmental concerns (History from 17^{th} to 21^{st} century)
5.2. Major environmental issues in India and Kerala
5.3. Readings in Environment Perspectives (eg. Silent Spring, Our Common Future etc- assignments only)

Unit 2 Environmental Pollution and its impacts

2.1 Air Pollution – air pollutants: Type, source and nature-Primary and Secondary pollutants, Natural and Anthropogenic sources, gaseous, solid-particulate and bio pollutants
2.2 Transport and diffusion of atmospheric pollutants- factors influencing
2.3 Impact of air pollutants on - Human beings-Animals-Plants-Materials, buildings and climate
2.4 Vehicular pollution and urban air quality
2.5 Water pollution: Types, sources and impact
2.6 Surface water, ground water pollution
2.7 sources of water pollution -Domestic, industrial, agricultural and natural
2.8 Impacts on human beings, animals, plants and environment
2.9 Eutrophication
2.10 Epidemiological and other water pollution related health impacts (Goitre, Flurosis, Arsenic)

2.11 Sources of soil pollution-Natural sources-Anthropogenic sources
2.12 Types of soil pollutants
2.13 Soil microorganisms and their functions
2.14 Different kinds of synthetic fertilizers and their interactions with different components of soil -fertilizers solubility
2.15 Industrial waste effluents and heavy metals-their interactions with soil components
2.16 Pesticides and metals in water, air and soil

Unit 3 Environmental Monitoring

3.1 Definition-aim
3.2 Environmental analysis-stages-sampling, processing, detection and interpretation-significance
3.3 Sampling methods-random-stratified-systematic
3.4 Water sampling-grab/composite-Air sampling-high volume air sampler-soil/sediment sampling-grab and core samplers
3.5 Processing methods-Digestion-Extraction-Filtration
3.6 Detection methods-analytical-classical-modern (instruments)
3.7 Water,air and soil quality analysis-Units
3.8 Methods of monitoring air pollutants
3.9 Air quality standards
3.10 Air quality monitoring studies: wind roses, air sampling, analysis for NOx, SOx, CO, O3 and particulate matter
3.11 Stack monitoring
3.12 Water quality studies
3.13 Characteristics of industrial wastewater-paper & pulp, textile, cement, chemical etc
3.14 Characteristics of water- physical, chemical and biological
3.15 Assessment of the level of pollution based on BOD, COD , nitrogen, phosphate and microbiological analysis
3.16 Water sampling- types, selection of sampling points, equipment used, sample preservation, maintenance of chain of custody records
3.17 Physico – chemical and bacteriological sampling and analysis of water quality. Water quality standards
3.18 Physico chemical analysis-Microbiological analysis
3.19 Physico-chemical and bacteriological sampling and analysis of soil quality
3.20 Soil pollution control measure-Soil pollution monitoring

Unit 4 Pollution control techniques

4.1 Control measures of air, water and soil pollutants – control and treatment at source
4.2 International treaties and their impact

Unit 5 Noise Pollution

5.1. Sources of noise pollution -Anthropogenic, natural sources
5.2. Impacts of noise pollution
5.3. Measurement of noise: decibels and noise levels
5.4. Noise propagation and noise attenuation
5.5. Effect of meteorological parameters in Noise propagation
5.6. Noise exposure levels and standards
5.7. Control measures of noise pollution

Unit 6 Radioactive, Thermal and Marine Pollution

6.1 Sources of radioactivity-Radioactivity: Natural and manmade
6.2 Causes of radioactive pollution-Radioactive pollution from nuclear power plants-Radioactive pollution episodes
6.3 Effect of radioactive pollution
6.4 Radioactive waste management
6.5 Radio nuclides-Origin of radio nuclides
6.6 Thermal pollution-Causes of thermal pollution-Effects of thermal pollution
6.7 Marine pollution-Sources: Natural and Anthropogenic source
6.8 Effect of marine pollution- specifically oil spills- on ocean flora and fauna
6.9 Control of marine pollution-Controls for the disposal of pollutants in marine ecosystems
6.10 Biofouling: impact and management strategies

Unit 7 Pollution Case Studies

7.1. Historic pollution episodes- oil spills, smog, industrial accidents etc.
Bhopal Gas Tragedy-The Ganga Pollution-The Yamuna Pollution-Minamata Tragedy-London smog disaster-TajMahal Issue-Delhi air pollution problems- restoration of Indian lakes

Recommended Readings

1 Abbasi S A 1998 Environmental Pollution and its control. Coent International, Pondicherry
2 Abbasi S A 1998 Water Quality sampling and Analysis. Discovery publishing house, New Delhi
3 Abbasi S A and Ramaswamy E V 1999 Biotechnological Methods of Pollution Control, Universities Press (India) Ltd, Hyderabad
4 Abbasi S A, Krishnakumari P K and Khan F I 1999 Hot Topics, Oxford University Press, Chennai
5 Anuj Kumar Purwar, Environment and Ecology, I K International publishing house Pvt ltd
6 BalramPani, Text Book of Environmental Chemistry and Pollution Control. I K International publishing house Pvt ltd

7 Dara S S, A text Bokk of Environmental Chemistry and Pollution Control. S Chand and Company ltd
8 Davis M L and Cornwell D A 1991 Introduction to Environmental engineering (second edn) McGraw Hill International edition
9 David, Michael, and Caroline (2010). "Air Pollution – Effects"
10 10. Maiti S K, Handbook of Methods in Environmental Studies-Air, Noise,Soil and Overburden Analysis,Oxford Book Company Ltd, New Delhi
11 Misra S P, S N Pandey, Essential Environmental Studies
12 Prasad T N, T R Amarnath, Environmental Noise Pollution- Causes, effects and control. Crescent Publishing Corporation
13 Prasad T N, T R Amarnath,Environmental Pollution -- Causes, effects and control
14 Purnimasethi, V S Kulkarni. Environmental Chemistry, Alpha Publication
15 RaghavanNambiar P K, Text Book Of Environmental Studies
16 Santra S C Environmental Science, New Central Book Book Agency Pvt Ltd
17 Sharma B K and Kaur H, Environmental Chemistry, Goel Publishing House.

COURSE CODE- ES010105

RESEARCH METHODOLOGY AND STATISTICS

Number of Hours / Week: 3 **Credits: 3**

Course Outcome

The course would help students to:

1. Understand various research methodologies and enable them to carryout research projects
2. Learn statistical methods for data interpretation and analysis
3. Understand basics of mathematics for the modeling studies
4. Learn statistical software's

Unit 1 Research Methodology

1.1 Meaning- Objectives-motivation-Significance of research, types of research, Research methods and methodology, Research and Scientific Method, Criteria of Good research, Problems of researcher

1.2 Selection of the problem: Criteria for selection of problem and evaluating problems, Statement of problem formulation and definition

1.3 Research design: Meaning, need for research design, Features and important concepts relating to research design, Different research design, Basic principles of experimental design.

1.4 Survey of literature: Different methods of surveying literature, different sources of information, internet, search engines, websites, recording surveying information

1.5 Hypothesis: Nature, types and sources of hypothesis, characteristics of a good hypothesis

1.6 Sample and Sampling: Sample - meaning, types. Sampling - Unit of sampling, population: techniques, characteristics of good samples, Sampling errors and ways to reduce them.

1.7 Collection and analysis and interpretation of data: Procedure of data collection scoring and coding of data, editing, tabulation, graphic representation - analysis and interpretation of data.

1.8 Research report: Meaning, definition, features of report, format of research report: Composition, pagination, Title pages, references pattern, Bibliography, Appendices.

Unit 2 Basic Mathematics

3.1 Introduction:-Functions and Progressions-Definition of constant, parameter variable and functions, sequence and series, Arithmetic and geometric progressions

3.2 Matrix algebra and applications- matrix theory, addition and multiplication of matrix, inverse of matrix, rank of matrix, eigen matrix; solution of simultaneous equation using matrix inversion, introduction to vectors (addition and multiplication)

3.3 Basic calculus and applications- Limit and continuity, concept of derivative, rule of differentiation.

Unit 3 Fundamental Statistics

3.1 Introduction – Definition, scope, Importance and limitation.

3.2 Classification and Tabulation of data

3.3 Graphical Representation

3.4 Measures of Central Tendencies – Mean, Median and Mode

3.5 Measures of Dispersion - Range, Quartile deviation, Mean deviation, Percentiles. Deciles Standard Deviation and Co-efficient of Variation

3.6 Moments, Skewness and Kurtosis

3.7 Correlation and Regression – Scatter diagrams – Karl Pearson's Coefficient of correlation - Rank correlation. Partial correlation and Multiple correlation. – Linear and Curvilinear regressions - Multiple regression, Trend analysis, Index numbers.

3.8 Testing of Hypothesis: Null and Alternative Hypothesis – Two types of error – Level of significance. Test based on t, Z, Chi –square and F -Analysis of Variance – one-way, two-way, three-way analysis. ANNCOVA, MANCOVA, Principle Compound Analysis (PCA) with reference to environmental modeling, Social and environmental modeling application

3.9 Probability – Frequency approach- Addition and multiplication theorems- Binomial, Poisson and Normal Distribution- Probit analysis (Graphic Method only)

Unit 4 Application of Computer in Statistics: Data analysis using Excel sheet - Statistical analysis using Packages like SPSS

Recommended Readings

1. Ahuja Ram, Research Methods, Rawath Jaipur.
2. Babbie Earl, Research methods in sociology, Cengage Learning Australia.
3. Barnett Vic, Environmental statistics, methods and applications. JhonWiley & Sons NewYork.
4. Chance, Beth L.; Rossman, Allan J. (2005). *Investigating Statistical Concepts, Applications, and Methods*. Duxbury Press.
5. Denscombe Martyn, The good research guide: for small scale social research projects, Viva Books New Delhi.
6. Des Raj &Promod Chandhok, Sample Survey Theory
7. Devendra Thakur. Research methodology in social science.Deep&Deep Publications NewDelhi.
8. Dodge, Y. (2003) *The Oxford Dictionary of Statistical Terms*, OUP.
9. Gupta S P, Statistical methods, Sultan Chandh, New Delhi
10. Gurumani N, Research methodology for Biological Sciences, MJP Publishers Chennai
11. Holmes Debbie Moody Peter Dine Diana, Research methods for the biosciences.Oxford,Newyork.
12. Jayaraman K, Handbook on statistical analysis in forestry research. Kerala Forest Research Institute Peechi.
13. Kothari C R, Research methodology: methods and techniques, Wiswa Prakashan New Delhi.
14. Kozak Antal Kozak Robert A Staudhammer Christina L Watts Susan B, Introductory Probability and Statistics, applications for forestry and the natural sciences, Cab International Wallingford.
15. Levin Richard I Rubin David S, Statistics for Management, Edition 7, P H I NewDelhi
16. Miller Jane, Statistics for advanced level, Ed.2, University Press Cambridge.
17. Mohankumar P S , Handbook on research methodology, Right Publishers Kudanechoor

18. Narwal SS Dahiya ,SS Singh,JP. Research methods in Plant science, Allelopathy Vol-1,Soil analysis, Scientific Publishers, Jodhpur.
19. Prabhakar V K, Research methodology and system analysis, Anmol NewDelhi
20. Santosh Gupta, Research methodology and statistical techniques, Deep & Deep Publications New Delhi
21. Thompson, B. (2006). Foundations of behavioral statistics. New York, NY: Guilford Press
22. Vaid A C &Aggarwal S L, Quantitative Method

COURSE CODE- ES010106

LABOURATORY COURSE-PART I (ECOLOGY AND ENVIRONMENTAL CHEMISTRY)

Number of Hours / Week: 10 **Credits: 5**

Course Outcome

The course would help students to:

1. Understand basic laboratory rules
2. Carry out analysis of physico-chemical parameters of water and soil
3. Conduct noise pollution measurement
4. Carry out ecological assessment

