Syllabus

for

M.Sc. Environment Science

(Semester I-II)

I.K. GURJAL PUNJAB TECHNICAL UNIVERSITY, KAPURTHALA

M.Sc. Environment Science (semester system)

Under credit based continuous evaluation grading system

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Scheme

First Semester

Course Code	Course Title	L-T-P	Credits	Internal	External	Marks
MEVS101	Fundamentals of Environment Science	3-0-0	3	25	50	75
MEVS102	Ecology and Ecosystem Dynamics	3-0-0	3	30	70	100
MEVS103	Earth Processes and Natural Hazards	3-0-0	3	30	70	100
MEVS104	Energy and Environment	3-0-0	3	30	70	100
MEVS105	Biodiversity Conservation and Natural resource Management	3-0-0	3	30	70	100
MEVS106	Agriculture and Sustainability	3-0-0	3	25	50	75
MEVS107	Lab Course -I (Ecology and Ecosystem Dynamics)	0-0-4	2	50	25	75
MEVS108	Lab Course-II (Biodiversity Conservation and Natural resource Management)	0-0-4	2	50	25	75
Total			**22**	**270**	**430**	**700**

Second Semester

Course Code	Course Title	L-T-P	Credits	Marks Distribution		Marks
				Internal	External	
MEVS201	Environment Monitoring and Pollution control	3-0-0	3	30	70	100

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MEVS202	Solid and Hazardous Waste Management	3-0-0	3	30	70	100
MEVS 203	Environment Chemistry and Toxicology	3-0-0	3	30	70	100
MEVS204	Analytical Techniques and Instrumentation	3-0-0	3	30	70	100
MEVS 501 MEVS 502	Elective-1 Aquatic Environment Or Laboratory safety	3-0-0	3	30	70	100
MEVS P205	Lab Course-I (Environment Chemistry & Toxicology and Environment Monitoring and Pollution control)	0-0-4	2	50	25	75
MEVS 206	Lab Course-II (Analytical Techniques & Instrumentation)	0-0-4	2	50	25	75
MEVS 207	*Industrial Visit/ Field Trip			Satisfactory/ Unsatisfactory		
Total			**19**	**250**	**400**	**650**

* Industrial visit/ Field trip to the selected locations of environmental significance will be undertaken which will help the students in developing the understanding of different aspects of environmental sciences. Scope of the work duration of field visit and locations will be decided by the faculties. It is mandatory for the students to submit the report of Industrial visit/Field Trip.

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Third Semester

Course Code	Course Title	L-T-P	Credits	Marks Distribution		Marks
				Internal	External	
MEVS301	Climatology and Meteorology	3-0-0	3	30	70	100
MEVS 302	Environment Management Plan: EIA and Auditing	3-0-0	3	30	70	100
MEVS 303	Remote Sensing and GIS	3-0-0	3	30	70	100
MEVS 304	Hydrology and Water Resources	3-0-0	3	30	70	100
MEVS503 MEVS504	Elective-II Environment Toxicology and Bioremediation Or Natural Disaster Management	3-0-0	3	30	70	100
MEVS305	Lab Course-I (EIA and Auditing)	0-0-4	2	50	25	75
MEVS306	Dissertation and Seminar	0-0-3	3	50	-	50
Total		**3**	**20**	**250**	**375**	**625**

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Fourth Semester

Course Code	Course Title	L-T-P	Credits P	Marks Distribution		Marks
				Internal	External	
MEVS 401	Environment Laws, Ethics and policies	3-0-0	3	30	70	100
MEVS 505 Or MEVS 506	Environment Biotechnology Watershed Management	3-0-0	3	30	70	100
MEVS402	Dissertation	0-0-24	15	150	150	300
Total			**21**	**260**	**240**	**500**

List of Optional/Elective Courses to be offered in All Semester

Sr. No	Course code	Course Title	Credit
1	MEVSES 501	Aquatic Environment	3
2	MEVSES 502	Laboratory safety	3
3	MEVSES 503	Environmental Toxicology and Bioremediation	3
4	MEVSES 504	Natural Disaster Management	3
5	MEVSES 505	Environment Biotechnology	3
6	MEVSES 506	Watershed Management	3

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** Dissertation work will begin in third semester and will be continued in fourth semester. At the end of third semester, students will submit their literature work in the form of a review on the topic selected. There will be a presentation before a panel of teachers from the department.

EXAMINATION AND EVALUATION

THEORY				
S.No.		Weightage in Marks		Remarks
1	Mid-Semester Examination	20	15	MSTs, Quizzes, assignments, attendance, etc. Constitute internal evaluation. Average of two mid-semester exams will be considered for evaluation
2	Attendance	5	5	
3	Assignments/ Seminars	5	5	
4	End-Semester Examination	70	50	Conduct and checking of the answer sheets will be at the department level in case of university teaching department of Autonomous institutions. For affiliated colleges examination will be conducted at the university level
	Total	**100**	**75**	
PRACTICAL				
1	Daily evaluation of practical performance/ record/ viva voce	30		Internal Evaluation
2	Attendance	5		
3	Internal Practical Examination	15		
4	Final Practical Examination	25		External Evaluation
	Total	**75**		

PATTERN OF END-SEMESTER EXAMINATION

I. **Part A** will be One Compulsory question consisting of short answer type questions [Q No. 1(a-j)] covering whole syllabus. There will be no choice in this question. It will be of 20 marks comprising of **10 questions of 2 marks each**.

II. **Part B** will be comprising of eight questions [2-9]. Student will have to attempt any six questions from this part. It will be of 30 marks with **6 questions of 5 marks each**.

III. **Part C** will be comprising of two compulsory questions with internal choice in both these questions [10-11]. It will be of 20 marks with **2 questions of 10 marks each**.

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Semester 1

MEVS 101: Fundamentals of Environment Science

Course Objectives:

- **CO1.** To acquire fundamental knowledge of concepts of environment and its components
- **CO2.** Inculcate concern for one's own surrounding and sustainable living; and develop capacity to act at own individual level to protect and management the environment

- **Unit 1: Introduction to Environment Science**: Definitions and concepts in environmental science; Principles and scope of environmental science; Components of environment-atmosphere, hydrosphere, pedosphere, biosphere.
- **Unit 2: Environmental Systems:** Environmental interactions, bio-geochemical cycles; Albedo and heat capacity; Greenhouse effect; Environmental concerns- pollution, population growth, human health, ozone depletion, climate change, global warming etc.
- **Unit 3: Theories and Concepts:** Gaia theory, Environmental Kuznet's curve, Ecological footprint, Environmental ethics, Environmental Conventions and treaties.
- **Unit 4: Sustainable Development:** Concept of sustainable development; Dimensions of sustainable development, The Millennium Development goals, Agenda 21, The Earth charter, Orienting agricultural and industrial systems towards sustainability Environmental degradation and sustainable development. Management of Natural Resources for sustainability
- **Unit 5: Resources management:** Land & water; Agriculture, Forest and Wetland; Common Property Resources (CPRs).

Suggested Books

- Wright RT & Nebel BJ, Environmental Science: Toward a Sustainable Future, 10th Ed. Pearson Educational (2007).
- Manahan SE, Environmental Science & Technology – A sustainable approach to Green Science and Technology, Taylor & Francis (2006).

Course Outcome (CO): After studying this course, student shall be able to:

1. Apply core concepts and methods of ecological and physical sciences in environmental problem solving.
2. Analyse the role of anthropogenic influences on biogeochemical processes.
3. Ability to understand different Environmental problems, their causes and effect
4. Ability to recognize and describe how about resource management and sustainability

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MEVS 102: Ecology and Ecosystem Dynamics

Course Objective

- **CO1.** Describe and define the structural and functional attributes of ecosystems
- **CO2.** Define the concept of biogeochemical cycles and Ecological models

Unit 1: - Ecology: Introduction to ecology, history and scope of ecology, ecological hierarchy, view point of modern ecology, system ecology, human ecology. Elements of ecology – biotic and abiotic and their interactions.

Unit 2: **Ecosystems:** Concept of ecosystem, structure and functions of ecosystem, ecosystem energetics, ecological dynamics and balance. Food chains and food web, ecological pyramids. Productivity in an ecosystem, primary and secondary productivity, ecological efficiency

Unit 3: Biogeochemical Cycles and Ecological Models: Evolution of biochemical cycles, biogeochemical cycles at the biosphere levels. Nutrient cycling at ecosystem level. Ecological models – introduction, analytical and computational models, Predator-prey model of Lotka and Volterra.

Unit 4: Population and Community Ecology: Autoecology (Population ecology) - population characteristics, population dynamics, population growth and regulation. Synecology (Community ecology) - characteristics of community, community structure andcomposition. Methods of studying communities.

