

**Ramakrishna Mission Vivekananda Educational and
Research Institute
(RKMVERI)**

(Deemed-to-be-university)

(Declared by Government of India under section 3 of UGC Act, 1956)

School of Environment and Disaster Management

SYLLABUS

Two Years M.Sc. in Environment and Disaster Management

**Faculty Centre for Integrated Rural Development and Management
Ramakrishna Mission Ashrama, Narendrapur
July 2024**

SUMMARY OF THE COURSE

SEMESTER-1		
CODE	TITLE	CREDIT
Unit-1: EDM-107	Fundamentals of Environmental Science	2+1
Unit-2 : EDM-108	Environmental Chemistry	2+2
Unit-3 : EDM-109	Disaster Risk Management: Concepts and Frameworks	2+1
Unit-4 : EDM-110	Environmental Microbiology	2+2
Unit-5 : EDM-112	Ecology and Biodiversity	2+1
Unit-6 : EDM-113	Environmental Geo-Science	2+1
Unit-7 : SCH-101	Spiritual and Cultural Heritage of India-1	1+0
		13+8

SEMESTER-II		
CODE	TITLE	CREDIT
Unit-8: EDM-208	Environmental Policies, Laws, Standards	2+1
Unit-9: EDM-209	Environmental Toxicology	2+2
Unit-10: EDM-210	Disaster Risk Reduction	2+1
Unit-11: EDM-211	Environmental Pollution and Its Control	2+2
Unit-12: EDM-212	Energy and Environment	2+1
Unit-13: EDM-213	Basics of Geo-informatics	2+2
Unit-14: EDM-215	Disaster Management in India	2+2
Unit-15 : SCH-201	Spiritual and Cultural Heritage of India-2	1+0
		15+11

SEMESTER-III		
CODE	TITLE	CREDIT
Unit-16: EDM-309	Climate Change: Issues and Challenges	2+1
Unit-17: EDM-310	Disaster Response, Relief and Recovery	2+1
Unit-18: EDM-311	Solid and Hazardous Waste Management	2+2
Unit-19: EDM-312	Environmental Health and Safety	2+1
Unit-20: EDM-313	Environmental Impact Assessment	2+2
Unit-21: EDM-315	Advanced applications of RS/GIS for Environment and Disaster Management	2+2
Unit-22: EDM-317	Research Methodology and Statistics	2+2

Unit-23	ONE OPTIONAL PAPER	1+1
Unit-23 : EDM-318	Environment Management	1+1
Unit-23 : EDM-319	Environment Economics and Ethics	1+1
Unit-23 : EDM-320	Environment Bio-Technology and Bioremediation	1+1
Unit-23 : EDM-321	Disaster Risk Profiling and Management	1+1
		15+12

SEMESTER-IV		
CODE	TITLE	CREDIT
Unit-24: EDM-404	Dissertation Work Selection of theme – Identification of issues Literature survey - Hypothesis of the study Research methodology Data collection and analysis	0+20
Unit-25: EDM-405	Presentation of Dissertation and Viva Voce	0+06
		0+26

SEMESTER-1

EDM-107

FUNDAMENTALS OF ENVIRONMENTAL SCIENCES

2+1 credit (36+18 hours)

Module-1: Introduction to Environmental Science **8 hrs**

- Environmental science – definition, scope and importance
- Components of environment and their interrelationships
- Multidisciplinary nature of environmental science
- Environmental movements
- Environmental movements in India

Module-2: Atmosphere **4 hrs**

- Chemical composition of atmosphere
- Structure of atmosphere: troposphere, stratosphere, mesosphere, thermosphere
- Ozone layer and its depletion
- Temperature, humidity and precipitation
- Wind: direction, speed, pressure and circulation

Module-3: Lithosphere **4 hrs**

- Chemical and physical composition of lithosphere
- Crust, mantle, outer and inner core of earth
- Rocks, minerals and their classifications
- Soils and their classifications and properties, soil pH, water holding capacity, soil salinity, fertility and productivity
- Oceanic and continental lithosphere

Module-4: Hydrosphere **4 hrs**

- Hydrological cycle and processes, precipitation, evaporation and transpiration, runoff, base flow, infiltration
- Ground water hydrology – origin, classification and profile of groundwater, water bearing characteristics of different types of rocks, water table and piezometric surface
- Hydrologic characteristics of aquifer (unconfined, confined and semi-confined), porosity, permeability etc.
- Laws of ground water movement: Darcy's law, Bernoulli's equation, recharge and discharge areas, safe yield and overdraft

- Rainwater harvesting and artificial recharge, Consumptive and conjunctive use of water, watershed management.

Module-5: Biosphere

4 hrs

- Origin of life on planet – plants, animals, microorganisms and humans
- Evolution of life forms through geological time scale
- Biomes and their classifications - deserts, forests, grasslands, aquatic, tundra, and chaparral
- Interdependence of living things – food chain cycles
- Biodiversity and extinction of species

Module-6: Anthroposphere

4 hrs

- Human settlement and its evolution
- Gradual social change in relation to environment
- Nature vs. Nurture – human interventions in nature
- Dynamics of demography.
- Demography and environment

Module-7: Environment and Sustainable Development

8 hrs

- Global environmental issues and their impacts on development
- Origin and development of the concept of sustainable development
- Definition and meaning of sustainable development
- UN Sustainable Development Goals and their classification
- Status of implementation of Sustainable Development Goals

Practical

- Measurement of dry and wet bulb temperature, pressure, wind speed
- Calculation and conversion of the basic meteorological parameters
- Soil and water pH measurement
- Water holding capacity of soil measurement
- Soil and water salinity measurement

Reading materials

1. R Carson, *Silent Spring*
2. World Commission on Environment and Development, *Our Common Future*.
3. Michael Allaby, *Basics of Environmental Science*
4. Eldon Enger and Bradely Smith, *Environmental Science: A Study of Interrelationships*
5. P H Raven, D M Hassenzahl, M C Hager, N Y Gift, and L R Berg, *Environment*
6. Erach Bharucha, *Text Book For Environmental Science*

EDM-108

ENVIRONMENTAL CHEMISTRY

2+2 credit (36+36 hours)

Module-1: Basic Concepts of Environmental Chemistry **8 hrs**

- Classification of elements with emphasis on potentially toxic elements
- Biogeochemical cycles of elements, saturated and unsaturated hydrocarbons in environment
- Stoichiometry, Gibb's energy, chemical potential, chemical kinetics, chemical equilibrium, mass and energy transfer across various interfaces
- Material balance, laws of thermodynamics, heat transfer process, acid-base reactions, solubility products, solubility of gases in water
- Chemistry of hydrocarbons and its decay

Module-2: Environmental aspects of air-chemistry **6 hrs**

- Chemical composition of air, particles, ions and radicals in atmosphere
- Chemical processes for formulation of inorganic and organic particulate matter
- Thermochemical and photochemical reactions in atmosphere
- Photochemical smog, oxygen and ozone chemistry

Module-3: Environmental aspects of water chemistry **4 hrs**

- Fundamentals of water chemistry
- Concepts of DO, BOD, COD, total hardness, redox potential.

