File Ref.No.39360/Ac A IV/2023/UOK

UNIVERSITY OF KERALA

(Abstract)

Revised Outcome based Syllabus for M.Sc. Programme in Environmental Science with effect from 2023 admissions - approved - orders issued - reg.-

Ac A IV

5687/2023/UOK Dated: 27.06.2023

Read:-1. Item No.IV.(I)I. of the minutes of the Faculty of Applied Sciences and Technology held on 14/03/2023.

2. Item No. II.xi. of the minutes of the Academic Council held on 25/05/2023.

ORDER

The Academic Council vide paper read as (2) above , approved the Revised Outcome based Syllabus for the M.Sc. Environmental Science Degree Programme with effect from 2023 admission, as recommended by the Board of Studies in Environmental Sciences and as endorsed by the Faculty of Applied Sciences and Technology vide paper read as(1)above

A copy of the respective syllabus is appended.

Orders are issued accordingly.

MAYA DEVI C.B

DEPUTY REGISTRAR
For REGISTRAR

To

To

1. Chairman , BoS in Environment Science
2. Dean , Faculty of Applied Sciences and Technology.
3. PA to CE/ Registrar
4. PS to V.C / P.V.C
5. Principals of Affiliated Colleges where M.Sc. Environmental Science
6. University Library
7. Tabulation section
8. AR/ DR/ JR (Academic)
9.AR/ DR/ JR (Exam)
10. PRO for uploading scheme and syllabus in the website.
11..Stock file / File copy.

Forwarded / By Order
Sd/-
Section Officer

UNIVERSITY OF KERALA

OUTCOME BASED SYLLABUS FOR MSc PROGRAMME IN

ENVIRONMENTAL SCIENCES FOR COLLEGES

AFFILIATED TO UNIVERSITY OF KERALA

WITH EFFECT FROM 2023

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

Course code	Title of Course	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
ES511	ENVIRONMENTAL BIOLOGY AND ECOSYSTEM DYNAMICS	90+72	5	4	3 hrs	25	75	100
ES512	ENVIRONMENTAL GEOLOGY	90+72	5	4	3hrs	25	75	100
ES513	NATURAL RESOURCES AND ENERGY MANAGEMENT	90+36	5	4	3 hrs	25	75	100
ES514	PRACTICAL I	180			4	25	75	100

SEMESTER II

Course code	Title of the Course	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
ES521	ENVIRONMENTAL CHEMISTRY	90+72	5	4	3	25	75	100
ES522	ENVIRONMENTAL TECHNIQUES AND RESEARCH METHODS	90+72	5	4	3	25	75	100
ES523	ENVIRONMENTAL POLLUTION AND TOXICOLOGY	90+36	5	2	3	25	75	100
ES524	PRACTICAL II	180			4	25	75	100

SEMESTER III

Course code	Title of the course	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

ES531	REMOTE SENSING AND GIS	90+36	5	2	3	25	75	100
ES532	ENVIRONMENTAL GENETICS, MICROBIOLOGY AND BIOTECHNOLOGY	90+72	5	4	3	25	75	100
ES533	ENVIRONMENTAL METEOROLOGY AND CLIMATE CHANGE	90+36	5	2	3	25	75	100
ES534	PRACTICAL III	144			4	25	75	100
ES535	PROJECT	36		2				

SEMESTER IV

Course code	Title of Course	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
ES541	ENVIRONMENTAL ENGINEERING AND WASTE MANAGEMENT	90+36	5	2	3	25	75	100
ES542	ENVIRONMENTAL IMPACT ASSESSMENT, DISASTER MANAGEMENT AND SUSTAINABLE DEVELOPMENT	90+36	5	2	3	25	75	100
ES543	ENVIRONMENTAL ECONOMICS, POLICIES AND LAWS	90	5		3	25	75	100
ES544	PRACTICAL IV & STUDY TOUR	72			4	25	75	100
ES535	PROJECT WORK	108		6				100
ES545	COMPREHENSIVE VIVA-VOCE & INTERNSHIP							100
TOTAL								**1800**

PROGRAMME SPECIFIC OUTCOMES OF MSC IN ENVIRONMENTAL SCIENCES

PSO NO.	PSO NAME	PSO
PSO 1	Academic Competence	Articulate the interdisciplinarity of Environmental Sciences and appreciate the interconnectedness of Environment in various other Science and Art subjects and to explain the laws of earth and nature to explain unique occurrences
PSO 2	Professional Competence	Work in various fields such as Effluent Treatment Plants of various Industries/Companies/Factories, Municipal Councils/Corporations, Central Pollution Control Board, State Pollution Control Boards, National Research Institutes/Organizations/Laboratories, NEERI, EIA, GIS, Environmental Monitoring Projects and as Environmental Consultants
PSO 3	Research Competence	Take up individual Science, Technology and Environmental Projects and perform environmental pollution control technologies and take appropriate measures for pollution control and to undertake individual research in various aspects of environment
PSO 4	Critical Thinking	Analyse the problems which lead to environmental deterioration and perform environmental management activities
PSO 5	Societal Commitment	Translate the theoretical and practical knowledge acquired to prevent disasters and alleviate the aftereffects in case of occurrence, solve issues of pollution and take mitigatory measures for climate change
PSO 6	Problem Solving Skills	Develop and strategize action plans to solve the problems based on social and environmental awareness
PSO 7	Environmental Analysis	Demonstrate environmental monitoring skills, including conduct of experiments and data analysis and practice these and perform environmental management activities in tune with principles of sustainability
PSO 8	Scientific Communication	Communicate principles of environment and the state-of-the science principles of environment to scientific and layman community
PSO 9	Managerial Skills	Formulate a successful Environment, Disaster and Industrial Safety Management Plan
PSO 10	Ethics and Values	Exhibit environmental ethics, academic ethics and research ethics avoiding scientific misconduct, plagiarism and violation of IPR

SEMESTER I

ES 511: ENVIRONMENTAL BIOLOGY AND ECOSYSTEM DYNAMICS

Total Hours: 90

OBJECTIVES:

- 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 environment
- To explore the role of ecological communities and its interaction.

COURSE DESCRIPTION:

The main objective of this course is to evolve effective management and conservation strategies of natural and manmade ecosystems and to understand 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, field-based and lab-based sessions. The course introduces the students to topics related to biomes and habitats, ecosystem dynamics, the evolution of ecosystems, ecological interactions, population dynamics and limiting factors of the environment.

COURSE OUTCOMES

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Describe the structure and functions of various ecosystems	Re ad Un
CO 2	Explain core concepts of community ecology and identify the stage of ecosystem development	Re, Un and Ap
CO 3	Describe the interactions of organisms with others and their ecosystem and its significance, also predict prey-predator interactions using Lokta-Volterra Model	Un and Ap
CO 4	Reflect critically on concepts of populations and their structure and function	Ap and An
CO5	Explain the concept of Limiting Factors, and the laws associated with it, and also describe the principles of Ecoinformatics	Ev

PRE-REQUISITE:

1. The students should have a basic knowledge of the Environment and its components
2. The students should have an idea about concept and scope of Environmental Science
3. The students should have knowledge about the basic concepts of environmental biology, ecosphere, biosphere, ecological factors, and variables.

COURSE CONTENT

MODULE I: **Structure and functions of ecosystem**

Ecosystem Dynamics: Introduction – Concepts, characteristics, kinds and structure, ecosystem functioning – food chain, food web, pyramids of numbers, biomass, energy, inverted pyramids, Ecological energetics – Solar energy and photosynthetic production, the efficiency of energy capturing, chemosynthesis, Energy flow - features of energy flow (unidirectional flow and loss of energy as heat) and pathways of energy flow, ecological efficiency. Productivity - primary production and production efficiency, secondary production, standing crop. Classification of ecosystems based on energy input (natural unsubsidized and subsidized solar-powered ecosystems, human subsidized solar powered ecosystems and fuel-powered urban and industrial systems.

Classification of biomes – Terrestrial biomes, tundra, taiga, grasslands, deserts, evergreen and deciduous forests, tropical rain forests and their characteristics– flora and fauna.; Classification of aquatic habitats – lentic and lotic, – freshwater- ponds, rivers, lakes, wetlands – their characteristics, flora and fauna: marine, marine habitats – pelagic, benthic, inter-tidal estuarine, mangroves.

(30 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:

MO1: Explain the structure of the ecosystem, including the organisms and physical features of the environment (Re)

MO 2: Illustrate the energy flow in an ecosystem (Un)

MO 3: Develop a deeper understanding and explain the complex interactions within biomes (Ap)

MODULE II: Community Ecology

Ecotone and concept of edge effects, Concepts of Habitat, Niche and Guild- Habitat, microhabitat and niche, different types of niches: spatial niche, trophic niche, species niche, multidimensional niche, fundamental and realized niche, Niche segregation, Evolution – succession concept; primary and secondary succession; allogenic and autogenic succession, theories of succession.

(12 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:

MO1: Differentiate the concepts of habitat, niche and guild (Re)

MO 2: Explain different types of niche with examples (Re)

MO3: Describe ecological succession as an important aspect for the growth and development of an ecosystem (Re and Ap)

MODULE III: Ecological interactions

Positive, negative and neutral: Neutralism, symbiosis, commensalism, mutualism, antagonism, antibiosis, parasitism, predation, competition – intra specific and inter

specific; temporal and spatial dynamics of interactions, ecological and environmental significance of interactions, Prey Predator relationship, Lotka – Volterra model.

(10 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:

MO1: Identify the species and community to which that organism belongs and interacts with the ecosystem and other organisms (Un)

MO 2: Explain the relationship between species in communities (Un)

MO 3: Define a relationship that is mutually beneficial/ harmful to the involved parties (Re)

MODULE IV: 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 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:

MO1: Comment on population size and distribution (Un)

MO2: Describe why populations change in size and structure over time (Un)

MO3: Determine the age structure of the population and adaptive information the population possesses (Ap)

MODULE V: **Limiting factors of the environment**

Limiting factors- Biotic and abiotic, density-dependent and density-independent, physical and biological - Concept of the law of limiting factors– laws of minimum and tolerance, combined concept of limiting factors, Liebig's and Shelford's law. Eco-informatics: Concepts, principles and applications.

(12 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:

MO1: Write about limiting factors that keep a population's numbers from growing out of control (Re)

MO2: Explain biotic and abiotic limiting factors (Re)

MO3: Discuss the science of information in ecology and environmental science through Eco-informatics (Un)

MODULE VI: 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.

Concepts of Urban ecology, Restoration ecology, Chemical ecology and Industrial ecology.

(11 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:

MO1: Understand the biogeochemical cycles which are focused on how certain natural chemicals are cycled within the living and non-living aspects of organisms and Earth (Un)

MO 2: Discuss the impact of anthropogenic activities on biogeochemical cycles (Ap)

MO 3: Comment on the terms Urban ecology, Restoration ecology, Chemical ecology and Industrial ecology (Re)

LEARNING APPROACHES:

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

EXPECTED COMPETENCY/ LEARNING OUTCOME:

- Students should be able to appreciate the environment and its components and functions.
- Students should be aware of the natural and anthropogenic changes in the 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. 6
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. Clarke, C.L. (1978). Elements of Ecology. John Wiley & Sons,
8. Freedman, B. (1989). Environmental Ecology, Academic Press,
9. Sharma P. D. (1996). Environmental Biology, Rastogi Publications, Meerut.
10. Verma P.S. and V.K. Agarwal. (1985). Principles of Ecology. S. Chand and Company (Pub.), New Delhi.
11. Bhatia A L. (2013). Text Book of Environmental Biology, I K International Pvt Ltd
12. Mathew R Fisher. (2018). Environmental Biology. Open Oregon educational Resources
13. Meetu Gupta. (2020). Fundamentals of Environmental Biology. Wiley India
14. Sharma B. M. (2011). Recent Progress in Environmental Biology. Oxford Book Company
15. Brewer R. (1994), The Science of Ecology, Saunders College Publishing, New York.

16. Michael P. (1990). Ecological methods for Laboratory and Field Investigations, Tata McGrew Hill Publishing Company Ltd, NewDelhi.

ES 512: ENVIRONMENTAL GEOLOGY

Total Hours: 90

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 studying 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 ways human activities have affected the planet. After the end of the course, students will have a solid understanding of currently occurring and historical geologic events, such as past earthquakes and floods. The course provides a challenging and stimulating environment using a mixture of class, laboratory, practical and field-based teaching with a focus on vocational and transferable skills to maximize student's career opportunities.

COURSE OUTCOMES

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Describe the basic geological concept, principles and theories related to the formation of the earth	Re and Un
CO 2	Present Ideas about the Geochemical classification of materials present on the earth's surface	Un and Ap
CO 3	Explain the concepts of Coastal geomorphology and river basins	Ap and An
CO 4	Interpret groundwater pollution and work on finding probable solutions	Ap and An
CO 5	Analyze Geological hazards with respect to previous instances and frame disaster management and watershed management strategies. Design and perform experiments in the lab to demonstrate the concepts, principles and theories learned in the classroom	Ap and An
CO 6	Interpretation of maps from field-based data and toposheets available. Give presentations using scientific literature and reference information sources effectively	An and Ev

PRE-REQUISITE:

1. The students should have a basic knowledge of the origin and evolution of earth; Evolution of human settlement, Origin of life and Speciation.
2. The students should be aware of the disasters related to earth and climate change issues.