Unit 5: Ecological Succession - concepts of ecological succession, general process of succession, types of succession, structural and functional changes in succession. Ecosystem degradation and restoration - factors/threats of ecosystem, restoration of ecosystem.

Course Outcome: After studying this course, student shall be able to

1. demonstrate sound understanding on scientific inquiry in the field of modernecology.

2. structure and functions of ecosystem.

3. examine the main limitations/ stress on patterns of productivity, energy flowthrough natural food webs, and ecosystems dynamics.

Suggested Books

1. Odum EP, Fundamentals of Ecology, Nataraj Publisher, Dehradun (1996)

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2. Kormondy EJ, Concepts of Ecology, Prentice Hall of India (1994)
3. Botkin, Daniel B, Environmental Science: Earth as a Living Planet, John Wiley andSons, New Delhi (2011).
4. Miller G, Tyler and Scott, Spoolman, Essentials of Ecology, Brooks/Cole Learning,USA (2011).
5. Dakshini KMM, Principle and Practices in Plant Ecology, CRC, Boston (1999)
6. Bingro H, Plants- Environment Interaction (3rd Edition), Taylor & Francis Group (2007).
7. Gurevitch J, Scheiner SM, and Fox GA, The Ecology of Plants. Sinauer Associates, Inc. Sunderland, MA, U.S.A (2002).

MEVS- 103 Earth Processes and Natural Hazards

Course Objectives:

- **CO1.**To introduce the basic concepts to understand internal structure of Earth and various internal and external processes.
- **CO2.** To understand various earth system processes which modify the landscapes and relief of the earth
- **CO3.** To analyse the geophysical processes as the drivers of different types of hazards.
- **CO4.** To learn the prevention and mitigation approaches for natural hazards

Unit 1: Introduction to physical system: Origin of the earth. A fundamental of chemistry of earth's various layers. Earth's size, shape, mass, density and rotational parameters., evolution earth's mantle and crust, continental drift, plate tectonics, sea floor spreading, seismic waves, plate boundaries.

Unit 2: Internal Structure and Rock-Air-Water Interactions: Internal structure of the earth in relation to its origin. Chemical composition of its various layers, Hydrosphere and hydrologic cycle. Role of atmospheric circulation and climates in earth. Biosphere: its distribution and origin through ages. Oceans, continents and mountains- their origin, types, relief features and their structures.

Unit 3: Earth's Processes: Exogenetic processes and landforms - denudation, fluvial, aeolian and glacial landforms; Run off process-generation, component, catchment process;

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Weathering and erosion: types and factors controlling erosion processes. Erosion, transportation and depositional processes, relief features and landscapes and evolution of rivers, groundwater, glaciers, wind and oceanic waves.

Unit 4: Mineral Resources and Environment: Rocks – types, formation, minerals, rock cycle. Chemical and mineralogical composition ofthe earth, abundance of elements, geochemical classification of elements, major and trace elements and their partitioning during mineral formation. BiogeochemicalCycles

Unit 5: Natural Hazards: Natural hazards-definitions and associated concepts; Causes, Effects, Impact on environment, Prevention and Mitigation for Natural hazards like River flooding, Earthquake, Drought, Cyclones, Landslides, Tsunami, Volcanoes & Avalanche.

Course Outcomes: After studying this course, student shall be able to

1.describe and explain processes and features within the Earth, particularly within the plate tectonics theory and the resulting geologic structures

2. explain processes operating on the surface of the Earth and the resulting landforms and features

3. describe processes and their relationship to natural hazards

4. describe and explain the most common methods used to mitigate and prepare for each type of hazardous natural process

Suggested Reading

1. Duff D, Home's Principles of Physical Geology, 4th Edn. Chapman & Hall (1992).
2. Emmons WH, Allison IS, Stauffer, CR and Thiel, G.A. Geology: Principles and Processes McGraw Hill (1960).
3. Smith K and Ward R, Floods: Physical Process and Human Impacts, John Wiley and Sons (1998).
4. Krauskopf KB and Bird DK, Introduction to Geochemistry.McGraw-Hill, (1994).
5. Bell FG, Environmental Geology –Principles and Practice, Blackwell Science, (1998).
6. Montgomery CW, Environmental Geology, 7th edition, Mc. Graw Hill, (2006).

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MEVS- 104 ENERGY AND ENVIRONMENT

Course Objectives:

- **CO1.** To understand the interrelationship of energy and environment
- **CO2.** To know the impacts of energy systems on environment

Unit 1: Introduction: Definition, concept and classification of energyresources, History of energy resource and their development, Global energy and its availability, Global energy use in various sectors, Energy use and its implications (atmospheric pollution and climate change), Energy crisis and its solution: development of renewable resources, Renewable Energy Application Park (REAP) for public awareness

Unit 2: Non-Renewable Sources: Fossil fuels: current status and future scenario, limitations, classification, composition, physico- chemical characteristics and energy contents of fossil fuels, Nuclear energy: Status, power generation, energyconversion through fission and fusion, nuclear waste disposal.

Unit 3: Renewable Energy Resources: Solar energy, Wind Energy and Hydropower

Solar Energy: Heat Budget of earth, photothermal, photovoltaic cell, Applications of using solar energy (solar cooker, solar still, solar street light, solar lantern, solar domestic light, solar grain dryer, solar water pump, solar heating system), Wind Energy: History, basic principle, structure of wind mill, advantages and limitations; wind potential at global and national level; Hydropower: Basic principle, status and prospects of hydro power, small hydropower system and their benefits and limitations Hydrogen fuel cell: sources of hydrogen, fuel for vehicles, working of hydrogen fuel cell; future of hydrogen as a energy

Unit 4: Biomass energy: Concept, status and future prospects, generation and utilization, biogas and biofuels, Typres of gasifiers, Biomass energy conversion technologies (Wet & Dry Processes); Magneto Hydro Dynamic Power (MHD): Principle, status, performance and limitations, Geo-thermal Energy: Potential sites, origin, types, estimation of geothermal power, application ofgeothermal energy, environmental issues; Tidal Energy and Ocean Energy: principle, performance and limitations,

Unit 5: Energy Management: Definition and objectives of energy management, Energy Audit: needs, types and methodology, Energy costs: fuel costs, power cost;

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Fuel and energy substitution of limited energy resources, Laws of limiting energy utilization, Emerging Alternate Energy Conversion System, Sustainable use of energy resources; Clean Development Mechanism (CDM).

Course Outcomes:

1. Acquiring scientific and technological understanding on the energy and associated environmentalissues

2. Get acquainted with the environmental impacts of energy technologies

3. Ability to demonstrate understanding of the global, regional and local initiatives for energy conservation and sustainable development.

4. Ability to understand and analyze the energy audit and alternatives sources of Energy

Suggested Books

1. Tiwari GN, Renewable Energy Resources: Basic Principles and Applications, Narosa Publishing House (2005)
2. Rai GD, Conventional and Non-conventional Energy sources, Khanna Publishers (2010)
3. R. A. Ristinen and J. J. Kraushaar, Energy and the Environment, John Wiley and Sons, 1998
4. N. H. Ravindranath, K. Usha Rao, B. Natarajan and P. Monga Renewable Energy and Environment - A Policy Analysis for India, Tata-McGraw Hill, 2000
5. Coley. D. Energy and Climate Change Creating Sustainable Future, John Wiley & sons Ltd. UK, 2008.
6. Soetaert, W. and Vandemme, E. J. Biofuels, John Wiley & sons Ltd. UK, 2009.
7. Nakicenovic N., (ed), Global Energy Perspectives, Cambridge University Press, 1998

Suggested Books

1. William G Cochran, Sampling Techniques, John Wiley (2007).
2. Richard J Larsen and Morris L Marx, An Introduction to Mathematical Statistics and its Applications, Prentice Hall (2011).
3. Spiegel MR & Stephens LJ, Theory and Problems of Statistics (3rd Ed.) Schaum's Outlines (2000).
4. Goon, Gupta and Dasgupta: Fundamentals of Statistics – Vol. I & II (Latest Edition)

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5. Bowker and Liberman, Engineering Statistics, Prentice-Hall (1972).
6. Venkatraman, MK, Numerical Methods in Science and Engineering, National Publisher Company (1999).
7. Berthouex PU, Statistics for Environmental Engineers, Lewis Publ.(1994)
8. Wayne R., Ott Environmental Statistics and Data Analysis, CRC Press. (1995)
9. Spiegel M. R., and Stephens L.J. Schaum's outline of theory and problems of Statistics.McGraw Hill, Singapore, 1999.