Module-4: Environmental aspects of soil chemistry **8 hrs**

- Soil formation, composition and classification
- Soil profile, soil erosion, soil reaction
- Inorganic and organic components of soil
- Nitrogen pathways in soil, NPK in soils.

Module 5: Toxic chemicals **4 hrs**

- Pesticides and their classification and effect, Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Sc), CO, O₃, PAN, VOC and POP. Carcinogens in the air.

Module-6: Analytical methods in environmental sample analysis **8 hrs**

- Preparation of solutions for standard curves, analytical reagents, standard solution and indicators.
- Titrimetry, Gravimetry, Bomb Colorimetry, Spectrophotometry
- Chromatography (Paper chromatography, TLC, GC and HPLC)

- Flame photometry, Spectrophotometry (UV-VIS, AAS, ICP-AES, ICP-MS)
- XRF, XRD
- Electrophoresis
- NMR, FTIR, GC-MS, SEM, TEM

Practical

- Sampling techniques and sample preparation of soil and water
- Physico-chemical characterization of water, soil and sediment
- Air quality assessment
- Acid-base titration

Reading materials

1. S. E. Manahan, Environmental Chemistry
2. A.K.De, Environmental Chemistry
3. V.Subramaniam, A text book of environmental chemistry
4. G.S. Sodhi, Fundamental concept of environmental chemistry
5. Botkin & Keller, Environmental Science
6. P.R. Sreemahadevan Pillai, A comprehensive laboratory manual for environmental science & engineering
7. Frank Settle, Hand book of instrumental techniques for analytical chemistry
8. Robert G. Mortimer, Physical Chemistry

EDM-109

DISASTER MANAGEMENT: CONCEPTS AND FRAMEWORKS

2+1 credit (36+18 hours)

Module-1: Understanding disasters

2 hrs

- Etymology and history of disasters
- Anger of God
- Wrath of Nature
- Perception and Practice
- Science of disaster

Module-2: Understanding risks of disasters

4 hrs

- Hazards – classification of hazards
- Vulnerabilities – types of vulnerabilities
- Exposures – exposure of population and economy
- Risks of disasters – natural hazards and unnatural disasters
- Measuring risks of disasters

- Module-3: Patterns and Trends of Disasters** **6 hrs**
- Trends of various types of disasters
 - Patterns of losses due to disasters
 - Global and regional trends of disasters and losses
 - Global and local database on disasters
- Module-4: Natural and manmade hazards** **6 hrs**
- Geological disasters
 - Hydro-meteorological disasters
 - Biological disasters
 - Technological disasters
 - Complex and systemic disasters
- Module-5: Disaster Management Cycle** **6 hrs**
- Pre disaster - risk assessment, risk prevention, risk mitigation, risk transfer, disaster preparedness
 - During disaster – disaster response and relief
 - Post disaster – disaster rehabilitation, reconstruction and recovery
 - Disaster Management, Disaster Risk Management, Disaster Risk Reduction
 - Disaster Risk Resilience
- Module-6: Framework of Disaster Management** **8 hrs**
- International Decade for Natural Disaster Reduction (1990-1999)
 - Yokohama Strategy for Safer World (1995-2005)
 - Hyogo Framework of Action: Building Resilience of Countries and Communities to Disasters (2005-2015)
 - Sendai Framework for Disaster Risk Reduction (2015-2030)
 - Targets and indicators of SFDRR
- Module-7: Community Based Disaster Management** **2 hrs**
- Traditional role of communities in disaster management
 - Strength and weakness of communities
 - Empowering communities for effective management of disasters
- Module-8: Participatory Disaster Risk Assessment** **2 hrs**
- Concept and theoretical framework
 - Methods and techniques
 - Tool kit
- Practical**
- Field visit for community based disaster risk assessment

- Analysis of Patterns and Trends of Disasters

Reading materials

1. UNISDR, Living With Risks
2. The World Bank, Natural Hazards, Unnatural Disasters
3. United Nations, Hyogo Framework of Action: Building Resilience of countries and Communities to Disasters
4. United Nations, Sendai Framework for Disaster Risk Reduction 2015-2030
5. Rajib Shaw and R R Krishnamurthy, Disaster Management: Global Challenges and Local Solutions
6. P G Dhar Chakrabarti, Nothing Called Natural Disasters
7. Oxfam, A Practitioner's Guide to Participatory Capacity and Vulnerability Analysis
8. EM-DAT, International Database of Disasters

EDM-110

ENVIRONMENTAL MICROBIOLOGY

2+2 credit (36+36 hours)

Module-1: Concept of three kingdom classification **4 hrs**

- Animal, Plants and Protista, Prokaryotes and eukaryotes
- Participation in elementary cycles of nutrients.

Module-2: Fundamental of Microbiology **4 hrs**

- Classification of microorganisms
- Factor controlling growth of microbes
- Measurement, kinetics and characteristics of bacterial growth in natural and artificial system.

Module-3: Microbiology of Air **4 hrs**

- Factors affecting the survival of microorganisms in air
- Sources of microorganisms
- Air-borne pathogens and its role on public health
- Sampling techniques for microbial air quality

Module-4: Microbiology of Water **6 hrs**

- Common microorganisms encountered in fresh water sources
- Self-purification of water
- Common sources of microbial pollution in water

- Assessment of microbiological quality of water
- Characteristics of pollution indicator microorganisms
- Water-borne diseases and public health

Module-5: Microbiology of Soil

6 hrs

- Beneficial and pathogenic microbes in agriculture
- Soil as a microbial growth medium
- Characteristics of soil microenvironment for microbes
- Interaction of microorganisms and plant in soil
- Role of microorganism in maintaining the soil fertility.

Module-6: Biological Nitrogen Fixation

4 hrs

- Nitrogen fixing organisms, biochemistry of nitrogenase, different types of biological nitrogen fixation.
- Estimation of nitrogen fixing ability of microbes

Module-7: Environmental Biotechnology and Bioremediation

2 hrs

- Basic concept, Role of biotechnology in waste management, Biomass production technology, Bioremediation – definition, types and role of plants and microbes for in situ and ex situ remediation.

Module-8: Elements of Food Microbiology

6 hrs

- Different fermented food (cheese, curd, wine)
- Harmful food born microorganism
- Detection of food-borne pathogens in raw and canned foods
- Bacteriology of milk, outline of the processes of food preservation (pasteurization, sterilization, canning and blanching)

Practical

- Laboratory safety.
- Aseptic techniques
- Microbial culture techniques
- Different types of culture media preparation
- Isolation of microorganisms from air, water and soil.
- Microbial staining, observation and micrometry.
- MPN techniques.
- Isolation of microorganisms of environmental interest.