COURSE CONTENT:

MODULE I: Introduction

Definition and relevance of environmental geology. Geological Time Scale; Anthropocene, Plate Tectonics – Sea floor spreading and continental drift; Forces acting on the surface of the earth – tectonic and diastrophic forces. Physiographic features of India – Peninsula, Extra-peninsula, Indo-Gangetic plain; major rivers, Koppen's climatic classification of India. recent views of origin of Himalayan mountains

(10 hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Understand the scope of environmental geology (Re)
MO2: Articulate and interpret geologic time scale (Re)
MO3: Understand the concept of plate tectonics (Re)
MO4: Know about the forces acting on earth (Un)
MO5: Gain an overall understanding of the Physiographic features of India (Un)
MO6: Evaluate the recent views of origin of Himalayan mountains (Ev)

MODULE II: Minerals and Rocks:

Definition of mineral; Physical properties of minerals; Brief overview of formation; forms, textures, structures, classification of Igneous, sedimentary and metamorphic rocks. Study of Interior of Earth: based on seismic waves: Crust, mantle and core. Earth's Surface Process: Geodiversity, Weathering of rocks – physical, chemical and biological; Erosion, transportation and deposition of earth's materials by water, wind and glaciers. Glaciers: Physical and chemical aspects; Recession of Himalayan glaciers; Glaciers as an index of climate change

(20 hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Articulate and distinguish minerals and rocks (Un)
MO2: Understand physical properties of minerals (Un)
MO3: Articulate and evaluate basic rock types and its Weathering (An)
MO4: Articulate and exemplify basic knowledge in mineral resources (Un)
MO5: Compare and contrast about the layers of interior structure of earth (Ev)
MO6: Develop an overall understanding of erosion, transportation and deposition of earth's materials (Un)

MODULE III: Coastal Geomorphology:

Coastal environment, coastal Processes and landforms, behavior of ocean waves, tides, longshore currents, and their role in coastal zone. Coastal erosion – causes and mitigatory measures. Marine resources – minerals and energy, coral reefs. Brief overview of Coastal Regulation Zone (CRZ) in India. River Basin Concept: 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 in river basin

(10 hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Understand the coastal geomorphology (Un)
MO2: Articulate and evaluate the mitigatory measures of coastal erosion (Un)
MO3: Articulate and evaluate Marine resources (An)
MO4: Articulate and exemplify an overview of Coastal Regulation Zone (Un)
MO5: Compare and contrast about the layers of interior structure of earth (Ev)
MO6: Develop an overall understanding of River Basin Concept and Evaluate the Watershed management and Flood control measures (Un and Ev)

MODULE IV: Groundwater:

Source, occurrence and movements of groundwater; Water Table; Aquifer, Aquiclude, Aquitard and Aquifuge; Aquifer types; Factors influencing Water table fluctuations – environmental influences, evapo-transpiration, meteorological phenomenon, urbanization. Artificial recharge methods- Rainwater harvesting techniques and groundwater recharging methods. Quality criteria of groundwater for drinking and irrigation purpose. Groundwater contamination- sources and management options

(15 hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Describe various aspects of groundwater (Re)
MO2: Identify various groundwater bearing formations (An)
MO3. Critically discuss Artificial recharge methods (Ev)
MO4: Compare and contrast Quality criteria of groundwater (An)
MO5. Articulate basic knowledge of Groundwater contamination (Un)
MO6: Evaluate ground water management options and applications (Ev)

MODULE V: Geological Hazards:

Earthquakes – causes, effects, distribution and prediction; Volcanoes –distribution, products of volcanic eruptions and their environmental impacts; Landslides – slope stability, factors affecting slope stability, causes, effects and prevention of landslides; Tsunami – causes, characteristics, effects; Avalanches – causes, types, effects. Cyclones - causes and effects. Prepare case studies in each category- Participatory Action Learning

(20 hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Articulate and critically evaluate science of earthquake and its management options (Un and Ev)
MO2: Articulate and critically evaluate science of volcanoes (Un and Ev)
MO3: Articulate and critically evaluate Landslide hazard (Un and Ap)
MO4: Articulate and critically evaluate tsunami (Un)
MO5: Articulate and critically evaluate Cyclones (Un)
MO6: Critically evaluate major disasters in India (Un and Ap)

MODULE VI: Maps:

Topographic maps and Geologic maps in Environmental Studies. (Need to add activity sessions). Impact of anthropogenic activities such as urbanisation, mining, river-valley projects on water resources. Environmental impacts of mining and various mitigatory measures. Concept of sea water intrusion in the coastal area and management options

(15 hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Articulate and critically evaluate the use of topographic maps and Geologic maps (Un and Ev)
MO2: Articulate and critically evaluate Impact of anthropogenic activities (Un and Ev)
MO3. Articulate and critically evaluate Environmental impacts of mining (Un and Ap)
MO4: Critically evaluate mitigatory measures of mining (Un)
MO5: Articulate and critically evaluate sea water intrusion (Un)
MO6: Critically evaluate major management options of sea water intrusion (Un and Ap)

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 513: NATURAL RESOURCES AND ENERGY MANAGEMENT

Total Hours: 90

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.

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Identify and list out soils based on their characteristics and suggest and describe reclamation techniques for problem soils	Re, Un and Ap
CO 2	Describe the major forest types of India with special reference to Kerala and discuss the forest conservation activities	Re, Un and An
CO 3	Describe biodiversity, its threats and conservation strategy and suggest a suitable conservation strategy for peculiar ecosystems	Re, Un, An and Ap
CO 4	Discuss the water budget as well as major water resources of India with special reference to Kerala and suggest management and conservation strategy for water resources	Re and Ap
CO 5	Discuss the sources and classification of energy resources and describe the environmental impact of their use	Re and Un
CO 6	Define and discuss energy audit and conduct and record energy audit of household/ institutional setup	Re, Un, An and Ap

PRE-REQUISITE

1. The students should have a thorough understanding on the concepts of natural resources and their major types
2. The students should have a background knowledge of forest products – NWFP and WFP
3. The students should have a thorough understanding on Water resource: types – surface water, ground water; water availability and uses
4. The students should have an understanding about fossil fuels, their energy

content, its use and the impacts of the over use of it

COURSE CONTENT:

MODULE I: Soil and mineral resources:
Major soil types and mineral deposits of India with special reference to Kerala; acidic, alkaline and saline soils – reclamation techniques.

(10 Hours)

MODULE OUTCOME

After learning this module, students should be able to:
MO 1: List out the soil types of India and Kerala (Re)
MO 2: Describe the various problem soils such as acidic, alkaline and saline soils (Un)
MO 3: Identify and suggest reclamation techniques for chemical problem soils (Un)

MODULE II: Forest resource:
Major Forest types in India with special reference to Kerala, Social forestry – multipurpose tree species, Nitrogen fixing tree species, community participation; agro forestry – concept and scope; eco-restoration; indigenous people, their ethnic knowledge and its conservation with a case study
Role of youth in conservation of forest – Participatory Action Learning (only for Continuous Evaluation)

(15 Hours)

MODULE OUTCOME

After learning this module, students should be able to:

MO 1: List out the major forest types in India with special reference to Kerala (Re)
MO 2: Discuss the social forestry practices (Un)
MO 3: Monitor and record the practices of indigenous people and their ethnic knowledge and make an inventory of those (Cr)

MODULE III: Biodiversity and its conservation:
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.
Strategies for biodiversity conservation; global agreements and national concerns; Ramsar sites, Convention on Biological Diversity (CBD); protection of wildlife – role of WWF, WCU, CITES, TRAFFIC, sustainable utilization.
Explore the biodiversity of Mangrove/ sacred grove/Miyawaki forest – Participatory Action Learning (For continuous Evaluation)

(20 Hours)

MODULE OUTCOME

After learning this module, students should be able to:

MO 1: Define biodiversity and discuss the various types of biodiversity and the importance of biodiversity (Un)
MO 2: Define terms such as hotspots of biodiversity, endemism and gene pool (Re)
MO 3: Identify and describe the threats to biodiversity with special reference to vulnerable, endangered, threatened and extinct species (Un)
MO 4: Describe the biodiversity of Western Ghats and discuss Gadgil and Kasthurirangan committee reports (Ev)

MO 5: Write an essay on the various strategies for biodiversity conservation (Un)
MO 6: Make an inventory of biodiversity of selected ecosystems (Cr)

MODULE IV: Water resource:

Water budget – global and regional, Major water resources of India with special reference to Kerala, impact of climate change on fresh water resources, management and conservation of water resources. Blue Carbon ecosystem; Wetland restoration with case studies

(15 Hours)

MODULE OUTCOME

After learning this module, students should be able to:

MO 1: Define and explain global and regional water budget (Re)
MO 2: List out the major water resources of India with special reference to Kerala (Re)
MO 3: Write an essay on impact of climate change on fresh water resources, management and conservation of water resources (Un)
MO 4: Discuss blue carbon ecosystem (Re)
MO 5: Discuss wetland restoration with a case study (Ap)

MODULE V: Energy resources: sources of energy and their classification; Impact of conventional energy use on the environment
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.
Hydrogen fuels – Green hydrogen, yellow hydrogen, pink hydrogen Energy efficiency concept

(20 Hours)

MODULE OUTCOME

After learning this module, students should be able to:

MO 1: Describe the sources of energy and their classification (Re)
MO 2: Discuss the impact of conventional energy use on the environment (Un)
MO 3: Write an essay on the various non-conventional energy sources with their harnessing techniques (Re)
MO 4: Explain Hydrogen fuels (Re)

MODULE VI: Energy Audit
Conduct energy audit of household/institutional set up (Participatory Action Learning – For continuous Assessment)

(10 Hours)

MODULE OUTCOME

After learning this module, students should be able to:

MO 1: Define energy audit (Re)
MO 2: Conduct and record energy audit of household/ institutional set up (Ap)

Learning approaches

- Learner centric – Preparation of flow charts and posters to study naturalresources.
- 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 EnergyResources (eg: ANERT)
d) Collaborative – students should collect data on the use pattern of fossilfuels and its impacts

Expected competency/ Learning outcomes:

- Helps to develop Skills in recognizing and solving environmental andsocial 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 514: PRACTICAL – 1
ENVIRONMENTAL BIOLOGY AND GEOLOGY

Total Hours: 180

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Identify the ecologically significant flora and fauna of various environment as well as phyto- and zoo-plankton and comment on their uniqueness in the ecosystem	Un, An
CO 2	Estimate the phyto- and zoo-plankton concentration in water bodies	Ap
CO 3	Estimate the primary productivity of a waterbody	Ev
CO 4	Analyze DO and BOD of waterbody	Ap
CO 5	Estimate the frequency, density and abundance of flora and fauna	Ap
CO 6	Identify rocks and minerals specimens, identification of common minerals and rocks. Gaining skill for reading a toposheet.	An
CO 7	Analyze and calculate the energy output of solar/ windmill and explain the working principle	Ev

1. Identification of ecologically significant flora and fauna (5 each) of terrestrial, freshwater and marine ecosystems with their systematic position.

   (25 Hours)
2. Identification of phytoplankton and zooplankton (either freshwater or marine)

   (25 Hours)
3. Quantitative estimation of Phytoplankton by Lacky's Drop Method

   (10 Hours)
4. Quantitative estimation of Zooplankton by Sedge wick - Rafter Cell Method

   (10 Hours)
5. Analysis of DO and BOD in water samples

   (10 Hours)
6. Estimation of primary productivity – Light and Dark bottle method – effects of depth and light

   (10 Hours)
7. Floral / Faunal community study by Quadrat method – estimation of frequency, density and abundance

   (25 Hours)

8. Floral / Faunal community study by Line Transect method – estimation of frequency, density and abundance

(25 Hours)

9. Field visit and reporting of solar power plant

OR

Field visit and reporting of windmill

(10 Hours)

10. Moh's Scale of Hardness

(10 Hours)

11. Megascopic identification of rock-forming minerals and ore minerals, and rocks.

(15 Hours)

12. Topographic Map Symbols, reading latitude and longitude of a grid and identification of features in a given topo sheet grid.

(5 Hours)

First Semester M Sc Degree Examination
Model Question Paper Branch -Environmental Sciences
ES 511 ENVIRONMENTAL BIOLOGY AND ECOSYSTEM DYNAMICS

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

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

1. Ecological Niche (TL 1; CO 1: 60%; CO 2: 40%)
2. Commensalism (TL 1; CO 1: 30%; CO 2: 70%)
3. Age Structure (TL 1; CO 1: 30%; CO 2: 70%)
4. Allogenic Succession (TL 1; CO 1: 30%; CO 2: 70%)
5. Life table (TL 1; CO 1: 60%; CO 2: 40%)
6. Antibiosis (TL 1; CO 3: 100%)
7. Ecoinformatics (TL 1; CO 5: 100%)
8. Sedimentary cycles (TL 1; CO 3: 100%)
9. Food web (TL 1; CO 1: 30%; CO 2: 70%)
10. Biome (TL 1; CO 1: 100%)
11. Edge effect (TL 1; CO 1: 100%)
12. Biotic Potential (TL 1; CO 1: 100%)

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

13. State and critically evaluate some of the impacts of man on nutrient cycles. (TL 3; CO 3: 100%)
14. Comment on Terrestrial biomes and analyze the factors responsible for its sustenance. (TL 4; CO 1: 100%)
15. What are the characteristics of inter-tidal ecosystems? (TL 3; CO 1: 100%)
16. Briefly explain ecological pyramids. (TL 2; CO 1: 100%)
17. Short note on Prey-predator relationship (TL 2; CO 3: 100%)
18. Combined concept of Leibig's and Shelford's Laws. (TL 3; CO 5: 100%)
19. Critically analyze and write a short note on factors of population regulation. (TL 4; CO 1: 100%)

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

20. Comment on Ecological Interactions with a critical perspective. (TL 4; CO 3: 100%)
21. What is ecosystem Development? What are the types and theories of Succession? (TL 2; CO 2: 100%)
22. Write an essay on Marine, Estuarine and Mangrove habitats with reflection on their role in the sustenance of earth. (TL 3; CO 1: 100%)
23. Write an essay on the classification of wetlands and mention the importance of wetlands. (TL 3; CO 1: 100%)

First Semester M Sc Degree Examination
Model Question Paper Branch -Environmental Sciences
ES 512 ENVIRONMENTAL GEOLOGY

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

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

1. Diastrophic forces (TL 1; CO 1: 100%)
2. Horton's stream classification (TL 2; CO 3: 100%)
3. Sea floor spreading (TL 1; CO 1: 100%)
4. Tectonic movements (TL 1; CO 1: 100%)
5. Run up and drawback (TL 2; CO 5: 100%)
6. Cation exchange capacity of soil (TL 1; CO 2: 100%)
7. Drainage basin (TL 2; CO 3: 100%)
8. Global water balance (TL 3; CO 3: 100%)
9. Mantle of Earth (TL 2; CO 1: 60%, CO 2: 40%))
10. Minerals (TL 2; CO 2: 100%)
11. Sedimentary rock (TL 2; CO 1: 40%; CO 2: 60%)
12. Tsunami (TL 3; CO 5: 100%)

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

13. Explain the origin and evolution of earth highlighting your perception on the theories (TL 4; CO 1: 100%)
14. List the factors affecting soil formation (TL 2; CO 2: 100%)
15. Brief the internal structure of the earth (TL 3; CO 1: 40%; CO 2: 60%)
16. What are the factors affecting slope stability and reflect on the disasters caused due to its failure in recent times. (TL 4; CO 5: 100%)
17. Folds and faults (TL 2; CO 2: 100%)
18. Radar and satellite analysis of precipitation (TL 3; CO 5: 100%)
19. How landslides can be prevented? Explain with real life situation mentioning as examples. (TL 4; CO 5: 100%)