Unit1 Introduction to laboratory techniques

1.1 Basic laboratory rules

1.2 Environmental samples-Sampling methods-preparation-preservation and anlysis

1.3 Biometry-Data representation-Bar diagram-Component Bar diagram.-Superimposed Bar diagram- Line diagram-Pie diagram

Unit 2 Ecology

2.1 Community study: quadrat method; flora and fauna study by frequency, density and abundance – line transect method.

2.2 Estimation of primary productivity – Light and dark bottle method – effects of depth and light

2.3 Identification of phytoplankton and zooplankton (either freshwater or marine).

2.4 Windrose

Unit 3 Instrumentation

3.1 pH Meter-BOD Incubator-Lux Meter-Wet & Dry bulb Hygrometer- Max-min Thermometer-TDS Meter-Sound Level Meter

Unit 4 Environmental Chemistry

2.1 Basic Water Quality Studies:-pH, conductivity, turbidity, Acidity, Alkalinity ,Total Solids ,Total Dissolved Solids and Total Suspended Solids of Water Sample

2.2 DO,BOD of Water Sample

SECOND SEMESTER COURSES

ES010201	Eco Toxicology and Occupational Health Hazards Management
ES010202	Environmental Microbiology
ES010203	Introduction to Geo-informatics
ES010204	Environmental Laws, Education and Policies
ES010205	Laboratory Course Part 2

COURSE CODE- ES010201

ECO TOXICOLOGY AND OCCUPATIONAL HEALTH HAZARDS MANAGEMENT

Number of Hours / Week: 3 **Credits: 4**

Course Outcome:

The course would help students to:

1. Describe sources and fates of chemicals in the environment
2. Explain mechanisms for adverse effects of chemicals
3. Explain the significance of sanitation and carryout awareness on awareness on sanitation and health
4. Understand Occupational safety and management measures
5. Estimate the risk for adverse effects of a chemical on different biological organization levels based on knowledge about the toxicity, degradability, and bioavailability of the chemical
6. Identify the interactive effects of toxicants

Unit 1 Introduction

1.1 Principles of toxicology, history of toxicants, concepts in toxicology
1.2 Classification of toxicants-toxicants terms-carcinogens-mutagens-teratogens
1.3 Biological and chemical factors influencing toxicity
1.4 Interactive effects of toxicants (Additive effects, Synergistic effects, Antagonistic effects, Potentiation)
1.5 Toxicants- entry into the environment, cycles and residence time
1.6 Movement and distribution of toxins in organisms (ADME studies)
1.7 Case studies-mercury and cadmium (related)

Unit 2 Ecotoxicology

2.1. Toxicants in ecosystem
2.2.Fate of Toxins-dispersion, transformation, degradation-physical, chemical and biological
2.3.Biotransformation-Bioavailability,Bio-concentration, Bio-accumulation and Bio-magnification—Biodegradation
2.4. Effect of interspecific interactions in the environment-food chain
2.5. Terrestrial and Aquatic Toxicology

Unit 3 Toxicity Testing and Indicators

3.1 Principles of toxicity testing, Factors to be considered in toxicity testing

3.2 Methods of toxicity evaluation at cellular and molecular level by in vitro and in vivo methods
3.3 Ecotoxicological testing methods – single species testing, microcosms etc.
3.4 Biomonitoring of toxicity-Bioindicators , lacustrine communities as indicators of ecosystem stress

Unit 4 Biomonitoring of toxicity

4.1 Biosensors– concept and approach
4.2 Biomarkers- classification, relationship of biomarkers to adverse effects
4.3 Molecular tools in biomonitoring- metabolites as indicators, protein induction, cytochrome P450 enzymes, stress proteins and metallothioneins
4.4 Toxicity of biohazard
4.5 Toxicity-Local and Systematic Toxicity- Immediate and Delayed Toxicity-Reversible and Irreversible Toxicity-Acute and Chronic Toxicity-Toxicity of mixtures-Variation in Toxic responses-Toxicity of organs and organ system

Unit 5 Occupational Hazards and Safety

5.1. Environmental and occupational safety- Definitions, concept and scope
5.2.Occupational exposure- Permissible Limits of exposure
5.3.Occupational hazards and diseases
5.4.Occupational safety and management measures

Unit 6 Health and Hygiene

6.1 Health and Hygiene- Epidemiology and health ecology
6.2 Epidemiological diseases due to pollution problems
6.3 Health effects of cosmetics and drugs
6.4 Occupational and industrial health management
6.5 Ecological risk assessment in environmental management
6.6 Legislative perspective in ecological risk assessment
6.7 Human health risk assessment

Recommended Readings

1 BalramPani(2010),Textbook of Toxicology,I.KInternationalPublishing House Pvt.Ltd
2 B K Sharma & H Kaur (1995), Environmental Chemistry, GoelPublishinh House.
3 Karen E Stine,Thomas M Brown(2006),Principles of Toxicology,CRC Press Taylor and Francis Group
4 M.ASubrahmanian(2004),Toxicology Principles and Methods,MJP Publishers
5 P.D Sharma(2001),Second Edition,Toxicology,Rastogi Publications
6 V P Kudesia& M U Charaya(1993) Pesticide Pollution, PragatiPrakashan, Meerut
7 V P Singh(2005),Toxic Metals And Environmental Issues, Sarup and Sons New Delhi.

8 Ming Ho Yu(2005),Environmental Toxicology Biological and Health Effects of Pollutants,CRC Press LLC
9 Raymond J.M Neisink,John de Vries and Manfred A Hollinger(1996),Toxicology Principles and Applications,CRC Press Inc.and Open University of Netherland
10 Niesink J M, Dc Vries and Hollinger M R (Ed) 1996. Toxicology Principles and Applications CRC Press
11 Nurenberg H W (Ed) 1985. Pollutants and their eco-toxicological significance. John Wiley & Sons
12 Ramada F (Ed) 1997 Ecotoxicology John Wiley & Sons
13 Richardson M (Ed) 1995. Environmental toxicology assessment. Taylor and Francis Ltd, London
14 Sigel A etal (2010) Organometalics in Environment and Toxicology RSC Publishing,Cambridge

COURSE CODE- ES010202

ENVIRONMENTAL MICROBIOLOGY

Number of Hours / Week: 3 **Credits: 4**

Course Outcome

The course would help students to:

1. Various microorganisms in the environment with their basic characteristics
2. Understand and apply the various techniques for the isolation and characterization of microorganisms from environmental compartments
3. Understand and evaluate the role of microorganisms in various biogeochemical cycles and other environmental processes
4. Understand and analyze the role of microorganism in various diseases
5. Analyze and apply the role of microorganisms in various environmental applications

Unit 1 Microorganisms in the environment

1.1 Ubiquity of microorganisms in the environment – general account of microorganisms in the environment – bacteria, fungi, protists, algae and viruses - characteristic features and their role in the environment.

1.2 Bacteria-Morphology and Ultra structure of Bacteria-Plasma membrane, cell wall, flagella, pili, capsule, slime layer, glycocalyx ,nucleoid, ribosomes and cytoplasmic inclusions

1.3 Basics of Gram staining

1.4 Fungi-Morphology and structure of fungal hyphae and mycelium-Physiology, nutrition, reproduction and life cycle-Classification of fungi

1.5 Protozoans- Ecology of free living, symbiotic and parasitic protozoans- Reproduction and life cycle of important parasitic protozoans (Giardia, entamoeba histolytica, plasmodium etc.)

1.6 Viruses- Chemical composition, structure architecture of viruses- Multiplication and life cycle- Bacteriophages- Lytic and lysogenic cycle-_T4 and Lambda phages

Unit 2 Microbial nutrition and growth

2.1 Nutritional diversity among prokaryotes – various types of autotrophy and heterotrophy among bacteria.

2.2 Nutritional requirements – macronutrients, micronutrients and trace elements in microbial nutrition; Culture media – complex and synthetic media. Use off specialized media (selective media, selective and differential media) for the isolation of specific microorganisms.

2.3 Microbial growth – cytological and population growth – factors affecting growth of bacteria. Characteristic features of bacteria growth curve-Continuous culture systems – chemostat and turbidostat.

2.4 Physical and chemical control of bacterial growth – disinfectants, antibacterial agents, antibiotics and chemotherapeutic agents

Unit 3 Isolation and characterization of bacteria from the environment

3.1 Isolation of bacteria from the environment – pour plate and streak plate method. Use of different media and culture techniques.

3.2 Pure culture techniques – streak plate method – quadrant streak and continuous streak methods-Maintenance of bacteria on agar slants and long term preservation as glycerol stock.

Unit 4 Microorganisms and the environment

4.1 Soil microbiology-Soil microorganisms and their association with plants-– bipartite and tripartite associations - rhizosphere microflora, mycorrhizae – ecto and endomycorrhizae – VAM – actinorrhizae

4.2 Role of microorganisms in biogeochemical cycles with special reference to carbon, nitrogen, phosphorus and sulphur cycles-Pesticides and microorganisms-Soil microorganisms interactions with the atmosphere

4.3 Aquatic microbiology- Microbial community and important microorganisms in marine and fresh water environments-Nutrient levels, gradients, surfaces and biofilms-Microbial mats-microbial loop

4.4 Water borne pathogens – diseases causes and symptoms – routes of infection and control measures. Microbial indicators of water quality – coliforms, faecal coliforms, Escherichia coli and faecal streptococci.

4.5 Foreign derived microorganisms in the environment – fate and survival.

4.6 Genetically modified microorganisms in the environment – fate and effects.

4.7 Microorganisms in extreme environments – Archaebacteria – Psychrophiles, Thermophiles, Halophiles, Barophiles, Methanogenes etc.

Unit 5 Genetically engineered microorganisms and their applications in the environment

5.1. Prokaryotic DNA and its characteristic features - Recombinant DNA techniques – restriction endonucleases and cloning vectors – plasmids, cosmids, phagemids etc. Polymerase chain reaction (PCR) technique for amplification and detection of specific genes

5.2. Application of genetically engineered organisms in the clean-up of the environment – bioremediation strategies for polluted soil and water ecosystems.

Recommended Readings

1. Claus, W.G. 1989. Understanding microbes: A Laboratory Text book for Microbiology. W. H. Freeman and Co., New York.
2. Eweis, J.B., Ergas, S.J., Chang, D.P. Y. and Schroeder, E.D. 1998. Bioremediation Principles, McGrawHill Publ.
3. Freifelder, D. 1987. Microbial Genetics. Johns and Barlett Publishers Inc.
4. Hawkins, J.D. 1996. Gene Structure and Expression, Third edition. Cambridge University Press, Oxford.
5. Lewin, B. 1998. Genes VI. Oxford University Press, Oxford.
6. Lynch, M. and Hobbie, J.E. 1988. Microorganisms in Action - Concepts and applications of Microbial Ecology. Blackwell Scientific Publications.
7. Pelcazr, M.J., Reid, R. and Chan, E.C.S. 1996. Microbiology. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
8. Prescott, L.M., Harley, J.P. and Klein, D.A. 2006. Microbiology. WCB Publishers. (Latest

editions available)
9. Salle, A.J. 1961. Laboratory Manual of Fundamental Principles of Bacteriology. Mc Graw Hill Book C, New York.
10. David C Sigee 2005. Freshwater Microbiology - Biodiversity and dynamic interactions of microorganisms in the aquatic environment. John Wiley and Sons Ltd. England.
11. Abigail A Salyers and Dixie D Whitt 2001. Microbiology - Diversity, disease and the environment. Fitzgerald Science Press, Maryland, USA.
12. Jacquelyn G Black 2005. Microbiology - Principles and Explorations - 6th Edition. John Wiley and Sons, USA

COURSE CODE- ES010203

INTRODUCTION TO GEO-INFORMATICS

Number of Hours - Week: 3 **Credits: 3**

Course Outcome:

The course would help students to:

- Demonstrate the basics of mapping concepts and Geodesy
- Understand the various data formats and data types in GIS
- Understand the significance of various satellite based remote sensing
- Apply the spatial and non- spatial data using various methods
- Outline and Evaluate the role of navigational satellite systems in geoinformatics

Unit 1 Geodetical aspects, mapping concepts and surveying

1.1 Earth System – Geodesy: Datum/Spheroids and coordinate systems, map projection - different projections and their characteristics

1.2 Features on the earth's surface: their basic properties – discrete vs continuous and geometries of representation

1.3 Cartography: Maps – their characteristics and elements, types - Basic surveying principles and techniques: EDMs and GNSSs; GNSSs – segments, various constellations, errors, differential correction and precise positioning

1.4 Map reading and interpretation;Global, national and state mapping agencies and their authorized reference maps – general & thematic

Unit 2 Remote sensing: Introduction

2.1 Remote sensing system – components and principles – platforms, sensors, medium, target, interactions and their characteristics including various resolutions, concept of DN value, radiance, reflectance, emission.