Reading materials

1. P.D. Sharma, Environment and Ecology
2. P.D. Sharma, Environmental Microbiology
3. Eldor A Paul. Soil Microbiology, Ecology, and Biochemistry

4. Mahua Basu and S.Xavier, Fundamentals of Environmental Studies by
5. Pelczar, General Microbiology
6. Maier, Pepper, Gerba, Environmental microbiology
7. Singh, Singh, Gupta, Ecology Environmental Science and conservation by
8. S. C. Santra, Environmental Science
9. Botkin & Keller, Environmental Science
10. N.S. Subba Rao, Soil Microbiology
11. P.R. Sreemahadevan Pillai, A comprehensive laboratory manual for environmental science & engineering
12. R.C. Dubey and Maheshwari, Practical Microbiology
13. J.G. Cappuccino and N Sherman, Microbiology A laboratory manual
14. K.R. Aneja, Experiments in microbiology plant pathology and biotechnology

EDM-112

ECOLOGY AND BIODIVERSITY

2+1 credit (36+18 hours)

Module-1: Introduction to Ecology

6 hrs

- Scope of ecology, System ecology
- Ecosystem concept, Structure and function, Ecosystem dynamics, energy flow, Different ecosystems with special context of Indian ecosystems, Ecological classification of the aquatic organism
- Concept of Food chain and food web, Problems on food web, , Keystone species
- Structure and function of forest, Lake and agricultural ecosystem.
- Concept of niche and habitat, Niche overlapping, Niche breadth and width, resource partitioning, Gauss's principle, MacArthur study, Competition, Character displacement, Fundamental and Realized niche
- Ecological succession: Primary and secondary succession, concept of sere and climax, Models of succession-inhibition, tolerance, and facilitation
- Biomes: Concept, classification and distribution. Characteristics of different biomes: Tundra, Taiga, Grassland, Deciduous forest biome, Highland Icy Alpine Biome, Chapparal, Savanna, Tropical Rain forest.
- Community ecology: Definition, community concept, types and interaction - predation, herbivory, parasitism and allelopathy. Biological invasions, Community structure and dynamics, Theory of island biogeography, Methodology of community study, Diversity indices, Species density, Ecotone and edge effect, Guild analysis, Study of Broken Stick model, Problems on connectance
- Gene pool, and Ecosystem services

Module-2: Population ecology

6 hrs

- Population growth models, R and K selection, carrying capacity
- Population properties: Density, Age distribution, Growth, Dispersion, Distribution, Interaction, Population regulation, Lotka–Volterra model, Human population size, age structure, adaptation and resilience, Population viability analysis
- Metapopulation, Levin’s model, metapopulation persistence time, correlated extinction
- Concept of diversity and stability, intermediate disturbance hypothesis, predator-prey-population oscillation
- Community development, Connell and Slatyer’s facilitation, inhibition and tolerance model, Trillman’s resource ratio hypothesis.

Module-3: Bio Diversity

8 hrs

- Origin of life and its diversification, and theories of organic evolution
- Concept of Biodiversity and its values, Diversities of life forms (Plants, animals and microbes)- importance of biodiversity, Type of biodiversity- alpha, beta and gamma diversity, Global patterns of biodiversity,
- Causes and consequences of biodiversity loss
- Biodiversity conservation approaches, In situ and Ex-situ conservation, concept of protected area network, Sanctuary, National Park and biosphere reserves, Design and management of protected areas,
- Biodiversity management policies, National and international efforts, Bio-prospecting and Bio-piracy issues.
- Biogeographic zones in India, National action plan for protection of biodiversity - role of Botanical Survey and Zoological Survey in biodiversity documentation and conservation.
- Legal provisions to protect Indian biodiversity
- Concept of Ecological Sensitive Zone (ESZ)

Module-4: Forestry

4 hrs

- Forest types and their distribution, global and India
- Analysis of forest communities, values of forests
- National and International efforts for forest conservation - people’s biodiversity register
- Forest Management Practices
- Scope and Future of National Green Mission

Module-5: Wild Life

4 hrs

- Tools for wildlife research, use of radio telemetry and remote sensing in wildlife research, legal binding of biological materials, concept of bio-patents and PBR
- Threats to wildlife conservation and wildlife trade

- Principles of conservation and management of animal communities,
- Wildlife habitat and behavior studies
- Wildlife census; captive wildlife

Module-6: Threats to bio-diversity

4 hrs

- Threats of biodiversity, overexploitation, fragmentation, habitat loss, poaching of wildlife
- Extinction vortex, Cause of extinction and vulnerability, Population viability analysis, IUCN and Red Data Book
- Man-wildlife conflicts, natural calamities
- Effect of degeneration of biodiversity on future of evolution

Module-7: Biodiversity hotspots

4 hrs

- Hotspots and Mega diversity Countries; Marine biosphere reserve
- India as a mega-diversity nation; flora & fauna of other megadiversity countries; hot-spots of biodiversity; wealth of Indian hot-spots.
- Endangered and endemic species of India

Practical

- Biodiversity measurement techniques- Biodiversity richness and diversity indexes
- IUCN red list categorization- Guideline criteria
- Eco restoration – site visit
- Field Study (under normal and usual condition)
- Audio video Demonstrations
- Case studies related to man animal conflict, habitat development and biodiversity conservation

Reading materials

1. E. Odum, Fundamentals of Ecology
2. S. C. Santra, Fundamentals of Ecology and Environmental Biology
3. P.D. Sharma, Ecology and Environment
4. M. J. Jeffries, Biodiversity and Conservation
5. P K Maity and P. Maity, Biodiversity –Perception, Peril and Preservation
6. Graeme Caughley, John M. Fryxell, and Tony Sinclair, Wildlife Ecology, Conservation and Management
7. O. P. Chaubey, Forest Ecology In India

EDM-113
ENVIRONMENTAL GEO-SCIENCE

Module 1: Earth's Origin and Differentiation **2 hrs**

- Origin of Earth
- Geological time scale
- Primary geochemical differentiation
- Formation of core, mantle, crust, atmosphere, and hydrosphere

Module 2: Minerals, Rocks, and Landforms **4 hrs**

- Concept of minerals and rocks
- Formation of igneous, sedimentary, and metamorphic rocks
- Controls on formation of landforms (tectonic and climatic)

Module 3: Earth's Energy and Atmospheric Dynamics **6 hrs**

- Concept of steady state and equilibrium
- Energy budget of the Earth
- Earth's thermal environment and seasons
- Atmospheric forces: Coriolis force, pressure gradient and frictional force
- Wind fields: Geostrophic and gradient winds
- Climates of India, western disturbances, Indian monsoon, droughts, El Nino, La Nina