MEVS 105: Biodiversity Conservation and Natural Resource Management

Course Objectives

- **CO1.** Understand the importance and conservation of biodiversity
- **CO2.** Encourage the integration of environmental issues and themes into courses and student projects in the basic and natural sciences
- **CO3.** Foster an understanding of fundamental environmental issues, including biological diversity and the preservation of natural ecosystem integrity, both in the University community and the public at large

Unit 1: Introduction: Concepts of biodiversity, Dimensions of Biodiversity, Taxonomic diversity, speciation and extinction of species, mass extinction events, measurement of biodiversity: diversity indices. Megadiverse countries, Ecoregions, Biodiversity hotspots. Importance of biodiversity, threats to biodiversity, causes and consequences of biodiversity loss, biodiversityand vulnerability to climate change, biodiversity and human health.

Unit 2: Conservation of Biodiversity: in situ and ex situ, selection criteria for protection of species, IUCN conservation status, Threatened species, Red Data book, ethics in conservation of biodiversity. Biodiversity related national and international conventions and organizations.

Unit 3: Management of Biodiversity: Sacred groves, Community reserve forest, Reserve forests, National Parks, Wildlife Sanctuary, Biosphere Reserve, Private/corporate forest. Traditional ecological knowledge, CBD, Participatory Rural Appraisal (PRA), Constrains of conservation.

Unit 4: Natural Resource: introduction to earth's natural resources, types of natural resources and theirclassification (Forest, Land, Water, Mineral), value of natural resources, extraction and uses of natural resources-linkages and benefits. Potentiality of natural

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resources for economic and livelihood development.

Unit 5: Conservation and management of Natural Resources: humans and conservation vice-versa, conservation and protection, sustainable use of natural resources. Natural resource management approaches: Community based natural resource management (CBNRM) and Integrated natural resource management (INRM).

Course Outcomes:

1. Understood systematically the biodiversity and its important role.

2. Able to effectively communicate natural resource and environmental issues in written, oral, andvisual formats to professionals and community stakeholders

3. Demonstrate the ability to draw conclusions and make recommendations based on aninterdisciplinary understanding of natural and human system

Suggested Readings

1. Wilson EO, Biodiversity, National Academic Press (1998).
2. Gary AK, Conservation of Natural Resource, Prentice Hall College Div (1991).
3. Khan TI & Sishoshodia YS, Biodiversity Conservation and Sustainable Development, Pointer, Jaipur (2005).
4. Dadlich LK, & Sharma AP (editrs.), Biodiversity Strategies for Conservation, APH Publisher, (2002).
5. Anne E, Magurran, Measuring Biological Diversity, Blackwell Publishers (2003).
6. Anne, E. Magurran and Brian J, Biological Diversity Frontiers in Measurement and Assessment. McGill (Eds.), Oxford University Press (2010).
7. Navjot S Sodhi and Paul R, Conservation Biology for All. Ehrlich (Eds.), Oxford University Press (2010).
8. Pandey BN, Biodiversity Issues Threats and Conservation. Narendra Publishing (2012).

MEVS 106: Agriculture and Environment Sustainability

- **CO1.** To acquaint the student from agricultural as well as other disciplines with conventional and alternative agricultural production practices and their effect on long-term sustainability and environmental quality.
- **CO2.** To show how agricultural scientists are attempting to minimize agricultural pollution and sustain food production adequate for the population.

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- **Agroclimatic zones of India:** heat unit concept; thermal time and thermal use efficiency; cardinal temperature; photoperiodism; thermoperiodism; phenology of crops; meteorological factors associated with pest and disease incidence (potato blight; apple scan; groundnut red hairy caterpillar; locust etc); growing seasons and botanical features of major crops (rice; wheat; maize; sugarcane, rapeseed & mustard and pulses).
- **Micrometerology:** microclimate and micrometereology of crops; day and night radiation, humidity, temperature, wind and CO2 profiles in crop canopies; different methods and modification of field microclimate; light interception of crop canopies as influenced by leaf area index; leaf arrangements and leaf transmissibility; extinction coefficient and radiation useefficiency.
- **Evapotranspiration:** concepts of water balance; evapotransipiration (ET): potential and actual ET, consumptive use and different approaches of ET determination; water use and water use-efficiency; dry matter production and crop yield functions; irrigation scheduling based on ET.
- **Agricultural pollution and sustainability:** Agricultural pollutants and their remediation with special reference to agrochemical (pesticides and fertilizers) and heavy metals; Sustainable agriculture; soil erosion; desertification, watershed management and dryland agriculture.
- **Environment impact:** biomass burning and its impact; Stubble burning in India and its impact (specially Punjab). Interaction between agriculture and landscape degradation; shifting cultivation in hill states and impact on environment; Flood damage on ecosystem due to river flood and related environmental problems; vegetation recovery in degraded land and sandy areas caused by flood.

Suggested Textbooks

- Reddy TY and Reddi GHS, Principles of Agronomy; Kalyani Publishers (2010).
- Panda SC, Agrometeorology and Contingent Crop Planning; Agrobios (India) (2010).
- Arakeri HR and Roy D, Principles of Soil Conservation and Water Management, Oxford IBH Pub. Co. Pvt. Ltd. (2000).

Course Outcomes

1. Ability to demonstrate sound understanding of the concepts of sustainability and agricultural systems.

2. Ability to identifying intricate relationships among crop growth and microclimatic conditions.

3. Ability to appreciate disease-pest cycle and epidemiology and apply in the field.

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MEVS 107-Lab-I (Ecology and Ecosystem Dynamics)

Exercise 1. To determine the Minimum of size of quadrate by species-Area Curve method.

Exercise2. Calculation of frequency, density and abundance ofspecies in a grassland ecosystem/Forest patch.

Exercise 3. Monitoring of biological diversity and calculationof Shannon Wiener diversity index in any ecosystems.

Exercise 4. Calculation of Importance Value Index (IVI) of plant species in a grassland ecosystem/forest patch.

Exercise 5. Estimate the Primary Productivity of any ecosystem.

Exercise 6. Determination of Total biomass.

Exercise 7. Study of Microclimatic variation in two different ecosystems.

Exercise 8. Compare the biomass and net primary production of ungrazed and grazed grassland.

Exercise 9. Determination of organic carbon of a given soil by Walkley and Black method.

Exercise 10. Preparation of inventory of biodiversity of different components of your campus.

Exercise 10. Analysis of various components (producer, consumer, decomposer) of ecosystems of your nearby area (Lake/Pond/Forest/river/Wetland/Grassland).

Suggested Books

1. Odum EP, Fundamentals of Ecology, Nataraj Publisher, Dehradun (1996)
2. Kormondy EJ, Concepts of Ecology, Prentice Hall of India (1994)
3. Botkin, Daniel B, Environmental Science: Earth as a Living Planet, John Wiley andSons, New Delhi (2011).
4. Miller G, Tyler and Scott, Spoolman, Essentials of Ecology, Brooks/Cole Learning,USA (2011).
5. Dakshini KMM, Principle and Practices in Plant Ecology, CRC, Boston (1999)
6. Bingro H, Plants- Environment Interaction (3rd Edition), Taylor & Francis Group (2007).

MEVS 108-Lab-II (Biodiversity Conservation and Natural Resource management)

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1. Preparation of inventory of natural resources of your campus.
2. Inventorization of natural resources of a nearbywater body.
3. Inventorization of natural resources of anyNational Park/Wildlife Sanctuary.
4. To study modern methods of conservation (*in- situ* and *ex-situ*) of species by visiting natural habitat.
5. Inventorization of drivers of depletions of natural resources of nearby ecosystem (grassland/river/ pond /spring).
6. Preparation of an inventory of WCS/IUCN categories of animal and plant species of any National Park/Sanctuary.
7. Preparation of inventory of endangered and extinct species of plants/animals of India Assessment of threats to biodiversity of a given region.

Suggested Readings

1. Wilson EO, Biodiversity, National Academic Press (1998).
2. Gary AK, Conservation of Natural Resource, Prentice Hall College Div (1991).
3. Khan TI & Sishoshodia YS, Biodiversity Conservation and Sustainable Development, Pointer, Jaipur (2005).
4. Dadlich LK, & Sharma AP (editrs.), Biodiversity Strategies for Conservation, APH Publisher, (2002).
5. Anne E, Magurran, Measuring Biological Diversity, Blackwell Publishers (2003).

Semester 2

MEVS 201: Environmental Monitoring and Pollution Control

Course Objectives

CO1. To provide exposure towards environmental monitoring programs and protocols

CO2. Facilitate understanding of the causes, effects of chemicals in the environment on organisms,including humans.

