UNIVERSITY OF KERALA

SYLLABUS FOR

M.Sc. PROGRAMME IN ENVIRONMENTAL SCIENCES

(Revised Syllabi under Semester System with effect from 2018 Admission)

M. Sc. ENVIRONMENTAL SCIENCES
COURSE STRUCTURE, MARK DISTRIBUTION AND SYLLABUS

SEMESTER I

Paper code	Title of Paper	No. of hours per semester (Lecture + Practical)	No. of hours per week (Lecture and Practical)		ESA Duration	CA (Continuous Assessment)	ESA (End Semester Assessment)	Maximum Marks
			L	P				
ES211	Environmental Biology and Ecosystem Dynamics	90 + 72	5	4	3 hrs	25	75	100
ES212	Environmental Geology	90 + 72	5	4	3hrs	25	75	100
ES213	Natural Resources and Energy Management	90 + 36	5	2	3 hrs	25	75	100
ES214	Practical I	180			4	25	75	100

SEMESTER II

Paper code	Title of the paper	No. of hours per semester (Lecture + Practical)	No. of hours per week (Lecture and Practical)		ESA Duration	CA (Continuous Assessment)	ESA (End Semester Assessment)	Maximum Marks
			L	P				
ES 221	Environmental Chemistry	90 + 72	5	4	3 hrs	25	75	100
ES222	Environmental Techniques	90 + 72	5	4	3 hrs	25	75	100
ES 223	Environmental Pollution and Toxicology	90 + 36	5	2	3 hrs	25	75	100
ES 224	Practical II	180			4 hrs	25	75	100

SEMESTER III

Paper code	Title of the paper	No. of hours per semester (Lecture + Practical)	No. of hours per week (Lecture and Practical)		ESA Duration	CA (Continuous Assessment)	ESA (End Semester Assessment)	Maximum Marks
			L	P				
ES 231	Remote Sensing and GIS	90 + 72	5	4	3 hrs	25	75	100
ES232	Environmental Genetics, Microbiology and Biotechnology	90 + 72	5	4	3 hrs	25	75	100
ES 233	Environmental Meteorology and Climate Change	90	5	-	3 hrs	25	75	100
ES 234	Practical III	144	-	-	4 hrs	25	75	100
ES 235	Project Work	36	-	2	-	-	-	-

SEMESTER IV

Paper code	Title of the paper	No. of hours per semester (Lecture + Practical)	No. of hours per week (Lecture and Practical)		ESA Duration	CA (Continuous Assessment)	ESA(End Semester Assessment)	Maximum Marks
			L	P				
ES 241	Environmental Engineering and Waste Management	90 + 36	5	2	3 hrs	25	75	100
ES242	Environmental Economics, Impact Assessment and Disaster Management	90 + 36	5	2	3 hrs	25	75	100
ES 243	Environmental Policies and Law	90	5	-	3 hrs	25	75	100
ES 244	Practical IV	72	-	-	4 hrs	25	75	100
ES 235	Project Work	108	-	6	-			100
	Viva-voce	-	-	-				100
Total	**1800**							

Aim and Scope of Post Graduate Programme in Environmental Sciences

The broad objective of the programme is to expose students to the wide base of knowledge of environment, its components and the principles maintaining it. The students will specialize and gain knowledge base in solving fundamental environmental problems and practice sustainable principles in their activities and also helps to disseminate the same to the society. This will enable the students to develop analytical skills, investigation capabilities and decision making skills in the areas of conservation of biodiversity, environmental and pollution monitoring and management of human induced environmental change.

Students will also take part in practical sessions which are focussed on laboratory techniques that allow them to acquire lab skills. Practical skills and competencies are critical to student engagement and effective learning thus enables them to engage effectively with advanced laboratory modules and projects preparing them for future employment.

Along with technical and laboratory skills offered, the students will also be trained to acquire transferable skills such as time management, team work, leadership skills, delegation, motivation, prioritisation, inter personal communication, analytics and Scientific Writing skills which is an essential component in today’s professional sector.

SEMESTER I

ES 211. ENVIRONMENTAL BIOLOGY AND ECOSYSTEM DYNAMICS

Total: 90 hrs

Objectives:

- To introduce students to the basics of Environment.
- To make students understand the distribution of life and life forms on earth.
- To make students aware of the basic structure and functions of ecosystem.
- To make students understand the distribution and cycling of energy and matter in the Environment.

Course Description:

The main objective of this course is to evolve effective management and conservation strategies of natural and manmade ecosystems, and for understanding the response of organisms to environmental changes. Students will be introduced to underpinning environmental processes such as nutrient cycling, ecology and evolution of organisms. Course delivery methods include tutorials and practical sessions both field based and lab based activities. This introductory module helps students develop a solid foundation for the pursuit of more specialist options in subsequent years.

Pre-requisite:

- The students should have a basic knowledge of the Environment and the components.

Course Content:

1. **Introduction**: Concept and scope of environmental Science; concepts of environmental biology, ecosphere and biosphere; ecological factors and variables

(5 hrs)

2. **Biomes and Habitats**: Classification of biomes – Terrestrial biomes- tundra, taiga, grasslands, deserts, forests and their characteristics – flora and fauna; Classification of aquatic habitats – Lentic and Lotic, wetlands – their characteristics, flora and fauna : marine, estuarine, mangroves.

(15 hrs)

3. **Ecosystem Dynamics**: Introduction – Concepts, characteristics, kinds and structure, ecosystem functioning – food chain, food web, ecological pyramids of numbers, biomass, energy, inverted pyramids, ecological energetics – energy flow, ecological efficiency; niche segregation.

(15 hrs)

4. **Development and Evolution of Species, Ecosystems** – ecotone and concept of edge effects, ecological niche and ecosystem stability; evolution – succession concept; primary and secondary succession; allogenic and autogenic succession, theories of succession.

(12 hrs)

5. **Ecological Interactions**: Positive and Negative: Neutralism, symbiosis, commensalism, mutualism, antagonism, antibiosis, parasitism, predation, competition – intra specific and inter specific; ecological and environmental significance of interactions, Prey Predator relationship, Lotka – Volterra model.

(10 hrs)

6. **Population Dynamics**: Concepts of population, population growth – density, natality, mortality and growth curves, Leslie's matrix model, life tables, age structure, function and equilibrium; population regulation – biotic potential, environmental resistances and Earth's carrying capacity; factors of population regulation – density dependent and density independent.

(15 hrs)

7. **Limiting factors of Environment**: Concept of law of limiting factors– laws of minimum and tolerance, combined concept of limiting factors, Liebig's and Shelford's law.

(8 hrs)

8. **Biogeochemical Cycles**: Nutrient cycling in the ecosystems – gaseous cycles (carbon and nitrogen), sedimentary cycles (phosphorus and sulphur); water cycle, impact of human being on nutrient cycles.

(8 hrs)

9. **Ecoinformatics**: Concepts, Principles and application.

(2 hrs)

Learning approaches:

- Learner centric – Preparation of ecological charts and posters to study biogeochemical cycles.
- Experiential – Collection of data regarding the ecological succession.

Expected competency/ Learning outcome:

- Student should be able to appreciate the environment and its components and functions.
- Student should be aware of the natural and the anthropogenic changes in environment.

RECOMMENDED READINGS

1. Botkin, Daniel B. (2011). Environmental Science: Earth as a living Planet, John Wiley and Sons, New Delhi.
2. Chapman. J. L. and Reiss, M.J. (2005). Ecology, Principles ad Applictions, Cambridge University Press, London.

3. Dash, M.C. (1994).Fundamentals of Ecology, Tata Mc Graw Hill, New Delhi.
4. Gunther, O. (1998) Environmental Information Systems. Berlin, New York, Springer.
5. Miller G. Taylor and Scot Spoolman. (2011). Essentials of Ecology, Books/ Cole Learning, U.S.A.
6. Odum, E.P. (1971). Fundamentals of Ecology, W.B. Saunder Company, Philadelphia
7. Sharma P. D. (1996). Environmental Biology, Rastogi Publications, Meerut.
8. Verma P.S. and V.K. Agarwal. (1985). Principles of Ecology. S. Chand and Company (Pub.), New Delhi.

ES 212. ENVIRONMENTAL GEOLOGY

Total: 90 hrs

Objectives:

- To make students understand the role of natural geologic processes that impact human infrastructure and activities.
- To make them learn the basic principles of geology and develop an understanding of the methods geologists use to study the Earth,
- Recognize the Earth is a unique, closed system and discuss the role humans play in changing the geologic environment.
- To make students aware of the impact of human activity on natural geologic systems, geo-environmental settings and ecosystems on local, regional and global scales.

Course Description:

The course involves a study of earth processes and natural hazards and their influences on life in ways that either affect or control man's environment. Furthermore, this is an introduction to geologic concepts as they relate to the environment we live in. Topics under discussion include earth’s geologic environment, problems posed by various geologic phenomena and some of the ways that human activities have affected the planet.

Pre-requisite:

- The students should have a basic knowledge of the geo-physical components of Earth and its processes.
- The students should be aware of the disasters related to Earth and Climate change issues.

Course Content:

1. **Introduction**: Origin and Evolution of Earth; Evolution of human settlement, Origin of life, Speciation; Geological Time Scale; Plate Tectonics – Sea floor spreading and continental drift; Forces acting on the surface of the Earth – tectonic and diastrophic forces.

(6 hrs)

2. **Minerals and Rocks**: Definition of mineral; Physical properties of minerals; Brief overview of formation; forms, textures, structures, classification of Igneous, sedimentary and metamorphic rocks. Environmental impacts of mining and various mitigatory measures.

(15 hrs)

3. **Study of the Interior of Earth:** based on seismic waves: Crust, mantle and core

(4 hrs)

4. **Earth's Surface Process**: Weathering of rocks – physical, chemical and biological; Pedogenesis; Factors affecting soil formation; Erosion, transportation and deposition of Earth's materials by water, wind and glaciers.

(15 hrs)

5. **Glaciers**: Physical and chemical aspects; Recession of Himalayan glaciers; Glaciers as an index of climate change.

(5 hrs)

6. **Ecohydrology**: Definition and Concept of Ecohydrology; hydrologic budget; Drainage basin – definition and characteristics, stream classification and ordering. Watershed management – concepts, objectives, planning and measures; Land use planning for watershed management; Flood control measures.

(10 hrs)

7. **Groundwater**: Source, occurrence and movement of groundwater; Water Table; Geologic formations as aquifers; Aquifer types; Groundwater contamination; Water Table fluctuations – environmental influences, evapo-transpiration, meteorological phenomenon, urbanization; Rainwater harvesting techniques and groundwater recharging methods.

(10 hrs)

8. **Natural Hazards**: Earthquakes – causes, effects, distribution and prediction; Volcanoes – types, distribution, products of volcanic eruptions and its environmental impacts; Landslides – slope stability, factors affecting slope stability, causes, effects and prevention of landslides; Tsunami – causes, characteristics, effects; Floods – causes, types, effects; Avalanches – causes, types, effects; Cyclones – causes, types, effects; Drought – causes, effects; Fire – causes, types, effects. Prepare case studies in each category.

(20 hrs)

9. **Maps**: Topographic and Geologic maps in Environmental Studies.