Module 4: Soil Science **4 hrs**

- Weathering, erosion, transportation, and deposition of sediments
- Soil forming minerals and process of soil formation
- Identification and characterization of clay minerals
- Soil physical and chemical properties, soil types, and climate control on soil formation
- Cation exchange capacity and mineralogical controls

Module 5: Geochemical Processes **4 hrs**

- Geochemical classification of elements
- Abundance of elements in bulk Earth, crust, hydrosphere, and biosphere
- Partitioning of elements during surficial geologic processes
- Geochemical recycling of elements
- Paleoclimate

Module 6: Hydrology and Hydrogeology **6 hrs**

- Distribution of water on Earth
- Hydrology and hydrogeology

- Major basins and groundwater provinces of India
- Groundwater fluctuations, hydraulic conductivity, groundwater tracers
- Land subsidence and effects of excessive groundwater use
- Groundwater quality and pollution
- Ghyben-Herzberg relation between fresh-saline water

Module 7: Glaciology and Oceanography

8 hrs

- Ice Poles, Mountain Glaciers, Ice Sheets and Permafrost
- Glacial lake geology
- Overview of oceans and seas
- Physical and chemical properties of seawater
- Major ocean currents and circulation patterns
- Ocean's role in climate regulation

Module 8: Natural Resource Management

2 hrs

- Exploration and exploitation of natural resources
- Environmental concerns related to resource exploitation
- Historical perspective and conservation of non-renewable resources

Practical

Projects on specific topics related to environmental geoscience.

Reading materials

1. Earth: An Introduction to Physical Geology by Edward J. Tarbuck, Frederick K. Lutgens, and Dennis Tasa
2. Essentials of Geology by Stephen Marshak
3. Environmental Geology by Carla W. Montgomery
4. Soil Science and Management by Edward Plaster
5. Earth Science" by Edward J. Tarbuck and Frederick K. Lutgens
6. Introduction to Environmental Geology by Edward A. Keller
7. The Blue Planet: An Introduction to Earth System Science by Brian J. Skinner and Barbara W. Murck
8. Principles of Glacier Mechanics by Roger LeB. Hooke
9. Glaciers and Glaciation by Douglas Benn and David Evans
10. Introduction to Physical Oceanography by Robert H. Stewart
11. Essentials of Oceanography by Alan P. Trujillo and Harold V. Thurman
12. Research papers and articles from scientific journal

SCH-101

SPIRITUAL AND CULTURAL HERITAGE OF INDIA -PART I

1+0 credit (18 hours)

Module-1: Personality Development: Western View

- Freud (Id, Ego, the Super ego - Instinctual energy (Libido) Alfred Adler (some ethical value), Carl Jung (Ego-conscious mind- personal unconsciousness, collective unconscious etc.)

Module-2: Personality Development: Oriental View

- Necessity to know our mind - four fold functions of mind; Personality-- An introduction; 'it is personality that matters'; Laws of personality development; Different layers of personality; Man is divine; 'Pleasure is not the goal'; How to change our character; control of our negative emotions, subjective changes

Module-3: Service

- What is service? Concept of service in Religions (Hinduism, Buddhism, Jainism, Christianity and Islam).

Module-4: Approach to Rural Development

- Three tier of organization for conducting rural development - what upper class should do? Ramakrishna Mission's approach to rural development.

Note: Students in groups will prepare a summary of the whole module and give a presentation just before the study leave for end of Semester Exams.

SEMESTER-II

EDM-208

ENVIRONMENTAL POLICIES, LAWS, STANDARDS

2+1 credit (36+18hours)

Module-1: Environmental Policy **6 hrs**

- Environmental Policy – rationale and objectives – factors that influence environmental policy - process of formulation of environmental policy
- National Forest Policy – National Water Policy – National Environmental Policy

Module-2: Environmental Laws **2 hrs**

- Environmental laws –evolution of environmental laws –Constitutional provisions on environmental issues – Powers of the Central, State and Local governments on environmental issues

Module-3: Environmental Laws of India **12 hrs**

- Central legislations on environment - Environment (Protection) Act - Water (Prevention and Control of Pollution) Act - Air (Prevention and Control of Pollution) Act- Factories Act - National Environmental Tribunal Act - National Green Tribunal Act - Wildlife Protection Act - Indian Forest Act - Forest Conservation Act - Forest Dwellers (Recognition of Forest Rights) Act

Module-4: International Environmental Laws **8 hrs**

- Overview of international environmental laws – driving forces and principles – UNFCCC, UNCCD, UNCBD, CITES, IWC, CMS, Basil, Rotterdam and Stockholm Conventions - Adoption and enforcement of International environmental laws in India

Module-5: Environmental Regulations **2 hrs**

- Regulations framed under various Central legislations on environment

Module-6: Environmental Standards: Global **2 hrs**

- Global environmental standards –ISO 14000 Family of Standards - USEPA, OSHA, ACGIH, ASHRAE,ENISO

Module-7: Environmental Standards: National **2 hrs**

- National environmental standards on air, water, noise etc
- Application of environmental standards in different contexts

Module-8: Environmental Information System **2 hrs**

- ENVIS (Environmental Information System)- Objective of the scheme, framework, Overview of ENVIS Centres - role of the centres, monitoring mechanism
- EIACP (Environmental Information, Awareness, Capacity Building and Livelihood Programme)
- Mission LiFE (Life Style for the Environment)

Practical

- Case studies on application and compliance of environmental laws

Reading materials

1. Bare Acts
2. Kohli and Menon, Development of Environmental Laws in India
3. Ved Nanda and George Pring, International Environmental Law and Policy for the 21st Century
4. P G Dhar Chakrabarti, Green Federalism

EDM-209

ENVIRONMENTAL TOXICOLOGY

2+2 credit (36+36 hours)

Module-1: General Principles of Toxicology **8 hrs**

- Basic definition and terminology
- Importance of dose and dose response relationship, Dose-response assessment, No-Observed-Adverse-Effect Level(NOAE), lowest-observed-adverse-effect level (LOAEL), reference dose (RfD), reference concentration (RfC), Slope Factor
- Dose response curve and factor affecting dose response curve
- Testing adverse effects of chemicals and generating dose response data
- Risk and risk assessment: carcinogenic and non-carcinogenic risks, principles and evaluation (use of software for area-specific prediction analysis)

Module-2: Major class of contaminants **6 hrs**

- Inorganic: Metal and metalloids, organo-metalic compounds, inorganic gases.
- Organic contaminants: CFC, organo-chlorine compounds, polycyclic aromatic hydrocarbons, pesticides, herbicides etc.
- Radiation: Source, nature and different types of radiation, protection and control from radiation.