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

20. Write the uses of topographic and environmental geologic maps in environmental studies. (TL 2; CO 6: 100%)
21. Causes, effects and control measures of earthquakes and volcanic eruptions (TL 3; CO 5: 100%)
22. Give an account of the formation, forms, textures and structures associated with sedimentary rocks. (TL 2; CO 2: 100%)
23. Describe the impact of mining. Comment on the various mitigation measures. (TL 4; CO 5: 100%)

First Semester M Sc Degree Examination
Model Question Paper Branch -Environmental Sciences
ES 513 NATURAL RESOURCES AND ENERGY MANAGEMENT

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

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

1. NFTs (TL 1; CO 2: 100%)
2. Geothermal energy (TL 2; CO 5: 100%)
3. Mining (TL 1; CO 3: 100%)
4. TRAFFIC (TL 1; CO 3: 100%)
5. Gene pool (TL 2; CO 3: 100%)
6. Jhum land (TL 2; CO 2: 100%)
7. Preservation plots (TL 2; CO 3: 100%)
8. Photovoltaics (TL 2; CO 5: 100%)
9. Impact of climate change on water resources (TL 2; CO 4: 100%)
10. Sodic soil (TL 2; CO 1: 100%)
11. Biopiracy (TL 2; CO 3: 100%)
12. Endemism (TL 2; CO 3: 100%)

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

13. How wind energy can be harnessed? (TL 3; CO 5: 100%)
14. Composition of fossil fuels with their effects on the environment. (TL 4; CO 5: 100%)
15. Major soil types in India. (TL 2; CO 1: 100%)
16. Impact of climate on biodiversity. (TL 4; CO 3: 100%)
17. Impact of land use change on the Environment. (TL 3; CO 1: 40%; CO 3: 60%)
18. What are the reclamation techniques done for saline soils? (TL 3; CO 1: 100%)
19. Comment on different agroforestry practices. (TL 3; CO 2: 100%)

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

20. Write a note on concept, objectives, planning and measures adopted in watershed management. (TL 4; CO 4: 100%)
21. Briefly explain (TL 2; CO 3: 100%)
    i. Ramsar sites
    ii. The Biological Diversity act
    iii. Biosphere reserves
22. Natural Resources and their direct and indirect values. (TL 4; CO 1: 40%; CO 3: 60%)
23. Explain social forestry with particular reference to community participation. (TL 4; CO 2: 100%)

M Sc ENVIRONMENTAL SCIENCES
I Semester Practical Examination
ES 514 ENVIRONMENTAL BIOLOGY AND GEOLOGY

Time: 4 Hours **Total Marks: 75**

1. Identify and comment on the ecological significance and systematic position of A, B & C (Any flora/fauna of terrestrial, fresh water and marine) (TL 4; CO 1: 100%)

[(1 +2+2) 3 = 15 marks]

1. Write briefly the texture and mineralogical aspects of the given rock samples (D & E). Give brief note on their mode of origin (TL 4; CO 6: 100%)

[(1+ 1 + 1 + 2) 2 = 10 marks]

2. Write down the diagnostic physical properties of the given mineral specimens (F & G) and identify their name. Give brief note on their uses (TL 4; CO 6: 100%)

[(1+2½ +1½) 2= 10 marks]

3. Represent Mohs scale of hardness with for the given sample (TL 4; CO 6: 100%)

[(2+3) = 5 marls]

4. Identify with diagrams any two phyto/zooplankton (H & I) from the given sample. Give reasons (TL 4; CO 2: 100%)

[(1+ 2+2)2 = 10 marks]

5. Quantitatively estimate the abundance of phyto/zooplankton using Lackey's Drop Method (TL 4; CO 2: 100%)

OR

Quantitatively estimate the abundance of phyto/zooplankton using Sedgewick Rafter Cell Method (TL 4; CO 2: 100%)

[(1+2+2)2 = 5 marks]

6. Calculate the frequency, density and abundance of the given area J using the quadrate method (TL 4; CO 4: 100%)

OR

Calculate the energy output of wind mill/solar panel using the data given below (TL 5; CO 7: 100%)

[15 marks]

7. Practical Record

[5 marks]

SEMESTER II

ES 521: ENVIRONMENTAL CHEMISTRY

Total Hours: 90

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.

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Describe the structure and chemistry of the atmosphere and the problems which affect the normal state of the atmosphere	Re, Un and An
CO 2	Explain the chemistry and composition of sea and freshwater and discuss the various chemical qualities of water resources	Re and Un
CO 3	Describe the composition, physical and chemical properties of soil and the formation and profile of soil	Re and Un
CO 4	Write essays on various aspects of pesticides, non-pesticide organic compounds and heavy metals	Re and Un
CO 5	Describe radioactivity, nuclear disasters and the environmental and health impacts of nuclear accidents	Re and Un
CO 6	Write an essay on the concept, goals and principles, applications, and limitations of green chemistry and discuss the green synthesis of selected materials	Re, Un and Ap

PRE-REQUISITE:

1. The students should have an understanding of the concept and scope of Environmental Chemistry
2. 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 ES511
3. The students should have an awareness regarding climate change, global warming and greenhouse gases.

4. Students should know soil formation and the classification of soil as they are part of previous papers.

COURSE CONTENT:

MODULE I: 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, Formation and composition of acid rain, oxidation of atmospheric SO_2

Ozone chemistry - Ozone depleting substances and ozone depletion, Green House Gases and Global Warming with case studies.

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

(20 Hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO 1: Describe the structure and composition of atmosphere (Un)
MO 2: Explain the chemistry of the troposphere (Re)
MO 3: List out ozone depleting substances (Re)
MO 4: Comment on Ozone depletion, Green House Gages and Global warming with case studies (Un)
MO 5: Define indoor air pollution and explain the sources, effects and the control measures (Un)

MODULE II: 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; Chloride; Silicate; Fluoride.

(15 Hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO 1: Explain the chemistry and composition of sea and freshwater (Re)
MO 2: Discuss the various chemical qualities of water resources (Un)

MODULE III: Soil Chemistry

Composition of soil; Soil profile; Pedogenesis; 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 Sodium Percentage (ESP); soil organic matter and organic carbon, NPK, micro and macro nutrients.

(10 Hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO 1: Write an essay on the composition of soil, soil formation and soil profile (Re)
MO 2: Explain the physical properties of soil (Re)
MO 3: Explain the chemical properties of soil (Re)

MODULE IV: 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. Dirty dozen.

Natural and Green Insecticides – sources, target insects; Integrated Pest Management Classification of common botanical insecticides based on chemotaxonomy (Participatory action learning – for internal assessment only)

Heavy metals – speciation and toxicity of heavy metals, bioaccumulation of heavy metals - case studies.

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

(20 Hours)

MODULE OUTCOME

After learning this module, students should be able to:

MO 1: Discuss the classification, structure, chemistry degradation and analysis of organochlorine, organophosphate and carbamate pesticides (Re)
MO 2: Explain Dirty dozen (Un)
MO 3: Write an essay on sources and target insects of natural and green insecticides (Re)
MO 4: Discuss and classify of botanical insecticides based on chemotaxonomy (Un)
MO 5: Write an essay on the speciation and toxicity of heavy metals and discuss on the bioaccumulation of heavy metals (Un)
MO 6: Discuss the sources, Structure and Impacts of selected non-pesticide organic compound (Re)

MODULE V: Radiation Pollution: Types of radiation; Units of radioactivity; detection and measurements of radioactivity; Radioactive nucleus decay; Radon from U^{238} decay sequence; Safety guidelines; Nuclear accidents and its health and environmental impacts - any two case studies

(10 Horus)

MODULE OUTCOMES

After learning this module, students should be able to:

MO 1: List out the types of radiations (Re)
MO 2: Discuss the units of radioactivity and the techniques for detection and measurement of radioactivity (Re)
MO 3: Describe the radioactive nucleus decay with radon from U^{238} decay sequence as example (Re)
MO 4: Discuss the nuclear safety guidelines (Un)
MO 5: Describe the health and environmental impacts of nuclear accidents with case studies (Un)

MODULE VI: Green Chemistry

Concept, goals and Principles, Applications, and Limitations.

Green Synthesis – Bioethanol/biodiesel, Healthier fat and oil, green nano particles, green solvent; Design a green synthesis using any one principle (Participatory Action Learning – For internal assessment)

(15 Hours)

Module outcome

After learning this module, students should be able to:

MO 1: Write an essay on the concept, goals and principles, applications, and limitations of green chemistry (Re)
MO 2: Discuss the green synthesis of selected materials (Un)
MO 3: Design a green synthesis using any one principle of green chemistry (Cr)

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 522: ENVIRONMENTAL TECHNIQUES AND RESEARCH METHODS

Total Hours: 90

OBJECTIVES:

- To introduce concepts of various environmental samples and sampling methods
- To give an introduction to modern methods in analytical techniques used in environmental analysis.
- To understand the basics of experimental design and acquire knowledge regarding various steps 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. It also provides hands on training in key analytical methods, data interpretation and various steps involves in environmental research. The advanced statistical methods and experimental methods helping the students to the interpretation of their research works in a scientific way.

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Enlist and explain the various steps involved in environmental sampling	Re &Un
CO 2	Describe the different analytical techniques and identify principles and their importance in applying environmental research	Re, Un & Ap
CO 3	Perform experiments and data analysis.	Un & Ap
CO 4	Analyze and determine the pollution status by using Environmental Analytical Techniques, Statistical Methods and Computational Techniques.	Ap & An
CO 5	Develop research methodology, collect data and carry out data analysis and interpretation for finding a suitable solution and acquire the ability to write the research findings in the form of structured thesis.	An & Ev
CO 6	Write dissertation in a scientific manner	Ev

PRE-REQUISITE:

1. Students should be able to enlist and explain the analytical techniques used by the environmental researchers for the analysis of environmental samples
2. Basic knowledge about various steps includes in the research project.

COURSE CONTENT:

MODULE I: Sampling and Sample Preparation

Sampling of air, water, soil and sediments - Types of Samples and Samplers: grab samples, composite samples, integrated samples; Sampling methods – manual sampling, automatic sampling, sorbent sampling; Sample collection, Preservation, storage and processing. Sampling types – simple random sampling, systematic

random sampling, stratified random sampling, representative sampling, ranked set sampling, adaptive cluster sampling; Sample collection equipment.

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.

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1 List out different types of environmental samples. (Re)
MO2 Describe various sample collection, preservation and storage for proper analysis. (Un)
MO3 To identify and describe the important methods and techniques involved in sampling. (Un)
MO4 Explain sample collection equipment (Un)

(20 Hours)

MODULE II: 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), Mass Spectrometry, Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Raman Spectroscopy, FTIR.

Module Outcomes:

After Completion of this module, the student should be able to:

MO1 Explain different types of instrumentation techniques in sample analysis (Un)
MO2 Explain the principles and environmental applications of various analytical techniques. (Re)
MO3 Apply knowledge of titrimetric methodologies in environmental analysis. (Ap)
MO4 Explain advanced analytical techniques involved in environmental research (Un)

(15 Hours)

Module 3: Separation Techniques

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

(10 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Describe principle and use of sedimentation and centrifugation (Un)
MO2: Communicate the principle and application of Electrophoresis (Un)
MO3: Describe different chromatographic methods and its applications (Un)
MO4: Explain the general principles governing chromatographic separations based on the interactions between analytes and stationary phase (Un)

MODULE IV: Biological Analysis

Microscopy- Phase contrast, Fluorescent and Electron microscopy –SEM and TEM, Isolation of DNA, 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

(15 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Describe different types of microscopy, their principles and instrumentation (Un)
MO2: Communicate the molecular techniques involved in microbial analysis (Un)
MO3: Compare advanced molecular techniques for the identification of microorganisms in the environment (Ap)
MO4: Comprehend biotechnological interventions on characterization of microbes (Un)

MODULE V: Statistical Methods and Computer Applications

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, Chi –square, One- and Two-way ANOVA.

MS Excel and its applications– Histogram, Bar Diagram, Box Plot, Frequency Polygon, Frequency Curve, Pie Diagram, Standard Deviation, Correlation and Regression.

(15 Hours)

Module Outcomes:

After Completion of this module, the student should be able to:

MO1: Explain the importance of statistical tools in data analysis (Un)
MO2: Describe different types of statistical measures to the interpretation of data (Un)
MO3: Demonstrate various statistical tools (Cr)
MO4: Communicate computational skills for enhancing the acquired knowledge from theory (Ap)

MODULE VI: Research Methods

Research methods: Objectives of research, Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical; Defining and formulating the research problem. Manuscript preparation and Thesis writing.
Literature review - Primary and secondary sources, Identifying gap areas from literature review - Development of working hypothesis.
Thesis writing - Structure and components of scientific reports - Layout, structure and Language of typical reports - Illustrations and tables - Bibliography, referencing and footnotes, publication in scientific journals – impact factor.

Research Ethics: Making presentation - Use of visual aids - Importance of effective communication. - Intellectual Property Rights (IPR) and patent law - Reproduction of published material - Plagiarism - Citation and Acknowledgement.

(15 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Explain the different types of research (Re)
MO2: Describe the ways in which writing the dissertation (Un)
MO3: Communicate the importance of maintaining ethics on research (Un)
MO4: To articulate report preparation, publication and citation (Cr)

Learning approaches:

- **Activity based** – students should engage in collection, preservation and storage of the environmental samples by using appropriate techniques

Expected competency/ Learning outcome:

- Students should be able to develop a practical skill to handle sophisticated instruments

RECOMMENDED READINGS

1. Alexander M.Mood and Franklin A Graybill (1963). Introdution to the theory of statistics.Mc Graw Hill book company, London
2. Donald, A.S.Fraser (1958).Statistics An Introduction,John coilley and sons,INC;London
3. Neelima Rajeridya and Dilip kumar Markandey. (2005). Environmental analysis and instrumentation. A.P.H. publishing corporation, New Delhi.
4. Pooja Bhagwan. (2005). A handbook of chemical analysis, International scientific publishing Academy, New Delhi
5. Clair N.Sawyer, Perry L. Mc carty and Gene F parkin, (2003). Chemistry for environmental engineering and science,Tata Mc –Graw-Hill publishing company Limited, New Delhi
6. Sivasankar B (2005). Bioseperceptions principles and Techniques,PHI learning private Limited,New Delhi
7. G.R.Chhatwal,M.C.Mehra,M.Satake,T.Katyal; Mohan Katyaland T.Nagahiro.(2014).Environmental analysis,Animol publications PT.LTD,NewDelhi
8. Bengt Nolting.(2004).Methods in Modern Biophysics,Sponger private Limited, India
9. Allen J. Bard and Lafrry R. Faulkner (2001). Electrochemical Methods, 2nd Ed., John Wiley & Sons.
10. APHA – AWWA- WPCF. (2012). Standard methods for the examination of water and waste water. Washington, D.C.
11. Barnett, Vic. (2006). Environmental Statistics: Methods and Applications, John Wiley and Sons, New Delhi.
12. Bender, G.T., W.K Saunders. (1972). Chemical Instrumentation. A Laboratory Manual based on Clinical Chemistry.
13. Christian Gary, D. (2001). Analytical Chemistry, 5th Ed. John Wiley & Sons, Inc. NY.
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15. De A.K. (1994). Environmental Chemistry. New Age International Ltd. New Delhi.