(5 hrs)

Learning approaches:

- Observational skills – Students will develop the basic observational skills to understand the occurrence and formation of earth resources and significant environmental effects caused by their extraction, processing, and use
- Experiential – Field surveys and sample collection will help students to analyze geological materials, features, and processes.

Expected competency/ Learning outcome:

- Students will synthesize the principles learned in the classroom, in the laboratory, and during field studies to identify geological features, interpret geological history, and solve geological problems.

RECOMMENDED READINGS

1. Duggal K. N. and J. P. Soni, (1996). Elements of water resource engineering; New Age International Publisher.
2. Read, H. H. Rutley's Elements of Mineralogy. John Wiley and Sons, New York.
3. Reghunath, H.M. (1996). Hydrology – Principles, analysis and design, New Age international publisher.
4. Singh V.P (1994). Elementary Hydrology, Prentice – Hall of India.
5. Strahler, A. N. and Strahler, A.H. (1987). Physical Geography, John Wiley and Sons, New York.
6. Strahler, A. V. and Strahler, A.A (1973). Environmental Geoscience, Wiley International.
7. Todd, D. K. and L.W. Mays (2005). Ground Water Hydrology, 3rd Edn. Wiley Inc.
8. Tyrell, G. W. (1978). Principles of Petrology. Chapman & Hall Ltd.

ES 213. NATURAL RESOURCES AND ENERGY MANAGEMENT

Total: 90 hrs

Objectives:

- To make students appreciate the role of natural resources in the sustenance of life on earth.
- To explain and discuss the distribution of different natural resources and their sustainable management.
- To explore the techniques of collecting, handling and interpreting Natural Resource data.

Course description:

Modules under Natural Resources Management focuses on the need of sustainable management of the Earth's depleting natural resources such as clean water, energy, minerals and biological resources, in relation to the growth of the human population. During the programme, students develop a

good scientific understanding of how the earth's natural systems work and new approaches to balancing the needs of society. The modules under energy management cover areas like conventional and non conventional energy sources and its conservation. Students also learn sustainable energy-efficient practices.

Pre-requisite:

- The students should have background knowledge on the different resources in earth.
- Students should have an overall idea regarding conservation strategies around the world.
- The students should have an understanding about fossil fuels, its use and the impacts of the over use of it.

Course Content:

1. **Natural Resources**: Concepts and major types of natural resources. **(3 hrs)**
2. **Soil and mineral resources**: Overview of major soil types and mineral deposits of India with special reference to Kerala; acidic, alkaline and saline soils – reclamation techniques. **(5 hrs)**
3. **Forest resource**: Overview of major forest types in India with special reference to Kerala, Forest products – NWFP and WFP; social forestry – multipurpose tree species, Nitrogen fixing tree species – characteristics; community participation; indigenous people and their ethnic knowledge; eco-restoration; agro forestry (brief account) **(15 hrs)**
4. **Biodiversity**: Introduction, Genetic, species and ecosystem levels, importance; hotspots of biodiversity -endemic, gene pool, climate and its impact on biodiversity; Threats to biodiversity: vulnerable, rare, endangered (critically), threatened, extinct species; IUCN threatened species of Kerala; Red Data book, Biodiversity of Western Ghats – brief account of Gadgil and Kasthurirangan report - a case study. **(12 hrs)**
5. **Biodiversity conservation**: strategies for conservation; global agreements and national concerns; Ramsar sites, Convention on Biological Diversity (CBD); protection of wildlife – role of WWF, WCU, CITES, TRAFFIC, sustainable utilization. **(15 hrs)**
6. **Water resource**: types – surface water, ground water; water availability and uses, impact of climate change on fresh water resources, management and conservation of water resources. **(10 hrs)**

7. **Energy and Environment**: Energy use pattern in India and its impact on the environment; sources of energy and their classification; Conventional energy – Fossil fuels – classification and composition, energy content of coal, petroleum and natural gas.

(15 hrs)

8. **Non-conventional energy:** Bioenergy, Biomass, biogas, energy from wastes; nuclear energy: fission and fusion; solar energy: harnessing of solar energy, solar collectors and concentrators, photovoltaics; solar energy utilization in India; Wind energy: wind power, harnessing of wind energy, power generation – wind mills; wind energy potential in India.

(15 hrs)

Learning approaches:

- Learner centric – Preparation of flow charts and posters to study natural resources.
- Experiential and Field Exposure –
  a) Collection of data regarding the rain water harvesting practices followed in the locale
  b) Functioning of Biogas energy units and solar panels
  c) Field visits to different organisations which promote Renewable Energy Resources (eg: ANERT)
- Collaborative – students should collect data on the use pattern of fossil fuels and its impacts.

Expected competency/ Learning outcome:

- Helps to develop Skills in recognising and solving environmental and social impacts of resource depletion.
- Enhances the knowledge base and skill sets.
- Be an active and lifelong learner and develop strategies to do so.
- Be innovative by generating new ideas, artefacts, products, interpretations or ways of viewing professional projects and tasks.

RECOMMENDED READINGS

1. Abbasi, S. (1997). Wetlands of India: Ecology and threats; Discovery Publishing, ND.
2. Biswas, A.K. (2007). Water resources: Environmental Planning, Management and Development, McGraw – Hill, New Delhi.
3. Boyle, G. Bob Everett and J. Ramage. (2003). Energy System and Sustainability, Oxford University Press, New York.
4. Daniel, D. Chiras and Reganold, John, P. (2009). Natural Resource conservation: Management for a sustainable Future, Addison Wesley, Boston.

5. Dwidei, A.P. (2003). A text book of Silviculture. International Book Dist., Dehradun.
6. Fai Fung, A. Lopez and Mark New [Eds.] (2010). Modelling the impact of climate change on water resources, Wiley Blackwell.
7. Ghosh, S.K and Singh, R. (2003). Social forestry and Forest Management, Global Vision Publication, New Delhi.
8. Jha, L. K. (1995). Advances in Agro forestry, APH Publication Corporation, New Delhi.
9. Kesler, P. (2002). Mineral Resources: Economics and Environment, CBS Publishers ND.
10. Rajora Rajesh. (1998). Integrated Watershed Management: A field Manual for Equitable, Productive and sustainable Development, Rawat Publications, Jaipur.
11. Sudhakara Reddy, B.P. Balachandra. (2006). Energy, Environment and development, Narosa Publishing House Pvt. Ltd., New Delhi.
12. Thapar, S. D. (1975). India's Forest Resource, Macmillan India, New Delhi.

ES 214. PRACTICAL – I

ENVIRONMENTAL BIOLOGY, GEOLOGY AND ENERGY MANAGEMENT

Total: 180 hrs

1. Identification of flora and fauna (5 each) of terrestrial, freshwater and marine ecosystems.
2. Identification of phytoplankton and zooplankton (either freshwater or marine)
3. Quantitative estimation of Phytoplankton by Lacky's Drop Method
4. Quantitative estimation of Zooplankton by Sedge wick -Rafter Cell Method
5. Analysis of DO and BOD in water samples
6. Estimation of primary productivity – Light and Dark bottle method – effects of depth and light.
7. Floral / Faunal community study by Quadrat method – estimation of frequency, density and abundance
8. Floral / Faunal community study by Line Transect method – estimation of frequency, density and abundance
9. Design and working of solar panel
10. Design and working of wind mill
11. Moh's Scale of Hardness
12. Megascopic identification of rocks, rock forming minerals and ore minerals.
13. Topographic Map Symbols.

First Semester M.Sc Degree Examination – Model Question Paper

Branch -Environmental Sciences

ES 211. ENVIRONMENTAL BIOLOGY AND ECOSYSTEM DYNAMICS

Time: 3 Hours **Max. Marks: 75**

I. Write short note on **any ten** of the following: **(10x2= 20 marks)**

1) Ecological Niche
2) Commensalism
3) Age Structure
4) Allogenic Succession
5) Life table
6) Antibiosis
7) Ecoinformatics
8) Sedimentary cycles
9) Food web
10) Biome
11) Edge effect
12) Biotic Potential

II. Answer **any five** of the following: **(5x5= 25 marks)**

13) State some of the impacts of man on nutrient cycles
14) Comment on Terrestrial biomes
15) What are the characteristics of inter-tidal ecosystems?
16) Briefly explain ecological pyramids.
17) Short note on Prey-predator relationship
18) Combined concept of Leibig's and Shelford's Laws.
19) Write a short note on factors of population regulation.

III. Answer **any three** of the following: **(3x10= 30 marks)**

20) Comment on Ecological Interactions.
21) What is ecosystem Development? What are the types and theories of Succession?
22) Write an essay on Marine, Estuarine and Mangrove habitats.
23) Write an essay on classification of wetlands and mention importance of wetlands.

First Semester M.Sc Degree Examination – Model Question Paper

Branch -Environmental Sciences

ES 212. ENVIRONMENTAL GEOLOGY

Time: 3 Hours **Max Marks: 75**

I. Write short note on **any ten** of the following: **(10x2= 20 marks)**

1) Diastrophic forces
2) Horton's stream classification
3) Sea floor spreading
4) Tectonic movements
5) Run up and drawback
6) Cation exchange capacity of soil
7) Drainage basin
8) Global water balance
9) Mantle of earth
10) Minerals
11) Sedimentary rock
12) Tsunami

II. Answer **any five** of the following:
(5x5=25 marks)

13) Explain the origin and evolution of earth
14) List out the factors affecting soil formation
15) Brief the internal structure of earth
16) What are the factors affecting slope stability
17) Folds and faults
18) Radar and satellite analysis of precipitation
19) How landslides can be prevented.

III. Answer **any three** of the following:
(3x10= 30 marks)

20) Write the uses of topographic and environmental geologic maps in environmental studies.
21) Causes, effects and control measures of earth quakes and volcanic eruption.
22) Give an account of the formation, forms, textures and structures associated with sedimentary rocks.
23) Describe the impact of mining. Comment on the various mitigation measures.

First Semester M.Sc Degree Examination – Model Question Paper

Branch -Environmental Sciences

ES 213. NATURAL RESOURCES AND ENERGY MANAGEMENT

Time: 3 Hours **Max. Marks: 75**

I. Write short note on **any ten** of the following: **(10x2= 20 marks)**

1. NFTs
2. Geothermal energy
3. Mining
4. TRAFFIC
5. Gene pool
6. Jhum land
7. Preservation plots
8. Photovoltaics
9. Impact of climate change on water resources
10. Sodic soil
11. Biopiracy
12. Endemism

II. Answer **any five** of the following: **(5x5= 25 marks)**

13. How wind energy can be harnessed?
14. Composition of fossil fuels
15. Major soil types in India
16. Impact of climate on biodiversity.
17. Impact of land use change on Environment
18. What are the reclamation techniques done for saline soils?
19. Comment on different agro forestry practices.

III. Answer **any three** of the following: **(3x10=30 marks)**

20. Write a note on concept, objectives, planning and measures adopted in water shed management.
21. Briefly explain
    a. Ramsar sites
    b. The Biological Diversity act
    c. Biosphere reserves
22. Natural Resources and their direct and indirect values.
23. Explain social forestry with particular reference to community participation.