Module-3: Adsorption, distribution, metabolism and elimination (EDME) of toxic agents **8 hrs**

- Passive diffusion, Filtration
- Carrier-mediated transport
- Engulfing by cell
- Gastro-intestinal tract, Respiratory tract, skin, Barriers, Binding and storage organs, Urinary and biliary excretion, Lungs and other routes of excretions
- Detoxification, toxicity in liver, kidney and nervous systems

Module-4: Bio-transformation of toxicants **6 hrs**

- Phase I (Degradation) reactions: Oxidation, Reduction and hydrolysis
- Phase II (Conjugation) reaction: Glucuronide formation, Sulfate conjugation, methylation, acetylation, amino acid conjugation, glutathione conjugation.
- Toxicokinetics, Comet assay (SCGE)

Module-5: Bio-activation and bioaccumulation **6 hrs**

- Epoxide formation, N-Hydroxylation, free radicals and superoxide formation, Activation in gastrointestinal tract.
- Factor affecting bio-accumulations

Module-6: Risk assessment **6 hrs**

- Chronic daily intake (CDI), Evaluation of Cancer risks, Non-cancer risks, hazard quotient (HQ) for a single substance, hazard index (HI) for multiple substances, sensitivity analysis
- Monte Carlo simulation, Mathematical problems on the determination of risk accompanying carcinogenic and non-carcinogenic contaminants,
- Computation of acceptable concentration

Module-7: Ecological risk assessment: an overview. **4 hrs**

- Biomarkers; Bioaccumulation; Biomagnification; Biotransformation, Bioconcentration factor; Bioentry (Pesticides, Parathione)
- Risk assessment; Effects on population and ecosystems; Damage process and action of toxicants; Toxicity of heavy metal (Pb, Cd, Hg and As).

Practical

1. Instrumentation for quantification of toxicological exposure.
2. Dose response curve plotting and significance
3. Calculations of pollution load index, Contamination index and other indices

Reading materials

1. P. D. Sharma, Environmental Biology and Toxicology
2. S. C. Santra, Environmental Science
3. Williams, James, Roberts, Principles of Toxicology
4. Michael C. Newman, Fundamentals of Ecotoxicology
5. Flanagan, Braithwaite, Brown, Widdop and Wolff, Basic Analytical Toxicology
6. Central Pollution Control Board, Guideline for Recognition of Environmental Laboratories under the environmental (Protection) Act, 1986

EDM-210

DISASTER RISK REDUCTION

2+1 credit (36+18 hours)

Module-1: Disaster Prevention and Mitigation

4 hrs

- Disaster Risk Reduction: Conceptual Issues
- Risk Prevention: Concept, Strategies and Limits of Prevention
- Risk Mitigation: Concept and Strategies
- Structural and non-structural mitigation
- Economics of Disaster Prevention and Mitigation

Module-2: Earthquake Risk Mitigation

4 hrs

- Understanding Risks of Earthquake
- Earthquake Resilient Housing and Infrastructure
- Retrofitting of Lifeline Structures
- Training of engineers, architects, planners and masons
- Enforcement of Building Regulations

Module-3: Cyclone Risk Mitigation

4 hrs

- Understanding Risks of Cyclone
- National Cyclone Risk Mitigation Project
- Structural Measures for Cyclone Risk Mitigation
- Non-Structural Measures for Cyclone Risk Mitigation
- Cyclone Resilient Agriculture and Livelihood

Module-4: Flood Risk Mitigation	4 hrs
<ul style="list-style-type: none"> • Understanding Risks of Flood • Structural Measures for Flood Risk Mitigation • Non-Structural Measures for Flood Risk Mitigation • Management of Urban Flood • Trans-border Management of Flood 	
Module-5: Drought Risk Mitigation	4 hrs
<ul style="list-style-type: none"> • Understanding Risks of Drought • Evolution of Drought Risk Management in India • Institutional Framework for Drought Risk Management • Programmes and Schemes for Mitigating Risks of Drought • National Drought Manual 	
Module-6: Mitigation of other Risks of Disasters	6 hrs
<ul style="list-style-type: none"> • Other geological disasters • Other hydro-meteorological disasters • Industrial disasters • Biological disasters 	
Module-7: Capacity Building for Disaster Risk Reduction	2 hrs
<ul style="list-style-type: none"> • Capacity: Concept and Issues • Capacity Development Strategies • Training and Sensitisation • Education and Research • Awareness Generation 	
Module-8: Eco-system based Disaster Risk Reduction	2 hrs
<ul style="list-style-type: none"> • Eco-system, Human Well-being and Disasters • How can Eco-system contribute to DRR • Strategies and Tools of Eco-DRR • Eco-DRR for Flood, Cyclone and Drought 	
Module-9: Mainstreaming DRR in Development	4 hrs
<ul style="list-style-type: none"> • Concepts, Principles and Strategic Approach • Mainstreaming DRR in Development Sectors • Mainstreaming DRR in Project Cycle Management • Tools for Mainstreaming DRR in Development 	
Module-10: Future of Disaster Risk Reduction	2 hrs
<ul style="list-style-type: none"> • Patterns and Trends of DRR since 1990 • Global Goals and Targets of DRR: Prospects and Challenges 	

- Future of DRR.

Practical

- Visit to India Meteorological Department
- Visit to an ongoing Disaster Risk Mitigation Project
- Case study on Disaster Risk Mitigation Project

Reading materials

1. Julio Kuroiwa, Disaster Reduction –Living in Harmony with Nature
2. Jochen Zschau and Andreas Kuppens, Early Warning Systems for Natural Disaster Reduction
3. UNISDR, Towards a Culture of Prevention –Disaster Risk reduction Begins at School: Good Practices and Lessons Learnt
4. NDMA, National Guidelines on Earthquake, Cyclone, Flood, Urban Flood, Drought
5. Planning Commission, Disaster Management – the Development Perspectives
6. P G Dhar Chakrabarti, Mainstreaming Disaster Risk Reduction for Sustainable Development: A Guidebook for the Asia-Pacific

EDM-211

ENVIRONMENTAL POLLUTION AND ITS CONTROL

2+2 credit (36+36 hours)

Module-1: Air Pollution

8 hrs

- Chemical composition of atmosphere (Classification of elements, chemical speciation, Particles, ions and radicals in the atmosphere)
- Sources of air pollution (Natural and anthropogenic sources of air pollution)
- Types of air pollutants (Primary and Secondary pollutants)
- SO_x, NO_x, PAN, PAH, photochemical smog, acid rain, urban heat island phenomenon.
- Organic and inorganic pollutants, their behaviour and fate on local, regional and global scale
- Monitoring of criteria and non-criteria pollutants (Stack sampling with special emphasis on isokinetic sampling)
- Air Quality standards. Effects of air pollutants on human health, plants, animals and materials
- Different aspects of air pollution control - Principle and application of mechanical collectors, Fabric Filters, Gas & Venturi Scrubbers, Electrostatic precipitators
- Global and national standards of air quality