Unit-1: Environmental Monitoring: Concept and objectives of environmental monitoring; Global environmental monitoring system (GEMS); National environmental monitoring programmes; Bioindicators and biological monitoring

Unit-2: Air Pollution: Sources of air pollution; Methods of monitoring of SOx, NOx, CO,

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$PM_{2.5}$, PM_{10}; Effects of pollutants on human beings, plants and animals; Ambient air quality standards; Indoorair pollution (smoke, hydrocarbons, particulate matter, radon); Control of air pollution.

Unit-3: Noise Pollution: Sources of noise pollution; Measurement of noise, exposure levels and standards; Impact of noise on human health; Noise control and abatement measures.

Unit 4: Water Pollution: Major sources of water pollution; Water quality indices; Water quality standards (National and International); Water pollution and human health; Heavy metals and their impact on aquatic life; Sewage and wastewater treatment and recycling; Industrial effluent treatment; Marine water pollution.

Unit-5: Radioactive and Thermal Pollution: Radioactive pollution: causes and consequences; Radioactive fallout, Chernobyl Accident: Three Mile Island accident, Fukushima radio-active leakage; Radioactive waste management; Thermal pollution: causes and consequences.

Unit-5: Soil Pollution: Sources of soil pollution, Effects on pollutants on human beings, plants and animals, Control measures, Bioremediation- approaches and techniques. Land farming and Phytoremediation.

Course Outcomes

1. Understanding of the basic knowledge of environmental monitoring.
2. Get acquainted with the sources, properties and ill-effects of important pollutants in air, water and soil.

Suggested Books

1.Flagan RC and Seinfeld JH, Fundamentals of Air Pollution Engineering, Prentice Hall (1988).

2. Perkins HC, Air Pollution, McGraw Hill (2004)

3. Rao CS, Environmental Pollution Control Engineering, New Age International (2006)

MEVS 202: Solid and Hazardous Waste Management

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Course Objective:

- **CO1.** Facilitate understanding of issues and approaches associated with solid waste, hazardous waste and special category waste management.
- **CO2.** Able to access legal requirements and strategies associated with management of municipal, hazardous and special solid waste.

Unit1: Municipal Solid Waste Management: Definitions, sources, generation, segregation, classification and physico-chemical characterization; principles of solid waste management Resource recovery from wastes; waste exchanges; Composting and vermi-composting of wastes; Microbial decay, Municipal solid waste management programs; Disposal– siting and design; Municipal solid waste rules.

Unit 2: Hazardous and Biomedical wastes: definition, sources of generation, categories, colour coding system for segregation, transportation specifications, treatment methods: Incineration, Microwave, Plasma Pyrolysis and disposal of Plastic waste Treatment and disposal of metal-sharps. Biomedical waste (Handling and management) Rules, 1998;

Unit 3: E-waste: Electronic waste: definition, types of e-waste, sources and generation of e-waste, trade of e-waste, hazardous substances in e-waste, environmental impacts of e-waste, management of e-waste- recycling, processing and disposal, E-Waste (Management & Handling) Rules, 2011. Rules related to recycled plastics, used batteries.

Unit 4: Flyash waste: definition, source, effects and management; Interface of waste and resource management and engineering in the context of sustainable waste management in global cities and developing countries; life cycle analysis.

Course outcome:

1. Understanding and appreciating the environmental pollution and nuisance potential ofmunicipal solid waste and of special category wastes.
2. Awareness of management of MSW and hazardous waste according their characteristics(selection of management technique)
3. Acquiring the knowledge of collection and transportation and solid waste route selectionand types of waste collection.

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4. Regulatory requirement applicable to the handling and management of MSW and specialcategory waste.

Recommended Books

1. Pichtel J, Waste Management Practices: Municipal, Industrial and Hazardous, CRC Press (2005).

2. Kreith F and Tchobanoglous G, Handbook of Solid Waste Management, McGraw Hill (2002).

3. Freeman H, Standard Handbook for Hazardous Waste Management, McGrawHill (1989).

4. Pollution Control Acts, Rules and Notifications Issued Thereunder: Pollution Control Law Series, Central Pollution Control Board, New Delhi (1986).

5. Hester RE and Harrison RM Electronic Waste Management (Issues in Environmental Science and Technology) Ist Edition RSC publishing (2008).

6.Sahai Sushma, Biomedical waste Management, APH Publishing Corporation (2009).

7. Blude AD and Sudaresan BB, Solid waste management in developing Countries INSDOC(1972).

8. LaGrega M., Buckingham, P., Evans, J. and ERM. Inc., Hazardous Waste Management, McGraw Hill (2000).

MEVS 203: Environmental Chemistry and Toxicology

Course Objectives

- **CO1.** Facilitate understanding of the biological effects of chemicals in the environment on organisms,including humans.
- **CO2.** Develop insights into key concepts in the field of environmental toxicology
- **CO3.** To think critically on environmental quality and risk assessment issues

Unit 1: Fundamentals of Environmental Chemistry: Stochiometry, Chemical kinetics, Thermodynamics, Gibbs energy, Chemical Potential, Redox Potential. Acid-base equilibria,

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the carbonate system, pH and pOH, ionic product of water, common ion effect, buffer solutions solubility of gases in water, solubility product, hydrolysis, Filtration, Chemistry of environmental toxicants,

Unit 2: Chemistry of Air: Tropospheric chemistry- Smog and Fog, Stratospheric chemistry, Carbon dioxide emission and Global temperature, Chemistry of atmospheric precipitation, gaseous and particulate pollutants, Atmospheric aerosols

Unit 3: Chemistry of Water: Physico-chemical properties of water, Organic matter and humic matter in water Concepts of DO, BOD, COD, Sedimentation,Coagulation, Chemistry of fresh water, Estuarine process and major ions, Chemistry of marine water

Unit 4: Chemistry of Soil: Formation of soil, Soil profile and classification of soil, Gross composition, Organic and inorganic components of soil, Mechanism of Weathering, Soil pH, Nitrogen pathways and NPK in soils.

Unit 5: Environmental Toxicology: Principles ofToxicology and eco-toxicology; Types of toxic substances; Influence of ecological factors on the effects of toxicity; Sigmoid relationships, Corollary of toxicology, Ecotoxicity: Toxic substances in the environment and their sources and entry roots; Transport of toxicants through air and water and through food chains; Ecosystem influence on the fate and transport of toxicants; Bio-transformation and bio-magnification. Toxicity and Dose-Response: Entry routes of toxicants into human body; Response to toxin exposures (Lethal and sub-lethal doses, Dose- Response relationships); Analysis of NOEL, LD50, LC50 and MLD; Detoxification of human body (mechanisms and organs of detoxification).

Course Outcome

1. Develop sound theoretical background of basic chemistry associated with environmental pollutants

2. Apply basic analytical tools to determine and measure toxicants in various environmental samples

Suggested Books

1. Girad J, Principals of Environmental Chemistry, Second Edition, Jones & Bartlett Publisher (2011).

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Vandana

2. Sawyer CN, McCarty PL and Parkin GF, Chemistry for Environmental Engineering andScience, McGraw Hill (2003)
3. Manahan SE, Fundamentals of Environmental Chemistry, CRC Press LLC (2008) 3rd ed.
4. Shaw IC and Chadwick J, Principles of Environmental Toxicology, Taylor& Francis ltd. (1998)
5. Manahan S, Environmental Chemistry, CRC Press (2017)
6. Cengel Y and Boles M, Thermodynamics- An Engineering Approach, McGraw-Hill (2017)
7. Nag PK, Engineering Thermodynamics, McGraw Hill Education (2017).

EVS 204: Analytical Techniques and Instrumentation

Course Objectives

CO1. To develop the skills to understand the theory and practice of analytical techniques

CO2. To provide scientific understanding of analytical techniques and detail interpretation of the result

Unit 1: Spectrophotometry: Rotational and vibrational spectroscopy, Basic principle, working and application of FTIR, UV-Vis Spectrophotometry, Flame photometry, Atomic absorption spectrophotometry AAS), Fluorescence spectrophotometer.

Unit 2: Optical Spectroscopy: Basic principle, working and application of Transmission electron microscopy (TEM), and Scanning electron microscopy (SEM).