2.2 Electromagnetic spectrum - energy interaction with atmosphere and earth surface, atmospheric windows, spectral properties of various objects on the earth's surface and the concept of spectral signature, active and passive remote sensing

2.3 Space borne earth observation: various orbits and their characteristics, operations, image acquisition and various data products.

2.4 Indian remote sensing programme & Other satellites and sensors like Landsat, SPOT, etc. Digital Image Processing: Basics

2.5 Various image formats, loading and visualization – panchromatic and multispectral colour visualization – TCC and FCCs

2.6 Image interpretation – visual and digital; visual interpretation elements and key.

2.7 Digital image classification – unsupervised and supervised; accuracy assessment

Unit 3 Geographical Information System (GIS): Basics

3.1 Concepts, components and organisation of GIS

3.2 Representing & modelling spatial features and processes - vector and raster structures, relationship between features – topology; raster data compressions and storage formats

3.3 Non-spatial/attribute Database Management Systems (DBMS), significance of DBMS, principles, data types, models – RDBMS, data storage, query and retrieval

3.4 Basic GIS functions: data inputting methods & various data sources, data management, data manipulation and geographic analysis and output presentation

Unit 4 GIS: Geographic analysis

4.1 Exploration, query, vector spatial analysis & geoprocessing – extraction, proximity, overlay

4.2 Raster based spatial modeling and analysis – density, distance, map algebra – arithmetic & weighted overlay: multi-criteria decision making

4.3 Surface modeling and analysis: DEM creation – input sources, interpolation; slope, aspect, volume, profile, hillshade, viewshed, visibility, contouring

Unit 5 GIS: Applications in Ecology & Environment Management

5.1 Sampling and ecological survey design

5.2 Mapping of natural resources – minerals, soil, water and bio-resources

5.3 Modelling and analysis of ecosystems and ecological processes – marine, forest, mountain, rivers & streams, coastal areas and wetlands – global ecosystem dynamics, climate change monitoring and modelling

5.4 Detailed vegetation and built environment characterization using high spatial and spectral resolution remote sensing images and in-situ hyper-spectral data

5.5 Landscape level biodiversity characterization, disturbance analysis including forest fire vulnerability analysis and conservation planning

5.6 Applications in EIA and Cost-Benefit Analysis: quantifying impacts and use in the preparation of EMP, Pollution dispersion modelling: water, air & soil – various quality indices, Soil erosion estimation, zonation and modelling

Recommended Readings

1. Agarwal S. K. 2002. Eco-informatics. APH Publishing Corporation, 1535 pages, ISBN-13: 978-8176483247.
2. Agarwal N. K. 2004. Essentials of GPS. Spatial Networks Pvt. Ltd., Hyderabad
3. Anji Reddy M. 2004. Geoinformatics for Environmental Management. B. S. Publications
4. Burrough P.A. and McDonnel A. R. 1998. Principles of Geographic information Systems. Spatial information systems and Geostatistics. Oxford university press.
5. Chouhan T. S. and Joshi K. N. 1996. Applied remote sensing and photo interpolation. Vigyan Prakasham, Jodhpur.
6. Coronel C., Morris S. and Rob P. 2009. Database Systems: Design, Implementation and Management (9th Ed.). Course Technology, 700 pages, ISBN-13: 978-0538748841.
7. David L. Verbyla. 1995. Satellite Remote Sensing of Natural resources. Lewis Publishers, New York
8. George Joseph. 2005. Fundamentals of remote sensing (Second Edition). Universities Press (India) Pvt. Ltd., Hyderabad
9. Goodchild M. F., Parks B. O. and Steyaert L. T. (Eds.). 1993. Environmental Modeling with GIS (Spatial Information Systems). Oxford University Press, USA, 520 pages, ISBN-13: 978-0195080070.

10. Heywood I., Cornelius S., Crever Steve. 2003. An Introduction to Geographical Information Systems. Pearson Education
11. Jensen J. R. 2000. Remote Sensing of the Environment - An Earth Resources Perspective, Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi
12. Jensen J. R. 1996. Introductory Digital Image Processing. Prentice Hall Series
13. John Wainwright and Mark Mulligan (Eds). 2004. Environmental modeling - finding simplicity in complexity. John Wiley & Sons Ltd.
14. Jorgensen S. E., Chon T. S. and Recknage F. A., 2009. Handbook of Ecological Modeling and Informatics. WIT Press, 448 pages, ISBN-13: 978-1845642075
15. Kang-tsung Chung. 2002. Introduction to Geographical Information System. McGraw Hill Companies, International edition.
16. Lillesand T. M., Kiefer R. W. and Chipman J. W. 2008. Remote Sensing and Image Interpretation (Sixth Edition). John Wiley & Sons, USA
17. Maguire D., Batty M. and Goodchild M. (Eds.) 2005. GIS, Spatial Analysis, and Modeling. Esri Press, 496 pages, ISBN-13: 978-1589481305.
18. Peng Z. P.and Tsou M.H. 2003. Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks. Wiley, Hoboken, NJ.
19. Rafael C. Gonzalea and Richard E. Woods. 2004. Digital Image Processing (2^{nd}). Pearson education.
20. Sabins Floyd F. 1987. Remote Sensing principles and interpretation (3^{rd}). W. H. Freeman and Company, New York.
21. Shan J and Toth C. K. 2008. Topographic laser ranging and scanning - principles and processing. CRC Press, Taylor & Francis Group, London.
22. Skidmore A. 2002. Environmental modeling with GIS and Remote Sensing. Taylor and Francis
23. Steven E. Franklin. 2001. Remote Sensing for Sustainable forest management. Lewis publishers.
24. Wise S. 2002. GIS Basics. Taylor Publications.
25. Zeleny M. 1982. Multiple Criteria Decision Making, Mc-Graw Hill

COURSE CODE- ES010204

ENVIRONMENTAL LAWS, EDUCATION AND POLICIES

Number of Hours - Week: 3 **Credits: 4**

Course Outcome

The course would help students to:

1. Describe the history of environmental law
2. Understand the environmental laws and policies in Kerala and India
3. Describe principles of international laws
4. Describe the significance of environmental education
5. Evaluate the development activities based on environmental laws
6. Understand Environmental Information Networks
7. To impart Environmental awareness

Unit 1 International environmental laws

1.1 Introduction to United Nation Organization and its various agencies- UNEP, UNDP, IUCN, UNESCO,FAO, IMO, EPA,GEMS, GEF,WCED, WWF, EARTHWATCH etc

1.2 Role of UN authorities in protection of Global Environment.

1.3 Evolution and Development of International Laws with Reference to-Stockholm Conference, Nairobi Conference, Rio Conference, Rio +5, Rio +10, Rio+20.

1.4 Global environmental issues and international laws to control global warming, ozone depletion, hazardous waste: CITES, Basel Convention, Vienna Convention, Montreal Protocol, CBD, UNFCC-Kyoto protocol, Agenda 21, Antartica Convention, Desertification Convention.

1.5 International agreements on wetlands, migratory species, mangroves, oceans, forest etc

1.6 Global Initiatives for sustainable development

Unit 2 Environmental laws in India

2.1 National Environmental Policy

2.2 Fundamental Principles of Environmental Laws

2.3 Environmental Laws in India-The Wildlife (Protection) Act, 1972- The Water (Prevention and Control of Pollution) Act, 1974-The Air (Prevention and Control of Pollution) Act, 1981-The Environment (Protection) Act, 1986-The National Environment Tribunal Act, 1992-The Biological Diversity Act, 2002-The Factories Act, 1948-The Forest (Conservation) Act, 1980, with amendments made in 1998-The Energy (Conservation) Act,2001-The Motor Vehicles Act, 1988-National Green Tribunal Act 2012-The public Liability Insurance Act, 1991

2.4 Rules and Notifications made under- Hazardous waste managent- Hazardous microorganisms -Biomedical Waste-Recycles Plastics-Ozone depleting substances -Noise Pollution (Regulation and Control) Rules, 2000

Unit 3 Environmental Information, Education and Communication

3.1 Information Networks- ENVIS Centre and INFOTERA

3.2 Environmental education-background, Goals, Objectives, Guiding principles and strategies for environmental education

Unit 4 Environmental movement, Participation and Awareness

4.1 Need for Public Awareness of Environmental Studies

4.2 Environmental movement and Peoples participation

4.3 Well Known Environmental Movements in India

4.4 Role of Tribal people, Women and NGOs in Environmental Protection

4.5 Various national and international NGOs

Recommended Readings

1 Anuj Kumar Purwar, Environment and Ecology, I K International Publishing House Pvt Ltd

2 Anti – Pollution Acts (3) and Commentaries Published theorem

3 Avanish Chiranjeev & Anil Kumar Jamwal, Environmental Law and Protection,Jnanada prakashan (P&D), New Delhi

4 Declaration of:The Stockholm Conference, Rio, Rio+5,and Rio+10

5 Gaur S & Chndrasekhar T, Environmental Management- Role of NGOs, Risk Perception and its Mitigation

6 Gupta K R, Environment problems and Policies, Vol 2, Atlantic Publishers and Distributors

7 Gouri Suresh, Environmental Studies and Ethics, I K International Publishing House Ltd

8 Misra S P, S N Pandey; Essentaila Environmental Studies, Ane Books Pvt Ltd

9 Sharma VS, Environmental Education, New Central Publications

10 Santra S C , Environmental Science,New Central Book Agency Pvt Ltd

11 Sudha Raghavan, India’s Environmental Policy with special reference to Marine Environment

12 Sundar I, Environment and Sustainable Development

COURSE CODE- ES010205

LABOURATORY COURSE-PART II (MICROBIOLOGY AND ENVIRONMENTAL CHEMISTRY)

Number of Hours / Week: 10 **Credits: 5**

Course Outcome

The course would help students to:

1. Assess microbial pollution
2. Identify and isolate various microbes from the environment
3. Preparation and characterization of bacteriological media – use of autoclave and hot air oven for sterilization
4. Isolation and enumeration of microorganisms in environmental samples (soil and water)
5. Understand the basic principles of the analysis of water, soil quality parameters
6. Carry out analysis of physico-chemical parameters of water and soil

Unit 1 Environmental microbiology

1.1 Preparation and sterilisation of bacteriological media – use of autoclave, laminar air flow and hot air oven for sterilization
1.2 Isolation and enumeration of microorganisms in environmental samples (soil and water)
1.3 Pure culture techniques – quadrant streaking, continuous streaking methods
1.4 Use of compound microscope
1.5 Staining techniques – Simple stain, Gram stain
1.6 Endospore staining
1.7 Detection of bacterial motility – hanging drop method, use of semi-solid agar
1.8 Basic biochemical test for characterisation of bacteria – Oxidase test and catalase test and oxidation/ fermentation (O/F) test
1.9 Water quality testing – MPN method to detect total coliforms, faecal coliforms and faecal streptococci
1.10 Membrane filter technique to detect faecal coliforms in water and Escherichia coli
1.11 Indole, Methyl Red (MR), Voges-Proskauer and Citrate (IMViC) tests for the characterization of E. coli

Unit 2 Environmental Chemistry

2.1 Water Quality Studies:- Salinity –Hardness-Iron-COD-Oil and Grease in Water Sample
2.2 Soil Quality Studies:-Moisture- pH-Organic matter-Organic carbon-Chloride content in Soil

THIRD SEMESTER COURSES

ES010301		Environmental Engineering	
ES010302		Environmental Planning and Resource Management	
ES800301	Group A	Elective 1	Environmental Impact Assessment and Audit
ES800302		Elective 2	Environmental Economics and Sustainable development
ES810301	Group B	Elective 1	Green Chemistry and Nano Technology
ES810302		Elective 2	Natural and Anthropogenic Disasters

COURSE CODE: ES010301
ENVIRONMENTAL ENGINEERING

Number of Hours / Week: 3 **Credits: 4**

Course Outcome

The course would help students to:

1. Understand air and water resource management, solid waste management through the concept of System approach.
2. Describe the basics of mass balance analysis in Environmental Engineering
3. Understand various steps and techniques of water and wastewater treatment. Apply system approach in water resource management.
4. Describe air quality standards. To understand meteorological factors in air pollution and apply theories and models in air pollution/emission dispersion.
5. Understand different air pollution control techniques.
6. Explain the importance of Solid Waste Management with the concept of system approach. Evaluate various techniques in solid waste processing and disposal.