M Sc ENVIRONMENTAL SCIENCES

I Semester Practical Examination

ES 214 Environmental Biology and Geology

Time: 4hrs **Total Marks: 75**

I. Identify and comment on A, B & C (Any flora/fauna of terrestrial, fresh water and marine)

[(1 + 4) 3 = 15 marks]

II. Write briefly the texture and mineralogical aspects of the given rock samples (D & E). Give brief note on their mode of origin

[**(1+ 1 + 1½ + 1½) 2 = 10 marks**]

III. Write down the diagnostic physical properties of the given mineral specimens (F & G) and identify their name. Give brief note on their uses

[**(2½ + 1 + 1½) 2= 10 marks**]

IV. Identify with well labeled diagrams any two phyto/zooplankton (H & I) from the given sample. Give reasons

[**(1½+ 1 ½+2)2 = 10 marks**]

V. Quantitatively estimate the abundance of phyto/zooplankton using Lackey's Drop Method

OR

Quantitatively estimate the abundance of phyto/zooplankton using Sedgewick Rafter Cell Method

[**10 marks**]

VI. Calculate the frequency, density and abundance of the given area J using the quadrate method

[**15 marks**]

VII. Practical Record

[**5 marks**]

SEMESTER II

ES 221. ENVIRONMENTAL CHEMISTRY

Total: 90 hrs

Objectives:

- To provide students a thorough knowledge on the chemistry of the environment.
- To make students understand the impacts of anthropogenic activities on Earth.
- To show students the harmful effects of heavy metals which now forms the raw materials of many gadgets.
- To make student understand the effects of a series of manmade compounds on environment.

Course description:

In this course the students will study the chemistry of the air, water, and soil, and how anthropogenic activities affect this. Specifically, students learn and understand the sources, reactions, transport, effects, and fates of chemical species in air, water, and soil environments, and the effects of technology thereon. Attention is paid to chemical equilibrium and kinetics of natural systems and how they are influenced by human actions. Additional topics of study include remediation of pollution, green chemistry and the analysis of environmental samples.

Pre-requisite:

- The students are expected to know the gaseous and sedimentary cycles and the flow of chemicals in an ecosystem as it is already covered in ES 211 The students should have an awareness regarding climate change, global warming and greenhouse gases.
- Students should know soil formation and the classification of soil as they are part of previous papers.

Course Content:

1. **Introduction**: Concept and scope of Environmental Chemistry

(2 hrs)

2. **Atmospheric Chemistry**: Structure and composition of atmosphere; Primary and Secondary pollutants; Particulate Pollutants; Atmospheric aerosols; Free Radicals; Tropospheric Chemistry – photochemical reaction; tropospheric oxidation of methane, photochemical smog, rain, snow and fog chemistry, formation and composition of acid rain, oxidation of atmospheric SO_2; Stratospheric Chemistry– oxygen and ozone chemistry, ozone depleting substances and ozone depletion, Green House Gases and Global Warming; Chemistry of urban air.

(20 hrs)

3. **Hydrochemistry**: Chemistry and composition of seawater and freshwater; Gases and organic matter in water; pH; pE; pH–pE diagrams; Electrical Conductivity; Alkalinity; Hardness; Salinity; Dissolved Oxygen, Biological Oxygen Demand; Chemical Oxygen Demand; Nitrite; Nitrate; Phosphate; Sulphate.

(10 hrs)

4. **Soil Chemistry**: Composition of soil; Soil profile; Water and air in soil; Physical properties of soil – soil texture, soil structure, bulk density,

porosity, water holding capacity; Chemical properties of soil – soil pH, Cation Exchange Capacity (CEC), exchangeable bases; soil organic matter and organic carbon, micro and macro nutrients.

(15 hrs)

5. **Pesticides and Heavy Metals**: Pesticides – classification, degradation and analysis; Structure, Mode of action and Degradation of Pesticides: Organochlorine pesticides – DDT, Endosulfan; Organophosphates– Malathion, Chlorpyriphos; Carbamates– Carbaryl; Bioaccumulation and biomagnification of organochlorine pesticides – case studies; Natural and Green Insecticides – sources, target insects; Integrated Pest Management; Heavy metals – speciation and toxicity of heavy metals, bioaccumulation of heavy metals – case studies.

(15 hrs)

6. **Non Pesticide Organic Compounds**: Sources, Structure and Impacts of Dioxins, Furans, Polychlorinated Biphenyls (PCBs), Polycyclic Aromatic Hydrocarbons (PAHs).

(12 hrs)

7. **Radiation Pollution**: Types of radiation; Units of radioactivity; detecting measurements of radioactivity; Radioactive nucleus decay; Radon from U^{238} decay sequence; Nuclear accidents and its health and environmental impacts - any two case studies

(8 hrs)

8. **Indoor Air Pollution**: Definition, Sources, Effects and Control Measures.

(8 hrs)

9. **Green Chemistry**: Concept, Principles and Applications with examples from Indian scenario

(2 hrs)

Learning approaches:

- Collaborative – group discussion regarding the known effects of pesticide pollution.
- Lerner centric – preparation of scientific charts on biogeochmical cycles, posters on soil formation.
- Experiential – preparation of flow charts or diagrams of structure of atmosphere.

Expected competency/ Learning outcome

- Students acquire analytical skills with respect to different environmental spheres.
- Capacity building in undertaking different on site tasks entrusted to them.
- Advanced levels of awareness regarding environmental pollution help design pilot projects related to pollution monitoring and abatement.

RECOMMENDED READINGS

1. Arnikar, H. J (1995). Essentials of Nuclear Chemistry. New Age International, New Delhi

2. Baird, C. And Cann, M (2005). Environmental Chemistry. W.H. Freeman and Company (Pub), New York.
3. Dara, S.S. (1993). A textbook of Environmental Chemistry and Pollution Control. S. Chand, New Delhi
4. Hamir S. Rathor. (2012). Pesticides: Evaluation of Environmental Pollution by CRC Press.
5. Lehninger, A. L. Principles of Biochemistry (1984). CBS Publishers and Distributors, Delhi
6. Lenihan, J. M. A. And Fletcher W.W. (1976). Energy Resources and the Environment. Academic Press.
7. Manahan, S. E. (1999). Environmental Chemistry. Lewis Publishers, U.S.A.
8. Santra, S.C. (2004). Environmental Sciences. New Central Book Agency, Kolkata.
9. Thomous S. Spiro and William M. Stiglicini, (2002). Chemistry of the Environment, Prentice Hall of India Pvt. Ltd.

ES 222. ENVIRONMENTAL TECHNIQUES

Total: 90 hrs

Objectives:

- To give students an understanding regarding environmental sampling, analysis and the various techniques associated.
- To make students know the importance of proper sampling in environmental research.

Course Description:

The course will introduce students to the application of some of the modern laboratory analytical techniques used in Environmental Sciences. The course also provides hands-on training in key analytical methods, data interpretation, researching literature, and scientific reporting of results. Study of statistical techniques help students in formulation of hypotheses and designing experiments.

Pre-requisite:

- Students should have knowledge on primary productivity, phytoplanktons etc.
- Students are expected to have a basic awareness on various separation techniques such as chromatography and analytical methods like titrimetry.
- Basics of computer application and statistical methods are desirable.

Course Content:

1. **Sampling and Sample Preparation**: Air, Water, Soil and Sediment: Definition; Types of Samples – grab samples, composite samples, integrated samples; Sampling methods – manual sampling, automatic sampling, sorbent sampling; Number of Sampling; Sampling types – simple random sampling, systematic random sampling, stratified random sampling, representative sampling, geo-statistical (random field) sampling, ranked set sampling, adaptive cluster sampling; Sample collection equipments.

(12 hrs)

2. **Analytical Techniques**: Theory, Principles, Instrumentation and Environmental Applications - pH, Conductivity, Turbidity, Titrimetry, Colorimetry, Spectrophotometry, Atomic Absorption Spectroscopy (AAS), Flame Emission Spectrometry, Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES), Inductively Coupled Plasma Mass Spectrometry (ICP-MS).

(16 hrs)

3. **Separation Techniques**: Principles, Types and Environmental Applications – Sedimentation, Centrifugation, Electrophoresis, Chromatography - Paper, Thin Layer Chromatography (TLC), Ion Exchange, Gas Chromatography, High Performance Liquid Chromatography (HPLC).

(15 hrs)

4. **Biological Analysis**: Collection, preservation and enumeration of planktons; Molecular techniques – Polymerase Chain Reaction (PCR), Denaturing Gradient Gel Electrophoreses (DGGE), Fluorescence In situ Hybridization (FISH), Fatty Acid Methyl Ester (FAME) analysis, Gene amplification, sequencing, molecular phylogeny and Stable Isotope Probing (SIP).

(15 hrs)

5. **Statistical Methods**: Measures of central tendency and dispersion – Arithmetic Mean, Geometric Mean, Harmonic Mean, Mode and Median; Measures of dispersion – Range, Standard deviation, Mean Deviation, Quartile Deviation, Variance, Mean Coefficient of Variation; Correlation and Regression; Hypothesis testing – F test, Chi –square, One and Two way ANOVA.

(15 hrs)

6. **Basic principles and designs of field experiments**: Randomization, replication and local control, Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), Factorial designs, Split Plot and Strip Plot designs.

(10 hrs)

7. **Computer applications in Environmental Research**: using MS Excel – Histogram, Bar Diagram, Box Plot, Frequency Polygon, Frequency Curve, Pie Diagram, Standard Deviation, Correlation and Regression.

(7 hrs)

Learning approaches:

- Activity based – Problems solving activities in the class room.
- Discussion on the differences between various separation technique and analysis where each technique need to be applied.

Expected competency/ Learning outcome:

- Students should be able to comprehend the various sampling technique and its applications.
- Students should be able to select sampling methods for making unbiased research.

RECOMMENDED READINGS

1. Allen J. Bard and Lafrry R. Faulkner (2001). Electrochemical Methods, 2nd Ed., John Wiley & Sons.
2. APHA – AWWA- WPCF. (2012). Standard methods for the examination of water and waste water. Washington, D.C.
3. Barnett, Vic. (2006). Environmental Statistics: Methods and Applications, John Wiley and Sons, New Delhi.
4. Bender, G.T., W.K Saunders. (1972). Chemical Instrumentation. A Laboratory Manual based on Clinical Chemistry.
5. Christian Gary, D. (2001). Analytical Chemistry, 5th Ed. John Wiley & Sons, Inc. NY.
6. Date, C.J. (1986). An introduction to Database System, Addison Wesley, UK.
7. De A.K. (1994). Environmental Chemistry. New Age International Ltd. New Delhi.
8. Eving G.W. (1985). Instrumental Methods of Chemical Analysis, 5th Ed., Mc-Graw Hill Book Company.
9. Manly. (2001). Statistics for Environmental Science and Management, Chapman and Hall, CRC
10. Medhi, J. (1992). Statistical Methods, Wiley Eastern (Pub.), New Delhi.
11. Radojecic M. and Bashkin V.N. (2007). Practical Environmental Analysis. RSC Publishing, Cambridge.
12. Skoog D.A., F.J. Holler and Nieman, (2003). Principles of Instrumental Methods, 5th Ed., Thomson Asia Pvt. Ltd., Singapore.
13. Vogel A.I.(1999). Textbook of Quantitative Chemical Analysis, 5th Ed., Addison Wesley Longman Singapore Ltd.
14. Wayne R Ott. (1995). Environmental Statistics and Data Analysis, CRC Press.
15. Willard, Merritt, Dean, and Settle, (1986). Instrumental Methods of Analysis, 7th Ed., C B S Publishers & Distributors.