16. G.W. (1985). Instrumental Methods of Chemical Analysis, 5th Ed., Mc-Graw Hill Book Company.
17. Manly. (2001). Statistics for Environmental Science and Management, Chapman and Hall, CRC
18. Medhi, J. (1992). Statistical Methods, Wiley Eastern (Pub.), New Delhi.
19. Radojecic M. and Bashkin V.N. (2007). Practical Environmental Analysis. RSC Publishing, Cambridge.
20. Skoog D.A., F.J. Holler and Nieman, (2003). Principles of Instrumental Methods, 5th Ed., Thomson Asia Pvt. Ltd., Singapore.
21. Vogel A.I. (1999). Textbook of Quantitative Chemical Analysis, 5th Ed., Addison Wesley Longman Singapore Ltd.
22. Wayne R Ott. (1995). Environmental Statistics and Data Analysis, CRC Press.
23. Willard, Merritt, Dean, and Settle, (1986). Instrumental Methods of Analysis, 7th Ed., C B S Publishers & Distributors

ES 523: ENVIRONMENTAL POLLUTION AND TOXICOLOGY

Total Hours: 90

OBJECTIVES:

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

COURSE DESCRIPTION:

The 6 modules designed under this course will 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 management and their impact on environment and health are dealt with. Environmental Toxicology module is designed to provide an overview of environmental toxicants, with special emphasis to emerging pollutants of concern. This also includes 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.

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Identify and explain the various types and sources of air, water and soil pollution along with the local, regional and global implications of environmental pollution	Re, Un
CO 2	List the major emerging pollutants and their impacts on the environment	Re, Un, Ap
CO 3	Describe the health impacts of xenobiotic pollutants present in the environment.	Re, Un
CO 4	Explain the principles of toxicity and draw a dose-response curve.	Re, Un
CO 5	Explain the various occupational health hazards and set terms for occupational health and safety	Re, Un
CO 6	Analyse the environmental health risk assessment procedure using a case study	Re, Un. Ev, Ap

PRE-REQUISITE:

1. Students are expected to know the various environmental pollutants and contaminants.
2. Students should know the effects of pesticides in environmental components

COURSE CONTENT:

MODULE I: Introduction:

Pollution- definition, sources: point and non - point sources, cost of pollution, pollutants-classification of pollutants-primary and secondary; degradable and non -

degradable, types of pollution and their global, regional and local aspects -Air, Water, Soil, Thermal, Radiation and Noise Pollution.

(15 hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO 1: Explain the different types of pollution (Re)

MO 2: List out various sources of pollution (Re)

MODULE II: Pollutants and their effects

Air pollutants and its effects on flora and fauna; Sources of water pollutants and their contamination; Causes of Soil pollution; Effects of Fungicides and weedicides on soil components, residual toxicity and pollution. Synthetic fertilizers (N, P, K), and their interactions with different components of soil, their toxicity and pollution. Industrial effluents and their interactions with soil components, Contamination by radionuclides, adverse effects of noise pollution on human beings.

(14 hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO 1: Explain the air pollutants' effects on flora and fauna. (Un)
MO 2: List out the causes of soil pollution. (Un)
MO 3: Explain the effects of various pollutants in soil. (Re)
MO 4: Explain the contamination of radio nuclides. (Un)
MO 5: List out the adverse effects of noise pollution (Re)

MODULE III: Emerging Pollutants:

Emerging Pollutants - Concept, Classification of EPs, Types of EPs. Microplastics, Occurrence in surface water, ground water and sea water. Toxicity of Contaminants of Emerging Concern, Impact of CEC on the environment and in humans.

(10 hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO 1: Explain the emerging pollutants and their concept (Un)

MO 2: Discuss the classification and types of emerging pollutants and their occurrence in aquatic ecosystems. (Un)

MO 3: Discuss the impacts of CEC on the environment and human beings (An)

MODULE IV: 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 of toxicants to the environment; Ecotoxicology - fate and transport of toxicants in air, water and food chain, biotransformation, bioaccumulation & bio magnification, Trans-boundary pollutants and its effects.

(14 hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO 1: Explain the principles of toxicology (Re)
MO 2: List out the types of toxic substances (Re)
MO 3: Discuss the sources and entry routes of toxicants into the environment (An)
MO 4: Explain the fate and transport of toxicants in air, water and food chains (Un)
MO 5: Discuss the transboundary pollutants and their effects (Un)

MODULE V: Man and Environmental Toxins

Routes of toxicants to the human body, Xenobiotic translocation - translocation, ,mechanism of xenobiotic transfer-active and passive transport, ADME – Absorption, Distribution, Metabolism & Excretion; Toxicity testing-Acute and chronic toxicity; lethal and sub-lethal doses; Dose-Response relationship, toxicity tests- acute, sub-acute and chronic tests , LC50, LD50, MLD, MATC; Cumulative response; NOEL , Analysis of NOEL; - Carcinogens, mutagens & teratogens , Toxicity testing procedures

(17 hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO 1: Discuss the routes of toxicants into the human body (Un)
MO 2 : Discuss the mechanism of xenobiotic transfer (Un)
MO 3: Write an essay on the translocation of toxicants (Re)
MO 4: Comment on acute and chronic toxicity (Re)
MO 5: Describe the dose-response relationship (Un)
MO 6: Describe the toxicity tests(Un)
MO 7: Explain carcinogen, teratogen, and mutagens and its toxicity testing procedures (Re)

MODULE VI: Environmental Health and Safety

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-Emerging Diseases-Bacterial and viral diseases with case studies. Occupational Health-definition, scope, an overview of workplace health hazards, Occupational exposure of workers to pollutants and health effects, Occupational health and safety management systems, OHSAS-18000. Risk assessment-scope and importance, ecological risk assessment and human risk assessment, Environmental Health Risk Assessment (EHRA)-Activity Oriented

(20 hours)

MODULE OUTCOMES

After learning this module, students should be able to:
MO 1: Discuss the concepts, scope, and basic requirements for a healthy environment (Un)
MO 2: Describe the various environmental and emerging diseases with case studies (Un)
MO 3: Describe the occupational health hazards and identification (Re)

MO 4: Explain the occupational exposure of workers to pollutants and its health hazards and management systems, (Un)

MO 5: Explain the ecological and human risk assessment (Un)

MO 6: Discuss Environmental Health Risk Assessment using a case study (Ap)

LEARNING APPROACHES:

Activity based – Students should collect information regarding the effects of various types of pollutants and make posters.

Field based/Survey based approach to collect data on various kinds of occupational hazards.

LEARNING OUTCOMES:

Students should get a clear idea regarding pollutants of concern, environmental toxicants, its various effects on humans as well as ecosystem.

RECOMMENDED READINGS

1. Abbasi, S. A. and E. Ramasami. (1999). Biotechnological Methods of Pollution Control, University Press, Hyderabad
2. Balram Pani. (2019).Text Book of Toxicology. Dream tech Press, New Delhi.
3. Calow. P. (1994). Handbook of Ecotoxicology. Blackwell Scientific Publications, London.
4. Chatterji M., M. Munasinghe and R. Ganguly (1998). Environment and Health in Devloping Countries. A.P.H Publishing House, New Delhi.
5. Charles ,D.R.(2017).Occupational Safety and Health. CRC Press, USA
6. De A.K. (1994). Environmental Chemistry. New Age International Ltd. New Delhi
7. Fellenberg, G. (1999). Chemistry of Pollution, John Wiley and Sons, New Delhi.
8. Forbes V.E. and T. L. Forbes (1994). Ecotoxicology in Theory and Practice. Chapman & Hall, London.
9. Francisco G Calvo-Flores, Joaquin Isac-Garcia , Jose A.Dobado. (2017). Emerging Pollutants- Origin, Structure and Properties, Wiley-VCH (Pub.). 528 Pages.
10. Hayes W.A. (2001). Principles and Methods of Toxicology, CRC Press, USA
11. Jacobson – Kram, D. (2006). Toxicological Testing Handbook: Principles, Applications and Data Interpretation, Taylor and Francis, New York.
12. Klaassen C.D. and Watkins, J.B. (2003). Essentials of Toxicology, McGraw Hill Professional, New Delhi.
13. Koren H and M. S. Bisesi (1995). Handbook of Environmental Health and Safety _ Principles and Practices (Vol II), CRC Press.
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15. Mahajan S.P. (1998). Pollution control in process industries, Tata McGraw Hill, ND.
16. Manahan S. E. (2000). Environmental Chemistry, Lewis Publishers, New York.
17. Pandey,K.,Sukhla ,J.P. and Trivedi,S.P(2006).Fundamentals of Toxicology,New Central Book Agency(P) Ltd.India.

18. Pery, G. (1980). Introduction to Environmental Toxicology, Elsevier, Amsterdam.
19. Raymond W. Miller and Roy L. Donalvee (1997). Soils in Our Environment, 7th Ed, Prentice Hall of India Pvt. Ltd.
20. Sharma B.K. and H. Kaur (1996). Environmental Chemistry. Goel Publishing, Meerut.
21. Subramanian M. A. (2004). Toxicology – Principles and Methods, MJP Publishers, Chennai.
22. Trivedi, R.K. and Goel, P.K. (2010). An introduction to Air pollution, DVS Publication, New Delhi.
23. Wadhwa Y. (2009). Air Pollution: Causes and Control. Cyber Tech Publications, ND.
24. Walker, C.H., R.M. Sibly, S.P. Hopkin and D.B. Peakall (2012). Principles of Ecotoxocology, CRC Press, New York.
25. Wright D. A and P. Welbourn (2002). Environmental Toxicology, Cambridge Univ. Press, London.

ES 524: PRACTICAL II
ENVIRONMENTAL TECHNIQUES, CHEMISTRY & POLLUTION

Total Hours: 180

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Perform soil, water and sediment sampling and analyze the physico-chemical parameters of these samples	Ap
CO 2	Estimate Na and k using Flame Photometer	Ev
CO 3	Separate plant pigments from leaf samples and amino acids from a mixture	Ev
CO 4	Do data analysis manually and in MS excel	Ap

1. Sampling and Analysis of Forest/ Agriculture/ Industrial soil/ water/ air

(20 Hours)

2. Physicochemical parameters – pH, Conductivity, Turbidity, Salinity, Free CO_2, Alkalinity, Acidity, TDS, Total hardness, NO2, PO4, Sulphate, SiO3, fluoride

(10 Hours)

3. Analysis of COD in water sample

(5 Hours)

4. Analysis of Particulate pollutants in air – Dust Fall Method

(20 Hours)

5. Analysis of Gaseous pollutants (NO2 and SO2) in air – High Volume Sampler

(20 Hours)

6. Estimation of organic carbon in soil samples

(5 Hours)

7. Estimation of total kjeldahl Nitrogen in soil samples

(15 Hours)

8. Estimation of Na and K using Flame photometer

(20 Hours)

9. Time series modelling

(20 Hours)

10. Significance testing using Chi square test

(5 Hours)

11. Computer application – using MS Excel – Calculate the mean, median, mode, standard deviation, regression, correlation

(40 Hours)

Second Semester M Sc Degree Examination
Model Question
Paper Branch - Environmental Sciences
ES 521 ENVIRONMENTAL CHEMISTRY

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

Answer any ten of the following

(2x10 = 20 marks)

1. Greenhouse effect (TL 2; CO 1: 100%)
2. Chemical composition of seawater (TL 2; CO 2: 100%)
3. Nuclear fission and fusion reactors (TL 2; CO 5: 100%)
4. Composition of soil air (TL 2; CO 1: 100%)
5. Isotopes (TL 2; CO 5: 100%)
6. Photochemical smog (TL 2; CO 1: 100%)
7. Radionuclides (TL 1; CO 5: 100%)
8. Textural classes in soil (TL 2; CO 3: 100%)
9. CFC s (TL 2; CO 1: 100%)
10. Significance of disulphide linkages in tertiary structure of proteins (TL 2; CO 4: 100%)
11. Sedimentary cycles (TL 2; CO 3: 100%)
12. Soil CEC (TL 2; CO 3: 100%)

Answer any five of the following

(5x5= 25 marks)

13. Write a note on organic matter in water. Comment on the sources of it. (TL 4; CO 3: 100%)
14. What are the major consequences of global warming. Explain the mechanism which results in global warming. (TL 3; CO 1: 100%)
15. Chelation and complexation in Natural waters (TL 2; CO 2: 100%)
16. Explain the alpha and beta decay of radioactive particle (TL 2; CO 5: 100%)
17. Briefly explain the tropospheric oxidation of methane (TL 2; CO 2: 100%)
18. Applications of Green Chemistry (TL 2; CO 6: 100%)
19. pH-pE Diagram (TL 2; CO 2: 100%)

Answer any three of the following

(3x10=30 marks)

20. Describe the formation, composition and effects of acid rain. Analyze the causes and give examples (TL 4; CO 1: 80%; CO 2: 2%)
21. Structure, Classification and function of carbohydrates (TL 2; CO 4: 100%)
22. Write an essay on the physical and chemical properties of soil and the role of macro and micro nutrients (TL 2; CO 3: 100%)
23. Give an account of soil pollution and its management. (TL 4; CO 3: 100%)

Second Semester M Sc Degree Examination
Model Question
Paper Branch -Environmental Sciences
ES 522 ENVIRONMENTAL TECHNIQUES AND RESEARCH METHODS

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

Answer any ten of the following

(2x10=20 marks)