Unit 1 Introduction

1.1 Environmental Engineering and Environmental Systems-Water resource management-Air resource management
1.2 Solid waste management systems
1.3 Mass-balance approach to problem solving

Unit 2 Water and wastewater Treatment

2.1. Water quality studies-Sampling technique- Sampling devices- Sample preservation-importance of Physical – Chemical and biological examination of water-Water quality standards
2.2. Water treatment-Filter plants-Mixing and flocculation, Coagulation, Jar test-Softening – lime soda and ion exchange process- Filtration – slow, rapid and high – rate sand filters-Disinfection – Chlorination, Ozonation and UV application
2.3. Wastewater treatment- Introduction, characteristics of wastewater-BOD,COD, Turbidity-classification of wastewater-municipal, industrial wastewater
2.4. Municipal wastewater treatment system-Unit operations of pre-treatment - Bar racks, grit chambers, communitors and equalization tank-Unit operations of primary treatment-Screening-sedimentation aided with coagulation-filtration

Unit 3 Secondary (Biological) wastewater treatment systems

3.1. Unit Process of Secondary treatment: (Biological unit processes)- Nature and kinetics of biological growth
3.2. Aerobic treatment-Aerobic activated sludge processes and its various modifications - Oxidation ponds- Attached growth systems-trickling filters- Rotating biological contactors (RBCs)
3.3. Anaerobic wastewater treatment systems-High rate and low rate reactors examples-Evolution of high-rate anaerobic reactors-CSTRs- Up-flow anaerobic filters (UAFs)-UASBs, Expanded /Fluidized bed reactors

Unit 4 Tertiary/ advanced treatment systems

4.1. Chemical unit processes-Filtration-Adsorption-Nitrogen and phosphorous removal-Biological nutrient removal (BNR) systems-Land treatment- slow rate, overland flow, rapid infiltration
4.2. Sludge treatment-sludge disposal
4.3. Application of nanotechnology in wastewater treatment systems.

Unit 5 Air quality management

5.1. Air quality standards –Ambient air quality management
5.2. Control of particulate matters, Control of gaseous contaminants, Air pollution control techniques: Particulate matters control devices-gravitational (gravity settling chambers), centrifugal (cyclones), electrostatic and fabric and wet precipitators-scrubbers-design concepts
5.3. Gaseous air pollution control methods-absorption-adsorption-condensation-combustion
5.4. Industrial emission-stack emission monitoring and management
5.5. Automobile emission control

Recommended Readings

1. Abbasi, S.A., Ramasamy, E.V., 1999b. Biotechnological Methods of Pollution Control. *Universities Press of India Ltd*. India.
2. Abbasi, S.A., Krishnakumari, P.K. and Khan, F.I. 1999.Hot topics, *Oxford University Press,* Chennai.
3. Abbasi, S.A. 1998 Water Quality: Sampling and Analysis, *Discovery publishing house,* New Delhi
4. Abbasi, S.A., 1998. Environmental pollution and its control. *Congent international*, Pondicherry.
5. Davis,M.L. and Cornwell,D.A. 1991. Introduction to Environmental Engineering (Second edition),*Mc Graw Hill International Edition*
6. De A K etal (2009) Environmental Engineering
7. Freeman, H.M. 1998. Standard book of Hazardous waste Treatment and disposal, *Mc Graw Hill*

8. Rand, M.C. Greenberg,A.E and Taras, M.J (edts.) Standard methods for the examination of water and waste water. APHA (American Public Health association) 1995. Standard methods for examination of water and wastewater, 19th edition. APHA, Washington DC, USA.
9. Scragg, A.1999. Environmental Biotechnology ,Addison Wesely Longman, Singapore
10. Srinivasan (2009) Environmental Engineering
11. Tchobanoglaus,G.1988 Wastewater Engineering: Treatment, Disposal, Reuse Tata *Mc Graw Hill*, New Delhi
12. Tchobanoglaus,G. Theisen,H and Vigil, S.A 1993 Integrated Solid waste Mangement: engineering principles and management issues, *Mc Graw Hill International Edit*

COURSE CODE: ES010302

ENVIRONMENTAL PLANNING AND RESOURCE MANAGEMENT

Number of Hours - Week: 3 **Credits: 4**

Course Outcome:

The course would help students to:

1. Understand the basic concepts of Environment Management
2. Understand and evaluate the fundamental concepts of ecosystem management
3. Understand and analyse the fundamental concepts of environmental planning and Management with various standards
4. Explain and apply the application of environmental planning and management in managing disasters
5. Explain and apply the ecosystem restoration in environment management
6. Understand and analyse the management of various physical and biological resources

Unit 1 Introduction

3.1. Basic Principles of Environment Management

3.2. Environment management – tools and techniques

3.3. Environment Management Systems (EMS)

3.4. Introduction to environmental quality models- input and output models, linear programming models of environmental quality management

3.5. Natural resources and their management

Unit 2 Ecosystem management

3.1. Grassland and forest management

3.2. Wetland Management

3.3. Management of coastal and marine ecosystems

3.4. People's participation in ecosystem management

3.5. Case studies

Unit 3 Water resource management

3.1 Global Water Budget, global water availability-depletion of water resources-Interrelation of water resources with other natural resources and the environment

3.2 Dams and water Resources-Watershed management -Irrigation water management

3.3 Integrated Water Resources Management (IWRM)

3.4 Concept of sustainable water resources development

3.5 Global Efforts - water resource management, Local water organizations-World water organizations- UN, GWP, WWC

Unit 4 Physical resources

4.1 Soil and mineral resources- status and significance, problems facing

4.2 Soil quality management – engineering and ecological solutions

4.3 Control of soil erosion

4.4 Eco-restoration of degraded land

4.5 Soil Management in Kerala

4.6 Radioactive minerals and their management

4.7 Metals and other minerals – management strategies

Unit 5 Biological resources

5.1 Forest resource management – NTFPs, biodiversity, medicinal plants

5.2 Integrated management of wild life population

5.3 Sustainable Management of biological resources of Kerala

Unit 6 Environmental Planning and Management

6.1. Principles of EPM-Principles, concepts and scope of environmental planning-Ecological aspects of EPM

6.2. Steps in Environmental planning-Identification and formulation of strategies of EPM Environmental analysis and EPM-Physical planning in relation to environmental and land use classification

6.3. EPM for Town and urban lands, Rural and agricultural lands, Waste lands,Wetlands, Mining areas, Industrial areas, Transportation and urban planning

Unit 7:EPM for Environmental Hazards

7.1 Environmental hazards in Environmental Planning and Management

7.2 Types of environmental hazards- Flood, drought, landslides, earthquakes, cyclones etc.

7.3 Significance and characteristics of hazards in environmental planning and development

7.4 Opportunities and regional planning for hazard management

Recommended Readings

1. Abbasi,S.A. (2001) Water resources projects and their environmental impacts. Discovery publishing house, Newdelhi.
2. Gangstad, I. (1990). Natural Resource management of water and land. Van Norstrand Reinhold, Newyork.
3. Petak, w.J and Atkisson, A.A. (1982). Natural Risk Hazard Assessment and Public policy. Springer- Verlag, New York.

COURSE CODE- ES010303

LABORATORY COURSE-PART III (ENVIRONMENTAL CHEMISTRY AND TOXICOLOGY)

Number of Hours / Week: 10 **Credits: 5**

Course Outcome

The course would help students to:

1. Explain gravimetric, volumetric, spectroscopic analysis
2. Explain the applications of gravimetric and volumetric methods
3. Describe the applications of spectroscopic methods
4. Explain mechanisms for adverse effects of chemicals

Unit 1 Environmental Chemistry

1.1 Water quality- Sulphate, Nutrients (Nitrite, Nitrate, Phosphate), hexavalent chromium
1.2 Soil/Sediment quality- Available Nitrogen, Available Phosphorous, Available potassium

Unit 2 Environmental Toxicology

2.1 Toxicology tests (LC50)

COURSE CODE: ES800301

ENVIRONMENTAL IMPACT ASSESSMENT AND AUDITING

Number of Hours - Week: 3 **Credits: 4**

Course Outcome:

The course would help students to:

1. Describe the global changes and sustainability
2. Explain the EIA process, LCA, Environmental audit
3. Explain the role of various agencies in EIA
4. Assess the project impacts and role of public participation in EIA
5. Do EIA using various methodologies
6. Do Environmental Audit
7. Explain the LCA and EMS

Unit 1 Environment Impact Assessment (EIA)

3.1. Introduction to EIA-EIA Guidelines and notification of Govt. of India-Procedure for reviewing Environmental Impact Analysis and statement-Definition, aim, principles, concepts and purposes of EIA
3.2. Components or participants of EIA
3.3. Types of EIA- Rapid EIA- Comprehensive EIA-Strategic Environment Assessment (SEA)

Unit 2 Process and methods of EIA

2.1 Screening, Scoping, Consideration of alternatives-Environmental Base line data collection
2.2 Factors causing environmental effects in development projects-Physical, biological and other factors
2.3 Identification of Impacts-Prediction of Impacts
2.4 Types of Impact-Primary & Secondary-Short Term & long term-Reversible and Non reversible-Positive and Negative impacts
2.5 Evaluation and assessment of impact-Assessment of effects on -Human beings, buildings and made features-Flora, fauna and geology-Land, water, air, and climate
2.6 Mitigation Measures-Public Consultation and Participation-Environment Impact Statement Preparation
2.7 Methods of EIA- Adhoc Method-Checklist Method-Matrices Method – (Leopold Metric)-Networks Method-Overlays Method-Index Method-Simulation Mode-Cost Benefit Analysis- Smith Study-Warner and Preston Study
2.8 Terms of Reference (TOR)

Unit.3 Environmental Management Plans (EMP)

3.1 Objectives of EMP

3.2 Components of EMP-Environmental Monitoring-Principles & types of monitoring-Environmental auditing-Guidelines for Auditing-Objectives and benefit of Auditing-Steps in Auditing-Types of Auditing

3.3 Environmental Management Systems (EMS)- Benefits of EMS-International Standard Organization and ISO 14001

3.4 Life Cycle Assessment

Unit.4 EIA case studies

4.1 Case studies of EIA-Nuclear Power plants-Hydroelectric Projects-Thermal Power Plants-Mining projects-Transportation projects-industries-development projects

4.2 Preparation of checklist for various stages of projects (examples only)

Recommended Readings

1. Abbasi, S.A. (2001). Water Resources Projects and their Environmental Impacts *Discovery Publishing House, New Delhi*
2. *Agarwal S K , Environmental Management, A P H Publishing Company , New Delhi*
3. *Anuj Kumar Purwar, Environment and Ecology, I K international publishing House*
4. *Bhatia A L , Sustainable Environment Impact Asessment, Avishkar Publishers.*
5. Cauter, L.N (1981). Environmental Impact Analysis. *Mc Graw Book Co* ,New York
6. Christian Ndubisi Madu (2007), Environmental Planning and Management. Imperical College Press
7. *Dara S S, A Text Book of Environmental Chemistry and Pollution Control*
8. Edward Stead W, Jean Garner Stead (2004), Sustainable Strategic Management , M E Sharp Inc
9. Gangstad, E.O**.(** Ed). (1990).Natural Resorce Management of Water and Land .*Van Norstrand Reinhold*. New York
10. *John Glasson etal, Introduction to Environmental Impact Aseesment- UCL Press Ltd,* London
11. Khadka, R.B**.,** *et al* (Eds). (1996). EIA- Training Manual for professionals and magers. Asian Regional Environmnetal Assesment Programme-*IUCN*, Nepal.
12. *Pandey G N, Environment Management*
13. Peter Wathern (2001) Environment Impact Assessment: Theory and Practices
14. *Santra S C, Environmental Science, New Central Agency Book Pvt Ltd.*
15. *Shrivastava A K, Environment Impact Aseesment, A P H Publishing Corporation, New Delhi*
16. *Trivedi P R, Environment Impact Asessment, A P H Publishing Company , New Delhi*
17. *Srivastava D C , Readings in Environmentall Ethics*