Module-2: Water Pollution **8 hrs**

- Type, sources and consequences of fresh water and ground water pollution
- Case study of Arsenic contamination of ground water with special references to Bengal basin
- Physico-chemical and bacteriological sampling and characterization of water
- Water standards, Sewage and effluent treatment
- Marine and coastal pollution: Types, natural and anthropogenic sources, consequences, effect on human and marine biota
- Control and management-significances of CRZ and integrated coastal zone management
- Global and national standards of water quality

Module-3: Waste Water Treatment **4 hrs**

- Primary, Secondary and tertiary treatment of waste water,
- Principles of coagulation, flocculation, porous media, filtration, disinfection and ion exchange, absorption, Membrane process,
- Major contaminants and natural pathways for their removal from water

Module-4: Soil pollution **6 hrs**

- Sources of soil pollutants
- Physico-chemical and biological sampling and analysis of soil quality, Effect and consequences of soil pollution, Interaction of soil pollutants with soil components
- Soil reclamation strategies
- Industrial effluent and their interaction with soil components
- Role of microorganisms in soil pollution control
- Soil pollution control

Module-5: Noise pollution **4 hrs**

- Concept of Noise, Sources of noise pollution
- Effect of meteorological parameters on noise pollution
- Management of noise and noise-indices (L_{eq} , L_{10} , L_{90} , L_{50} , L_{DN} , TNI)
- Noise exposure levels and standard, Impact of noise on human health, noise abatement strategies
- Noise control measures: active and passive methods
- Global and National standard on noise at various places

Module-6: Thermal, Marine and Radioactive pollution **4 hrs**

- Pollution from industries and thermal power stations, types, causes, consequences and management

- Marine pollution, types, causes and consequences, effects on human and marine biota - management and control of marine pollution
- Radioactive pollution, causes, consequences and management

Module-7: Polymers and plastic degradation

2 hrs

- Polymers and plastic degradation: polymer degradation, photo chemical degradation, disposable synthetic polymers, polymer recycling, role of microorganisms in degradation, micro plastics

Practical

- Application of advanced instruments for monitoring, measurement of pollutants and related studies
- BOD, COD, DO, Acidity, alkalinity
- Visit to different laboratories and industries with pollution applications

Reading materials

1. S. C. Santra, Environmental Science
2. John H Duffus and Howard G J Worth. Fundamental Toxicology
3. M A Subramaniam. Toxicology-Principle and Methods-
4. MahuaBasu and S.Xavier, Fundamentals of Environmental Studies
5. P.D. Sharma, Environment and Ecology
6. S M Khopkar, Environmental pollution analysis
7. P. Narayanan, Environmental Pollution - Principles, Analysis and Control
8. Botkin & Keller, Environmental Science
9. Central Pollution Control Board, Guideline for recognition of environmental laboratories under the environmental (Protection)Act,
10. C V Chalapati Rao, Urban Air Pollution India – Status and Challenges

EDM-212

ENERGY AND ENVIRONMENT

2+1 credit (36+18 hours)

Module-1: Solar energy and environment

2 hrs

- Sun as source of all energy
- Solar radiation and its spectral characteristics

Module-2: Fossil fuels

6 hrs

- Fossil fuels: classification, composition

- Physico-chemical characteristics and energy content of coal, petroleum and natural gas
- Shale oil, Coal bed Methane
- Gas hydrates
- Gross-calorific value and net-calorific value.

Module-3: Renewable energy **6 hrs**

- Hydro-energy, tidal energy, geo-thermal energy, ocean thermal energy, wind power, solar energy (solar collectors, photo-voltaic modules, solar ponds), Bio-energy

Module- 4: Nuclear energy **4 hrs**

- Nuclear energy - fission and fusion
- Nuclear fuels
- Nuclear reactor – principles and types.

Module-5: Energy efficiency **6 hrs**

- Energy codes, energy audit, energy efficiency and energy rating
- Energy efficient production and consumption development
- Energy efficient building codes and design
- Bureau of Energy Efficiency, BEE energy performance star rating of commercial buildings
- Building envelope, performance cost index, co-efficient of performance, energy efficiency ratio
- Green Building, GRIHA Rating Norms.

Module-6: Lighting system **4 hrs**

- Selecting lighting sources - FL, CFL, LED etc.
- Lighting control, emergency lighting, standards - LDS, LES, LENI

Module-7: Energy standards **6 hrs**

- ANSI/ASHRAE/IES Standard energy standard 90.1-2016
- EN 15193- Energy requirements for Lighting; ISO EN 13790:2008 - Energy performance of buildings (industry and residential)
- ISO EN 13790:2008 calculation procedures
- ISO 50001:2011, Energy management systems; Energy code Compliance evaluation (objective methods)

Module-8: Energy use **2 hrs**

- Environmental implications of energy use
- Energy use pattern in India and the world
- Impacts of large scale exploitation of solar, wind, hydro and nuclear energy source

Practical

1. LENI calculation
2. Energy transfer in building envelop
3. Energy sources and consumption pattern of the different countries
4. Energy and Environment related project work

Reading materials

- Richard Wolfson, Energy, Environment and Climate
- Sandeep Kundu and Mohd Nawaz, Sustainable Energy and Environment: An Earth System Approach
- Foster, Ghassemi and Cota, Solar Energy: Renewable Energy and Environment

EDM-213

BASICS OF GEO-INFORMATICS

2+2 credit (36+36 hours)

Module-1: Data Base Management System

4 hrs

- DBMS – concept, formation and management procedure

Module-2: Remote Sensing

8 hrs

- Remote sensing: Introduction and process, agencies and satellite system
- Electro Magnetic Radiation – associated wavelength and frequency, other atmospheric phenomena
- Types of Remote Sensing, Image characteristics, orbits, swath, nadir, orbital calendar

Module-3: Remote Sensing Imageries

10 hrs

- Sensor resolutions and its types
- Digital image and classification, visual image interpretation
- Concepts on co-ordinate system - map, scale, sphere/spheroid, diatums, projection, projection parameters

Module-4: Geographic Information System (GIS)

14 hrs

- Overview of GIS: introduction, components, functions and advantages, application
- Raster and vector data concept - data sources and format, data capture

- (raster/vector/attribute)
- Image processing
 - Practical orientation and demonstration

Practical

1. DBMS- MS Access
2. Introduction to ERDAS Imagine; Geo-referencing
3. AOI tool, Mosaicking and Subsetting, Digital image processing
4. Visual interpretation of digital images
5. Map composition; import/export
6. Introduction with ArcGIS; Raster and vector data recognition, Georeferencing, Reprojection; digitization, creating Geodatabase, feature class and shape file
7. Thematic Map, graphs and Layout; Import and export
8. Preparation and submission of assignment