1. Principle of colorimetry (TL 2; CO 2: 100%)
2. Standard Error (TL 2; CO 4: 100%)
3. Grid method of sampling (TL 2; CO 1: 100%)
4. Electrostatic precipitators (TL 2; CO 2: 100%)
5. DNA Microarray (TL 2; CO 2: 100%)
6. What is the purpose of the enumeration of microbes in potable water? (TL 2; CO 2: 100%)
7. Correlation (TL 1; CO 4: 100%)
8. PCR (TL 2; CO 2: 100%)
9. Harmonic mean (TL 2; CO 4: 100%)
10. COD (TL 2; CO 2: 100%)
11. Define bioindicators (TL 2; CO 4: 100%)
12. Paper chromatography (TL 2; CO 2: 100%)

Answer any five of the following

(5x5= 25 marks)

13. Explain DO and BOD. Explain why BOD is high in water samples rich in organic matter. (TL 3; CO 2: 100%)
14. Chain of custody procedures. (TL 2; CO 2: 100%)
2. How and why we analyze the presence and load of coliforms in water bodies? (TL 4; CO 2: 100%)
15. Explain the basic statistical methods employed in field experiments. (TL 3; CO 4: 100%)
16. Explain the theory and principle behind the working of flame emission and Atomic Absorption spectrophotometer. Where in real life situation, this technique can be applied? (TL 3; CO 2: 100%)
17. Calculate Karl Pearson coefficient of correlation (TL 3; CO 4: 100%)

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

18. What are the various measures of dispersion. (TL 2; CO 4: 100%)

Answer any three of the following

(3x10= 30 marks)

19. Give an account of the microbes in air, water and soil. (TL 2; CO 2: 100%)
20. Describe the various separation techniques used in environmental analysis. (TL 2; CO 2: 100%)
21. Write a note of different sampling equipment used for air and water

sampling. (TL 2; CO1: 100%)

22. Write an essay on the analysis for BOD and COD. Mention the significance of these parameters. (TL 2; CO 2: 100%)

Second Semester M Sc Degree Examination
Model Question Paper
Branch - Environmental Sciences
ES 523 ENVIRONMENTAL POLLUTION AND TOXICOLOGY

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

Answer any ten of the following

(2x10= 20 marks)

1. Eutrophication (TL 1; CO 1: 100%)
2. Units of radioactivity (TL 1; CO 1: 50%; CO 2: 50%)
3. Point and Non-point sources of pollution (TL 1; CO 1: 100%)
4. Biological indicators of air pollutants (TL 2; CO 1: 100%)
5. Toxicant (TL 1; CO 4: 100%)
6. Teratogens (TL 1; CO 4: 100%)
7. Acute and chronic toxicity (TL 1; CO 4: 100%)
8. Basic properties of sound waves (TL 1; CO 5: 100%)
9. Dragging (TL 1; CO 1: 100%)
10. Environmental health (TL 1; CO 5: 100%)
11. Sources of oil pollution (TL 1; CO 2: 100%)
12. NOEL (TL 1; CO 4: 100%)

Answer any five of the following

(5x5= 25 marks)

13. Synthetic fertilizers and their effects on soil components (TL 1; CO 3: 100%)
14. Describe ADME. Comment on the various factors coming into play in the process. (TL 4; CO 4: 100%)
15. Carcinogens and Mutagens (TL 2; CO 6: 100%)
16. Nuclear reactors. Comment on the health hazards faced by workers in a nuclear power plant. (TL 3; CO 5: 100%)
17. Write a note on different sources and entry routes of toxic substances into the human body (TL 1; CO 5: 100%)
18. Absorption routes of toxicants (TL 3; CO 4: 100%)
19. Explain air quality parameters adopted in India (TL 2; CO 6: 100%)

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 (TL 4; CO 6: 100%)
21. Describe the source, measurement and analysis of sound. Write a note on measures to control noise pollution (TL 4; CO 5: 100%)
22. Causes and effects of industrial effluents on soil components (TL 4; CO 1: 100%)
23. Explain the safety landfill procedures for nuclear waste and radioactive waste. (TL 4; CO 6: 100%)

M Sc ENVIRONMENTAL SCIENCES
II Semester Practical Examination
ES 524 ENVIRONMENTAL TECHNIQUES, CHEMISTRY & POLLUTION

Time: 4 Hours **Total Marks:75**

1. Write critical notes on the spotters A, B & C (Identification, Principle and Uses) (TL 4; CO 1: 100%)

[(1+2+2)3 = 15 marks]

2. Identify and write critical notes on the spotters D, E & F (Air pollution sample, Water pollution sample and Soil pollution sample) (TL 4; CO 1: 100%)

[(1+4)3=15 marks]

3. Estimate organic carbon/ nitrogen/ phosphorous in sample G. Write the brief procedure. (TL 4; CO 1: 100%)

[7+3 =10 marks]

4. Estimate SO_4^{2-} /PO_4^{2-} /NO_3^{2-} using spectrophotometer. Write principle, procedure and calculation with graph (TL 4; CO 1: 100%)

[7+3=10 marks]

5. Determine total alkalinity/acidity/total hardness of the given sample. Give a brief procedure. (TL 4; CO 1: 100%)

[2+3+2+3= 10 marks]

6. Find the Standard Deviation (SD) for the given distribution (TL 4; CO 4: 100%)

OR

Test the statistical significance of the given data using $\chi 2$ test (TL 4; CO 4: 100%)

[10 marks]

7. Practical Record

[5 marks]

SEMESTER III

ES 531: REMOTE SENSING AND GIS

Total Hours: 90

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.
- To be able to apply geospatial technology for analysing and solving a given environmental situation.

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.

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Explain the principles, concepts and techniques of Remote Sensing Technology and application of Remote Sensing in various management aspects	Un
CO 2	Write notes on the aerial remote sensing, the various sensors on board and the elements of the image of interpretation and write an essay on photogrammetry	Un
CO 3	Write an essay on types of sensors and their applications in environmental monitoring	Un
CO 4	Explain in detail satellite remote sensing with types of satellite orbits	An
CO 5	Explain Digital Image processing and the utilization of Geomatics Science in Resource Management and thus to monitoring the spatial and temporal environmental changes.	Ev

PRE-REQUISITES:

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

COURSE CONTENT:

MODULE I: Concept and Foundation of Remote Sensing:

Basic processes in remote sensing – data acquisition – energy sources and radiation principles, propagation of energy through the 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; advantages and disadvantages of remote sensing.

(15 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Understand the basic concept of Remote sensing (Re)
MO2: Articulate and interpret electromagnetic spectrum (Re)
MO3. Acquire knowledge about the generation of sensor data (Un)
MO4: Understand basic difference between passive and active remote sensing (Re)
MO5: Know about the salient features of remote sensing (Un)
MO6: Understand higher levels in remote sensing (Un)

MODULE II: 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.
Photogrammetry: definition and advantages of photogrammetry; Scale of photographs; Stereo models; Principles of stereophotography; Relief displacement; Image Parallax; Aerial mosaics; Ortho-photos; Photogrammetric Instruments.

(15 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Understand the advantages of aerial remote sensing (Un)
MO2: Understand the elements of photographic system (Un)
MO3: Acquire knowledge about process of vertical photography (Ap)
MO4: Understand photo interpretation for terrain evaluation (An)
MO5: Understand fundamentals of photogrammetry (Un)
MO6: Understand various measurements from aerial photos (Un)

MODULE III: Types of Sensors:

Thermal Sensors, Multispectral Sensors (MSS), Microwave (RADAR), LIDAR – definition, principles, general characteristics, spectral resolution, interpretation, and applications in environmental monitoring. Overview of Hyperspectral Remote sensing.

(10 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Understand the general aspects of sensors (Un)
MO2: Articulate and understand thermal sensing (Un)
MO3: Acquire knowledge about MSS sensor (Un)
MO4: Understand the concept of microwave sensor (Re)
MO5: Analyse the difference between Lidar and Radar (An)
MO6: Gain an understanding on hyper spectral remote sensing (Un)

MODULE IV: Satellite Remote Sensing:

Advantages of satellite remote sensing; Types of satellite orbits – Polar and Geostationary; Satellite characteristics - Orbit, Swath, Resolution, Scale; Overview of Satellites – Landsat, SPOT, IRS, Cartosat, Oceansat, IKONOS, QUICKBIRD, RISAT, INSAT – their sensors, orbital characteristics, data products and applications.

(15 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:
MO1: Understand advantages of satellite remote sensing (Un)
MO2: Differentiate polar and geostationary satellite orbits (Un, Ev)
MO3: Understand and evaluate low resolution satellites (Un, Ev)
MO4: Understand and compare high resolution satellites (Un, Ev)
MO5: Explain and critically discuss different commercially available satellites (An)
MO6: Articulate and exemplify the application of satellites (An)

MODULE V: Digital Image Processing:

Image Rectification and Restoration; Image Enhancement; Image Classification – Supervised and Unsupervised; Data merging; Case Study.

(15 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:
MO1: Define the basic term DIP (R)
MO2: Recognise various processing stages (U)
MO3: Outline various image rectification process (R)
MO4: Analyze image enhancement processes (An)
MO5: Distinguish supervised and unsupervised classification (U)
MO6: Demonstrate the environmental application of geospatial technology (An)

MODULE VI: Geographical Information System (GIS):

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. Bhuvan Geoportal.

Global Positioning System (GPS): System segments; GPS satellite signals; Calculating locations; Differential GPS; IRNSS, Environmental applications of GPS with case studies.
Application of Remote Sensing and GIS: Application in Forestry and Wildlife management; Mapping and monitoring of land use/ land cover; Soil mapping and Agriculture; Water resources; Urban planning; Disaster management; Health studies; Ecological modelling; Case studies.

[20 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:
MO1: Define the term GIS (R)
MO2: Recognise various components of GIS (U)
MO3: Identify various data types in GIS (U)
MO4: Articulate and understand various analysis in GIS (An)
MO5: Analyse the principles and functions of GPS (U)
MO6: Critically analyse the applications of GIS and GPS (An)

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, appreciate and apply 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.
14. Pearson Inc.
15. Jhanwar M.L and T.S. Chouhan (1998). Remote sensing and Photogrammetry – Principles and Applications. Vigyan Prakashan, Jodhpur.
16. Kolay A.K. (2009). Remote sensing & Assessment of Soil resources, Atlantic Pub., New Delhi.
17. Martin, D. (1991). Geographic Information Systems and their socioeconomic Applications. Routledge, N.Y.
18. Narayan L. R. A. (1999). Remote Sensing and its applications. Orient Blackswan, AP.
19. Stephen Wise. (2002). GIS Basics, Taylor and Francis, New York.
20. Thomas M. Lillesand and Ralph W. Kiefe (1987). Remote sensing and Image interpretation 7th Edn., John Wiley and Sons, New York.
21. Basudeb Bhatta (2018); Remote Sensing and GIS: Oxford University Press
22. George Joseph and C. Jeganathan (2019); Fundamentals of Remote Sensing: University Press.
23. A. M. Chandra and S. K. Gosh (2019); Environmental Protection; Narosa Publications.

ES 532: ENVIRONMENTAL GENETICS, MICROBIOLOGY AND BIOTECHNOLOGY

Total Hours: 90

OBJECTIVES:

- To make students aware of the role of microbiology in the sustenance of environment
- To make students understand 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 catalyzed 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.

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Describe the structure of chromosomes and environmental causes for structural and numerical aberrations of chromosomes	Re and Un
CO 2	Explain the causes, mechanisms and effects of mutation	Re and Un
CO 3	Describe the theories and principles of evolutionary genetics, organisms modified by genetic manipulation and their environmental implications	Re and Un
CO 4	Articulate the role of microbes in various environments, food, industries, microbial interactions as well as the role of microbes in emerging diseases and the development of antibiotic resistance	Re, Un and An
CO 5	Describe the various culture-dependent and culture-independent techniques for the isolation and enumeration of microorganisms	Re and Un
CO 6	Explain the role of microorganisms in bioremediation and biomining	Re, Un and Ap

PRE-REQUISITE:

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

COURSE CONTENT

MODULE I: Chromosomal variation in number & structure:

Environmental causes of euploidy, non-disjunction & aneuploidy, induced polyploidy, applications of polyploidy, chromosomal mosaics and aberrations, chromosomal rearrangements in human being.

(10 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:

MO 1: Describe the chromosomal variation in number with examples
MO 2: Describe the chromosomal variation in structure with examples
MO 3: Describe the environmental causes of chromosomal variations
MO 4: Explain the chromosomal rearrangements in human beings

MODULE II: 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 Hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO 1: Define and explain genetic codes
MO 2: Explain the types of mutations and their causes
MO 3: Articulate the phenotypic effects of mutation
MO4: Explain the role of mutation in evolution and the practical applications of mutation

MODULE III: Population genetics:

Darwin's theory of evolution, Neo-Darwinism, modern synthesis theory of evolution, Macroevolution & Microevolution. Chromosomal aberrations & evolution. Principles of Evolutionary Genetics: A brief history of evolutionary genetics

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

(15 Hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO 1: Describe the various theories of evolution
MO 2: Explain the types of mutations and their causes
MO 3: Articulate the phenotypic effects of mutation
MO 4: Explain the role of mutation in evolution and the practical applications of mutation

MODULE IV: Environmental Microbiology:

Aeromicrobiology, hydromicrobiology, geomicrobiology Microbes in environment and their functions (beneficial and harmful), Food and industrial microbiology - Food spoilage–causes and preservation, fermented foods, dairy products. 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. Biological role of viruses, Antibiotic resistance, MAR. Some Participatory learning activity on Emerging diseases for Internal Assessment alone (like case study on emerging diseases nipah/Covid 19)

(15 Hours)

MODULE OUTCOME

After learning this module, students should be able to:

MO 1: Explain the microbiology of various environment and describe its functions
MO 2: Describe the microbiology of food
MO3: Articulate the microbiology of extreme environments as well as in biogeochemical cycles
MO 4: Explain the role of microbes in human health and emerging diseases
MO 5: Describe the biological role of viruses
MO6: Discuss the issues related to antibiotic resistance and Multiple Antibiotic Resistance

MODULE V: Enumeration Techniques:

Categories of Bacteria Enumeration - Direct Cell Count, Indirect Cell Count, Viable Cell Count, Total Cell Count: - Direct/Viable, Indirect/Viable, Direct/Total, Indirect/Total Techniques for Bacteria Enumeration - Standard Plate Count (Viable Counts), Advantages of plate count method, Limitations of plate count technique. Turbidimetric Measurement, Advantages of turbidimetric measurement, Limitations of turbidimetric measurement. Direct Microscopic Count, Using fluorescent dyes. Metagenomics/Environmental genomics, eco genomics or community genomics; Applications of metagenomics

(15 Hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO1: Describe the techniques for bacterial enumeration and define the various terms associated with bacterial enumeration
MO2: Explain the techniques for measurement of growth of microorganisms
MO3: Define metagenomics/ environmental genomics/ ecogenomics/ community genomics and describe the process of metagenomics
MO4: Explain the various applications of metagenomics

MODULE VI: Environmental Biotechnology and Bioremediation:

Biotechnology for environmental protection and pollution prevention. 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). concept, principles and applications of bioremediation; types- insitu, exsitu; microbes involved; rhizoremediation, phycoremediation, biomining: microbial leaching of low-grade mineral ores Microbial transformations – metals and non-metals; molecular probes for organisms in mines and mine tailings.