18. Edward Stead W, Jean Garner Stead (2004), Sustainable Strategic Management , M E Sharp Inc
19. Gangstad, E.O.(Ed). (1990).Natural Resorce Management of Water and Land .*Van Norstrand Reinhold*. New York

COURSE CODE- ES800302

ENVIRONMENTAL ECONOMICS AND SUSTAINABLE DEVELOPMENT

Number of Hours / Week: 3 **Credits: 3**

Course Outcome

The course would help students to:

1. Explain the basics concepts and theories of environmental economics and sustainable development
2. Describe the environmental problems and its impacts
3. To synthesize the new field of environment and economics in a holistic approach towards solution of environmental problems
4. Understand the importance of environmental education in attaining Sustainable Development
5. Identify methods, tools, and techniques for sustainability

Unit 1 Environmental Economics

1.1 From economics to Environmental Economics
1.2 Definition and scope of Environmental Economics
1.3 Externalities- types and importance problem of second best and solution to Externality - Market failure - Solution.
1.4 Properties of public goods - Coase theorem-Common pool resources - Tragedy of commons.
1.5 Basic theories of EE - Material Balance Approach and law of entropy.
1.6 Welfare aspects of Environmental Economics - Principle of maximum social welfare - Pareto Criterion
1.7 Environment Cost- Benefit Analysis (CBA) - Introduction and concept of CBA ; Efficiency in pollution control ; Environmental pollution-control, private cost and social cost , Social CBA - Application of CBA
1.8 Environmental cost of Economic growth

Unit 2 Resource Economics

2.1 Economics of Natural Resources-Theories of natural resource use, natural resource scarcity and indicators of scarcity – Role of natural resources on economic development.
2.2 Resource Pricing Techniques; Green Accounting
2.3 Consumption – consumer behaviour – theories of consumption, over consumption.
2.4 Income – income inequalities – extent of poverty, poverty and environment (at the global and national levels) HDI – new concepts of development.

2.5 Population as resource - Size and density of population, population. Concepts of overpopulation and over consumption- North Vs South. Demonstration effects, Globalization and new strategy of marketing

Unit 3 Industrial development & Environment

3.1 Traditional Industries- cottage and small scale production, marketing and natural resource use techniques and rural setup
3.2 Modern large scale industries- nature process and techniques of production- impact on environment
3.3 Problems related to modernization and urbanization-pollution, health etc
3.4 Green Policies of industrialization – Green technology, Green Productivity and Green Marketing etc

Unit 4 Sustainable Development

4.1 From problems to crises- Depletion of resources and degradation of environment
4.2 From modern development to Sustainable Development
4.3 Definition, World Commission on Environmental Development (WCED)
4.4 Policies for SD at international and national levels
4.5 Indicators of SD, Criteria – Strategies for measurement of SD,
4.6 Sustainable human development index and Sustainability pillars
4.7 Gandhian model of SD
4.8 Definition, Importance of sustainable production and consumption

Unit 5 Educations for Environment and Sustainable Development

5.1 Environmental education
5.2 Education for Sustainable Development
5.3 Eco – School

Recommended Readings

1. AbhijitDutta et.al (2005), Environmental Economics, APH Publishing Corporation, New Delhi
2. Bowers, J. (1997). Sustainability and Environmental Economics. Longman, Singapore.
3. Brown, L. R. (2001). Eco-Economy. Earth Scan Publications, London.
4. Caprei, F. (1984). The Turning Point. Flemingo Pub., London
5. Charles D Kolstad(2002), Environmental Economics, Oxford New York
6. David Pearce (2002). "An Intellectual History Of Environmental Economics", Annual Review of Energy and the Environment 2002
7. Eugine.T.(2007),Environmental Economics,VrindaPublications,Delhi
8. Hackett, S. C. (1998). Environmental and Natural Resource Economics. M. E. Sharpe, London
9. Karpagam, M. (1991). Environmental Economics. Sterling Pub., New Delhi
10. Katar Singh & Anil Shishodia(2007) ,Environmental Economics, Sage publications, New Delhi
11. Muralivallabhan T. V., Dimensions of Sustainable Economic Development, Unma Pub., 2005

12. Murty M N, Environment, Sustainable Development and Well being, Oxford University Press, New Delhi
13. Natalia Mirovitskaya and William Ascher., Guide to Sustainable Development and Environmental policy., Duke University Press, London, 2001.
14. Owen, L and Unwin, T. (Ed.). (1997). Environment Management. Backwell Pub., USA.
15. Prasad S N (2011), Environmental Economics, Avishkar Publications, Jaipur
16. Purnima Sethi,V.S .Kulkarni (2011). Environmental Economics, Alfa publications, New Delhi
17. Rajyalakshmi V ., Environment and sustainable development ,A.P.H Pub, New Delhi
18. Robert N. Stavins (2008). "Environmental economics", *The New Palgrave Dictionary of Economics*, 2nd Edition. Abstract & article
19. Rosencranz, A., Divan, S. and Noble, M. L. (1992). Environmental Law and Policy in India - cases, materials and statutes. Tripathi Pvt. Ltd., Bombay.
20. Savitha Singh, Global Concern with Environmental crisis and Gandhi's Vision (1999),APH Publishing Corporation,Delhi.
21. Schumacher, E. F. (1990). Small is Beautiful. Rupai & Co. Pub., New Delhi
22. Titanberg, T. (1998). Environmental Economics and Policy (2nd Edn.). Addison Wesley Publishers.
23. Trivedi, P. R. and Singh, V. K. (1994). Environmental Protection and Law. Commonwealth Publishers.
24. World Bank: World Development Report (1992).
25. World Commission on Environment and Development. (1987). Our Common Future.

COURSE CODE- ES810301

GREEN CHEMISTRY AND NANOTECHNOLOGY

Number of Hours / Week: 3 **Credits: 4**

Course Outcome

The course would help students to:

1. Explain green chemistry
2. Describe the applications of green chemistry
3. Describe green synthesis
4. Explain nanotechnology for environmental benefits
5. Explain green synthesis of nanoparticles and their characterization.
6. Apply the Nano technology in environmental monitoring and remediation.

Unit 1

1.1 Introduction and need for green chemistry; Principles of green chemistry; percentage atom utilization and percentage atom economy; rearrangement, addition, substitution and elimination reactions; examples of catalytic reactions.

Unit 2

2.1 Planning green synthesis; evaluation of rearrangement, addition, substitution, elimination and pericyclic reactions for green reactions; selection of solvents; selection of starting materials; use of protecting groups; use of catalyst and low energy reactions.

Unit 3

3.1 Alternate approach to solvent chemistry; solvent free reactions; microwave assisted synthesis; ionic liquids as an ecofriendly solvent; supercritical fluid extraction as a cleaner technology.

Unit 4

4.1 Green technologies: catalytic reactions; alternate waste treatment technologies: Advanced Oxidation Technologies for waste water treatment , Phycoremediation, Sustainable sanitation

Unit 5

5.1 Introduction to nanotechnology – particle size, surface area and quantum dots ; synthesis and fabrication – nano scale metal oxides, Carbon nanotubes , nanocomposites., Green nanosynthesis- types , methods and advantages; nanotechnology as a tool for sustainability, health and safety.

Unit 6

6.1 Characterization of nano particles for structural and chemical nature. Environmental applications of nano materials –ground water remediation, water purification, absorbent, membrance process, nano sensors, detection of pesticides and trace metal ions, environmental monitoring, social implications of nanoscience and technology.

Recommended Readings

1 Manahan Stanley E ., Environmental chemistry, Lewis Publishers London
2 Srivastava M M (2007) Chemistry for Green Environment
3 Lichitouse Eric et al (2009) Environment Chemistry, Green Chemistry and pollutants in ecosystem
4 Ahluwalia V K (2009) Green Chemistry Environmentally benign reactions
5 Anastas Paul T (2000) Green Chemistry theory and practice
6 Sanghi Rashmi (2006) Green Chemistry, Environment friendly alternatives
7 Lancaster Mike (2010) Green Chemistry : An introductory text
8 Prasad T. (2007) Nano: The Essential understanding of Nanoscience and nanotechnology. McGraw Hill.
9 Hornyak, Moore and Tibbals Dutta (2007). Fundamentals of Nanotechnology ,CRC press
10 Wiesner M.R., Jean-Yves Bottero (2007). Environmental Nanotechnology applications and impacts of Nanomaterials. McGraw Hill.
11 Savage N (2009). Nanotechnology Applications for Clean water. William Andrew Inc..
12 John (2013). Role of natural products in Green synthesis of Nanoparticles.

COURSE CODE ES810302

NATURAL AND ANTHROPOGENIC DISASTERS

Number of Hours / Week: 3 **Credits: 3**

Course Outcome

The course would help students to:

1. Explain the relation between Earth's processes and disasters
2. Distinguish various types and causative factors of disasters
3. Illustrate the key concepts of disaster management
4. Identify the major disasters in the country and Assess the disaster management strategies in India

Unit 1 Disaster Management Concepts and Field of Study

1.1 Introduction to key concepts, terminologies and their complexities (Hazard, vulnerability, Exposure, Risk, Crisis, emergencies, Vulnerability, Disasters, Resilience) Types and classifications of disasters-Natural and Human made, Anthropogenic, Chemical, Biological etc., Impact of disasters,.

1.2 Disaster management Spectrum and its components

1.3 Scope of DM and Disaster Management Cycle

Unit 2 Disasters and Development – Introduction

2.1 Relationship between disasters and development, implications. History of disaster Response strategies

2.2 Disasters, Poverty and Development. Global challenges and trends of Disasters

2.3 Disaster Management: The interaction of Earth system and Human System

2.4 Disaster Risk Management - key concerns. Mainstreaming Disaster Risk Reduction to developmental efforts.

2.5 Geography and dimensions of Disasters- global outlook.

Unit 3 Environment and Disasters

3.1 Science and Facts of Natural Hazards. Earth's processes as disasters: Internal and external Characteristics. Causal factors and characteristics of disasters.

3.2 Disaster typology and Classification.

3.3 Water and climate related disasters

3.4 Geologically related Disasters

3.5 Biologically related Disasters

3.6 Chemical, Industrial and Nuclear related Disasters

3.7 Accident related Disasters

3.8 Climate change and Disasters

Unit 4 International Disaster management System

4.1 Organizations, bodies and Finance. International Strategies and functions. United Nations role in Disaster management.

4.2 International Disaster management support system. Unified response strategy
4.3 Mapping Disasters using global datasets. National and international information networks and inventories.

Unit 5 Disaster Management in Indian Context

5.1 Major Disasters in India. National Vulnerability profile
5.2 National Disaster management Hierarchy and Institutionalisation
5.3 National Disaster Decision support system. Technological applications. Role of Research Organisations.
5.4 Challenges of disasters in India

Recommended Readings

1 Coppola D. P., 2007. Introduction to International Disaster management. Elseiver. Butterworth-Heinemann
2 Peduzzi P., Dao H., and Herold C., 2005. Mapping Disastrous Natural Hazards Using Global Datasets Natural Hazards Volume 35, Number 2, 265-289,
3 Shaw R and Krishnamurthy R.R., (ed.)2009. Disaster management Global Challenges and Local solutions. University Press, India
4 Keller E.D., and Blodgett R. H, 2006. Natural Hazards. Pearson Printice Hall
5 Kapur A., Neeti, Meena, Deepthima, Roshani and Debanjali, Disastetrs in India Studies aof Grim Relaity. Rawat Publications, New Delhi

FOUTH SEMESTER COURSES

ES010401	Environmental Biotechnology and Waste Management
ES800403	Group A Elective 3Disaster Management
ES810403	Group B Elective 3Climate Change and Governance
ES010403	Project Work (Report/Thesis)
ES010404	Comprehensive Viva Voce

COURSE CODE- ES010401

ENVIRONMENTAL BIOTECHNOLOGY AND WASTE MANAGEMENT

Number of Hours / Week: 3 **Credits: 3**

Course Outcome

The course would help students to:

1. Describe the basics of molecular biology and environmental biotechnology and its relevance
2. Understand the techniques involving Biotechnology applicable to combat air, soil and water pollution. To assess the efficiency of different wastewater treatment techniques.
3. Understand different solid waste management steps; to assess their potential at present and in future.
4. Describe the need of zero waste concept
5. Identify the benefits and drawbacks of both conventional and ecological sanitation

Unit1 Cell Technology and Biotechnology

1.1 Cell: Structure and function – Prokaryotes and Eukaryotes. Nucleic Acids, Central dogma - Protein synthesis Recombinant DNA (r DNA) techniques. Fermentation Technology.