Unit 3: Thermal and X-ray methods: Basic principle, working and applications of DTA-TGA, X-ray diffraction (XRD), X-ray fluorescence (XRF)

Unit 4: Chromatography: Principle of chromatography, Classifications of chromatography, Techniques of planar and column chromatography, Gas chromatography, High-performance liquid chromatography (HPLC)

Course Outcome

1. Ability to demonstrate sound understanding of analytical techniques applied in environmental analyses.

2. Ability to design of monitoring and analytical experiments and conclude the findings.

Suggested Readings

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1. Quantitative Chemical Analysis, 8th Edition, by Daniel C. Harris, W. H. Freeman and Co. (2006),
2. The Solutions Manual for Quantitative Chemical Analysis 8th Ed. (2010).
3. Skoog, Holler, Nieman, Principles of Instrumental Analysis, Fifth Edition (1997).
4. Gary D. Christian, Purnendu K Dasgupta, Kevin A Schug, Analytical Chemistry (2013) .
5. Rouessac, Francis, and Annick Rouessac, Chemical analysis: modern instrumentation methodsand techniques. John Wiley & Sons (2013).
6. Kemp W., Organic Spectroscopy, ELBS Macmillan (1991).
7. Helfrick D and Cooper WD, Modern Electronic Instrumentation and MeasurementTechniques, Prentice Hall of India, New Delhi (1997).
8. Banwell C. N. and McCash E. M., Fundamentals of Molecular Spectroscopy 5th ed, McGraw-Hill (2013).
9. Hollas J. M., Modern Spectroscopy, 4th edition, John Wiley & Sons, Ltd., Chichester (2004).

MEVS 205: Lab-I (Environment Chemistry and Toxicology and Environmental Monitoring and Pollution control)

1.Determination of dissolved oxygen (Winkler's method) in a given sample of water

2. Determination of pH of water and Soil

3. Determination of Chloride contents in a givensample of water

4. Determination of total dissolved solids (TDS)in a water sample

5. Determination of free CO_2 in a given sample of water

6.Estimation of Potassium and Sodium in a givensample of water and soil

7. Determination of alkalinity in water and soil samples

8.Estimation of Calcium, phosphates and nitrates in a water sample

9.Quantitative analysis of heavy metals in environmental samples. Lead, Cadmium, Mercury, Chromium andArsenic in air, water and soil samples

10.Determination of noise levels at different places

Suggested Books

- Girad J, *Principals of Environmental Chemistry,* Second Edition, Jones & Bartlett Publisher (2011).
- Manahan S. E. (2010) Environmental Chemistry, Ninth Edition, CRC Press.
- Environmental Chemistry, Sharma & Kaur, krishna Publishers
- Environment Pollution Analysis, S.M. Lhopar, Wiley Eastern

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4.

MEVS 206: Lab-II (Analytical Techniques & Instrumentation)

1. Principle, working and handling of pH meter.
2. Principle, working and handling of Turbidity meter.
3. Principle, working and handling ofConductivity meter.
4. Principle, working and handling of Fluorescence spectrophotometer.
5. Principle, working and handling UV-ViS Spectrophotometer.
6. Principle, working and handling of IR spectrophotometer.
7. Principle, working and handling of Gas Chromatograph.
8. Principle, working and handling of HPLC Chromatograph.

Suggested Readings

1. Quantitative Chemical Analysis, 8th Edition, by Daniel C. Harris, W. H. Freeman and Co. (2006),
2. The Solutions Manual for Quantitative Chemical Analysis 8th Ed. (2010).
3. Skoog, Holler, Nieman, Principles of Instrumental Analysis, Fifth Edition (1997).
4. Gary D. Christian, Purnendu K Dasgupta, Kevin A Schug, Analytical Chemistry (2013) .
5. Rouessac, Francis, and Annick Rouessac, Chemical analysis: modern instrumentation methodsand techniques. John Wiley & Sons (2013).
6. Kemp W., Organic Spectroscopy, ELBS Macmillan (1991).
7. Helfrick D and Cooper WD, Modern Electronic Instrumentation and MeasurementTechniques, Prentice Hall of India, New Delhi (1997).

Elective Subjects:

MEVSES 501: Aquatic Environment

Course objectives

CO1. Explain basic population, community ecology, and ecosystem-level concepts.

CO2. Think critically and solve problems using evidence-based reasoning.

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CO3. Evaluate ecology, evolution, and natural resource management concepts in a global context.

Unit 1: Introduction- Introduction to aquatic system, physicochemical properties of fresh water; Heat budget of water bodies; Oxygen and other dissolved gases;

Unit 2: Life in Fresh water: - Phytoplankton, periphyton, zooplankton, fish, benthic organisms and Macrophytes; Microbiology of freshwaters; Primary and Secondary production, Production Processes and factors influencing them; Food-chain dynamics and energetic; Detritus and Carbon cycle; Comparative study of lentic and lotic ecosystems;

Unit 3: Wetland & Estuarine ecosystem: Introduction, Types and functions, life in wetlands, Conservation of wetlands, Ramsar convention. Land-water interactions; estuaries-mangroves- lagoons- salt marshes.

Unit 4: Marine Ecosystem: Introduction-Classification- open ocean- shallow marine and deep sea environment- marine resources- marine ecology- marine organisms-productivity-coastal environment-coastal water movement- beaches- coastal dunes- barrier islands- cliffed coast- deltas-coast line- coral reefs. Chemical processes in the aquatic environment with respect to chemical nature of water; sources, pathways and reservoirs of contaminants in aquatic systems. Applied Limnology; Water Pollution, Eutrophication; Wastewater treatment, Water quality management and modeling; Aquaculture; Water quality standards; Monitoring water quality; Methods of water and waste-water analysis.

Course Outcomes:

1.Synthesize information on the physical, chemical and biological factors that influence freshwater environments

2. Demonstrate skills in the identification of aquatic organisms and what their presence or absence means for the quality of the waterbody.

Suggested Books

1. Garrison, Tom S, Robert Ellis Essentials of Oceanography, 8th Edition, Brooks/Cole (2017)

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2. Tyler Miller's G, Living in the Environment 14th Edition, Cengage (2006).
3. Wetzel RG, Limnology: Lake and River Ecosystems. Third Edition, Academic Press (2001).

MEVSES 502: Laboratory Safety

Course Objectives

CO1. Students will be able to identify safety equipment in the lab

CO2. Students will acquire knowledge to explain the purpose and use of lab safety equipment

Unit 1: Basic laboratory manners, Common-Sense Rules, Experimental Data Recording, Possible laboratory hazards, Safety, Security and Risk assessment, Handling dangerous equipments, Accidents and First-aid, Procedures after the first aid

Unit 2: Handling of hig pressured gas, Classification of hazardous chemicals, Chemical regulations, Development of instrument management system, Maintenance of instruments and Importanceof instrument calibration, Quality control and Quality assurance

Unit 3: Safety-Precautions in the processes and operations involving explosives, flammables, toxic substances, dusts, vapours, cloud formation and combating. Safety precautions for transportation for hazardous chemicals. Handling and storage of hazardous chemicals. colour coding. Risk assessment and on-site and off-site emergency planning. Respiratory personal protective equipment (RPPE)& non respiratory personal protective equipment (NRPPE): head protection, ear protection, face and eye protection, hand protection, foot protection and body protection. Quality control of protective equipments.

Unit 4: Types of experimental waste, Classification of hazardous wastewater, Handling of unknown chemicals, Material Safety Data Sheet (MSDS), Pollutant Release and Transfer Register (PRTR).

Course Outcomes

1. Understand and analyses the Industrial hygiene and chemical safety procedures

2. Understand the general knowledge of good laboratory safety practices and the laboratorysafety rules.

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3. Evaluate Standard Operating Procedures (SOPs) and safety plans for handling dangerous samples, equipment's and chemicals.

4. Ability to handle dangerous chemicals

Suggested Books

1. Industrial Hygiene & Chemical Safety - M.H. Fulekar: I. K. International Publishing House, New Delhi.
2. Industrial Hygiene Reference and Study Guide- Allan K. Fleeger, Dean Lillquist, AIHA (2006)
3. Barbara A Plog, Patricia J Quinlan, Fundamentals of Industrial Hygiene National Safety Council Press (2002).
4. Willie Hammer, Dennis Price Occupational safety management and engineering, Prentice Hall (2001).
5. Asfahl C Ray, David W Rieske, Industrial Safety and Health Management, Prentice Hall, 31-Jul-2009
6. Fundamentals of Occupational Safety and Health, Mark A. Friend, James P. Kohn, Government Institutes, 16-Aug-2010
7. Handbook of occupational safety and health, Louis J. DiBerardinis, John Wiley (1999).
8. Gardiner, Occupational Hygiene, Blackwell Science, Harrington, Oxford (1995).
9. Micheal S Bisesi, Industrial Hygiene Evaluation Methods, CRC Press (2003).

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Syllabus

M.Sc. Environment Science

(Semester III-IV)

I.K. GURJAL PUNJAB TECHNICAL UNIVERSITY, KAPURTHALA

M.Sc. Environment Science (semester system)

Under credit based continuous evaluation grading system

Semester III

MEVS 301: Climatology and Meteorology

Course Objectives (CO)

CO1. Ability to demonstrate sound understanding of the atmosphere and climate as integral part of the physical environment.
CO2. Ability to appreciate the interaction between earth and atmosphere system, particularly the microclimate
CO3. Ability to integrate and use meteorological knowledge in the matrices of environmental research

Unit 1: The earth systems and Atmosphere

The earth and the atmosphere system, Overview of the structure and composition of the atmosphere; Energy for the earth-atmosphere- sun relation, rotation revolution and variation of energy received, radiation and atmospheric interaction.