Reading materials

1. Basudev Bhatta, Remote Sensing and GIS
2. K Elangovan, GIS: Fundamentals, Applications and Implementation
3. Ray, Dwvedi, and Vijayan, Remote Sensing Applications

EDM-215

DISASTER MANAGEMENT IN INDIA

2+1 credit (36+18 hours)

Module-1: Disasters in India

4 hrs

- Hazards
- Vulnerabilities
- Exposures
- Risks
- Pattern and trends of disasters in India

- Module-2: Evolution of Disaster Management in India** **2 hrs**
- Disaster management in ancient and medieval India
 - Disaster management in colonial India
 - Disaster management in post-colonial India
 - Four mega disasters that made difference
 - Report of High Powered Committee (HPC)
- Module-3: Legal and Institutional Framework** **6 hrs**
- Disaster Management Act 2005
 - Disaster Management Authorities at National, State and District levels
 - National and State Executive Committees
 - National Institute of Disaster Management
 - National Disaster Response Force
- Module-4: Role of other Institutions** **4 hrs**
- National Crisis Management Committee
 - Nodal Ministries and Departments
 - Armed Forces
 - Civil Defence
 - SDRF, State Police, Fire Services
- Module-5: Other Stakeholders in Disaster Management** **4 hrs**
- Urban and Local bodies
 - Scientific and technical organisations
 - Academic and research institutions
 - Civil Society and NGOs
 - Private and Corporate sector
 - International and regional organisations
 - Religious and faith based organisations
 - Community based organisations
 - Volunteers
- Module-6: Disaster Management Policy, Guidelines, Plans** **8 hrs**
- National Policy on Disaster Management
 - National Guidelines on Disaster Management
 - National Plan on Disaster Management
 - State Disaster Management Plan
 - District Disaster Management Plan
 - Relief Manuals and SOPs
- Module-7: Disaster Communication System** **2 hrs**
- Early Warning of Disasters in India
 - Disaster communication network

- Emergency Operation Centres at national, state and district levels
- India Disaster Resource Network

Module-8: Financing Disaster Management in India

6 hrs

- National Disaster Response Fund
- National Disaster Mitigation Fund
- State Disaster Response Fund
- State Disaster Mitigation Fund
- Finance Commission Awards

Practical

- Critical review of Disaster Management Plan of a State, District and City

Reading materials

1. Report of the High Powered Committee on Disaster Management 2001
2. Disaster Management Act, 2005
3. National Policy on Disaster Management 2009
4. National Plan on Disaster Management 2016
5. Ministry of Home Affairs, Disaster Management in India
6. P G Dhar Chakrabarti, Financing Disaster Management in India
7. Chapter-8 of the Report of Fifteenth Finance Commission titled Disaster Risk Management

SCH-201

SPIRITUAL AND CULTURAL HERITAGE OF INDIA-2

1+0credit (18 + 0 hours)

Module-1: Service

- Difference between Service and Charity, Types of Service, Gradation of Service, Why should we serve others? A. Practical Reasons, B. Scientific Reasons, Biology, Physics, C. Ethical Reasons, D. Religious Reasons - Islam, Christianity, Hinduism, E. Philosophical Reasons.
- Philosophy of Service- Service of God in Man and Karma Yoga.

Module-2: Regeneration of India

- India - Her Eternal Glory, Her Life Center, Causes for the decay of

India, Regeneration of India and Her Future.

Module-3: Swami Vivekananda on Social Reforms

- Swamiji's view on Social Reforms, Condition of the masses and ways for their uplift, Condition of the Women and ways for their uplift, Social evils and their eradication, All round development of the society, Swami Vivekananda on Organization, Qualities of a successful reformer.

Note: Students in groups will prepare a summary of the whole course and give a presentation of their respective portions just before the study leave

SEMESTER-III

EDM-309

CLIMATE CHANGE: ISSUES AND CHALLENGES

2+1 credit (36+18 hours)

Module-1: Climate Change – Concepts and Issues **4 hrs**

- Concepts of climate change – Climate, weather and climate change – natural and anthropogenic climate change – Climate variation and climate change –Definition of climate change
- Dynamics of climate change – Global Carbon Cycle – Green House Emission –Effects of GHGs
- Issues of climate change - Impacts of climate change – climate change mitigation and adaptation – climate change and sustainable development
- Science of climate change–development of science of climate change – multi-disciplinary character of climate change science

Module-2: Parameters and Projections of Climate Change **4 hrs**

- Rising temperature
- Changing pattern of precipitation
- Melting glaciers
- Sea Level Rise

Module-3: Extreme Climatic Events **4 hrs**

- IPCC Special Report on Extreme Climatic Events
- Increasing frequencies and intensities of cyclonic storms
- Changing pattern of floods
- Growing risks of droughts
- Emerging extreme climatic events
- Slow onset climatic events

Module-4: Models for Climate Change Projections **2 hrs**

- Climate change scenarios, climate models- components of climate models
- AR-1- 1990- Simple emission trend
- AR-2-1995-IS92 Model
- AR-3 and 4 -2001 and 2007- SRES Model
- AR-5-2015-RCP Model
- AR-6-2021-SSP Model
- Net Zero Emission

Module-5: Impacts of Climate Change **4 hrs**

- Impact of climate change on agriculture and food security
- Impact of climate change on water resources
- Impact of climate change on eco-system
- Impact of climate change on human health

Module-6: Climate Change Mitigation **4 hrs**

- Concept of climate change mitigation – how does it differ from disaster risk mitigation
- Strategies for reducing Anthropogenic Green House Gas Emission
- Strategies for enhancing carbon sinks
- Differential responsibilities for climate change mitigation
- Clean Development Mechanism and Carbon Credit

Module-7: Climate Change Adaptation **4 hrs**

- Adaptation, adaptation cycle and adaptive capacity
- Adaptation options, approaches and policy needs
 - Agriculture
 - Water resources
 - Forestry
 - Human health
 - Disaster risk reduction
- Integration of Climate Change Adaptation with Disaster Risk Reduction

Module-8: Climate Convention, Protocol and Agreements **4 hrs**

- Intergovernmental Panel on Climate Change
- UN Framework Convention on Climate Change
- Conference of Parties
- Kyoto Protocol 1997
- Paris Agreement on Climate Change 2015
- Glasgow Climate Change Pact 2021
- Sharm-el-Sheikh Loss and Damage Fund
- Dubai Global Stocktake on Climate Action

Module-9: Climate Change in India **6 hrs**

- Climate risks of India
- National Action Plan on Climate Change and Climate Missions
- State Action Plans on Climate Change
- India's Nationally Determined Contributions to Climate Change
- India's Long Term Low Emission Development Strategy