16. Zar, Jerrold, H. (1998). Bio statistical Analysis, Prentice Hall, NJ.

ES 223. ENVIRONMENTAL POLLUTION AND TOXICOLOGY

Total: 90 hrs

Objectives:

- To give students an understanding regarding the various pollution sources in environment and effects of toxicants to life.

Course Description:

The modules under this course have been designed to improve the familiarity of the students about different pollution problems and the control strategies in three environmental compartments i.e. air, water and soil. Issues related to solid-waste disposal and noise pollution and their impact on environment and health are dealt with. Environmental Toxicology module is designed to provide an overview of environmental toxicants, including an examination of the major classes of pollutants, their fate in the environment, their disposition in organisms, and their mechanisms of toxicity. An emphasis will also be placed on assessing the toxicity of pollutants in biological and environmental systems.

Pre-requisite:

- Students are expected to know basics of bio indicators, microbes in air
- Students should know the effects of pesticides in environmental components
- Students should be aware of the basics of radioactivity.

Course Content:

1. **Introduction**: Pollution, definition, sources: point and non point sources, types of pollution and their global, regional and local aspects.

   (2 hrs)
2. **Air Pollution**: Types and sources of air pollutants, natural and anthropogenic, indoor, vehicular and industrial air pollutants, effects of air pollutants on flora, fauna, and sinks of atmospheric gases, Criteria air pollutants and air pollution indices, biological indicators of air pollutants – bio monitoring.

   (8 hrs)
3. **Water Pollution**: Sources of water pollution and their contamination, types of pollutants – domestic, agricultural and industrial, various industrial effluents – pulp and paper, distilleries, tanneries, food industries, oil and refineries, petrochemicals, iron and steel industries, domestic wastes, agricultural wastes, storm water, eutrophication –

causes and effects, Water pollution and its control; Oil pollution –sources and its effects on birds and fish , factors affecting fate of oil after spillage.

(10 hrs)

4. **Soil Pollution**: Sources of soil pollution and its effects on soil components, Synthetic fertilizers and its effects on soil, industrial effluents and their interaction with soil components, Changes in characteristics of soil by waste disposal by plastic and e-waste.

(10 hrs)

5. **Radiation Pollution**: Radionuclide's and its sources, Interaction of radiation with matter, Radiation and effects, Nuclear reactors, Radiation pollution and its health impacts.

(5 hrs)

6. **Noise Pollution**: Basic properties of sound waves – plane and spherical waves, sound pressure, loudness and intensity levels, decibel, source of noise pollution – measurement and analysis of sound, measures to control noise pollution.

(4 hrs)

7. **Thermal Pollution**: Definition and sources, chemical and biological effects of thermal pollution, effects on water quality.

(6 hrs)

8. **Toxicants in the environment**: History of toxicants, principles of toxicology – toxicants and toxicity, types of toxic substances – degradable and non-degradable; Sources and entry routes; Ecotoxicology - fate and transport of toxicants in air, water and food chain, bio transformation & bio magnification, Trans-boundary pollutants and its effects.

(10 hrs)

9. **Man and Environmental Toxins**: Routes of toxicants to the human body, ADME – Absorption, Distribution, Metabolism & Excretion; Acute and chronic toxicity; lethal and sub lethal doses; Analysis of NOEL, LD50 & MLD; Dose Response relationship and Cumulative response; Carcinogens, mutagens & teratogens; Toxicity testing procedures.

(15 hrs)

10. **Environmental Health**: Concepts & scope, global & regional perspectives, basic requirements for a healthy environment, environmental quality, human exposure & health impact; Environmental diseases – asbestosis, silicosis, synopsis, asthma, fluorosis & allergies; Water borne and vector borne diseases.

(10 hrs)

11. **Industrial Pollution and Chemical Safety**: Exposure from industrial pollutants, industrial environmental accidents, occupational safety & health, relationship of occupational hygiene/safety & disease, Health problems due to industrial dust, heat, chemicals, noise, toxic gases & metals. **(10 hrs)**

Learning approaches:

- Activity based – Students should collect information regarding the effects of various types of pollutants and make posters.
- Discussion on various kinds of occupational hazards.

Expected competency/ Learning outcome:

- Students should get a clear idea regarding pollution, toxicants, its various effects on humans as well as ecosystem which will make them careful in future.

RECOMMENDED READINGS

1. Abbasi, S. A. and E. Ramasami. (1999). Biotechnological Methods of Pollution Control, University Press, Hyderabad
2. Calow. P. (1994). Handbook of Ecotoxicology. Blackwell Scientific Publications, London.
3. Chatterji M., M. Munasinghe and R. Ganguly (1998). Environment and Health in Devloping Countries. A.P.H Publishing House, New Delhi.
4. De A.K. (1994). Environmental Chemistry. New Age International Ltd. New Delhi
5. Fellenberg, G. (1999). Chemistry of Pollution, John Wiley and Sons, New Delhi.
6. Forbes V.E. and T. L. Forbes (1994). Ecotoxicology in Theory and Practice. Chapman & Hall, London.
7. Hayes W.A. (2001). Principles and Methods of Toxicology, CRC Press, USA
8. Jacobson – Kram, D. (2006). Toxicological Testing Handbook: Principles, Applications and Data Interpretation, Taylor and Francis, New York.
9. Klaassen C.D. and Watkins, J.B. (2003). Essentials of Toxicology, McGraw Hill Professional, New Delhi.
10. Koren H and M. S. Bisesi (1995). Handbook of Environmental Health and Safety _ Principles and Practices (Vol II), CRC Press.
11. Levin, S. A. and M. A. Harwell, J. R. Kelley and K. D. Kemball (1989). Ecotoxicology: Problems and Approaches. Springer-Verlag, New York.
12. Mahajan S.P. (1998). Pollution control in process industries, Tata McGraw Hill, ND.
13. Manahan S. E. (2000). Environmental Chemistry, Lewis Publishers, New York.
14. Nylie C. Brady (1996). The Nature and Properties of Soil, 10th Ed., Prentice Hall Pvt. Ltd.
15. Pery, G. (1980). Introduction to Environmental Toxicology, Elsevier, Amsterdam.
16. Raymond W. Miller and Roy L. Donalvee (1997). Soils in Our Environment, 7th Ed, Prentice Hall of India Pvt. Ltd.
17. Sharma B.K. and H. Kaur (1996). Environmental Chemistry. Goel Publishing, Meerut.

18. Subramanian M. A. (2004). Toxicology – Principles and Methods, MJP publishers, Chennai.
19. Trivedi, R.K. and Goel, P.K. (2010). An introduction to Air pollution, DVS Publication, New Delhi.
20. Wadhwa Y. (2009). Air Pollution: Causes and Control. Cyber Tech Publications, ND.
21. Walker, C.H., R.M. Sibly, S.P. Hopkin and D.B. Peakall (2012). Principles of Ecotoxocology, CRC Press, New York.
22. Wright D. A and P. Welbourn (2002). Environmental Toxicology, Cambridge Univ. Press, London.

ES 224. PRACTICAL II

ENVIRONMENTAL TECHNIQUES, CHEMISTRY & POLLUTION

Total:
180 hrs

1. Methods of sampling – water, air, soil and sediment
2. Physicochemical parameters – pH, Conductivity, Turbidity, Salinity, Free CO_2, Alkalinity, TDS, Total hardness, NO_2, PO_4, Sulphate, SiO_3, Fluoride
3. Analysis of COD in water sample
4. Analysis of Particulate pollutants in air – Dust Fall Method.
5. Analysis of gaseous pollutants (NO_2 and SO_2) in air – High Volume Air Sampler.
6. Estimation of organic carbon and organic matter in soil samples.
7. Estimation of Total kjeldahl Nitrogen in soil samples
8. Estimation of Na and K using Flame Photometer
9. Chromatographic techniques – Paper chromatography in the identification of amino acids and plant pigments
10. Computer application – using MS Excel – Calculate the mean, median, mode, standard deviation, regression, correlation analysis.

Second Semester M.Sc Degree Examination – Model Question Paper

Branch - Environmental Sciences

ES 221. ENVIRONMENTAL CHEMISTRY

Time: 3 hrs **Max. marks: 75**

I. Answer any ten of the following: (2x10 = 20 marks)

1. Green house effect
2. Chemical composition of sea water
3. Nuclear fission and fusion reactors
4. Composition of soil air
5. Isotopes
6. Photochemical smog
7. Radionucleids
8. Textural classes in soil
9. CFC s
10. Significance of disulphide linkages in tertiary structure of proteins
11. Sedimentary cycles
12. Soil CEC

II. Answer any five of the following: (5x5= 25 marks)

13. Write a note on organic matter in water
14. What are the major consequences of global warming
15. Chelation and complexation in Natural waters
16. Explain the alpha and beta decay of radioactive particles
17. Briefly explain the tropospheric oxidation of methane
18. Applications of Green chemistry
19. pH-pE Diagram

III. Answer any three of the following: (3x10=30 marks)

20. Describe the formation, composition and effects of acid rain
21. Structure, Classification and function of carbohydrates
22. Write an essay on the physical and chemical properties of soil and the role of macro and micro nutrients
23. Give an account of soil pollution and its management.

Second Semester M.Sc Degree Examination – Model Question Paper

Branch -Environmental Sciences

ES 222. ENVIRONMENTAL TECHNIQUES

Time: 3 hrs **Max. marks: 75**

I. Answer any ten of the following: (2x10=20 marks)

1. Principle of colorimetry
2. Standard Error
3. Grid method of sampling
4. Electrostatic precipitators
5. DNA Microarray
6. What is the purpose of enumeration of microbes in potable water?
7. Correlation
8. PCR
9. Harmonic mean
10. COD
11. Define bioindicators
12. Paper chromatography

II. Answer any five of the following: (5x5= 25 marks)

13. Explain DO and BOD.
14. Chain of custody procedures.
15. How do we analyse the presence and load of coliforms in water bodies.
16. Explain the basic statistical methods employed in field experiments.
17. Explain the theory and principle behind the working of flame emission and Atomic Absorption spectrophotometer.
18. **Calculate Karl Pearson coefficient of correlation**

Price	14	16	17	18	19	20	21	21	23
Demand	87	78	70	75	66	67	62	58	60

19. What are the various measures of dispersion.

III. Answer any three of the following: (3x10= 30 marks)

20. Give an account of the microbes in air, water and soil.
21. Describe the various separation techniques used in environmental analysis.

22. Write a note of different sampling equipments used for air and water sampling.
23. Write an essay on the analysis for BOD and COD. Mention the significance of these parameters.

Second Semester M.Sc Degree Examination – Model Question Paper

Branch -Environmental Sciences

ES 223. ENVIRONMENTAL POLLUTION AND TOXICOLOGY

Time: 3 hrs **Max. marks: 75**

I. Answer any ten of the following: (2x10= 20 marks)

1. Eutrophication
2. Units of radioactivity
3. Point and Non-point sources of pollution
4. Biological indicators of air pollutants
5. Toxicant
6. Teratogens
7. Acute and chronic toxicity
8. Basic properties of sound waves
9. Dragging
10. Environmental health
11. Sources of oil pollution
12. NOEL

II. Answer any five of the following: (5x5= 25 marks)

13. Synthetic fertilizers and their effects on soil components
14. Describe ADME
15. Carcinogens and Mutagens
16. Nuclear reactors
17. Write a note on different sources and entry routes of toxic substances into the human body
18. Absorption routes of toxicants
19. Explain air quality parameters adopted in India

III. Answer any three of the following: (3x10=30 marks)

20. Describe the sources, chemical and biological effects of thermal pollution and its impact on water bodies
21. Describe the source, measurement and analysis of sound. Write a note on measures to control noise pollution
22. Causes and effects of industrial effluents on soil components
23. Explain the safety landfill procedures for nuclear waste and radioactive waste.