Unit 2: Meteorology

Meteorology fundamentals- temperature; pressure, pressure belts, wind and atmospheric circulation; atmospheric moisture- condensation, formation of precipitation, dew, fog and clouds; atmospheric stability (-lapse rate, adiabatic process, mixing height.), world latitude zones.
Micrometeorology- introduction to Atmospheric boundary Layer (ABL), microclimate of vegetated surface, urban microclimate- factors that modifies meteorological process in urban area, modified process and observed results, Urban Heat Island (UHI), thermal comfort.

Unit 3: Weather system

Tropical system- equatorial trough, ITCZ, jet streams, vortices; monsoon. Natural and atmospheric extreme events: Tropical cyclone, thunder storms, tornadoes, flood, cloud burst, drought.

Unit 4: Climate

Climate- elements of climate, climate control; classification of climate, degree days, thermal comfort. Climate of India; spatial and temporal patterns of climatic parameters- temperature, rainfall and its variability in India. Oceans and international variations in climate (El Nino, ENSO, La Nina).

Course Learning Outcomes (CLO)

CLO1. Ability to understand the atmosphere and climate as integral part of the physical environment.
CLO2. Ability to integrate and use meteorological knowledge in the matrices of environmental research
CLO3. Ability to integrate and use of weather and climate knowledge in the matrices of environmental research.

Suggested Books

1. Ahrensand R.C.D., Hensen, 2013. Meteorology Today: An Introduction to weather climate and theEnvironment. 10th Edition. Brookes/ Cole Cengage Learning.
2. Oliver J.E. and Hidore J., 2003. Climatology: An atmospheric science, Second Edition, Pearson Education.
3. Thornthwaite C. W.,1948. An Approach toward a Rational Classification of climate. Geographical Review, 38(1), 59-94.
4. John M. Wallace, Peter V. Hobbs, 2006. Atmospheric Science, Second Edition: An Introductory survey (International Geophysics) 2nd Edition, Academic Press.
5. Valdia K.S., 1987. Environmental Geology, Tata-McGraw Hill.
6. Robin Mcllveen, 2010. Fundamentals of Weather and Climate, Second edition, Oxford University Press.
7. Lutgens Frederick K., Tarbuck Edward J., 2011. The Atmosphere: An Introduction to Meterology, Prentice- Hall.
8. Donald C. Ahrens, 1994. Meteorology Today: An Introduction to weather, Climate and Environment, Brooks/Cole.

MEVS 302: Environment Management Plan: EIA and Auditing

Course Objectives (CO)

CO1. Understanding of concept of EIA and procedure and policies
CO2. To develop the skill of environment auditing
CO3. Understanding environment management plan and sustainable development

Unit 1: Environmental Impact Assessment (EIA)

Concept, scope and objectives of EIA; Evolution of EIA and its development; Developmental projects under EIA; Protocol for environmental impact statement (EIS); EIA Laws and Policy: An overview; EIA guidelines 1994: Notifications of Government of India; EIA Notification 2006 and subsequent modifications, Corporate Social Responsibility (CSR).

Unit 2: Methods of Impact Analysis

Procedure of EIA; Screening, scoping and baseline data collection for EIA; Impact prediction on air, water, land, biota, socio-economic environment; Impact assessment methodologies (Ad-hoc, Simple Checklist, Overlays, Matrices, Network, Combination Computer aided); Concept of Cumulative Environmental Impact Assessment (CEIA), Case studies of EIA:

River valley projects, mining, roadconstruction, industries

Unit 3: Statuary Clearance Procedure and Public

Expert Appraisal Committee (EAC); Environmental Clearance, Wildlife Clearance and Forest Clearance; Permission for carrying out survey and investigation; State Expert Appraisal Committee (SEAC) and State EIAAuthority (SEIAA); Concept and objectives of Public Consultation: Techniques and consultation approach for public consultation.

Unit 5: Environmental Auditing and Environment Management Plan (EMP)

Environmental Auditing- Principles and guidelines of environmental auditing, General Audit: Methodology and basic structure of environmentally auditing Preparation and submission of audit report to the regulatorybodies, ISO 14000 series: ISO 9001, 9002.
Environment Management Plan- Concept, objectives and scope of environmental Management; Environmental management in terms of developmental projects, Guidelines for EMP; Development of EMP- air, water, groundwater, noise, land and biodiversity, Rehabilitation and resettlement; Compensatory afforestation; Green belt development; EMP of any development project (Case study).

Course Learning Outcomes (CLO)

CLO1. Ability to appreciate the philosophies and historical development of EIA in India and elsewhere.
CLO2. Ability to demonstrate sound understanding of the EIA process and the methodologies toprepare an EIS.
CLO3. Ability to critically examine development actions with the fundamentals understanding of EIA and sustainable development.

Suggested Books

1. Munn R.E., 1979. Environmental Impact Assessment -Principles and Procedures, Scientific Committee on Problems of the Environment (SCOPE)-5.
2. Petts J., 1995. Handbook of Environmental Impact Assessment, Taylor & Francis.
3. Sadler B. and McCabe M., 2002. Environmental Impact Assessment: Training Resource Manual, UNEP.
4. EIA manual. Ministry of Environment and Forests, Government of India (http://www.envfor.nic.in/legis/eia/so195.pdf).
5. EIA notification, 2006. Gazette Notification:SO1533dated14-09-2006, MOEF. GOI.
6. ISO19011:2018: Guidelines for auditing management systems.

MEVS 303: Remote Sensing and GIS

Course Objective (CO)

CO1. To analyse the remote-sensed data for solving geospatial problems.
CO2. To understand the importance and applications in different areas of environment

CO3. To develop skill to understand and analyse GIS data and statistics

UNIT- 1: General Introduction to Remote Sensing

Definition, concepts and scope of remote sensing; History of remote sensing; remote sensing and its components, Electromagnetic radiations (EMR) and electromagnetic spectrum and atmosphere window; Earth's and atmospheric interaction with EMR; Spectral reflectance of vegetation, soil and water, Platforms, Sensors & Resolution.

UNIT- 2: **Digital Image Processing and Image Interpretation**

Satellite image– characteristics and formats, Image histogram, Introduction to image rectification, Image enhancement, Principals involved in thermal IR image and microwave image interpretation. Applications of different types of images in earth Sciences, Environmental Sciences, urban planning, water resource management, Forestry, Soils, Hazard management, disaster management.

UNIT- 3: **Geographic Information System (GIS)**

Basic concepts of geographic data, GIS and its components, Data models, Topology, Process in GIS: Data capture, data sources, data encoding, geospatial analysis, Map projection, defining spatial relationships, Spatial Analysis, measurements, queries, buffering and neighbourhood functions, map overlay, network analysis, spatial interpolation.

UNIT–4: RS and GIS Applications and Environmental Statistics techniques

GIS and RS Applications in Environment Sciences EIA, land use/land cover mapping, groundwater, Mining, Forest Management, Characterization & monitoring of biodiversity, mapping of Wetlands. Statistical techniques for Environmental modelling. Measurement of central tendency- (mean, mode and median), Dispersion-standard deviation, standard error, mean deviation and coefficient of variation; Simple and multiple correlation and regression coefficient; Basic laws and concept of probability; Test of hypothesis and significance; t, F, chi square tests; ANOVA.

Course Learning Outcomes (CLO)

CLO1. Building the foundation for understanding Remote Sensing and Geographic Information system (RS-GIS) as a powerful tool for geospatial analysis.
CLO2. Learn about data and sources (RS based and other sources, field data) and GIS software.
CLO3. Ability to apply GIS Principles and Techniques.
CLO4. Obtain basic capability in skills and functional knowledge to carry out GIS (RS-GIS) based environmental applications.
CLO5. Ability to demonstrate sound understanding on descriptive and analytical statistics and apply statistical techniques for environmental modelling.