1.2 Plant tissue culture techniques

1.3 Environmental Biotechnology: an overview.

Unit 2 Biotechnological Methods in Pollution Control

2.1 Air pollution control: Bio-desulphurization of coal, Green belts.

2.2 Water pollution control : Aerobic and Anaerobic wastewater treatment Systems.- microbial and algal fuel cells

2.3 Bioremediation : Soil / land contaminated with oil spills, PCBs, PAHs; Bioremediation technology; Phytoremediation

2.4 Biosensors **:** Concept and principle ,Biosensors for environmental monitoring

Unit 3 Emerging Trends in Environmental Biotechnology

5.1 Agro-biotechnology : Plant genetic engineering – role of r DNA technique; transgenic plants - GM crops, Bio-pesticides and Bio-fertilizers

5.2 Phyto-reactors- Plants used to produce genetically engineered products

5.3 Ecological Engineering Aquatic macrophyte based wastewater treatment systems (AMS)- constructed/ artificial wetlands

5.4 Nutrient Film Technique (NFT**)-** Overland flow irrigation of treated effluents

5.5 Biodegradable plastics – PHBs and PHAs

Unit 4 Solid Waste Management

4.1. Municipal Solid Waste : Types, sources , properties and impacts

4.2. Techniques for treatment / processing: Concept of three R's, Thermal processes – incineration, Pyrolysis, RDF. Biological processes – Anaerobic digestion, Composting and vermicomposting.

4.3. Disposal techniques: Landfills – design, operation and management.
4.4. Hazardous waste management.
4.5. Concept of Zero waste

Unit 5 Ecological Sanitation

5.1 Conventional sanitation : a linear flow system – its limitations
5.2 Eco San –Circular flow and closing the loop : concept, goals and advantages
5.3 Eco San for human night soil management: Dry Toilets, Composting Toilets UDDT,UDFT.
5.4 Grey water management
5.5 Eco San - Human Health and Food Security

Recommended Readings

1 Abbasi, S.A. 1998. Environmental Pollution and its Control ,C*ogent Internationa*l , Pondicherry
2 Abbasi, S.A., Ramasamy, E.V., 1999. Biotechnological Methods of Pollution Control. *Orient Longman*, (*Universities Press of India Ltd.)* India, 168.
3 Abbasi, S.A., Ramasamy, E.V., 2001. Solid Waste Management with Earthworms. *Discovery Publishing house*, New Delhi.
4 Davis, M.L. and Cornwell,D.A. 1991. Introduction to Environmental Engineering, *Mc Graw Hill* International Edition
5 Edwards, C.A. 2004. Earthworm Ecology, *CRC Press*, London.
6 Freeman, .H.M. 1998. Standard book of Hazardous Waste Treatment and Disposal, *Mc Graw Hill*, New York.
7 Hill, M.K. 2004. Understanding Environmental Pollution, *Cambridge University Press*, Cambridge,U.K.
8 Ismail, S.A., 1997. Vermicology: The Biology of earthworms. *Orient Longman*, India.
9 Ismail, S.A. 2005. The Earthworm Book, *Other India Press*, Goa, India.
10 Odum, E.P. 1971. Fundamentals of Ecology, *W.B.Sounders Company*, Philadelphia.
11 Peavy, H.S., Rowe,D.R., and Tchobanolous,G. 1985.Environmental Engineering, *Mc Graw Hill* , International Edition, Singapore.
12 Scragg, A. 1999. Environmental Biotechnology. *Addison Wesley Longman*, Singapore.
13 Tchobanoglaus, G., Theisen, H and Vigil, S.A. 1993. Integrated Solid Waste Management : Engineering Principles and Management issues, *Mc Graw Hill* International Edition, Singapore. Winblad U and Simpson-Hébert M (editors) 2004: Ecological sanitation –revised and enlargededition. *SEI*, Stockholm, Sweden.

COURSE CODE ES800403

DISASTER MANAGEMENT

Number of Hours / Week: 3 **Credits: 3**

Course Outcome

The course would help students to:

1. Define and describe Disaster management, Hazard, Emergency, Vulnerability and Risk
2. Identify and explain types of natural and non-natural disasters
3. Define various phases of Disaster Management Cycle
4. Explain Environmental Planning and management for environmental hazards
5. Hazard identification and vulnerability analysis
6. Preparation of Emergency Operation Plan
7. Explain the importance of hazard identification and mitigation
8. Identify the role and importance of Community Based approaches in Disaster Management
9. Describes the importance of indigenous knowledge in education and public awareness on disaster management
10. Identify the main communicable diseases common in disaster situations and their management
11. Assess the types of impacts on people
12. Identify the vulnerable groups and strategies to reduce the effect of disaster.

Unit 1 Introduction

1.1 Introduction to Disaster Management (Concepts and terminologies)
1.2 Distinguishing between an emergency and a disaster situation
1.3 Types of natural and non-natural disasters (Typology and classification of disasters- HPC classification, 5 class and 31 types)
1.4 Implications of disasters on environment (disasters and development)
1.5 Environmental Planning and management for environmental hazards (resilience and capacity development)

Unit 2 Disaster Management Cycle

2.1 Introduction
2.2 Disaster Management Cycle (The four phase approach in modern emergency management- Mitigation, Preparedness, Response and Recovery)
2.3 Disaster Mitigation
2.4 Mitigation strategies (Mitigation goals)
2.5 Hazard identification and vulnerability analysis (Risk assessment)
Mitigation measures (Structural and non-structural)

2.6 Disaster Preparedness
2.7 Disaster Risk Reduction (DRR)
2.8 The Emergency Operation Plan (EOP)
2.9 Disaster Response and Recovery
2.10 Modern methods of disaster response
2.11 The Recovery Plan

Unit 3 Disaster Education and Public Awareness

3.1 Community-based Initiatives (CBDP, CBDRM, CBEWS)
3.2 Stakeholders' Roles and Responsibilities, Categories of stakeholders
3.3 Government, Non-Government Organizations (NGOs),Regional and International Organizations-Donor Agencies, Island Councils / Local Government, Community Workers, National and Local Disaster Managers, Trainers, Policy Makers and Grass-roots people
3.4 Advantages and Disadvantages of the Community-Based Approach
3.5 Duties of Response Personnel, Pre-Disaster Mitigation Plan
3.6 Hazardous Materials-Ways of storing and safely handling hazardous materials-Opportunities and regional planning for hazard management
3.7 The Role of Technology in Disaster Management-Geographic Information Systems (GIS) and Disaster Management-The Role of Media in Disaster Management

Unit 4 Physical and Socio-economic Impacts of Disasters

4.1 Disaster Associated Health Issues
4.2 Emergency Health Services in Disasters (Public health sector and disaster management)-Infrastructure and procedures in accessing emergency situations
4.3 Communicable diseases common in disaster situations-Monitoring and Evaluation of Communicable Diseases Control Programme
4.4 Disaster and Development-The impact of disasters on development programmes-Vulnerabilities caused by development

Recommended Readings

1. Abbasi S.A, Krishnakumari P.K and Khan F.I. (1999), Hot topics, *Oxford University Press*. Chennai.
2. Edward Bryant (2004), Natural Hazards
3. Embard Haque C (2005) Mitigation of Natural Hazards and DisastersNatural
4. Ghosh G.K (2006),disaster management (vol2),Kul bhushan Nangia, APH Publishing Corporation, New Delhi.
5. Maxx Dilley (2005) Disaster Hotspots
6. Namboodripad P(2008)Disasters and Hazard Mangement. *Rajadhani Printers,* Delhi.
7. Sharma R.K and Gagandeep, Sharma (2005) Natural Disaster. , *APH Publishing Corporation*, New Delhi.
8. Srinivas, H. (2005) *Disasters: a quick FAQ.* Accessed on 24/01/08 at:Sumit Malhotra,(2005) Natural Disaster Management. *Aavishkas Publishing,* Jaipur
9. William J Petals *et al.(1982)Natural Hazard Risk Assessment and Public Policy, Springer-verlag* ,New York

10. Introduction to Disaster Management, Course Manual. Virtual University for Small States of the Commonwealth (VUSSC).Disaster Management. Version 1.0
11. Natural Disaters-A guide for relief workers, (1980), JACAdhyatma Sadhna Kendra Mehrauli, New Delhi

COURSE CODE- ES810403

CLIMATE CHANGE AND GOVERNANCE

Number of Hours / Week: 3 **Credits: 3**

Course Outcome

The course would help students to:

1. Describe the basics of Climate Change and explains the changes occurred so far and prediction of the future changes
2. Explain the causes of climate change and analyses the impacts of climate change
3. Explain various procedures of inventorying the greenhouse gas emissions (GHG).
4. Explain various climate change adaptation methods, integrated natural resource management systems; evaluate various information systems including early warning systems.
5. Explain the global action and governance for climate change mitigation
6. Describe various technical and financial aids for climate change mitigation and adaptation

Unit 1: Basic definitions - Climate and weather

1.1 climate change; greenhouse gases; radiative forcing; warming potential
1.2 climate modelling; global and regional circulation models; IPCC modelling scenarios.

Unit 2: Observed and projected changes in the climate system

2.1 land surface temperature; ocean surface temperature; precipitation; cryosphere;sea level;greenhouse gas concentrations (CO_2 and Non CO_2 gases);and extreme climatic events.

Unit 3: Drivers of climate change

3.1 natural and anthropogenic radiative forcings; solar irradiance; aerosols, water vapour and clouds; volcanic eruption; GHG emissions from energy, industries, and transport; and gross and net emissions from agriculture, forestry and other land use.

Unit 4: Impacts of climate change
4.1 Impacts of climate change on physical systems on physical systems (Glaciers, snow, iceand/or permafrost;Rivers, lakes, floodsand/or drought; Coastal erosion and/or sea level effects); 4.2 biological systems (Terrestrial ecosystems; aquatic ecosystems); Human and managed systems (Food production; Livelihoods, healthand/or economics)

Unit 5: Greenhouse gas inventorying –
5.1 IPCC guidelines on national greenhouse gas inventorying; general guidance and reporting; guidance specific to energy, industrial processes and product use (IPPU), agriculture, forestry and

other land use (AFOLU), and waste; activity data; emission factors; key categories; tiered approach; stock-difference and gain-loss methods; principles of reporting; measurement, reporting and verification (MRV) system.

Unit 6: Climate change mitigation and adaptation

6.1 **Climate change mitigation -**decarbonizing energy production; use of clean energy and enhancing the energy efficiency in industries, transport, and buildings; carbon dioxide storage and capture; bioeconomy or low carbon economy; enhancing the carbon sequestration capacity of forests and land use; climate smart agriculture; REDD+, long term mitigation pathways.

6.2 **Climate change adaptation** - social, ecological asset and infrastructure development;technological process optimization; integrated natural resources management; institutional, educational and behavioural change or reinforcement; financial services including risk transfer;information systems to support early warning and proactive planning.

Unit 7: Climate change institutions and governance

7.1 UNFCCC - Conference of Parties (COP); International Climate Agreement;Policy approaches for adaptation and mitigation, technology and finance; National Communications; Biennial Update Report; Intended Nationally Determined Contributions; Funding streams – Green Climate Fund, Forest Carbon Partnership Facility, Global Environment Facility, Adaptation fund, Bilateral and multilateral funds, and official development assistance fund, voluntary and compliance markets; global think tanks in climate change.

Recommended Readings

1 Angelsen, A., Brockhaus, M., Sunderlin, W.D., &Verchot, L.V. (2012). Analysing REDD+: Challenges and choices. Center for International Forestry Research (CIFOR). Bogor, Indonesia.426p.