M Sc ENVIRONMENTAL SCIENCES

II Semester Practical Examination

ES 224 Environmental Techniques, Chemistry and Pollution

Time: 4hrs **Total Marks:75**

I. Write critical notes on the spotters A, B & C (Identification, Principle and Uses)

[(1+3+1)3 = 15 marks]

II. Identify and write critical notes on the spotters D, E & F (Air pollution sample, Water pollution sample and Soil pollution sample)

[**(1+4)3=15 marks**]

III. Estimate organic carbon/ nitrogen/ phosphorous in sample G. Write the brief procedure.

[**7+3 =10 marks**]

IV. Identify the components of the given mixture H of amino acids/ chlorophyll using paper chromatography/ TLC by comparing the Rf values of known samples. Give a brief procedure.

[**7+3=10 marks**]

V. Determine total alkalinity/total hardness/nitrite/phosphate/silicate of the given sample I. Give a brief procedure.

[**7+3 = 10 marks**]

VI. Find the Standard Deviation (SD) for the given distribution

OR

Examine the distribution pattern of the given data using χ^2 test

[**10 marks**]

VII. Practical Record

[**5 marks**]

SEMESTER III

ES 231. REMOTE SENSING AND GIS

Total: 90 hrs

Objectives:

- To provide students an understanding regarding remote sensing, its principles and characteristics under different platforms, modes of scanning, an introduction to the major remote sensing systems.
- To impart an understanding of current technology and policy developments in the GIS/RS area and their potential applications to environmental monitoring and natural resources conservation.

Course Description:

Through lectures and laboratory exercises, the course will present and assess the fundamental concepts of GIS and remote sensing technologies in the context of environmental sciences. Topics include the physical basis for remote sensing, systems, digital image processing, data structures, database design, and spatial data analysis. Examples of applications of GIS and remote sensing technologies to various environmental applications with a particular focus on sustainable practices will be used throughout the course. Hands-on computer laboratory sessions re-enforce theoretical concepts.

Pre-requisites:

- Students should have working knowledge of personal computers as well as a basic understanding of database management.
- An orientation towards spatial data concept shall be an added advantage.

Course Content:

1. **Concept and Foundation of Remote Sensing**: Basic processes in remote sensing – data acquisition – energy sources and radiation principles, propagation of energy through atmosphere, energy interactions with earth's surface features, retransmission of energy into the atmosphere and generation of sensor data – data analysis; Active and Passive remote sensing; Platforms and Scanners; Principle of Scanner and CCD array; Special features of remote sensing.

   (10 hrs)
2. **Aerial Remote Sensing**: Advantages of aerial remote sensing; Elements of photographic systems – films, aerial cameras, filters; Classification of aerial photos and processes of aerial photos; Elements of image interpretation and interpretation keys for environmental analysis.

(12 hrs)

3. **Photogrammetry**: Geometric characteristics of aerial photographs; Scale of photographs; Stereo models; Principles of stereophotography; Relief displacement; Parallax measurement of height and slope; Convergence and evidence; Aerial mosaics; Orthophotography; Photogrammetric Instruments.

(12 hrs)

4. **Types of Sensors**: Thermal Sensors, Multispectral Sensors (MSS), Microwave, LIDAR – definition, principles, general characteristics, spectral resolution and interpretation, applications in environmental monitoring.

(12 hrs)

5. **Satellite Remote Sensing**: Advantages of satellite remote sensing; Types of satellite orbit – Polar and Geostationary; Satellite characteristics - Orbit, Swath, Resolution, Scale; Overview of Satellites – Landsat, SPOT, IRS, NOAA, Cartosat, Oceansat, IKONOS, QUICKBIRD, ERS, RADARSAT, INSAT satellites – their sensors, geometry and radiometry, orbital characteristics, data products and applications.

(10 hrs)

6. **Digital Image Processing**: Digital Image Formats; File structures; Image Rectification and Restoration; Image Enhancement; Image Classification – Supervised, Unsupervised; Ground truth data and training set manipulation; Data merging.

(10 hrs)

7. **Geographical Information System (GIS)**: Introduction: definition, components, basic principles; Data models – Vector and Raster data, Spatial and Non-spatial data; Map projections; Defining spatial relationships; Spatial Analysis – measurements, queries, buffering, map overlay; Spatial interpolation – TIN, DEM; WebGIS.

(12 hrs)

8. **Global Positioning System (GPS)**: System segments; GPS satellite signals; Calculating locations; Differential GPS; Applications of GPS in environmental studies.

(5 hrs)

9. **Application of Remote Sensing and GIS**: Application in Forestry and Wildlife management; Survey, mapping and monitoring of land use/ land cover; Soil and Agriculture; Water resources; Urban planning; Disaster management; Health studies.

(7 hrs)

Learning approaches:

- Learner centric – Students should collect information regarding the various satellites.
- Group discussions – on the applications of remote sending and GIS in environmental management.

Expected Competency/ Learning Outcome:

- Students should be able to understand and appreciate the application of Remote sensing and GIS in Environmental Studies.

RECOMMENDED READINGS

1. Abbassi, T. & Abbassi, S. A. (2010). Remote sensing, GIS and Wetland management, Discovery Publishing House, Pvt. Ltd.
2. Agaral N. K. (2004). Essentials of GPS. Spatial Networks Pvt. Ltd. Hyderabad.
3. Anji Reddi M. (2000). Remote sensing and Geographic Information System. B.S. Publications, Hyderabad.
4. Askne Jain (2005). Sensors and Environmental Applications of Remote Sensing. A. A. Balkeme Publishers.
5. Chang Kang – Tsung (2007). Introduction to GIS. Tata McGraw Hill Education.
6. Chrisman and Nicholas (1997). Exploring GIS, John Wiley and Sons.
7. Clarke K. C. (1997). Getting started with Geographical Information System. Prentice Hall, New Jersey.
8. Cracknell A. P. & C. A. Varotsos (2012). Remote sensing and Atmospheric Ozone. Springer – Verlag Berlin Heidelberg.
9. Demers, Michael N. (1996). Fundamentals of GIS. John Wiley & Sons (Pub.)
10. Fisher Peter (1995). Innovations in GIS. Taylor and Francis (Pub.), New York.
11. Heywood I., S. Cornelius, S. Carver (2011). An Introduction to GIS ,4th Edn., Prentice Hall.
12. Jensen J.R. (2006). Remote Sensing of the Environment –An earth resource perspective. Pearson Education (Prentice Hall Series in GIS).
13. Jenson J.R. and R.R. Jensen (2012). Geographic Information Systems. Pearson Inc.
14. Jhanwar M.L and T.S. Chouhan (1998). Remote sensing and Photogrammetry – Principles and Applications. Vigyan Prakashan, Jodhpur.
15. Kolay A.K. (2009). Remote sensing & Assessment of Soil resources, Atlantic Pub., New Delhi.
16. Martin, D.(1991). Geographic Information Systems and their socioeconomic Applications. Routledge, N.Y.
17. Narayan L. R. A. (1999). Remote Sensing and its applications. Orient Blackswan, AP.
18. Stephen Wise. (2002). GIS Basics, Taylor and Francis, New York.
19. Thomas M. Lillesand and Ralph W. Kiefe (1987). Remote sensing and Image interpretation 7th Edn., John Wiley and Sons, New York.

ES 232. ENVIRONMENTAL GENETICS, MICROBIOLOGY AND BIOTECHNOLOGY

Total: 90 hrs

Objectives:

- To make students aware of the role of microbiology in the sustenance of environment and the current growth of molecular concept and their applications in Environmental Sciences.

Course description

The course provides students an idea of how environment interacts with an organism's genetic makeup and life style. A basic introduction is given to the students regarding microbiology and microorganisms, and explores their role in shaping the Earth. It also deals with how metabolic processes catalysed by microorganisms are related to major elemental cycles, biogeochemical processes, and organic contaminant degradation. Most up to date molecular methods used to study the diversity and activity of microorganisms in their natural habitats, along with their benefits and limitations are also covered.

Pre-requisite:

- Basic knowledge of the flow of genetic information through replication, transcription and translation (Central dogma).
- An understanding of basic microbiology.
- General over view of current issues related to the use of genetic techniques in environment.

Course Content:

1) **Chromosomal variation in number & structure**: Environmental causes of euploidy, non disjunction & aneuploidy, induced polyploidy, applications of polyploidy, chromosomal mosaics, chromosomal rearrangements in human being, chromosomal aberrations.

(10 Hrs)

2) **Mutations**: Genetic code, changes in the general structure of DNA, types of mutation and causes (spontaneous and induced, lethal biochemical), detection of mutation, phenotypic effects of mutation, role of mutation in evolution of life, practical applications of mutation.

(15 Hrs)

3) **GMOs**: Genetically modified organisms and their environmental implications – pros and cons (Eg. BT cotton, Bt mustard, GM food). GEAC and their roles.

(5 Hrs)

4) **Environmental Microbiology**: Microbes in environment and their functions (beneficial and harmful), general nutrition characteristics of microbes, microbial ecology, microbes in extreme environment and role of microbes in biogeochemical cycles, microbial interactions with plants and animals, microbes in human health and emerging diseases.

(22 Hrs)

5) **Enumeration Techniques**: Culture Dependant and Culture Independent; Metagenomics/Environmental genomics, eco genomics or community genomics; Applications of metagenomics

(8 hrs)

6) **Bioremediation**: concept, principles and applications; types- insitu, exsitu; microbes involved; rhizoremediation, phycoremediation, biomining: microbial leaching of low grade mineral ores; molecular probes for organisms in mines and mine tailings.

(15 Hrs)

7) **Environmental Biotechnology**: Fermentation Technology, Vermiculture technology, Microbial composting technology, Biofertilizer technology, Waste management technology - role of microorganisms in the degradation of natural and manmade compounds- pesticides recalcitrant chemicals, persistent organic pollutants (POP).

(15 hrs)

Learning approaches:

- Collaborative – Group discussions on beneficial and harmful microbes found in various components of environment.
- Learner centric – The students have to collect information on genetically modified organisms and their uses in various fields including industries and food sources.
- Experiential – Students have to collect paper cuttings of reports of emerging microbial infections.
- Experiential – the students should try to correlate the occurrence of high rate of cancer with factors in environment and lifestyle.

Expected competency/ Learning outcome:

- Student should be able to realize the activities and roles of microbes on earth and know how to use them in different applications.
- Student should be aware of the modern molecular and biotechnological approaches in Environmental analysis and management and need how to use this understanding in real life situations.