Suggested Books

1. Estes J. E. and Senger L.W., 1973. Remote Sensing Techniques for Environmental Analysis, John Wiley and Sons, New York.
2. Murali Krishna I.V., 1995. Remote Sensing and GIS for Environmental Planning, Tata-McGraw Hill.
3. Singh R.B., 1992. Environmental Monitoring: Applications of Remote Sensing and GIS, Geocarto International Centre, Honk Hong.
4. William K. Pratt., 2001. Digital Image Processing, John Wiley & Sons.
5. Bonham Carter G.F., 1995. Geographic Information Systems for Geoscientists, Volume 13: Modelling with GIS (Computer Methods in the Geosciences).
6. Otto Huisman and Rolf A.de., 2009. Principles of Geographic Information Systems: An introductory textbook, fourth editions, ITC, Enschede, The Netherlands.
7. William G. Cochran., 2007. Sampling Techniques, John Wiley.
8. Richard J. Larsen and Morris L. Marx, 2011. An Introduction to Mathematical Statistics and its Applications, Prentice Hall.
9. Spiegel M R., and Stephens, L. J., 2017. Theory and Problems of Statistics, Third editions, Schaum's Outlines.
10. Gun, Gupta, and Dasgupta, 2016. Fundamentals of Statistics – Vol. II, World press.
11. John R. Jensen., 2013. Remote Sensing of the Environment: An Earth Resource Perspective, Pearson.
12. Campbell J. B. and Wynne R. H., 2011. Introduction to Remote Sensing, Fifth Edition, Guilford Press.
13. Emilio Chuvieco, 2016. Fundamentals of satellite remote sensing: An Environmental Approach, Second Editions**,** CRC press.
14. Lillesand Thomas M. and Ralph W. Kiefer. Remote sensing and image interpretation. John Wiley and Sons. 2000. 736p.

MEVS- 304 Hydrology and Water Resources

Course Objective (CO)

CO1. To demonstrate sound understanding of the hydrology of earth ecosystem.
CO2. To understand the interaction between earth and hydrosphere system, particularly groundwater transport and soil-water chemistry.
CO3. To develop skill to understand and analyse Integrated water resource management.

Unit 1: Catchment hydrology

The global system, fluxes, reservoirs, and residence times; Evaporation, condensation, precipitation; Regional water balances and resources; Structure and properties of water; Precipitation and Interception; Water and energy balance, Subsurface flow; Infiltration and soil moisture; Hydrographs.

Unit 2: Groundwater transport

Water in natural formations (aquifer, aquitard, aquiclude etc); Hydraulic head; conductivity, permeability, storativity and porosity, Darcy's law, advection, dispersion, adsorption and decay, Steady state groundwater flow & Flow nets; Forces on waterin the unsaturated zone; Tracer techniques.

Unit 3: Hydrogeochemical Processes

Chemical Weathering- Clay mineralogy, Cation exchange and Carbonate mineral equilibrium; Silicate weathering, Carbonate weathering, Contaminant transport Adsorption processes; Hydrogeochemical processes and its role in contemporary environmental scenario.

Unit 4: Water Resource Management

Arsenic and fluoride hydrogeochemistry, Remote sensing and hydrological networks, Desalination, Controlling demand and waste, Integrated water resources management, Case studies.

Course Learning Outcomes (CLO)

CLO1. Ability to quantify mass balance relations and thermodynamic reactions.
CLO2. Ability to understand and describe the major hydrogeochemical processes and parameters that controlmetal mobility in an aquatic system.
CLO3. Ability to explain the differences in water composition that are observed in the environment as a result of differences in soil, geology and climate.

Suggested Books

1. Kenneth N. Brooks, Peter F. Folliott, Joseph A. Magner, 2012. Hydrology and the management of Watersheds, fourth editions, Wiley-Blackwell.
2. Franklin W. Shwartz, Hubao Zhang, 2002. Fundamentals of Ground Water, first edition, Wiley.
3. Madan Mohan das, 2013. Watershed Management, PHI.
4. Chow V.T., Maidment D.R. and Mays L.W., 1998. Applied Hydrology, McGraw Hill.
5. Todd D. K., and Larry W. M., 2004. Groundwater hydrology. John Wiley and Sons.

EVS 305: Lab-I (EIA & Auditing)

1. Presentation of EIA through flowchart

2. Presentation of case study of EIA of any developmental Projects

3. Presentation of procedure of environmental auditing through flow chart

4. To prepare an audit report for submission to the regulatory body

5. Presentation of environmental clearance (EC) throughflow chart

6. Presentation of forest clearance (FC) through flow chart

7. Presentation of wildlife clearance (WC) through flow chart

Semester IV

MEVS 401: Environment Laws, Ethics and Policies

Course Objective (CO)

CO1. To develop understanding of national and international laws related to natural resources and Environment.
CO2. To understand Indian traditional value system and develop sense of responsibility towards environment.

Unit I. National and International Efforts for Environmental Protection

Provision of environmental issues and problems in National and International Agenda; Environmental protection in the Indian Constitution(Article 48A, Article 51A (g); International efforts (Stockholm Conference, Montreal Protocol, Kyoto Protocol and other climate related agreements, Ramsar Convention, CITES.

Unit II. National Environmental Laws-1

Indian Forest Act 1927; The Forest Conservation Act 1980 and Rules 1981and successive amendments; Wildlife Protection Act 1972 and subsequent amendments; Water (Prevention and Control of Pollution) Act 1974 and Rules 1975 and subsequent amendments; Air (Prevention and Control of Pollution) Act 1978 and Rules 1982 and successive amendments. Supreme Court Cases – Ratlam Municipality, Ganga Action Plan, Taj Trapezium, Delhi CNG, Tamil Nadu Tanneries, Doon Valley, Span motels private limited case, Oleum gas case.

Unit III. National Laws –II and Policies

National Environmental Tribunal Act 1995; National Green Tribunal (NGT); Public Liability Insurance Act 1991; Biomedical Waste (Management and Handling) Rules 1998 and successive amendments; Hazardous Waste (Management and Handling) Rules1989; Plastic manufacture, sale & usage rules 2011; CBD, Biological Diversity Act 2002 and Rules 2004, and successive amendments, Scheme of labelling Env friendly products (Eco-marks) study. Forest Policy; Environmental Policy; Water Policy.

Unit –IV. Environmental Ethics

Definition and concept of environmental ethics; Resource consumption patterns and need for equitable utilization; Anthropocentrism, stewardship, biocentrism, ecocentrism, Cosmo centrism; conservation ethics, traditional value system in India

Course Learning Outcomes (CLO)

CLO1. Ability to demonstrate understanding Environmental Laws and policies in India.
CLO2. Ability to critically appreciate national and international laws and policies connected with India.

Suggested Books

1. Thakur Deep K., 2002. Environment Protection Law and Policy of India, Deep Publications.
2. Divan Shayam, 2002. Environmental law and Policy in India: Cases, Material & Statues Paperback, Rosencranz Armin Oxford.
3. Nandimath O.V., 2008. Handbook of Environmental Decision Making in India: An EIA Model (Handbooks Series), Oxford University Press.
4. Sahasranaman P.B., 2012. Handbook of Environmental Law, OUP India.

Elective Subjects

MEVSES 503: Environmental Toxicology and Bioremediation

Course Objective (CO)

CO1. To develop sound understanding of the concept of environmental toxicology and bioremediation.
CO2. To acquire knowledge of toxicants and their interactions and risk assessment studies

Unit 1: Environmental toxicology

Definition and principles, biological and chemical factors influencing toxicity, inorganic and organic toxicants – entry into Environment, cycles and residence time, Toxicity of pesticides, insecticides, heavy metals, Radioactive minerals, fluorides, chemical fertilizers.

Unit 2: Assessment and Monitoring of toxicants

Dose-effect and dose response relationships; Principles of toxicity testing, Acute and chronic toxicity, OECD Guideline, test organism, test species selection, bioassays, statistical tests, Methods of toxicity evaluation at cellular and molecular levels by vitro and in vivo methods, monitoring approaches-indicator populations and indicator species, indicators of ecosystem stress, invertebrate microbio tests.

Unit 3: Bio-monitoring and Risk Assessment

Bioconcentration, bioaccumulation and bio magnifications and its impact, impact of toxicants/ pollutants at cellular and molecular level of plants and animals with special reference to human, Sensitivity of ecosystems. Risk assessment methods, models and management. Biosensors and biomarkers- Concept and approach, advantages, and disadvantages, Molecular marker to toxicants – metabolites as indicators.

Unit 4: Ecosystem Toxicity

Toxicants and Ecosystems: Toxicants and communities in ecosystems, Multilevel tropic interactions and non- tropic interactions, Functional changes in the Ecosystem, Effect of intersections interactions in the environment, model ecosystems- microcosms and microcosms.

Course Learning Outcomes (CLO)

CLO1. Ability to demonstrate sound understanding of the concept of environmental toxicology and bioremediation.
CLO2. Ability to summarize the most relevant terms, principles, and methods in environmentaltoxicology.
CLO3. Ability to recognize the importance of environmental changes and risk assessment studies.