2 Bonan, G.B. (2008). Forests and ClimateChange: Forcings, Feedbacks, and the Climate Benefits of Forests. *Science, 320*, 1444-1449.

3 *Ecosystem Marketplace (2015). Ahead of the Curve: State of the Voluntary Carbon Markets 2015*, Forest Trends, Washington DC, United States. pp 55.

4 IPCC (2006) 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the NationalGreenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds).Published: IGES, Japan.

5 IPCC (2008) 2006 IPCC Guidelines for National Greenhouse Gas Inventories – A primer, Prepared by theNational Greenhouse Gas Inventories Programme, Eggleston H.S., Miwa K., Srivastava N. and Tanabe K. (eds).Published: IGES, Japan.

6 IPCC (2013) Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

7 IPCC(2014) Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of theIntergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

8 IPCC(2014) Summary for Policymakers, In: Climate Change 2014, Mitigation of Climate Change. Contribution ofWorking Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer,O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B.Kriemann,

J. Savolainen, S. Schlomer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press,Cambridge, United Kingdom and New York, NY, USA.

9 IPCC (2014) Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability.Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of theIntergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea,T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken,P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and NewYork, NY, USA, pp. 1-32.

10 Lenton, T., M., Held, H., Kriegler, E., Hall Jim, W., Lucht, W., Rahmstorf, S., &Schellnhuber Hans, J. (2008). Tipping elements in the Earth's climate system. *Proceedings of the National Academy of Sciences of the United States of America, 105*, 1786-1793.

11 Loarie, S.R., Duffy, P.B., Hamilton, H., Asner, G.P., Field, C.B., &Ackerly, D.D. (2009). The velocity of climatechange. *Nature, 462*, 1052-1055.

12 Pal, J.S., &Eltahir, E.A.B. (2016). Future temperature in southwest Asia projected to exceed a threshold for human adaptability. *Nature Clim. Change, 6*, 197-200.

13 Parmesan, C., &Yohe, G. (2003). A globally coherent fingerprint of climatechange impacts across natural systems. *Nature, 421*, 37-42.

14 Rockstrom, J., Steffen, W., Noone, K., Persson, A., Chapin, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sorlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., & Foley, J.A. (2009). A safe operating space for humanity. *Nature, 461*, 472-475.

15 Rosenzweig, C., Karoly, D., Vicarelli, M., Neofotis, P., Wu, Q., Casassa, G., Menzel, A., Root, T.L., Estrella, N., Seguin, B., Tryjanowski, P., Liu, C., Rawlins, S., &Imeson, A. (2008). Attributing physical and biological impacts to anthropogenic climatechange. *Nature, 453*, 353-357.

16 Scheffran, J., Brzoska, M., Kominek, J., Link, P.M., & Schilling, J. (2012). ClimateChange and Violent Conflict. *Science, 336*, 869-871.

17 Shindell, D., Kuylenstierna, J.C.I., Vignati, E., van Dingenen, R., Amann, M., Klimont, Z., Anenberg, S.C., Muller, N., Janssens-Maenhout, G., Raes, F., Schwartz, J., Faluvegi, G., Pozzoli, L., Kupiainen, K., Höglund-Isaksson, L., Emberson, L., Streets, D., Ramanathan, V., Hicks, K., Oanh, N.T.K., Milly, G., Williams, M., Demkine, V., & Fowler, D. (2012). Simultaneously Mitigating Near-Term ClimateChange and Improving Human Health and Food Security. *Science, 335*, 183-189.

FIRST SEMESTER
MODEL QUESTION PAPERS

COURSE CODE- ES010101

ECOLOGY AND BIODIVERSITY CONSERVATION

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Co- evolution
2. Life zone
3. Carring capacity
4. Stress Ecology
5. Edge effect
6. Estuaries
7. Key-stone species
8. Endemism
9. Gause principle **(8 x 1 = 8)**
10. Net primary productivity.

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Differentiate Ecotype and Ecad.
12. Explain gene pool and gene frequency.
13. Ecological efficiencies
14. Importance of Mangroves
15. Briefly explain phenology with examples
16. Differentiate Geographic speciation and Sympatric speciation
17. Compare the species diversity indices of Simpson and Shannon-Wiener (**6 x 2 = 12**)
18. Trophic relations

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Explain Ecological Niche and add a note on the views of Odum, Hutchinson and Gause
20. Explain Hardy-Weinberg equilibrium and its application in population genetics

21. Describe ecological succession mentioning the various processes involved in it and the types of ecological succession **(2 x 5 = 10)**

22. Compare r-selection and k-selection strategies of species survivability

COURSE CODE- ES010102

ENVIRONMENTAL GEOSCIENCES

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Subsidence
2. Thornwaites classification
3. Heat Island
4. Safety factor
5. .Albedo
6. La Nina
7. race element
8. Watershed
9. Cloud seeding **(8 x 1 = 8)**
10. Isostacy

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Climatic regions of India
12. Mention the hydrological classification of water bearing formations
13. Give an account of global actions on climate change
14. Explain slope process
15. Explain erosional and depositional features of rivers
16. Mention different physical properties of minerals
17. Interior of the earth (**6 x 2 = 12**)
18. Different types of drainage pattern

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Explain atmospheric stability and describe the factors influencing stability
20. Which are the meteorological factors influencing the dispersal of air pollutants
21. Explain geodynamism (**2 x 5 = 10)**
22. Briefly explain slope process

COURSE CODE- ES010103

ENVIRONMENTAL CHEMISTRY, INSTRUMENTATION AND ANALYTICAL TECHNIQUES

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight**questions. Each question carries a weight of 1)

1. Enthalpy
2. Reducing Smog
3. Green Polymer
4. Redox Reactions
5. Cation Exchange capacity
6. Define Beer –Lambert law?
7. Write short note on Thin Layer Chromatography.
8. Write short note on Flame Photometer.
9. Nephelometry. **(8 x 1 = 8)**
10. What are primary standard solutions?

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Saturated and unsaturated hydrocarbons.
12. List out the soil quality parameters
13. Acid – Base equilibria
14. First, Second and Zero order reactions
15. Write short note on UV-Visible Spectrophotometer.
16. What is Geiger Muller Counter? Give a brief note on it?
17. What is gel electrophoresis? (**6 x 2 = 12**)
18. Write the principle and procedure of Gas Liquid chromatography

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. List out the Green House gases; prioritize them how do they contribute to the greenhouse effect?
20. What are the impact of Chloro-Fluro carbons (CFCs) and halogenated organic compounds in the atmosphere and ozone depletion?
21. Write short note on Electron Microscopy? (**2 x 5 = 10)**
22. Write short note on Gas Chromatography? And the different detectors used in GC?

COURSE CODE- ES010104

ENVIRONMENTAL POLLUTION AND MANAGEMENT

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Aerosols
2. Hardness
3. Composite sample
4. Oxidizing smog
5. Effects of noise pollution
6. Biofouling
7. Eutrophication
8. Flocculation **(8 x 1 = 8)**
9. Methamoglobanemia
10. Stratospheric Ozone

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. What are the sources of soil pollution particularly with NOx and its control measures?
12. What are the physical and chemical characteristics of water?
13. Explain on water quality standards.
14. Explain on the bacteriological sampling and analysis of soil.
15. What is noise propagation and attenuation?
16. What are the impacts of thermal pollution?
17. Comment on Bhopal Gas Tragedy? (**6 x 2 = 12**)
18. Explain on marine pollution particularly with oil pollution.

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Explain on sources of radioactive wastes and its management.
20. Explain on the transport and dispersion of pollutants.
21. Explain on the causes and effects of soil pollution (**2 x 5 = 10)**
22. Explain on the problems facing our coastal area and its management measures.

COURSE CODE- ES010105

RESEARCH METHODOLOGY AND STATISTICS

Time: Three hours **Max. Weight: 30**

Section- A

(Answer any **eight** questions. Each question carries a weight of 1**)**

1. Measures of dispersion
2. How many types of central tendencies are used in statistics?
3. Distinguish between linear and nonlinear correlation.
4. What are Ogives? How median may be obtained from it?
5. Explain Chi square test.
6. Research Design
7. Explain the criteria for the selection of a problem.
8. Matrix
9. Standard deviation **(8 x 1 = 8)**
10. Skewness and kurtosis

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Explain analysis of variance
12. Calculate the coefficient of correlation between X and Y for values given below

    X: 1 2 3 4 5 6 7 8 9 10 /Y:10 9 8 7 6 5 4 3 2 1

13. Explain review of literature.
14. Explain briefly the probability distribution
15. Explain arithmetic and geometric progression
16. Explain analysis of variance
17. Explain research, its types and methods (**6 x 2 = 12**)
18. Explain basic principles of experimental design.

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Calculate mean, median and mode from the following data

Class:	0-10	10-20	20-30	30-40	40-50	50-60	60-70
Frequencies:	4	6	10	15	8	7	3

20. Explain briefly collection, analysis and interpretation of data.
21. Explain data analysis using computer package (**2 x 5 = 10)**
22. Classify research methods and different types of variables in research.

SECOND SEMESTER
MODEL QUESTION PAPER

COURSE CODE- ES010201

ECO TOXICOLOGY AND OCCUPATIONAL HEALTH HAZARDS MANAGEMENT

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight**questions. Each question carries a weight of 1)

1. Differentiate acute and chronic toxicity test
2. Cytochrome P 450
3. Metallothionein
4. Dose Response assessment
5. Microbiotest
6. Biococentration factor
7. Biohazard
8. Xenobiotics
9. Antidote **(8 x 1 = 8)**
10. Mesocosm

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Discuss the toxic effects of drugs
12. What are the toxic factors influencing the toxicity of reactive metabolites
13. How does the phase II reactions of toxicants carry out in organisms
14. What are the different steps involved in ecological risk assessment
15. What are the aims and objectives of environmental monitoring and how do you monitor it
16. Differentiate microcosms and mesocosms
17. Toxicity of heavy metals (**6 x 2 = 12**)
18. Describe occupational safety and management measures

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. What are the legal perspectives of ecological risk assessment
20. Explain the distribution of toxicants in the ecosystem
21. Briefly explain the impacts of toxicants on cellular and molecular level **(2 x 5 = 10)**

22. Explain toxicity tests for assessing toxicity on cellular and molecular level

COURSE CODE- ES010202

ENVIRONMENTAL MICROBIOLOGY

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Name two chemoautotrophic nitrifying bacteria?
2. Which antibiotic act as cell membrane inhibitor?
3. What is meant by stromatolites?
4. Define co metabolism?
5. Gram staining?
6. Glycocalyx.
7. Taq polymerase
8. Foreign derived microorganisms (8 x 1 = 8)
9. Microbial mats
10. Bipartite and tripartite associations

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Illustrate the replication cycle of HIV?
12. Write notes on microorganisms in extreme environment.
13. Explain microbial microcosm with an example?
14. List out various events takes place in a replication fork?
15. Describe the differences between cell wall of gram positive and gram negative bacteria?
16. Add a note on principle of gram staining?
17. What are the steps involved in micro propagation? (**6 x 2 = 12**)
18. Explain continuous culture systems?

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. Classify the antibacterial agents based on their mode of action?
20. Explain the causative agents, route of infection and control measures of waterborne diseases?
21. Comment on soil microorganisms. (**2 x 5 = 10)**

22. Explain the mechanism of gene regulation in prokaryotes with special reference to *E.coli?*

COURSE CODE- ES010203

INTRODUCTION TO GEO-INFORMATICS

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Remote sensing
2. Scales, types of scales.
3. Contour map, Cadastral map
4. Aerial photogrammetry
5. Define active and passive remote sensing.
6. What is specular reflection and diffuse reaction?
7. What are atmospheric windows and spectral signature?
8. What are spatial and attribute data? **(8 x 1 = 8)**
9. Difference between polar synchronous satellite and geo stationary satellite?
10. What are a pixel, scale, resolution and projection?

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. What is Geocoding? Write short note on it?
12. What is supervised and unsupervised classification?
13. Difference between aerial photogrammetry and remote sensing?
14. What are the different platforms used in remote sensing?
15. Give a brief note on whisk broom scanners in remote sensing.
16. Write short note on vector format and raster format? (**6 x 2 = 12**)
17. Role of RS and GIS in disaster management.
18. Write short note on various resolutions used in satellite remote sensing.