RECOMMENDED READINGS

1. Agarwal S. K. (1998). Environmental Biotechnology. APH Publishing Corp., New Delhi.
2. Alan Scroog (2005). Environmental Biotechnology, Oxford University Press, New York
3. Baker K. H and D. S. Herson (1994). Bioremediation. Mc Graw Hill. Inc. New York.
4. Benjamin Lewin (2000). GenesVII. Oxford University Press Inc. New York
5. Berger, M.W. (1996). Genetics – Strick, Prentice Hall of India, New Delhi

6. Hoffmann A. A. (1993). Evolutionary Genetics and Environmental Stress. Oxford University Press.
7. Jemba P.K. (2004). Environmental Microbiology, Science Publishers, USA
8. Jogdand S. N. (1995). Environmental Biotechnology-Industrial Pollution Management. Himalaya Publishing House, Bombay.
9. Lehninger A.L. (1984). Principles of Biochemistry. C.B.S. Publishers, Delhi.
10. Murugesan A. G. and Rajkumari C. (2006). Environmental Science and Biotechnology, MJP Publishers, Chennai
11. Pradipta Kumar Mohapatra (2006). Text Book of Environmental Biotechnology. I.K International Publishing House Pvt. Ltd. New Delhi.
12. Raina M., I. Pepper, C. Gerba (2006). Environmental Microbiology, Academic Press, NY.
13. Ram Kumar (2000). Environmental Biodegradation. Sarup and Sons, New Delhi.
14. Reza Marandi and Ali Shaeri (2009). Environmental Biotechnology. SBS Publishers and Distributors Pvt. Ltd. New Delhi.
15. Rick Lewis (1998). Human Genetics – Concepts and Applications – 3rd edition, McGraw-Hill Publishing Company.
16. Srivastava M.L. (2003). Basic Environmental Microbiology, Manohar Books, New Delhi.

ES 233. ENVIRONMENTAL METEOROLOGY AND CLIMATE CHANGE

Total: 90 hrs

Objectives:

- To make students understand the various meteorological phenomena which shape the climate of earth and problems affecting the normal weather pattern.
- To introduce students to Clean Development Technologies to deal with climate changes and associated issues.

Course Description

The course provides an overview of the science of climate change including motions of earth and seasons, structure of the atmosphere, different climatological parameters in the formation of clouds, and precipitation, air masses and major mechanisms influencing climate. It also includes Earth's energy balance, water cycle, and atmospheric circulation; spatial distribution of climate and climate classification; natural climate variability, including El Niño; past climate variations; and the carbon cycle and human-induced climate change. CDM technology, which is a new technique which finds application world-wide, is also introduced in this course.

Pre-requisite:

- Students should know the structure of atmosphere.
- Students should know smog, PAN and acid rain.

Course Content:

1. **Motions of the Earth and Seasons**: Earth – Sun relationship; Earth's Radiation balance; Latitudinal and Seasonal variation of Insolation.
(1 hrs)
2. **Air temperature**: Warming and cooling of air near ground; Measurements of temperature; Humidity - expressions of humidity, measurement of humidity; Clouds -classification and types; Precipitation – processes, types, measurement-recording, non-recording, radar, satellite; Wind – forces affecting wind, types, measurement, wind roses.
(20 hrs)
3. **Climatology**: Elements of weather and climate, climatic controls, energy balance in the atmosphere, elementary ideas about weather systems, climatic classifications; climates in India; monsoons of India, preliminary concept of climate change, El Nino and ENSO
(15 hrs)
4. **Fundamentals of Meteorology**: Atmospheric thermodynamics - specific heats and laws of thermodynamics; Temperature lapse rate and Inversion; Atmospheric stability; Scales in meteorology; Energy budget near surface; Planetary Boundary layer.
(15 hrs)
5. **Micrometeorology**: Effects of topography, applications to vegetated surfaces; Urban areas – urban climatology – heat dome, human beings and animals; Impact on the physiology of plants and animals; Stress induced changes.
(8 hrs)
6. **Pollution Meteorology and Climatology**: Applications of meteorological principles to transport and diffusion of pollutants, diffusion and turbulence, mixing heights, effect of meteorological factors on air pollution, size and structure of plume, dispersion of air pollutants – Gaussian Plume model.
(15 hrs)
7. **Science of Climate Change**: Drivers of climate change – greenhouse gases, aerosols – reflective and black; Feed-back processes in climate systems; Global Warming Potential (GWP); Radiative forcing; WMO, IPCC, NAPCC: Concept of green architecture, Carbon Trading, Carbon Credits; Carbon Sequestration; Impact of climate change on agriculture, forest and water resources.
(5 hrs)
8. **Clean Technology**: History, purpose, Clean Development Mechanism (CDM) project process, methodologies, role of CDM projects in climate change; Imperatives of clean technology in the context of mitigation and adaptation measures; CDM concept and scenario in India.
(5 hrs)

Learning approaches:

- Collaborative- group discussions and open forums based on the curriculum can be incorporated.
- Learner centric- literature survey and content generation on current issues pertaining to climate change and various issues of environmental concern.
- Skill Acquisition through internships for specific modules to be encouraged.

Expected competency/ Learning outcome:

- Students should get a clear idea regarding the factors responsible earth's climate and its changes.
- Students should understand the various ways by which the ill effects of climate change can be mitigated.

RECOMMENDED READINGS

1. Arya S. Pal (1998). Introduction to Micrometeorology, Academic Press.
2. Arya, S. Pal (1999). Air Pollution Meteorology and Dispersion, Oxford University Press, London
3. Barry R. G. and R. J. Chorley (2009) Atmosphere, Weather and Climate. Routledge.
4. Berry F. A., E. Bollay and N. R. Beers. (1945). Hand Book of Meteorology. McGraw Hill.
5. Bryers H. R. (1974) General Meteorology, Mc Graw – Hill.
6. Finlayson – Pitts (1986). Atmospheric Chemistry: Fundamental and Experimental Techniques, John Wiley and Sons, New Delhi.
7. Hess S. L. (1959). Introduction to Theoretical Meteorology, Holt Renehart and Winston, New York.
8. Menon P.A. and C.K. Rajan (1989). Climates of Kerala, Classic Printers, Cochin.

ES 234. PRACTICAL III

ENVIRONMENTAL GENETICS, MICROBIOLOGY AND REMOTE SENSING

Total: 144 hrs

1. Models of genetic significance – syndrome, sex linked inheritance- colour blindness, web toes etc.
2. Sterilization techniques, culture media preparation: serial dilution, plating, isolation and identification of bacteria and fungi - physiological and biochemical
3. Staining – Simple and Gram's staining

4. Microscopic counting of microbes using haemocytometer
5. Measurement of microbes using ocular and stage micrometer
6. Estimation of coliform bacteria in water by MPN method.
7. Study of topographic sheets and interpretation (5 grids)
8. Fundamental exercise on generation of a basic thematic map layer using any GIS open source/ licenced software (Lab facilities to be provided).

ES 235. PROJECT WORK

Total: 144 hrs

An original research work on a selected topic is to be undertaken by each student under the guidance of a supervising teacher. The work is to be started in III semester and continued to IV semester. Submit the same as the project report at the end of IV semester.

Third Semester M.Sc Degree Examination – Model Question Paper

Branch -Environmental Sciences

ES 231. Remote Sensing and GIS

Time: 3 Hours **Max. Marks: 75**

I. Write short note on **any ten** of the following: **(10x2= 20 marks)**

1. Application of remote sensing in land use
2. Thermal scanning
3. Soil mapping
4. OGC
5. IRS
6. Name any two Indian satellites
7. CCD
8. Land Use survey
9. Base map
10. Active and passive remote sensing
11. Advantages of aerial remote sensing
12. TIN

II. Answer **any five** of the following: **(5x5= 25 marks)**

13. Energy source and Radiation principles in remote sensing
14. Write a note on GPS , its function, characteristics and applications in Environmental studies
15. Explain the characteristics of RADARSAT
16. Explain energy interaction with earth's surface features
17. Give an account of elements of image interpretation
18. Polar and Geostationary satellites
19. Advantages of satellite remote sensing

III. Answer **any three** of the following: **(3x10= 30 marks)**

20. What is DIP? Explain the different steps employed.
21. Give a detailed account on types of sensors- with emphasis on its principle, general characteristics, spectral resolution and application in environmental monitoring.
22. Give a descriptive account of MSS with neat illustrations regarding working and different types of scanning employed and applications
23. Describe in details the satellite characteristics and describe the functions of Cartosat and Oceansat.

Third Semester M.Sc Degree Examination – Model Question Paper

Branch -Environmental Sciences

ES 232. Environmental Genetics, Microbiology and Biotechnology

Time: 3 Hours **Max. Marks: 75**

I. Write short note on **any ten** of the following: **(10x2= 20 marks)**

1. Carcinogens with two examples
2. Frame shift mutations
3. Bt cotton
4. Biosensors
5. Clinical irradiation
6. Biochips
7. Rhizoremediation
8. Any two use of microbes in waste water treatments
9. Pasteurization
10. Biomining
11. Persistent Organic Pollutants (POPs)
12. Genetic counseling

II. Answer **any five** of the following: **(5x5= 25 marks)**

13. Mention the significance of Human Genome Project
14. Write a brief account of metagenomics
15. Explain euploidy and aneuploidy.
16. Transgenic species may cause threat to the environment. Why?
17. 'Biomass'- a potential source of energy for tropical countries- How?
18. Culture dependent and culture independent techniques for bacterial enumeration
19. Explain how degraded landscapes are restored using biotechnological principle.

III. Answer **any three** of the following: **(3x10= 30 marks)**

20. Discuss the recombinant DNA technology and its application.
21. Explain the process of Transcription and the enzyme involved with a neat labeled diagram.
22. Explain the concept, principles, types and applications of bioremediation.
23. Explain the ethical and social impacts of Biotechnology.

Third Semester M.Sc Degree Examination – Model Question Paper

Branch -Environmental Sciences

ES 233. Environmental Meteorology and Climate Change

Time: 3 Hours **Max. Marks: 75**

I. Write short note on **any ten** of the following: **(10x2= 20 marks)**

1. Adiabatic process in the atmosphere
2. Cumulo nimbus
3. Acid rain
4. Green house gases
5. Mixing height
6. GWP
7. Carbon sequestration
8. Radiative forcing
9. Carbon footprint
10. Planetary boundary layer
11. Sustainable habitat
12. Laws of blackbody radiation

II. Answer **any five** of the following: **(5x5= 25 marks)**

13. Stability of atmosphere and lapse rate
14. Elaborate on NAPCC
15. Describe formation of clouds
16. Formation of PAN
17. Scales in meteorology
18. Explain dispersion of air pollutants in the Gaussian plume model
19. Elements of weather and climate

III. Answer **any three** of the following: **(3x10= 30 marks)**

20. Detailed account on Global warming and its effects on the environment

    (1) How are clouds formed and what are the different types?

    (2) Give a brief account on climate and monsoon in Indian context.