(20 Hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO1: Discuss the role of Biotechnology in environmental protection and pollution prevention

MO2: Explain microbial composting, biofertilizer technology, waste management technology

MO3: Articulate the role of microbes in degradation of natural and manmade compounds

MO4: Explain the principles and applications of bioremediation

MO5: Explain the microbial transformation

MO6: Discuss the role of microbes as molecular probes in mines and mine tailings

RECOMMENDED READINGS

1. QUILTER, C. (1998). Chromosomal Variation in Man: A Catalog of Chromosomal Variants and Anomalies. By DS Borgaonkar. Chichester, New York: Wiley-Liss. 1997. Pp. 1175.£ 195.00. ISBN 0 471 54332 9. Annals of Human Genetics, 62(1), 93-95.
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5. Weinreich, D. M., Delaney, N. F., DePristo, M. A., & Hartl, D. L. (2006). Darwinian evolution can follow only very few mutational paths to fitter proteins. science, 312(5770), 111-114.
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8. Walk, S. T., & Feng, P. C. (Eds.). (2011). Population Genetics of Bacteria: A Tribute to Thomas S. Whittam. American Society for Microbiology Press.
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14. Yates, M. V. (2020). Manual of environmental microbiology. John Wiley & Sons.
15. Hurst, C. J. (2022). The Biological Role of a Virus.
16. Mayhall, C. G. (2012). Hospital epidemiology and infection control. Lippincott Williams & Wilkins.

17. Matthews, K. R., Kniel, K. E., & Montville, T. J. (2017). Food microbiology: an introduction. John Wiley & Sons.
18. Sabale, S. N., Suryawanshi, P., & Krishnayaj, P. U. (2019). Metagenomics–basic methods and applications. Soil metagenomics: Concepts and applications. DOI: http://dx. org/https://doi. org/10.5772/intechopen, 88958.
19. Charles, T. C., Liles, M. R., & Sessitsch, A. (Eds.). (2017). Functional metagenomics: tools and applications. Cham: Springer International Publishing.
20. Environmental Biotechnology, 2/e by Bruce E. Rittmann and Perry L. McCarty
21. Scragg, A. H. (2005). Environmental biotechnology. New York: Oxford university press.
22. Rajendran, P., & Gunasekaran, P. (2019). Microbial bioremediation. MJP Publisher.
23. Alexander, M. (1999). Biodegradation and bioremediation. Gulf Professional Publishing.

ES 533: ENVIRONMENTAL METEOROLOGY AND CLIMATE CHANGE

Total Hours: 90

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.

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Articulate and exemplify basic knowledge of environmental meteorology and new concepts of climate change	Un
CO 2	Summarise enhanced greenhouse effect, global warming El Nino and ENSO	Un
CO 3	Explain the fundamental principles of meteorological instrumentation and measurements	Un
CO 4	Define vertical variation in temperature, lapse rate and inversions	Re
CO 5	Acquire knowledge on fundamentals of climatology	Un
CO 6	Analyze and describe the phenomenon of climate change and address problems of pollution climatology with emphasis on India	Ap

PRE-REQUISITE:

1. Students should have a basic understanding about the structure of atmosphere
2. Students should have basic knowledge about smog, PAN and acid rain.
3. Students should be knowing about Earth – Sun relationship and Latitudinal and seasonal variation of Insolation.

COURSE CONTENT:

MODULE I: Elements of weather:

Temperature, humidity, wind, rainfall, Warming and cooling of air near ground; Measurements of temperature; Clouds -classification and types; Precipitation – processes, types, measurement-recording, non-recording, radar, satellite; Wind – forces affecting wind, types, measurement, wind roses.

Climatology: 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, Different methods in weather forecasting, Numerical modelling, Koppan's classification.

(20 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Define air temperature, its measurement, vertical variations in temperature and inversions (Re)
MO2: Describe humidity (Re)
MO3: Outline clouds classification and types (Re)
MO4: Measurement and estimation of precipitation (Un)
MO5: Define forces affecting wind and measurement of wind (Re, Ap)
MO6: Analyse different methods in weather forecasting (An)

MODULE II: Fundamentals of Meteorology:

Atmospheric thermodynamics - specific heats and laws of thermodynamics; Temperature lapse rate and Inversion; Atmospheric stability; Scales in meteorology; Earth's Radiation balance; Energy budget near surface; Planetary Boundary layer.

[10 Hours]

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Define specific heat and state laws of thermodynamics (Re)
MO2: Describe temperature lapse rate and inversion (Re)
MO3: Explain atmospheric stability (Re)
MO4: Describe earth's radiation balance (Un)
MO5: Explain the energy budget (Re)
MO6: Define planetary Boundary Layer (An)

MODULE III: Micrometeorology:

Effects of topography, applications to vegetated surfaces; Urban Heat Islands – urban climatology – heat dome, human beings and animals; Impact on the physiology of plants and animals; Stress induced changes, LST & SST.

(10 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Understand the effects of micrometeorology to vegetated surfaces (Un)

MO2: Relate micro meteorology to human beings and animals (Ap)
MO3: Explain impact of micrometeorology on the physiology of plants and animals and stress-induced changes (Un)
MO4: Assess the role of LST and SST in climate change (Re)

MODULE IV: 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 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Apply meteorological principles to transport and diffusion of pollutants (Ap)
MO2: Demonstrate effect of meteorological factors on air pollution (Ap)
MO3: Design Gaussian plume model (Cr)
MO4: Evaluate reaction of pollutants in air (Ev)
MO5: Explain pollution climatology and climate change (Un)

MODULE V: Science of Climate Change:

Drivers of climate change – greenhouse gases, aerosols – reflective and black; 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, Carbon neutral society, Net zero emissions.

(20 Hours)

MODULE OUTCOMES

After Completion of this module, the student should be able to:

MO1: Generalise drivers of climate change - Greenhouse gases and aerosols (Un)
MO2: Comprehend concepts of global warming potential, radiative forcing and feed-back processes in climate system (Un)
MO3: Explain the concept of green architecture (Un)
MO4: Assess the different methods of assessing carbon sequestration potential
MO5: Appreciate the importance of Carbon neutral society, Net zero emissions

MODULE VI: 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.

(15 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1: Describe the CDM mechanism (Un, Re)
MO2: Elaborate on the importance of clean technology in climate change mitigation (Un)
MO3: Assess the Indian context of CDM concept (Un)

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.
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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.
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ES 534: PRACTICAL III
ENVIRONMENTAL GENETICS, MICROBIOLOGY AND REMOTE SENSING

Total Hours: 144

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
COURSE OUTCOMES:	**COURSE OUTCOMES:**	**COURSE OUTCOMES:**
CO 1	Identify models of genetic significance	Un
CO 2	Perform sterilization, serial dilution, media preparation, plating and identification of bacteria and fungi using physiological and biochemical characteristics	Cr
CO 3	Perform simple and gram-staining techniques	Cr
CO 4	Estimation of the number of microbes and measurement of microbes	Ap
CO 5	Generate thematic map layer using GIS	Cr

1. Models of genetic significance- syndrome, sex linked inheritance- color blindness, web toes etc.
   (14 Hours)
2. Sterilization techniques, culture media preparation: serial dilution, plating, isolation and identification of bacteria and fungi - physiological and biochemical
   (20 Hours)
3. Staining- Simple and Gram's staining
   (10 Hours)
4. Microscopic counting of microbes using haemocytometer
   (10 Hours)
5. Measurement of microbes using ocular and stage micrometer
   (10 Hours)
6. Estimation of coliform bacteria in water by MPN
   (20 Hours)
7. Study of topographic sheets and interpretation (5 grids)
   (25 Hours)
8. Fundamental exercise on generation of a basic thematic map layer (land use, landcover map) using aerial photographs and briefly describe the geomorphic and environmental features
   (25 Hours)
9. Visit to different land use/ land cover category of Kerala (minimum five)
   (10 Hours)

ES 535: PROJECT WORK

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Conduct literature survey on a given topic	Ap
CO 2	Perform meticulous planning of lab work	Cr
CO 3	Demonstrate precision and practical skills	Ap
CO 4	Perform statistics in the data acquired	Ap
CO 5	Express the results and justify it with suitable scientific discussion	Cr
CO 6	Prepare a well-structured dissertation	Cr

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. The learners shall 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 531 REMOTE SENSING AND GIS

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

Write short note on any ten of the following

(10x2= 20 marks)

1. Application of remote sensing in land use (TL 2; CO 1: 100%)
2. Thermal scanning (TL 2; CO 3: 100%)
3. Soil mapping (TL 2; CO 1: 100%)
4. OGC (TL 1; CO 5: 100%)
5. IRS (TL 1; CO 5: 100%)
6. Name any two Indian satellites (TL 2; CO 5: 100%)
7. CCD (TL 2; CO 3: 100%)
8. Land Use survey (TL 2; CO 1: 100%)
9. Base map (TL 2; CO 5: 100%)
10. Active and passive remote sensing (TL 2; CO 1: 100%)
11. Advantages of aerial remote sensing (TL 2; CO 2: 100%)
12. TIN (TL 1; CO 5: 100%)

Answer any five of the following

(5x5= 25 marks)

13. Comment on the importance of Energy source and Radiation principles in remote sensing. How they are applied in the technique (TL 3; CO 1: 100%)
14. Write a note on GPS, its function, characteristics and applications in Environmental studies (TL 3; CO 5: 100%)
15. Explain the characteristics of RADARSAT (TL 2; CO 4: 100%)
16. Explain energy interaction with earth's surface features (TL 3; CO 1: 100%)
17. Give an account of elements of image interpretation (TL 2; CO 2: 100% 2)
18. Polar and Geostationary satellites (TL 3; CO 4: 100%)
19. Advantages of satellite remote sensing (TL 2; CO 4: 100%)

Answer any three of the following

(3x10= 30 marks)

20. What is DIP? Explain the different steps employed. (TL 3; CO 5: 100%)
21. Give a detailed account on types of sensors- with emphasis on its principle, general characteristics, spectral resolution and application in environmental monitoring. (TL 3; CO 3: 100%)
22. Give a descriptive account of MSS with neat illustrations regarding working and different types of scanning employed and applications (TL 4; CO 3: 100%)
23. Describe in details the satellite characteristics and describe the functions of Cartosat and Oceansat. (TL 3; CO 4: 100%)

Third Semester M Sc Degree Examination
Model Question Paper
Branch -Environmental Sciences
ES 532 ENVIRONMENTAL GENETICS, MICROBIOLOGY AND BIOTECHNOLOGY

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

Write short note on any ten of the following

(10x2= 20 marks)

1. Carcinogens with two examples (TL 2; CO 2: 100%)
2. Frame shift mutations (TL 2; CO 2: 100%)
3. Bt cotton (TL 2; CO 3: 100%)
4. Biosensors (TL 2; CO 4: 100%)
5. Clinical irradiation (TL 2; CO 4: 100%)
6. Biochips (TL 2; CO 4: 100%)
7. Rhizoremediation (TL 2; CO 4: 100%)
8. Any two use of microbes in waste water treatments (TL 2; CO 4: 100%)
9. Pasteurization (TL 2; CO 4: 100%)
10. Biomining (TL 2; CO 6: 100%)
11. Persistent Organic Pollutants (POPs) (TL 2; CO 6: 100%)
12. Genetic counseling (TL 2; CO 3: 100%)

Answer any five of the following:

(5x5= 25 marks)

13. Mention the significance of Human Genome Project (TL 3; CO 3: 100%)
14. Write a brief account of metagenomics. Which are the areas where the principles of metagenomics can be applied to? (TL 4; CO 5: 100%)
15. Explain euploidy and aneuploidy. (TL 2; CO 1: 100%)
16. Transgenic species may cause threat to the environment. Why? (TL 4; CO 3: 100%)
17. 'Biomass'- a potential source of energy for tropical countries- How? (TL 3; CO 6: 100%)
18. Culture dependent and culture independent techniques for bacterial enumeration. (TL 4; CO 5: 100%)
19. Explain how degraded landscapes are restored using biotechnological principle. (TL 4; CO 6: 100%)

Answer any three of the following

(3x10= 30 marks)

20. Discuss the recombinant DNA technology and its application. (TL 4; CO 3: 100%)
21. Explain the process of recombination and the enzyme involved with a neat labeled diagram. (TL 4; CO 3: 100%)
22. Explain the concept, principles, types and applications of bioremediation. (TL 4; CO 6: 100%)
23. Explain the ethical and social impacts of Biotechnology. (TL 4; CO 3: 100%)

Third Semester M Sc Degree Examination
Model Question Paper
Branch -Environmental Sciences
ES 533 ENVIRONMENTAL METEOROLOGY AND CLIMATE CHANGE

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

Write short note on any ten of the following

(10x2= 20 marks)

1. Adiabatic process in the atmosphere (TL 1; CO 1: 30%; CO 3: 70%)
2. Cumulo nimbus (TL 2; CO 5: 100%)
3. Acid rain (TL 2; CO 6: 100%)
4. Greenhouse gases (TL 2; CO 5: 100%)
5. Mixing height (TL 2; CO 1: 100%)
6. GWP (TL 2; CO 6: 100%)
7. Carbon sequestration (TL 2; CO 6: 100%)
8. Radiative forcing (TL 2; CO 3: 100%)
9. Carbon footprint (TL 2; CO 6: 100%)
10. Planetary boundary layer (TL 2; CO 6: 100%)
11. Sustainable habitat (TL 2; CO 1: 100%)
12. Laws of blackbody radiation (TL 2; CO 3: 100%)

Answer any five of the following

(5x5= 25 marks)