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Write short note on electromagnetic radiation and its application in remote sensing.
20. Write short note on image enhancement techniques? (**2 x 5 = 10)**
21. What is GPS? What are the different segments of GPS? Write short note on it?
22. Write short essay on application off RS and GIS in natural resource management.

COURSE CODE- ES010204

ENVIRONMENTAL LAWS, EDUCATION AND POLICIES

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Rio+20
2. Aichi Targets
3. WCSD
4. Earthwatch
5. GEMS
6. Biomedical Waste
7. Montreal Protocol
8. Carbon Sequestration
9. Clean Development Mechanism **(8 x 1 = 8)**
10. Sustainable development

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Explain the role of NGOs in environmental protection.
12. Explain information networks.
13. What are the fundamental Principles of Environmental Laws?
14. Importance of Environmental Education in India.
15. Stockholm Conference 1972
16. Forest Conservation Act 1980.
17. Ramsar Convention (**6 x 2 = 12**)
18. Explain on Agenda 21

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. Role of UNEP in global environmental protection.
20. Comment on UN organizations and its functions
21. What are the rules and notifications made under hazardous waste management?
22. Bio-Medical Waste (Management and Handling) Rules, 1998 (**2 x 5 = 10)**

THIRD SEMESTER
MODEL QUESTION PAPERS
COURSE CODE- ES010301

ENVIRONMENTAL ENGINEERING

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Residual chlorine.
2. Composite sample.
3. MLSS
4. What is fluidized bed reactor
5. Sludge bulking.
6. What is water softing
7. What is the basic difference between absorption and adsorption.
8. What is coagulation.?
9. Jar test. **(8 x 1 = 8)**
10. Slow sand filters?

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Mass balance approach to problem solving.
12. UASBs
13. Land treatment.
14. Activated sludge process
15. Explain the working of electrostatic precipitator.
16. Disinfection of drinking water.
17. What are sanitary landfills? (**6 x 2 = 12**)
18. Water sampling techniques.

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. Write an essay on anaerobic waste water treatment systems.
20. Write an essay on Air Pollution control. Add a note on automobile emission control
21. Give a detailed account of the solid waste management techniques (**2 x 5 = 10)**
22. Compare lime soda softing and ion exchange softening.

COURSE CODE- ES010302

ENVIRONMENTAL PLANNING AND RESOURCE MANAGEMENT

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What is EMS?
2. Eco-Tourism
3. Desertification
4. 5) Agroforestry
5. Bioprospecting
6. OTEC
7. Petroplants
8. EMP
9. NTFP
10. Integrated Water Resources Management (IWRM)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Write short note Wetland Management
12. Explain the scope and concepts of Environmental Planning?
13. Discus urban development and its importance to the society?
14. Briefly explain the management of wildlife population
15. Write a note on land use planning in India?
16. Discuss the problems in connection with the over exploitation of ground water
17. write notes on management strategies for estuaries (**6 x 2 = 12**)
18. Mineral wealth of India?

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. Define Sustainable development. Explain the strategies for attaining sustainable development.
20. Principles and objectives of Environment planning and Management.
21. Write an essay on water conservation and water conservation strategies in Kerala context
22. Significance and characteristics of hazards in environmental planning and development (**2 x 5 = 10)**

COURSE CODE- ES800301

ENVIRONMENTAL IMPACT ASSESSMENT AND AUDIT

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What is environmental audit?
2. Scoping
3. Networks
4. Warner Preston study
5. Secondary impacts
6. EMP
7. Urban Planning
8. Scope and relevance of EIA
9. Environmental Monitoring
10. Comprehensive EIA

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Explain different process in EIA?
12. Explain the scope and concepts of Environmental Planning?
13. Discus urban development and its importance to the society?
14. Explain different Environmental quality Standards?
15. Write a note on land use planning in India?
16. Comment on Smith Study?
17. Advantages and disadvantages of CBA? (**6 x 2 = 12**)
18. Discuss the different steps involved in environmental auditing?

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. Explain various methods of EIA?
20. Write an essay on environmental Impacts of mining and suggest remedial measures?.
21. Write an essay on EIA for Industry. Illustrate with case study
22. Prepare checklist for the construction of well as part of a development project?

(**2 x 5 = 10)**

COURSE CODE- ES800302

ENVIRONMENTAL ECONOMICS AND SUSTAINABLE DEVELOPMENT

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Opportunity Cost
2. Contingent valuation
3. Green Marketing
4. Welfare Economics
5. Globalization
6. Green Tax
7. Social cost **(8 x 1 = 8)**
8. Market Failure
9. Cottage Industry
10. Soil Profile

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Tragedy of the Commons.
12. Green Productivity
13. What are the indicators of sustainable development?
14. Discuss about Pareto criterian.
15. Write short note on over population and over consumption.
16. Impact of large scale industries on environment. (**6 x 2 = 12**)
17. Explain allocation of property rights.
18. Application of green technologies in modern industries.

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. What is CBA? Describe the role of CBA in analyzing efficient level of environmental quality
20. Explain in detail resource pricing techniques.
21. Write an essay on Environmental Cost of economic growth **(2 x 5 = 10)**
22. Write an essay on Externalities.

COURSE CODE- ES810301

GREEN CHEMISTRY AND NANOTECHNOLOGY

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Who introduced the term, "Green Chemistry"
2. Who wrote the book "Silent Spring"?
3. What is percentage atom utilisation?
4. Give one example of a substitution reaction
5. Give two examples of bio-fertilizers
6. Ultrasound has frequency in the range -----
7. The basic free radical involved in Advanced Oxidation Processes is –
8. What do you understand by Nanotechnology ? **(8 x 1 = 8)**
9. Define Carbon nanotubes
10. Mention the types of Nano composites

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. What is ionic liquid? Write 5 typical examples
12. What is sonolysis? How this can be used in the degradation of pollutants?
13. What is super critical fluid? How this can be formed?
14. How catalyst decrease the activation energy in a chemical reaction? Explain with examples
15. Write briefly on characterisation of nano particles using Spectroscopy (**6 x 2 = 12**)
16. How Nano materials are exploited in Environmental monitoring
17. Advanced Oxidation Technologies for waste water treatment explain?
18. Social implications of nanoscience and technology explain?

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. Discuss the *12 point principle* of green chemistry
20. How Oxidation Technologies at ambient conditions will be helpful for wastewater treatment ?
21. What are the general considerations in the alternate approach to solvent chemistry? Substantiate with examples
22. Write a detailed note on application of Nano materials for the detection of pesticides and trace heavy metal ions.

COURSE CODE- ES810302

NATURAL AND ANTHROPOGENIC DISASTERS

Time: Three hours Max. Weight: 30

Section- A

(Answer any eight questions. Each question carries a weight of 1)

1. What is the major calamity associated with Indo Gangetic plains?
2. Define the term 'exposure'.
3. Expand IDNDR
4. Give two examples of risk transfer mechanisms.
5. The word vulnerability originated from the Latin term vulnerabilis, which means.....
6. Which is the world's largest humanitarian agency?
7. What you meant by 'golden hour concept'? (8 x 1 = 8)
8. Who will be the chairperson of the national executive committee as per DM Act- 2005?
9. The name 'Ockhi' means.....
10. Give an example for the structural mitigation of wildfire.

Section B

(Answer any six questions. Each question carries a weight of 2)

11. Write a note on pre- disaster activities in the emergency management cycle.
12. Illustrate international disaster management system.
13. How the technological advancement influence recent trends of disasters?
14. Mention the roles and responsibilities of national disaster management authority.
15. Explain accident related disasters as per the HPC classification.
16. How physical geography affects India's vulnerability profile?
17. Briefly describe five goals of disaster mitigation. (6 x 2 = 12)
18. How disaster affected on an economy?

Section C

(Answer any two questions. Each question carries a weight of 5.)

19. Write an article on disaster management in India.
20. Explain with relevant examples the interconnections between disasters and development. (2 x 5 = 10)
21. Recount the history of disaster management from the civil defence era.
22. Narrate (i) Disasters and development and (ii) Role of UN in disaster management.

FOURTH SEMESTER
MODEL QUESTION PAPERS

COURSE CODE- ES010401

ENVIRONMENTAL BIOTECHNOLOGY AND WASTE MANAGEMENT

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Distinguish 'phytoremediation' and 'bioremediation'.
2. DNA ⟲ → RNA → Protein : What does this figure indicate?
3. Expand the following: (a) PHA (b) APTI
4. What do you understand by 'Zero waste concept'?
5. What are restriction enzymes? Give an example **(8 x 1 = 8)**
6. The term 'Biosorption ' refers to _____.
7. State main functions of Golgi apparatus in a cell.
8. Give an example for each : (a) Grits (b) Xenobiotics
9. The major components of Biogas are _____ and _____
10. Distinguish 'Reuse' from 'Recycle'

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. How does 'Trickling Filter 'function? Explain briefly with a neat diagram.
12. What is a 'Super Bug'? How it was created? Mention the name of the scientist behind it.
13. Write brief note on High- rate anaerobic reactors (b) Composting toilets
14. Discuss briefly the significance of biodegradable plastics. (**6 x 2 = 12**)
15. Write brief note on Composting toilets
16. Explain briefly the significance of 'Biosensors'
17. Write note on Industrial Ecology .
18. Write a brief note on 'Artificial wetlands'

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. Explain the role of biotechnology in air pollution control.

20. Write an essay on the importance of 'processing / treatment of solid wastes' with examples.
21. What are sanitary landfills? Explain their construction and operation. **(2 x 5 = 10)**
22. Give a detailed account on Bioremediation Technology.

COURSE CODE- ES800403

DISASTER MANAGEMENT

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Define risk, vulnerability.
2. Differentiate between disaster and emergency condition.
3. Hazardous material.
4. Write short note on emergency operation Plan (EOP).
5. What are the objectives of Disaster Response?
6. Comment on disaster risk reduction?
7. Write short note on Cyclone?
8. Explain typical disaster response activities? **(8 x 1 = 8)**
9. Write short note on preparedness and mitigation.
10. What is SAR (search and rescue) in disaster management?

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Write short note on Hazard identification and vulnerability analysis.
12. What are hazardous materials and what are the different ways of storing and safely handling hazardous materials?
13. How landslide affected a community?
14. Write short note on The Role of Media in Disaster Management.
15. What is Emergency Management Systems(EMS)?
16. Write short note on manmade disasters.
17. Role of RS and GIS in disaster management. **(6 x 2 = 12)**
18. Explain typical disaster response activities.

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. Give an account of disaster related health issues.
20. Write an essay on how to manage a flood situation in a community?

21. Give an idea about the role of governmental and nongovernmental organizations on disaster management activities**.** **(2 x 5 = 10)**
22. How disaster affected on development activities?

COURSE CODE- ES810403

CLIMATE CHANGE AND GOVERNANCE

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What is decarbonisation in energy sector? Give example?
2. Why natural gas is preferred over coal in power plants?
3. Mention the role of soil macrpfauna in soil carbon dynamics?
4. What is the full form of IPCC and mention its role?
5. What are GHGs?
6. What is GWP?
7. What are the instruments used to measure wind speed and atmospheric pressure?
8. Explain radiative forcing? **(8 x 1 = 8)**
9. Name three gases causing greenhouse effect?
10. Global warming?

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Explain above and below ground level carbon sequestration with examples?
12. Role of decarbonisation in the context of climate change?
13. Impact of climate change on biota?
14. What are the contributors of GHGs in the environment?
15. Write briefly on climate change adaptation methodologies? (**6 x 2 = 12**)
16. Write the major declarations in Kyoto Prtocol and the various ways for its implementation?
17. Impacts of climate change on livelihoods and economic system?
18. What are the evidences of climate change with example?

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. Explain (a) permafrost and role in climate change?(b) impact of climate change in marine ecosystem?
20. What are the missions for mitigation and adaptationmissions under NAPCC, explain in details?
21. Explain the constitution, structuring and functioning of IPCC?

22. What are the important considerations in Paris agreement of Climate change? How developing countries undergoes for climate change mitigation/adaptation under this agreement?

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