21. Explain the science of climate change and the role of clean technology in the context of mitigation.

22. Role of monsoon in India’s environmental, economic and social scenarios

23. Describe in detail the role of meteorological parameters in the transport and dispersion of pollutants.

M.Sc. ENVIRONMENTAL SCIENCES

III Semester Practical Examination, October, 2015

ES 234 - Environmental Genetics, Microbiology and Remote Sensing

Time: 4 hrs **Max. Marks: 75**

I. Identify and write critical notes on the spotters A, B, C, D and E

[**5 x 2 = 10 marks**]

II. Write critical notes on F and G [2 x 5 = 10 marks]

III. Conduct cell count using haemocytometer / measurement of microbes using ocular and stage micrometer

[**1 x 10 = 10 marks**]

OR

Enumeration of bacteria by plate count – serial dilution technique (pour plate method)

[**1 x 10 = 10 marks**]

IV. Conduct any one of the following [1 x 10 =10 marks]

a) Gram staining

b) Simple staining to study the shape of microorganisms

V. From the given survey of Indian toposheet, answer the following questions

[**1 x 15 = 15 marks**]

a) Number and scale of the toposheet

b) Latitude and longitude of the given grid

c) Briefly describe the geomorphology, drainage, land use and vegetation of the area in the given grid

VI. From the given aerial photograph, prepare a land use/ land cover map and briefly describe the geomorphic and environmental features in it

[**1 x 15 = 15 marks**]

VIII. Practical Record

[**5 marks**]

SEMESTER IV

ES 241. ENVIRONMENTAL ENGINEERING AND WASTE MANAGEMENT

Total: 90 hrs

Objectives:

- To give students an understanding regarding the various pollution sources in environment and fate of environmental toxicants

Course description:

The course provides basic idea regarding pollution control strategies employed in various sectors including air, water, wastewater and solid waste treatment in conventional unit operations including the scientific engineering principles on which they are based. It also deals with advanced techniques available in the treatment of potable water and also incorporates a general learning on hazardous waste management strategies. Policies and laws pertaining to the management of aforesaid areas are also dealt within.

Pre-requisite:

- Students should have a fairly good knowledge on various types of pollution and its effects on environment and ecosystems.
- Basic knowledge about various wastes to energy conversion techniques.

Course Content:

1. **Air pollution control measures**: Gaseous and particulate matter control (cyclone collectors, scrubbers, electrostatic precipitators, fabric filters,) and control of vehicular emission (Catalytic converters, Engine modification).

(12 hrs)

2. **Waste water/Sewage treatment**: Preliminary treatment (Grit removal, clarification, Fats, Oil and Grease removal), Primary treatment (Primary Clarification/ Sedimentation, Scum removal), Secondary treatment – Aerobic (Aeration, Trickling filters, Rotating Biological Contactors, Stabilization/Oxidation pond, Activated Sludge Process – Suspended growth processes and Attached growth processes) and Anaerobic (Septic tank, Imhoff tank, Upflow Anaerobic Sludge Blanket and Anaerobic Baffled), Tertiary (Filtration, Aerated lagoons, Biological nutrient-Phosphorus and Nitrogen removal), Disinfection, odour control, Sludge treatment and disposal.

(15 hrs)

3. **Industrial effluent treatment**: Effluent characteristics and Treatment methods employed at different industries – Sugar and Distillery, Dairy Industry and Paper and Pulp Industry, Common Effluent Treatment Plants (CETPs).

(15 hrs)

4. **Municipal water treatment and Specifications of Drinking water**: Physical, chemical and bacteriological standards by WHO and BIS, municipal water treatment; collection and pumping, aeration, flocculation, sedimentation, filtration, disinfection, water softening; advance treatment methods: demineralization, ultrafiltration, and reverse osmosis, colour and odour removal by activated carbon**.**

(15 hrs)

5. **Solid waste treatment**: Industrial and municipal solid wastes; basic concepts – collection, transportation and disposal – open dumps, ocean dumping, landfills, incineration, composting and vermin composting, recycling and reuse

(15 hrs)

6. **Hazardous wastes**: Definition, types and characteristics; Biomedical Wastes – sources, type, characteristics and management; Nuclear and Radioactive wastes – sources, types, hazards, storage and management; Electronic wastes (E wastes): sources and types, constituents, recycling of e-wastes.

(13 hrs)

7. **Waste hierarchy**: Polluter pays principle, waste management policies (Case studies); energy recovery from wastes.

(5 hrs)

Learning approaches:

- Experiential – Students should be taken to field to understand the problems of wastes as well as to get a real understanding about the social and economic impacts of wastes.
- Activity based – students should prepare flow charts on various waste treatment procedures.
- Field oriented activities and team work encouraged to bring about individual constructive feedback.

Expected competency/ Learning outcome:

- Students should get a clear idea regarding treatment of wastes and management of pollution and they should be able to practise it in real life situations.

RECOMMENDED READINGS

1. Abbasi S. A and E. Ramasami. (1999). Biotechnological Methods of Pollution Control. University Press, Hyderabad.

2. Arceivala S.J. & S.R. Asolekar (2007). Waste Water treatment for Pollution Control and Reuse. Tata McGraw Hill (Pub.).
3. Bhatia S. C. (2007). Solid and Hazardous Waste Management. Atlantic Publishers.
4. Chereminsinoff, N.P. (1996). Biotechnology for Waste and Wastewater Treatment. William Andrew Publishing, New York.
5. Khan M. K. (2004). Hospital Waste Management: Principles and Guidelines. Kanishka Publishers, New York.
6. Met Caff and Eddy (1991). Waste Water Engineering. Tata Mc Graw Hill.
7. Reddy Jayarama P. (2011). Municipal Solid Waste Management: Processing, energy recovery global examples. BSP Books Pvt Ltd. Hyderabad.
8. Santra S.C. (2001). Environmental Science. New Central Book Agencies Pvt. Ltd. Kolkata
9. Waste Water Treatment Plant design. (1997), A Manual of Practice. Water Pollution Control Federation.

ES 242. ENVIRONMENTAL ECONOMICS, IMPACT ASSESSMENT AND DISASTER MANAGEMENT

Total: 90 hrs

Objectives:

- To make students aware of principles of economics applicable in Environmental Sciences.
- To make students understand how the impacts of a developmental activity can be assessed and problems mitigated.
- To help students to get a basic understanding about disasters and how to deal with disasters.

Course Description:

Environmental economics module offers insight into the exploitation, allocation and use of renewable and fixed natural resources. Also, it offers understanding economic effects of worldwide environmental policies, through theoretical and empirical study.

The module on EIA offers an overview of the concepts, methods, issues and various forms and stages of the EIA process. It also explains the methodology of environmental impact assessment (EIA) as a vital tool for sound environmental management and preparation of Environmental Risk Management (ERM) in decision-making.

Disaster Management modules described offer theoretical and practical management skills in preparation, response and recovery from natural and man-made disasters.

Pre-requisite:

- The students should have a basic idea regarding natural and manmade disasters.

Course Content:

1. Economy and Environment: Nature and scope of environmental economics; economics and ecology; Economic Development and resource utilisation – Frontier, Cowboy and Spaceship economy; economics of natural resources exploitation; Tragedy of Commons; Limits to growth; Economics of pollution- optimum level of pollution; economics of climate change, Economic benefits of Green House Gas control.

(10 hrs)

2. Cost-Benefit analysis (CBA): Types of benefits and costs; methods of valuation of environmental costs and benefits; market value approach of environmental costs and benefits; CBA applied to environmental protection- in a case study.

(15 hrs)

3. Environmental Auditing: Objectives, frequency and criteria; audit team, environmental appraisal, accounting and environmental audit. Environmental guidelines for siting of industry, green balance sheet (GBS), status of compliance of mandatory and voluntary requirements for industries – cement, pesticide.

(10 hrs)

4. Environmental Impact Assessment (EIA): Definition, concepts and characteristics of EIA; participants, stages and types EIA. Environmental inventory, Baseline data on EIA- environmental data, project data and project alternative data, Measurement of impact- physical, social, economic, natural; Public participation in environmental decision making; Framework of environmental assessment; description of environmental setting; environmental impact factors and area consideration. Environmental impact statement (EIS) and Environmental Management Plan (EMP).

(20 hrs)

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

(10 hrs)

6. Natural and manmade hazards: Definition – hazard, vulnerability, risk and disaster; classification of hazards; causative factors of hazards; natural hazards - case studies, manmade hazards - case studies.

(10 hrs)

7. Hazard mitigation: Identification of hazard prone belts, hazard zonation and risk assessment; risk reduction in vulnerable areas, developing warning systems, emergency preparedness, education and training activities, planning for rescue and relief works.

(5 hrs)

8. Disaster management: Capability, vulnerability, risk - preparedness and mitigation; disaster management cycle - crisis management and risk management. Components of crisis management- quick response & relief, recovery, rehabilitation; component of risk management- risk identification & assessment, risk reduction, risk transfer, disaster management act and policy.

(10 hrs)

Learning approaches:

- Experiential – Students should do an environmental auditing.
- Activity based – students should collect information regarding recent developmental activities and the EIA done for those activities.

Expected competency/ Learning outcome:

- Students should be able to assess the result of an environmental activity and should know how the effect can be mitigated.

RECOMMENDED READINGS

1. Allen V. Kneese and James L. Sweeney. (1985). Handbook of Natural Resources and Energy economics. North Holland, Elsevier Science Publishers.
2. Anjaneyulu Y and Manickam, W. (2010). Environmental Impact Assessment Methodologies, BSP Books Pvt Ltd., Hyderabad.
3. Canter L. (1996). Environmental Impact Assessment, McGraw Hill, New Delhi.
4. Charles H. Eccleston. (2011). Environmental Impact Assessment. CRC Press, New York.
5. Cutter Susan L. (1999). Environmental Risks and Hazardous. Prentice Hall, New Delhi.
6. Field B. C. (1994). Environmental Economics: An Introduction, Mc Graw Hill (Pub.).
7. Glasson Therivel and Chadwick (1999). An Introduction to Environmental Impact Assessment, UCLA, Los Angeles.
8. Gupta Harsh K. (2003). Disaster management, Universities Press (India) Pvt. Ltd.
9. Hill Mc Jurie, Ian Mason and C. Kilburn. (2002). Natural Hazards and Environmental Change. Oxford University Press, New York.
10. Ian Hodge (1995). Environmental Economics Macmillan Press Ltd, London.

11. Jha Madhankumar. (2010). Natural and Anthropogenic Disasters: Vulnerability, Preparedness and Mitigation, Springer.
12. Karpagam M. (1999). Environmental Economics – A text book, Sterling Publishers Pvt. Ltd., New Delhi.
13. Lawerence D.P. (2003). Environmental Impact Assessment: Practical solutions to recurrent problems, John Wiley and Sons, New Delhi.
14. Morris P. And R Therivel (2011). Methods of EIA, Spoon Press.
15. Oates W. E. (1992). The Economics of the Environment. Edward Elgar Publishing.
16. Rau J.G. and D.C. Woolen (1980). Environment Impact Analysis Handbook, McGraw Hill.
17. Sankar U. (2001). Environmental Economics, New Delhi: Oxford University Press.
18. Srivastav A.K. (2003). EIA. APH Publishing Corporation.
19. Srivastava D.C.(2005). Readings in Environmental Ethics: Multidisciplinary perspectives, Rawat Publications, Jaipur.
20. Strahler A.N. and A. H Strahler (1973). Environmental Geosciences – Interaction between natural systems and man: Santa Barbara, California, Hamilton Publishing.
21. Vaidya K. S. (1987). Environmental Geology. Tata Mc Graw Hill (Pub.).
22. Weston J. (1997). Planning and EIA in Practice, Longman.
23. White G.H. (ed). Natural hazards – local, national, global: Oxford University Press.

ES 243. ENVIRONMENTAL POLICIES AND LAWS

Total: 90 hrs

Objectives:

- To make students aware of various policies and regulations available for environmental protection.
- To show students the various environmental protection movements in the past.
- To make students aware of the translational environmental policies.
- To develop an ethical consideration to environment and its components.