13. Stability of atmosphere and lapse rate (TL 2; CO 3: 100%)
14. Elaborate on NAPCC (TL 4; CO 6: 100%)
15. Describe formation of clouds (TL 3; CO 5: 100%)
16. Formation of PAN (TL 4; CO 6: 100%)
17. Scales in meteorology (TL 1; CO 6: 100%)
18. Explain dispersion of air pollutants in the Gaussian plume model (TL 4; CO 6: 100%)
19. Elements of weather and climate (TL 3; CO 1: 100%)

Answer any three of the following

(3x10= 30 marks)

20. Detailed account on Global warming and its effects on the environment. (TL 4; CO 6: 100%)
21. How are clouds formed and what are the different types? (TL 3; CO 5: 100%)
22. Give a brief account on climate and monsoon in Indian context. (TL 3; CO 6: 100%)
23. Explain the science of climate change and the role of clean technology in the context of mitigation. (TL 4; CO 6: 100%)

M.Sc. ENVIRONMENTAL SCIENCES
III Semester Practical Examination
ES 534 ENVIRONMENTAL GENETICS, MICROBIOLOGY AND REMOTE SENSING

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

1. Identify and write critical notes on the spotters A, B, C, D and E (TL 4; CO 2: 100%)

[5 x 2 = 10 marks]

2. Write critical notes on F and G (TL 4; CO 1: 40%; 2: 60%)

[2 x 5 = 10 marks]

3. Conduct cell count using haemocytometer / measurement of microbes using ocular and stage micrometer (TL 4; CO 4: 100%)

[1 x 10 = 10 marks]

OR

Enumeration of bacteria by plate count – serial dilution technique (pour plate method) (TL 4; CO 4: 100%)

[1 x 10 = 10 marks]

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

Gram staining (TL 4; CO 4: 100%)

OR

Simple staining to study the shape of microorganisms (TL 4; CO 4: 100%)

5. From the given survey of Indian toposheet, answer the following questions (TL 4; CO 5: 100%)

[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

6. From the given aerial photograph, prepare a land use/ land cover map and briefly describe the geomorphic and environmental features in it (TL 4; CO 5: 100%)

[1 x 15 = 15 marks]

7. Practical Record

[5 marks]

SEMESTER IV

ES 541: ENVIRONMENTAL ENGINEERING AND WASTE MANAGEMENT

Total Hours: 90

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.

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	List out and explain the techniques and equipment in air pollution control	Re, Un
CO 2	Describe the various waste water and sewage treatment processes	Re Un
CO 3	Describe the various Industrial effluent treatment processes	Re, Un
CO 4	Discuss the WHO and BIS standards for drinking water	Re, Un
CO 5	Describe and set up a composing unit	Un, An, Ap
CO 6	Explain the management strategies of hazardous wastes and also the policies related to this	Re, Un, Ap

Pre-requisite:

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

COURSE CONTENT:

MODULE I: 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). CNG, Electric/Hybrid vehicles.

(15 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1 Identify the types air pollutants and their impacts on environment (Ap)
MO2 Describe various control measures taken up for the effective management (Re)
MO3 Explain the important methods and techniques involved to manage vehicular pollution (Un)

MO4 Use sample collection equipment (Ap)

MODULE II: 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. Design and layout of waste water treatment plant.

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1 Differentiate types sewage, effluent and sludge and their impacts on environment (Un)
MO2 Describe various treatment measures for the safe disposal of waste water (Re)
MO3 Identify the important methods and techniques involved to manage vehicular pollution (Re)
MO4 Explain design and layout of waste water treatment plant (Re)

(15 Hours)

MODULE III: 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 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1 Explain the physico-chemical characteristics of effluents (Re)
MO2 Describe management of industry specific waste issues (Un)
MO3 Explain treatment methods employed at different industries (Re)
MO4 Discuss Common Effluent Treatment Plants (An)

MODULE IV: 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 Hours)

Module Outcomes:

After Completion of this module, the student should be able to:

MO1 Explain ecological and biological effects of domestic, industrial and agricultural wastes on water bodies (Ap)
MO2 Explain sampling methods and physico-chemical and bacteriological analysis of water (Re)
MO3 Elucidate Water Quality Standards (Re)
MO4 Explain the methods of waste water treatment (Re)

MODULE V: Solid waste treatment:

Industrial and municipal solid wastes; basic concepts – collection, Segregation, transportation and disposal – open dumps, ocean dumping, landfills, incineration, composting and vermin composting, recycling and reuse. Decentralised waste management with a case study-Activity Oriented. Design and layout of Biogas plant.

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1 Identify and interpret the criteria for the classification of a substance as a solid waste (An)
MO2 Explain waste minimization and source reduction, assess and describe the procedure for solid and hazardous waste identification and characterization and various waste processing options (An)
MO3 Describe solid waste management including landfill operation (Un)
MO4 Design and layout of biogas plant (Cr)

(15 Hours)

MODULE VI: 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.

(15 Hours)

MODULE OUTCOMES:

After Completion of this module, the student should be able to:

MO1 Explain the different types and characteristics of hazardous wastes (Re)
MO2 Describe impacts of various hazardous waste issues (Un)
MO3 Explain sources, types, hazards, storage and management (Re)
MO4 Discuss recycling of e-wastes (An)

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 operations.

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 practice 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 542: ENVIRONMENTAL IMPACT ASSESSMENT, DISASTER MANAGEMENT AND SUSTAINABLE DEVELOPMENT

Total Hours: 90

OBJECTIVES:

- 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:

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.

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Explain the process of Environmental Impact Assessment and define various terms associated with EIA	Re and Un
CO 2	Explain the impact identification, prediction and evaluation and conduct EIA of High-Rise building, Highway construction, quarrying with case studies applying theoretical principles	Re, Un and Ap
CO 3	Describe he classification and causative factors of hazards with case studies and define the terms related to disasters and hazards	Re and Un
CO 4	List hazard prone belts and describe risk assessment and risk reduction methodologies	Re, Un and An
CO 5	Explain disaster management cycle	Re and Un
CO 6	Explain sustainable development and aspects related to SDGs and describe the scope of ecotourism in India and Kerala	Re, Un and An

PRE-REQUISITE:

1. The students should have a basic idea regarding natural and manmade disasters.
2. The students should have a general idea on the environmental effects of anthropogenic activities

COURSE CONTENT:

MODULE I: Environmental Impact Assessment (EIA):

Definition, goals and characteristics of EIA; participants, stages of EIA, types of EIA. Environmental inventory, Baseline data on EIA- environmental data, project data and project alternative data. Measurement of impact, physical, social, economic, natural; Public participation in EIA process; Framework of environmental assessment; description of environmental setting. Environmental impact statement (EIS) and Environmental Management Plan (EMP).

(10 Hours)

MODULE OUTCOME

After learning this module, students should be able to:

MO 1: Define and explain Environmental Impact Assessment (Re)
MO 2: Explain the general process of EIA (Re)
MO 3: Articulate Framework of environmental assessment (Cr)
MO 4: Explain Environmental Impact Statement (EIS) and Environmental Management Plan (EMP) (Re)

MODULE II: Environmental Impact Identification and Mitigation:

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. Current procedures of environmental clearance in India. EIA of High-Rise building, Highway construction, Quarrying with case studies

(20 Hours)

MODULE OUTCOME

After learning this module, students should be able to:

MO 1: Explain impact identification and methods of impact identification (Re)
MO 2: Explain the current procedure of environmental clearance in India (An)
MO 3: Articulate the EIA of High-Rise buildings on the basis of a case study (Cr)
MO 4: Articulate the EIA of Highway construction with the help of a case study (Cr)
MO 5: Explain the EIA of quarrying with a case study (Un)

MODULE III: 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 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:

MO 1: Define and distinguish hazard and vulnerability (Re)
MO 2: Define and distinguish risk and disaster (Re)
MO 3: Classify hazards (Un)
MO 4: Explain the causative factors of hazards (Re)
MO 5: Explain natural and manmade hazards with the help of case studies (An)

MODULE IV: 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. Mitigatory measures of geological hazards - earthquakes, volcanoes, floods, landslides, cyclones

(20 Hours)

MODULE OUTCOMES

After learning this module, students should be able to:

MO 1: Do hazard zonation and risk assessment (Cr)
MO 2: Explain the risk reduction methods in vulnerable areas (Re)
MO 3: Describe the development of warning system, emergency preparedness (Re)
MO 4: Explain the causative factors of hazards (Un)

MO 5: Explain the Mitigatory measures of geological hazards - earthquakes, volcanoes, floods, landslides, cyclones (An)

MODULE V: 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.

(20 Hours)

MODULE OUTCOME

After learning this module, students should be able to:
MO 1: Define the terms capability, vulnerability, risk, preparedness and mitigation (Re)
MO 2: Explain disaster management cycle (Re)
MO 3: Describe the components of components of crisis management (Re)
MO 4: Explain the components of risk management (Re)
MO 5: Articulate disaster management act and policy (Cr)

MODULE VI: Sustainable Development:
Concept and growth of the idea, indications of sustainability, models of sustainable development, sustainable development scenario – global, national; sustainable agriculture. Sustainable Development Goals.
Ecotourism - Definition, concept and principles, types of ecotourists, Scope for ecotourism in Kerala, India, Benefits of ecotourism.

(10 Hours)

MODULE OUTCOME

After learning this module, students should be able to:
MO 1: Define and explain the concept of sustainability (Re)
MO 2: Describe the models of sustainable development (Re)
MO 3: Explain the global and national scenario of sustainable development (Un)
MO 4: Define and explain the concept and principles of ecotourism (Re)
MO 5: Explain the scope of ecotourism in Kerala and India and the benefits of ecotourism (An)

LEARNING APPROACHES:

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. Daly,H.E. 1997. Beyond Growth: The Economics of Sustainable Development. Beacon Press.
2. ISO 14004 – Environmental Management Systems: General guidelines on principles, systems and supporting techniques (International Organization for Standardization – Switzerland).
3. Anji Reddy Mareddy, Butterworth-Heinemann, 2017. Environmental Impact Assessment.
4. Bregman, J.I. and Mackenthum, K.M. 1992. *Environmental impact statements*. Chelsia Michigan: Lewis.

5. Calow, P. 1997. *Handbook of environmental risk assessment and management.* Oxford: Blackwell Science.
6. Canter, W. Larry. 1996. *Environmental impact assessment.* McGraw-Hill International editions. 660p.
7. Fortlage, C. 1990. *Environmental assessment: a practical guide.*Aldershot: Gower
8. Geological Hazards- *A Source Book on Hazards and Disasters. Kushy,* T. M., Green wood Press, Westport, Conn. London.
9. Glasson, J; Therivel, R and Chadwick, Al. 1999*. Introduction to environmental impact assessment.* UCL Press. 496p.
10. Glasson J, Taylor and Francis, 2019. Introduction To Environmental Impact Assessment 5Ed.
11. Gupta and Harsh, K. 2003. *Disaster Management,* Universities Press (India) Pvt. Ltd.
12. Hamele Hubert, 1988. *A major impact.*Naturopa, 59, 5-7.
13. Hunter Collin and Green Howard, 1995*. Tourism and the environment. A Sustainable relationship.* London. Routledge.
14. Janki Andharia (2020). Disaster Studies. Springer Singapore. p462. Hardcover ISBN 978-981-329-338-0
15. Jha and Kumar, M. 2010. *Natural and Anthropogenic Disasters; Vulnerability, Preparedness and Mitigation,* Springer.
16. Khandeshwar, S.R., Raman, N.s., Gajbhiye, A.R (2019). Environmental Impact Assessment. IK International publishing house Pvt. Ltd.
17. Morris, P and Therivel, R. 1995. *Methods of environmental impact assessment*. London. UCL press.
18. Munn, R.E.1979. *Environmental impact assessment: principles and procedures, 2nd Edn*. New York: Wiley.
19. Peijun Shi (2019). Disaster Risk Science. Springer Singapore. P 753. ISBN 978-981-13-6691-8
20. Rao, Y.R.M and Raman, N.S, 2018. ENVIRONMENTAL IMPACT ASSESSMENT , Laxmi Publications Pvt Ltd,2018.
21. Salim Momtaz and Zobaidul Kabir, 2018. Evaluating Environmental and Social Impact Assessment in Developing Countries.
22. Salim Momtaz, Zobaidul Kabir. (2019) Evaluating Environmental and Social Impact Assessment in Developing Countries (2nd Edition). p229. Elsevier. Paperback ISBN: 9780128150405.
23. Sabu Joseph and Arunkumar K.S (2022). Environmental Impact Assessment of Developmental Projects. Narendra Publications, New Delhi. P236. ISBN : 9789392851186.
24. Singh, K .K .&. Singh, A .K. 2010. *Natural and manmade disasters: vulnerability, preparedness and mitigation, Vol(1&2),* M.D. publications. Pvt. Ltd. New Delhi.
25. Strahler, A.N. and Strahler, A.H. 1973. Environmental *Geoscience – Interaction between natural systems and man: -Santa Barbara,* California, Hamilton Publishing.
26. Talwar, A.K. &Juneja, S. 2009. *Flood Disaster Management,* Commonwealth publishers, New Delhi.

On-line Sources

1. http://www.downtoearth.org.in/
2. http://www.epa.vic.gov.au/our-work/environmental-auditing
3. http://www.investopedia.com/terms/e/environmental-economics.asp

4. http://www.legalservicesindia.com/article/article/environmental-laws-and-constitutional-provisions-in-india-1926-1.html
5. http://www.undp.org/content/undp/en/home/sustainable-development-goals.html
6. https://link.springer.com/referenceworkentry/10.1007%2F1-4020-4494-1_116
7. https://www.epa.gov/environmental-economics
8. https://www.journals.elsevier.com/journal-of-environmental-management
9. www.epa.gov/environmental-economics
10. www.investopedia.com/terms/e/environmental-economics.asp

ES 543: ENVIRONMENTAL ECONOMICS, POLICIES AND LAWS

Total Hours: 90

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.

COURSE OUTCOMES:

On completion of the course, the students will be able to:

Course Outcome No.	Course Outcome	Taxonomic Level
CO 1	Comprehend the economics of natural resources exploitation	Un
CO 2	Identify the methods of economic valuation	Re
CO 3	List out and describe National Environmental Policy and Regulatory Frame Work	Re and Un
CO 4	Describe the environmental laws in India	Re and Un
CO 5	Explain the various environmental movements in India and International environment conventions and treatise	Re and Un
CO 6	Describe and analyze the environmental standards and the scheme of labelling environment friendly products	Re, Un and An

PRE-REQUISITE:

1. Students should have a general understanding about the environmental movements
2. Students should have knowledge regarding the various conventions on environment.
3. 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:

MODULE I: Economy and Environment:
Nature and scope of environmental economics; economics and ecology; economics of natural resources exploitation - Methods of valuation of environmental cost and benefits. Market value approach of environmental cost and benefits. Economics of pollution - optimum level of pollution.