Suggested Books

1. Thompson K.C., Wadhia K., Loibner A.P., 2005. Environmental Toxicity Testing, Taylor and Francis, UK.
2. Calow P.P., 2009. Handbook of Ecotoxicology, Wiley, USA.
3. Newman M.C., 2009. Fundamentals of Ecotoxicology, Third Edition, CRC Press, USA.
4. Johnson E., 2010. Ecotoxicology, Academic Press, New York.
5. Walker C.H., Sibly R.M., Hopkin S. P., Peakall D.B., 2012. Principles of Ecotoxicology, Fourth Edition, CRC Press.
6. Newman M.C., 2012. Quantitative Ecotoxicology, Second Edition, CRC Press, New York.

MEVSES 504: Natural Disaster Management

Course Objective (CO)

CO1. Understanding of earth processes, natural cycles and natural hazards.
CO2. To provide knowledge of disaster and its management and rehabilitation policies.

Unit 1: Earth's Processes and Geological Hazards

Earths processes; concept of residence Time and rates of natural cycles. Catastrophic geological hazards; Study of floods, landslides, earthquakes, volcanism and avalanche; Tsunami, ice sheets and fluctuations of sea levels,marine pollution by toxic wastes; Prediction

and perception of the hazards and adjustments to hazardous activities.

Unit 2: Fundamentals of Disaster

Definition, types of disaster; Natural disasters: hydrological, wind related, geophysicaland climate related; Man-made disasters: nuclear disaster, industrial, Environmental (forest fire), rail, road, air and sea accidents.

Unit 3: Disaster Management

Need for disaster management, Disaster preparedness (concept, nature, plan and mitigation); Disaster response (Plan, communication, logistic management, stress and panic movement, integration of multiple stakeholders); Disaster medicine (Prevention, preparedness, response andrecovery of health problems); Post disaster management (Relief camps, role of voluntaryorganizations and armed forces)

Unit 4: Rehabilitation, Reconstruction and Recovery

Reconstruction and rehabilitation as a means of development; Damage assessment; Role of various agencies in disaster management; Development of physical and economic infrastructure; Information management structure; Education and awareness; Constrain in monitoring and evaluation; Long term recovery and counter disaster Planning.

Course Learning Outcomes (CLO)

CLO1. Ability to understand the geophysical processes as the drivers of different types of hazards.
CLO2. Ability to appreciate how human activities interface with the geophysical processes in causing and / or accentuating natural hazard.
CLO3. Ability to Learn the mitigation approaches, their choices and alternatives.
CLO4. develop foundations for hazard, risk and vulnerability assessment.

Suggested Books:

1. Alexander D.,1993. Natural Disaster, UCL.
2. Bryant E., 1985. Natural Hazard, Cambridge University Press.
3. Chapman, D., 1999. Natural Hazards, OUP.
4. Bell, F.G., 1998. Environmental Geology - Principles and Practice, Blackwell Science.
5. Gilbert M. Masters, Wendell P. ElA, 2015. Introduction to Environmental Engineering and Science, Pearsson.
6. Beven K. and Carling D., 1989. Flood: Hydrological, Sedimentological and Geomorphologic Implications, John Wiley and Sons.

MEVSES 505: Environmental Biotechnology

Course objective (CO)

CO1. To provide knowledge and understanding of current applications of biotechnology to environmental quality evaluation,monitoring, and remediation of contaminated environments.
CO2. To provide a working knowledge of the principles, techniques and current applications of biotechnology to environmental quality evaluation, monitoring, remediation of contaminated environments and energy production.

Unit 1. Microbial growth and Enzyme kinetics

Media design for growth, Kinetic models for cell growth, Design equations based on biochemical reactions, Substrate and product inhibited growth models, Factors affecting microbial growth, Enzyme kinetics, enzyme deactivation kinetics, active and passive immobilization,

Unit II. Microbiology of wastewater treatment systems

Microbiology of waste water treatment unit operations: Aerobic and Anaerobic processes; emerging biotechnological processes in waste – water treatment; Treatment schemes for waste waters of dairy, pulp, dye, leather and pharmaceuticals, distillery process.

Unit III. Solid and Hazardous Waste biotransformations

Sources and management (Composting, vermiculture and methane production); Hydrocarbons, substituted hydrocarbons, polyaromatic hydrocarbons; Microbial biotransformation of pesticides and xenobiotics in environment.

Unit IV. Bioremediation and Biorestoration

Bioremediation of contaminated soils and waste land in- situ and ex-situ bioremediation; Concepts and applications of phytoremediation. Bioreactors and Fermentation: Bioreactor selection criteria and classification; Parameters for control; Design of ideal reactors; Single (Batch, Flow) and multiple reactors. Environmental genetics-Degradative plasmids, release of genetically engineered microbes in environment. Biosafety and Bioethics in Biotechnology**.**

Course Learning Outcomes (CLO)

CLO1.Ability to explain the importance of microbial diversity in environmental systems, processes and biotechnology as well as the importance of molecular approaches in environmental microbiology and biotechnology.
CLO2. Ability to describe existing and emerging technologies that are important in the area of environmental biotechnology.
CLO3. Ability to describe biotechnological solutions to address environmental issues

Suggested Books

1. Wainwright M., 1999. An Introduction to Environmental Biotechnology, Kluwer Academic Press.
2. Scargg A.,1999. Environmental Biotechnology, Longman.
3. Gareth M, Evans, Judith C. Furlong, 2002. Environmental Biotechnology: Theory and Application, John Wiley and Sons.
4. Jjemba P.K., 2003. Environmental Microbiology, Science Publication, USA.
5. Abbasi S. A. and Ramasami E., 1999. Biotechnological methods of Pollution control University Press, Hyderabad.
6. Alan Scrogg, 2005. Environmental Biotechnology, second editions, Oxford University Press, New York.
7. Yuan Kun Lee., 2006. Microbial Biotechnology: Principles and Applications, 2nd Edition, World Scientific Publisher.
8. Rittmann B. and McCarty P., 2006. Environmental Biotechnology: Principles and Applications, McGraw Hill.
9. Mohapatra P.K., 2007. Text book on Environmental Biotechnology, I. K. International, New Delhi.
10. Pelczar M.J., Chan E.C.S. and Kreig N.R., 2002. Microbiology. fifth editions, Tata McGraw-Hill, New Delhi.

MEVSES 506: Watershed Management

Course Objectives (CO)

CO1. To provide guidance on direction for assessment and development of water potential of regimes.
CO2. To facilitate understanding of approaches for maintenance of watershed based ecosystem.
CO3. To develop ability to apply theories underlying the solutions for practical problems of watershed.

Unit I. Watershed development

Concept, Objectives, need, integrated and multidisciplinary approach. Characteristics of Watershed: Size; Shape; Physiography; Slope, Climate, Drainage, Land Use; Vegetation; Geology and Soils; Soils; Hydrology and Hydrogeology; Socio-Economic Characteristics; Basic Data On Watersheds.

Unit II. Erosion and Measures to Control Erosion

Erosion - Types; Factors affecting and effects of Erosion; Estimation of soil loss due to erosion (universal soil loss equation); Erosion control measures: Contour techniques; Ploughing; Furrowing; Terracing; Gully control; Rockfill; Dams;Brushwood dam; Gabion.

Unit III. Water Harvesting and Land Management

Rainwater harvesting; catchment harvesting; Harvesting structures; Soil moisture conservation; Check dams; Artificial recharge; Farm ponds; Percolation tanks. Land Management- Land use and land capability; Classification; Management of forest,Agricultural, grass land and wild land; Reclamation of saline and alkaline soils.

Unit IV. Ecosystem Management

Role of ecosystem, Crop husbandry, Soil enrichment, inter-mixed and strip cropping, Cropping pattern, Sustainable agriculture, Biomass management, Dry land agriculture, Silvipasture, Horticulture, Social forestry and afforestation. Influence of ponding on water quality, Thermal stratification and mixing, Eutrophication and water weeds, Sediment-water interactions, Effects of waste disposal and pollution, Fate of pollutants discharged into water bodies, Self-cleansing capacities of water bodies. Management of catchments/watersheds and prevention of pollution, Flood control, Wetlands and constructed wetlands, Control of weeds and nutrient removal.

Course Learning Outcomes (CLO):

CLO1. Ability to demarcate, characterize and analyse watersheds.
CLO2. Ability to understand the issues and concerns associated with watersheds and to frame the watershed management objectives.
CLO3. Development of skill to examine best management practices for the sustainable management of watershed.

Suggested Books

1. Murthy J.V.S.,1998. Watershed Management, New Age International.
2. Majumdar D.K., 2000. Irrigation and Water Management, Prentice Hall.
3. Awurbs R. and James W.P., 2001. Water Resources Engineering, Prentice Hall.
4. Nathanson J.A., 2002. Basic Environmental Technology. Prentice-Hall.
5. Murthy V.V.N., 2009. Land and Water Management, Kalyani Publications.