Course description:

The modules provided under this course give a thorough and in-depth understanding of Environmental Laws and policies, environmental protection movements and environment related legal regulatory framework in India. The course also outlines the role of environmental education and ethical considerations for proper utilization of environmental resources. It also imparts different International treaties, conventions and agreements with respect to alleviating pollution for sustainable development of the nation.

The various environmental standards and certification criteria for goods and services offered are also envisaged in detail. Eco-tourism forms an important component of the course wherein it plays a vital role in conservation and revenue generation for the state. The course modules also give insights on politico-economic issues underlying environmental policy formulation and implementation at an international and domestic level.

Pre-requisite:

- Students should have a general understanding about the environmental movements.
- Students should have knowledge regarding the various conventions on environment.
- Students should be aware about Environmental policy in ancient India: medieval India, British India during post independent era and environmental history of India.

Course Contents:

1. **National Environmental Policy and Regulatory Frame Work**: Legal, administrative and constitutional provisions for environmental protection in India; Constitutional and Statutory laws in India – Article 48A, Article 51A(g); National Environment Policy, 2006; Intellectual Property Rights; Public Liability Insurance Act, 1991; Biopiracy; Green funding and taxes; Green Bench; Central and State Pollution Control Boards.

(15 hrs)

2. **Environmental Laws in India**: Indian Forest Act, 1927; Factories Act, 1948; the Mines and Minerals Act, 1957; The Wildlife Protection Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest Conservation Act, 1980; The Air Act (Prevention and Control of Pollution), 1981; The Environment Protection Act, 1986; Motor Vehicles Act, 1988; The National Environment Appellate Authority Act, 1997; The Biodiversity Act, 2002; Coastal Regulation Zone Notification, 2011; Biomedical Waste Management Rules, 2016; Solid Waste Management Rules, 2016.

(20 hrs)

3. **Environmental Movements in India**: Chipko movement; Narmada Bachao Andolan; Appiko movement; Tehri Dam; Almetti Dam; Silent Valley movement.

(5 hrs)

4. **Environmental Standards**: Scheme of labeling environment friendly products (Ecomark); Environmental Management and ISO Certification; Environmental Management System (EMS); ISO 14000.

(10 hrs)

5. **International Environmental Conventions and Treaties**: Stockholm Conference, 1972; Nairobi Declaration, 1982; Rio Conference, 1992; Rio +5; Rio +10; Montreal Protocol, 1987; Vienna Convention for the protection of ozone layer, 1985; Conference of Parties; Kyoto Protocol, 1997; Basel Convention, 1989; Convention on Biological Diversity,

Convention on Climate Change - UNFCC; Trans-national Environment Policy – The Indus Water Treaty, 1960; The Ganga – Brahmaputra River Treaty, 1996.

(15 hrs)

6. **Sustainable Development**: Concept and growth of the idea; Indications of sustainability; Models of sustainable development; Case studies – Sustainable development scenario – global and national level.

(4 hrs)

7. **Ecotourism**: Definition; Concepts and principles; Types of ecotourism; scope for ecotourism in Kerala, benefits of ecotourism.

(4 hrs)

8. **Environmental Ethics**: Concept of environmental ethics; philosophies of biocentrism and ecocentrism; application of ethics to environmental issues; ecofeminism; environmental equity and justice.

(7 hrs)

9. **Environmental Education**: Meaning and scope– principles and objectives; environmental awareness strategies; formal and non-formal education - environmental education in primary, secondary and tertiary level; environmental education for professional groups; action plans.

(10 hrs)

Learning approaches:

- Activity based – Students should collect information regarding environmental disputes and environmental movements.
- Field visits to be conducted to gather first hand information regarding ecologically sensitive areas.
- Group discussions on various topics of environmental ethics such as Ecofeminism.

Expected competency/ Learning outcome:

- Students will have a thorough knowledge on various legal provisions on environment.
- Students will be vigilant in issues related to environment.
- Students will be able to apply all those studied in the programme to the societal level.

RECOMMENDED READINGS

1. Archana Tomar (2011). Environmental Education. Kalpaz Publications, New Delhi.
2. Gurdip Singh (2005). Environmental Law in India, MacMillan, New Delhi.
3. ISO 14004 – Environmental Management Systems: General Guidelines on Principles, systems and supporting techniques (International Organisation for Standardisation - Switzerland).

4. Johnson E.A. and M.J. Mappin (2005). Environmental Education and Advocacy. Cambridge University Press, UK.
5. Misra R.P. (1995). Environmental Ethics. Concept Publishing Company, New Delhi.
6. Mridula and N. Datt. (1993). Ecology and Tourism. Universal Publishers Distribution, New Delhi.
7. Shyam Divan and Armin Rosencranz (2002). Environmental Law and Policy in India. 2nd Edn. Oxford University Press, New Delhi.
8. Srivastava D.C. (2005). Readings in Environmental Ethics: Multidisciplinary perspectives, Rawat Publications, Jaipur.

ES 244. PRACTICAL IV

WASTE MANAGEMENT, IMPACT ASSESSMENT AND DISASTER MANAGEMENT

Total: 72 hrs

1. Vermicomposting technique, Vermiwash.
2. Production of biogas from waste.
3. Landfill design and design criteria.
4. Study on the impact of chosen waste materials on seed germination.
5. Designing of Activated Sludge System.
6. Environmental Impact Assessment of any 2 projects - mining / hydroelectric project / highway construction project / industries and the preparation of Environmental Impact Statement and Environmental Management Plan using conventional methods.
7. Preparation of disaster management plan with respect to any one disaster (flood, tsunami, landslide, earthquake).

STUDY TOUR AND REPORT: Study tour for five days to environmentally significant areas or hotspots. It includes field and institutional visits. They shall submit a detailed report of field work at the time of practical examination of semester IV.

INDUSTRIAL INDUCTION TRAINING: Industrial induction training programmes to be undertaken of duration one week/7 days during III/IV semesters is mandatory.

Fourth Semester M.Sc Degree Examination – Model Question Paper

Branch- Environmental Sciences

ES 241. Environmental Waste management and Engineering

Time: 3 Hours **Max. Marks: 75**

I. **Write short note on any ten of the following:** **(10x2= 20 marks)**

1. Fabric Filters
2. Sanitary landfill
3. Oxidation ponds
4. What is Alum? Give examples
5. Trickling filter
6. e- wastes
7. Water softening
8. Dose and dose rate
9. Electrostatic Precipitators
10. Colour and odour removal by Activated carbon
11. Waste hierarchy
12. Ultrafiltration and Reverse Osmosis.

II. **Answer any five of the following**:
(5x5= 25 marks)

13. Explain Activated Sludge Process
14. Explain Polluter Pays Principle
15. Write a note on management of medical and hospital wastes
16. Comment on limestone injection and fluidized bed combustion.
17. Give an Account of Anaerobic Waste Water Treatment Methodologies
18. Describe the recycling of e- wastes.
19. Write a note on Coagulation and Flocculation.

III. **Answer any three of the following**:
(3x10=30 marks)

20. Explain the treatment of Drinking water.
21. What are the basic concepts and methods employed in solid waste collection and disposal.
22. Draw a neat flowchart and explain the processes involved in waste water treatment.
23. Explain the type, characteristics and management measures of hazardous wastes.

Fourth Semester M.Sc Degree Examination – Model Question Paper

Branch -Environmental Sciences

ES 242. Environmental Economics, Impact Assessment and Disaster management

Time: 3 Hours **Max. Marks: 75**

I. **Write short note on any ten of the following**:
(10x2= 20 marks)

1. Economic problems of resource depletion and pollution.
2. Cowboy economics
3. Rehabilitation
4. EIS
5. Limits to growth
6. Environmental auditing
7. Matrices
8. Vulnerability
9. Spaceship economics
10. Risk transfer
11. Environmental Inventory
12. Relation with economics and environmental sectors.

II. **Answer any five of the following**:
(5x5= 25 marks)

13. Give an account of the nature and scope of Environmental Economics.
14. What are the hazards posed by dams and reservoirs? Brief the mitigation measures that can be adopted in this case.
15. Describe the environmental guidelines for citing the industry.
16. Comment on the importance of public participation in an EIA. Which are the stages at which public participation can be incorporated?
17. What is risk management? What are its components?
18. Types of costs and benefits.
19. Explain various aspects of environmental auditing.

III. **Answer any three of the following**: **(3x10= 30 marks)**

20. Elaborate on the Prediction, Perception, mitigation and management of cyclones.
21. Elaborate the steps of an EIA for Thermal Power Plant.

22. Explain cost benefit analysis and the evaluation techniques used for the same.
23. Explain resource depletion and economics.

Fourth Semester M.Sc Degree Examination – Model Question Paper

Branch -Environmental Sciences

ES 243. Environmental Policies and Laws

Time: 3 Hours **Max Marks: 75**

I. **Write short note on any ten of the following**:
(10x2= 20 marks)

1. Our Common Future
2. Kyoto Protocol
3. The Factories Act
4. Agenda 21
5. Eco mark
6. The Wild Life Protection Act
7. Environmental Policy in ancient India
8. Appiko Movement
9. Ecotourism
10. Rio+5
11. Environmental policy resolution
12. Polluter Pays Principle

II. **Answer any five of the following**:
(5x5= 25 marks)

13. Explain the different strategies of formal and non-formal methods that can be employed in the field of Environmental Education.
14. Role and Functions of Central and state pollution control boards.
15. The Air Act 1981.
16. Comment on any one trans-boundary river basin issue in India.
17. The Biodiversity Act 2002.
18. Write a short note on Anti Pollution Acts.
19. What are the concepts and principles of Environmental Education? What are its benefits?

IV. **Answer any three of the following**:
(3x10=30 marks)

20. Explain the role of UN authorities in protection of global environment.
21. Sustainable Development - Concepts, Indicators and Models.
22. International and National Conservation Agencies.
23. Explain major strategies of Environmental education.

M Sc ENVIRONMENTAL SCIENCES

IV Semester Practical Examination

ES 244 – Waste Management, Impact Assessment and Disaster Management

Time: **4 hrs** Max. Marks: **75**

I. Explain Vermi-composting technique/ Biogas production from waste

[**10 marks**]

II. Describe the operating units of Activated Sludge Process. From the given operational data for a conventional activated sludge treatment, describe the following:
   a. Aeration period
   b. F/M ratio
   c. Efficiency of BOD removal
   d. Sludge age

The operational parameters are:

1. Waste water flow = 40000 m^3/day
2. Volume of aeration tank = 10900 m^3
3. Influent BOD = 300 mg/L
4. Effluent BOD = 23 mg/L
5. Mixed Liquor Suspended Solids = 35 mg/L
6. Effluent Suspended Solids = 35 mg/L
7. Waste Sludge Suspended Solids = 9700 mg/L
8. Quantity of Waste Sludge = 230 m^3/day

[**10+2.5+2.5+2.5+2.5)=20 marks**]

III. Explain the EIA procedure involved in a hydroelectric/ highway/ mining project

[**10 marks**]

IV. Prepare a disaster management plan with respect to Flood/ Tsunami/ Landslide

[**10 marks**]

V. Field Report

[**20 marks**]

VI. Practical Record

[**5 marks**]

****