(5 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:
MO1: Comprehend the economics of natural resources exploitation (Re)
MO 2: Identify the methods of economic valuation (An)
MO 3: Demonstrate the optimum level of pollution (Ap)

MODULE II: Economics of climate change:
Kyoto Protocol – Flexibility mechanisms – CDM concept, CDM scenario in India. National Action plan on climate change, Sustainable habitat, Concept of Green Architecture, Carbon sequestration methods, Carbon Foot print, Ecological Foot-print, Issues of energy security and social security.

(10 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:
MO1: Articulate the economics of climate change (Cr)
MO2: Describe the methods of carbon sequestration (An)
MO3: Evaluate carbon and ecological foot-print and analyze the issues of food, energy and social security to climate change (Cr)

MODULE III: Environmental Auditing and Management:
Objectives, frequency and criteria; audit team, environmental appraisal, accounting and environmental audit. Environmental guidelines for siting of industry, green balance sheet (GBS).
Environmental Management: Concept and scope, System and approaches.
Environmental Standards: International and National, Intellectual Property Rights, Scheme of labelling environment friendly products (Ecomark); Public Liability Insurance Act 1991, Environmental Management and ISO Certification; Environmental Management System (EMS); ISO 14000.

(25 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:
MO1: Apply the concept of Environmental Auditing for auditing of environment (Ap)
MO2: Comprehend the components of green balance sheet (Ap)
MO3: Compare the international and national environmental standards and identify the Environmental Management Systems (Ap)

MODULE IV: National Environmental Policy and Regulatory Frame Work:
Rules and regulation of Central and State Pollution Control Boards for environmental protection. International and national conservation agencies: Role of NGOs in Environmental Conservation; Major environmental movements in India – Bishnoi Movement, Silent Valley movement, Jungle Bachao Andolan, Chipko Movement, Appiko movement, Narmada dam and Tehri dam.

(15 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:
MO1: Articulate the environmental policies in India (AN)
MO2: Describe the features of NEP (Un)
MO3: Compare the regulations of Central and State PCBs (Un)
MO4: Explain the environmental movements in India (Re)

MODULE V: International Environmental laws:

Evolution and development of International environmental laws with reference to Stockholm Conference, 1972; Nairobi Declaration, 1982; Rio Conference, 1992; Rio +5; Rio +10; Rio +20. Global Environmental issues and environmental laws to control – Global warming, Climate change, Ozone depletion, acid rain and hazardous waste; Role of UN authorities in protection of global environment; Convention on biodiversity.

Environmental Laws in India: Constitutional and statutory laws in India, Statutory protection of human environment - Factories Act, 1948; Motor Vehicles Act, 1988; Indian Forest Act, 1927; Mines and Minerals Act, 1957; Hazardous waste legislation for pollution abatement, The Water Act, The Air Act 1981; The Environment Protection Act, 1986; The National Environment Appellate Authority Act, 1997; The Wildlife Protection Act, 1972; The Forest Conservation Act, 1980; Biodiversity Act 2002.

(25 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:
MO1: List the international environmental laws (Re)
MO2: Explain the salient features of environmental laws in India (Re)
MO3: Critically analyse the policies relating to global environmental issues (An)

MODULE VI: Environmental Education:

Meaning and scope– principles and objectives; environmental awareness strategies; formal and non-formal education.

(10 Hours)

MODULE OUTCOMES:

After learning this module, students should be able to:
MO1: Describe the principles and objectives of environmental education (Re)
MO2: Differentiate formal and non-formal environmental education (Un)

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
9. Vijay Prakash (2021); Environmental Law; Academic aspirations
10. S. K. Murthy (2010); Environmental Protection Laws; Anmol Publications Pvt. Ltd.

ES 544: PRACTICAL IV
WASTE MANAGEMENT, IMPACT ASSESSMENT AND DISASTER MANAGEMENT
Total Hours: 72

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Perform vermiculture technique	Cr
CO 2	Design a landfill and activated sludge system as per the criteria	Cr
CO 3	Perform seed germination by using chosen waste materials	Cr
CO 4	Perform EIA of the respective category	Cr
CO 5	Prepare a Disaster Management Plan of the given disaster	Cr
CO 6	Prepare an Environmental Audit/Green Audit/Energy audit	Cr

1. Biocomposting/ Vermicomposting technique
(5 Hours)
2. Production of biogas from waste
(5 Hours)
3. Landfill design and design criteria
(10 Hours)
4. Study on the impact of chosen waste materials on seed germination
(7 Hours)
5. Designing activated sludge system
(15 Hours)
6. Environmental impact assessment of any 2 projects – high rise buildings / quarrying / mining / hydroelectric project / highway construction project / industries and the preparation of Environmental Impact Statement and Environmental Management Plan using conventional methods
(10 Hours)
7. Preparation of disaster management plan with respect to any one disaster (flood, tsunami, landslide, earthquake, cyclone)
(10 Hours)
8. Preparation of environmental, energy and green audit in the Campus (Field based Activity)
(10 Hours)

ES 535: PROJECT WORK

COURSE OUTCOMES:

On completion of the course, the students will be able to:		
Course Outcome No.	**Course Outcome**	**Taxonomic Level**
CO 1	Conduct literature survey on a given topic	Ap
CO 2	Perform meticulous planning of lab work	Cr
CO 3	Demonstrate precision and practical skills	Ap
CO 4	Perform statistics in the data acquired	Ap
CO 5	Express the results and justify it with suitable scientific discussion	Cr
CO 6	Prepare a well-structured dissertation	Cr

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.

STUDY TOUR AND REPORT:

Study tour for five days to environmentally significant sites or hot spots. It includes field and institutional visits. They should submit a detailed report of field work at the time of practical examination of semester IV. Submission of field report is mandatory.

ES 545: COMPREHENSIVE VIVA-VOCE & INTERNSHIP

INDUSTRIAL INDUCTION TRAINING PROGRAMME OF DURATION TWO WEEKS TO ONE MONTH IS TO BE UNDERTAKEN BY STUDENTS DURING III/IV SEMESTERS. A REPORT OF INTERNSHIP NEEDS TO BE SUBMITTED. THIS IS MANDATORY FOR ATTENDING FOURTH SEMESTER PRACTICAL EXAMINATION.

Fourth Semester M Sc Degree Examination
Model Question Paper
Branch- Environmental Sciences
ES 541 ENVIRONMENTAL ENGINEERING AND WASTE MANAGEMENT

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

Write short note on any ten of the following

(10x2= 20 marks)

1. Fabric Filters (TL 1; CO 1: 100%)
2. Sanitary landfill (TL 1; CO 3: 100%)
3. Oxidation ponds (TL 1; CO 3: 100%)
4. What is Alum? Give examples (TL 1; CO 3: 100%)
5. Trickling filter (TL 1; CO 3: 100%)
6. e- wastes (TL 1; CO 2: 100%)
7. Water softening (TL 1; CO 4: 100%)
8. Dose and dose rate (TL 1; CO 3: 100%)
9. Electrostatic Precipitators (TL 1; CO 1: 100%)
10. Colour and odour removal by Activated carbon (TL 1; CO 3: 100%)
11. Waste hierarchy (TL 1; CO 2: 100%)
12. Ultrafiltration and Reverse Osmosis. (TL 1; CO 3: 100%)

Answer any five of the following

(5x5= 25 marks)

13. Explain Activated Sludge Process (TL 4; CO 3: 100%)
14. Explain Polluter Pays Principle, Explain a case study (TL 3; CO 3: 100%)
15. Write a note on management of medical and hospital wastes (TL 1; CO 6: 100%)
16. Comment on limestone injection and fluidized bed combustion. (TL 3; CO 3: 100%)
17. Give an Account of Anaerobic Waste Water Treatment Methodologies (TL 4; CO 3: 100%)
18. Describe the recycling of e- wastes. (TL 3; CO 6: 100%)
19. Write a note on Coagulation and Flocculation. (TL 3; CO 3: 100%)

Answer any three of the following

(3x10=30 marks)

20. Explain the treatment of Drinking water. (TL 4; CO 4: 100%)
21. What are the basic concepts and methods employed in solid waste collection and disposal. (TL 4; CO 5: 100%)
22. Draw a neat flowchart and explain the processes involved in waste water treatment. (TL 4; CO 3: 100%)
23. Explain the type, characteristics and management measures of hazardous wastes. (TL 4; CO 6: 100%)

Fourth Semester M Sc Degree Examination
Model Question Paper
Branch -Environmental Sciences
ES 542 ENVIRONMENTAL IMPACT ASSESSMENT, DISASTER MANAGEMENT AND SUSTAINABLE DEVELOPMENT

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

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

1. Economic problems of resource depletion and pollution. (TL 2; CO 1:50%; CO (TL 2; CO 1: 100%)
2. EMP (TL 2; CO 1: 100%)
3. Rehabilitation (TL 2; CO 1: 100%)
4. EIS (TL 2; CO 1: 100%)
5. Limits to growth (TL 2; CO 6: 100%)
6. Environmental auditing (TL 2; CO 1: 100%)
7. Matrices (TL 2; CO 1: 100%)
8. Vulnerability (TL 2; CO 3: 100%)
9. Risk (TL 2; CO 3: 100%)
10. Risk transfer (TL 2; CO 3: 100%)
11. Environmental Inventory (TL 2; CO 1: 100%)
12. Relation of development and environmental sectors. (TL 2; CO 1: 100%)

Answer any five of the following

(5x5= 25 marks)

13. Give an account of the nature and scope of Environmental Hazards. (TL 3; CO 3: 100%)
14. What are the hazards posed by dams and reservoirs? Brief the mitigation measures that can be adopted in this case. (TL 3; CO 3: 100%)
15. Describe the environmental guidelines for citing the industry. (TL 3; CO 2: 100%)
16. Comment on the importance of public participation in an EIA. Which are the stages at which public participation can be incorporated? (TL 3; CO 1: 100%)
17. What is risk management? What are its components? (TL 3; CO 4: 100%)
18. Types of EIA. (TL 3; CO 1: 100%)
19. Explain various aspects of environmental auditing and the measures taken in case of any problem in the audit. (TL 3; CO 6: 100%)

Answer any three of the following

(3x10= 30 marks)

20. Elaborate on the Prediction, Perception, mitigation and management of cyclones. (TL 4; CO 3: 60%; CO 4: 40%)
21. Elaborate the steps of an EIA for Thermal Power Plant. (TL 3; CO 2: 100%)
22. Explain environmental risk analysis and the evaluation techniques used for the same. (TL 3; CO4: 100%)
23. Explain resource depletion and SD. (TL 3; CO 6: 100%)

Fourth Semester M Sc Degree Examination
Model Question Paper
Branch -Environmental Sciences
ES 543 ENVIRONMENTAL ECONOMICS, POLICES AND LAWS

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

Write short note on any ten of the following

(10x2= 20 marks)

1. Our Common Future (TL 2; CO 1: 100%)
2. Kyoto Protocol (TL 3; CO 3: 100%)
3. CBA (TL 1; CO 1: 100%)
4. Agenda 21 (TL 2; CO 1: 100%)
5. Eco mark (TL 2; CO 6: 100%)
6. The Wild Life Protection Act (TL 2; CO 4: 100%)
7. Environmental Policy in ancient India (TL 2; CO 4: 100%)
8. Appiko Movement (TL 2; CO 5: 100%)
9. Ecotourism (TL 2; CO 6: 100%)
10. Rio+5 (TL 2; CO 1: 100%)
11. Environmental policy resolution (TL 2; CO 4: 100%)
12. Polluter Pays Principle (TL 2; CO 2: 100%)

Answer any five of the following:

(5x5= 25 marks)

1. Explain the different strategies of formal and non-formal methods that can be employed in the field of Environmental Education. (TL 3; CO 4: 100%)
2. Role and Functions of Central and state pollution control boards. (TL 2; CO 4: 100%)
3. The Air Act 1981. (TL 2; CO 4: 100%)
4. Comment on any one trans-boundary river basin issue in India. (TL 4; CO 5: 100%)
5. The Biodiversity Act 2002. (TL 2; CO 4: 100%)
6. Write a short note on Anti-Pollution Acts. (TL 2; CO 4: 100%)
7. What are the concepts and principles of Environmental Education? What are its benefits? (TL 3; CO 4: 100%)

Answer any three of the following:

(3x10=30 marks)

8. Explain the role of UN authorities in protection of global environment. (TL 2; CO 1: 100%)
9. Sustainable Development - Concepts, Indicators and Models. (TL 2; CO 6: 100%)
10. International and National Conservation Agencies. (TL 2; CO 3: 100%)
11. Explain major strategies of Environmental education. (TL 2; CO 4: 100%)

M Sc ENVIRONMENTAL SCIENCES
IV Semester Practical Examination
ES 544 WASTE MANAGEMENT, IMPACT ASSESSMENT AND DISASTER MANAGEMENT

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

1. Explain Vermi-composting technique/ Biogas production from waste (TL 6; CO 1: 100%)

[10 marks]

2. Describe the operating units of Activated Sludge Process. From the given operational data for a conventional activated sludge treatment, describe the following: (TL 6; CO 2: 100%)

   Aeration period
   F/M ratio
   Efficiency of BOD removal
   Sludge age

   The operational parameters are:

   Waste water flow = 40000 m3/day
   Volume of aeration tank = 10900 m3
   Influent BOD = 300 mg/L
   Effluent BOD = 23 mg/L
   Mixed Liquor Suspended Solids = 35 mg/L
   Effluent Suspended Solids = 35 mg/L
   Waste Sludge Suspended Solids = 9700 mg/L
   Quantity of Waste Sludge = 230 m3/day

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

3. Explain the EIA procedure involved in a hydroelectric/ highway/ high rise building/ mining project (TL 6; CO 4: 100%)

[10 marks]

4. Prepare a disaster management plan with respect to Flood/ Tsunami/ landslide (TL 6; CO 5: 100%)

[10 marks]

5. Field Report (TL 6; CO 6: 100%)

[20 marks]

6. Practical Record

[5 marks]

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