Practical

- Climate change related project works

Reading materials

1. Mark Maslin, Climate Change: A Very Short Introduction
2. Joseph Rom, What Everybody Needs to Know about Climate Change
3. IPCC, Fourth, Fifth and Sixth Assessment Reports- Summary for Policy Makers
4. IPCC, Special Report on Extreme Climatic Events, Summary for Policy Makers
5. Paris Agreement on Climate Change, 2015
6. National Action Plan on Climate Change
7. R Krishan and others, Assessment of Climate Change over the Indian Region
8. P G Dhar Chakrabarti (ed), Climate Change and Sustainable Development

EDM-310

Disaster Response, Recovery and Reconstruction

2+1 credit (36+18 hours)

Module-1: Disaster Preparedness for Response **6 hrs**

- Scenario building and contingency planning
- Mock drills and table top exercises
- Emergency Support Functions and Coordination
- Logistics and supply chain management
- Emergency Operation Centres

Module-2: Disaster Response **6 hrs**

- Incident Response System
- Evacuation
- Search and Rescue
- Emergency Health Management
- Emergency Humanitarian Assistance

Module-3: Post Disaster Need Assessment **6 hrs**

- Rapid Assessment of Disaster Damage
- Damage and Loss Assessment (DALA)
- Post Disaster Need Assessment (PDNA)
- Case studies on PDNA

Module-4: Disaster Relief and Rehabilitation **6 hrs**

- Humanitarian Charter, Standard and Principles
- SPHERE Core Standards of Relief

- Minimum Standards of Relief
- SDRF Norms for Disaster Relief & Rehabilitation

Module-5: Disaster Reconstruction and Recovery **6 hrs**

- Early recovery and long term recovery
- Inclusive recovery
- Livelihood recovery
- Psycho-social recovery

Module-6: Building Back Better **6 hrs**

- Concept and principles of Build Back Better
- Build back houses and habitat
- Build back infrastructure
- Build back communities

Practical

- Visit to NDRF Battalion Headquarter in Kalyani
- Visit to State Emergency Operation Centre in Nabanna

Reading materials

1. National Plan on Disaster Management, 2016
2. NDMA, National Guidelines on Disaster Management
3. Ministry of Home Affairs, Standard Operating Procedure for Responding to Natural Disasters
4. Sphere Minimum Standards in Humanitarian Response
5. Ministry of Home Affairs, Handbook for Post Disaster Need Assessment
6. Ministry of Home Affairs, Disaster Management in India
7. UN Special Envoy on Tsunami recovery, Key Propositions for Building Back Better

EDM-311

SOLID AND HAZARDOUS WASTE MANAGEMENT

2+2 credit (36+36 hours)

Module-1: Solid waste – composition and characteristics **4 hrs**

- Waste and solid waste – Definition of solid waste - Types of solid waste – sources of solid waste – Municipal solid waste
- Physical composition of solid waste - Density of waste - Moisture content in waste- Size of waste - Distribution of waste

- Chemical composition of solid waste –Lipid – Proteins - Carbohydrates
- Proximate and ultimate analysis of solid waste –Kinetics of waste generation
- Process of waste degradation –Aerobic and anaerobic process of waste degradation

Module-2: Collection, segregation and transportation of MSW **4 hrs**

- Generation of municipal solid waste from different sources –Generation from different income groups
- Collection of municipal solid waste – House-to-house collection of solid waste –Community bin system of collection of waste
- Segregation of municipal solid waste –Segregation of waste at source – Secondary and final segregation
- Transportation of municipal solid waste –stages in transportation of solid waste – Choice of vehicles for transportation –Types of vehicles and other mechanical means for transportation of solid waste

Module-3: Treatment of municipal solid waste **4 hrs**

- Solid waste processing technologies - Mechanical and thermal volume reduction - Biological and chemical techniques for energy and other resource recovery.
- Landfill –Sanitary landfill – Technology and processes of sanitary landfill - Controlled landfill - Open dump of solid waste
- Technology and processes of composting of municipal solid waste
- Incineration of solid waste –Waste-to-energy projects
- Four R's of Municipal Solid Waste Management

Module-4: Municipal solid waste management in India **6 hrs**

- Municipal Solid Waste Scenario in India – Estimates of waste generation in cities –Sources of waste – Composition of municipal solid waste
- Legal and Institutional Framework – Constitutional provisions – Municipal Acts of the States
- Municipal Solid Wastes (Management and Handling) Rules, 2000
- Solid Waste Management Rules 2016 – Responsibilities of different stakeholders
- Collection and segregation of solid waste in large, medium and small cities of India
- Disposal and treatment of solid waste in India – State of landfills, open dumps, composting
- Sustainable Solid Waste Management Strategies in India – Challenges and opportunities

Module-5: Waste to wealth**2 hrs**

- Recycling of waste
- Waste to energy

Module-6: Management of hazardous waste**8 hrs**

- Hazardous waste – Types of hazardous waste –Systems and processes for collection, treatment and disposal of hazardous waste
- Manufacture, Storage and import of Hazardous Chemical Rules, 1989
- Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996
- Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2015
- Hazardous and Other Waste Management Rules 2016

Module-7: Management of other waste**6 hrs**

- Construction waste –Collection and disposal of construction waste - Construction and Demolition Waste Management Rules 2016
- Plastic waste - Plastic Waste Management Rules 2016
- Electronic and electrical waste - E-Waste Management Rules 2016
- Bio-medical waste - Biomedical Waste Management Rules 2016

Module-8: Management of Nuclear and Radioactive waste**2 hrs**

- Nuclear waste
- Radioactive waste

Practical

- Field visit to municipal solid waste disposal and treatment facilities
- Project work on waste management

Reading materials

1. Sunil Kumar, Municipal Solid Waste Management in Developing Countries
2. Shyamala Mani, P U Asnani and others, Improving Municipal Solid Waste Management in India
3. Ministry of Urban Development, Municipal Solid Waste Management Manual, Part-1 and Part-2
4. Subhasis Chattopadhyaya and others, Municipal Solid Management in Kolkata- A Review

EDM-312

ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT

1+1 credit (18+18 hours)

Module-1: Environmental health

4 hrs

- Environmental diseases –types and classification of environmental diseases – growing incidence of environmental diseases
- Zoonotic and vector borne diseases –Toxic metals and elements – pesticides and other organic chemicals –Pesticide and other organic chemicals – Climate change related environmental diseases

Module-2: Environmental health regulations

4 hrs

- Water quality monitoring –air quality monitoring – food safety regulations – solid, liquid and hazardous waste management

Module-3: Occupational health

4 hrs

- Occupational health concepts –Significance of occupational environment for health – agents of occupational diseases –prevention of occupational disease
- Concept of ergonomics, Importance of ergonomics in the workplace, Assessment of ergonomic risks, Design and implementation of ergonomic solutions

Module-4: Safety regulations

6 hrs

- Need for integration of Safety, Health and Environment (SHE), Hazard Identification - Assessment of risk; Risk management
- Principles of Accident Prevention: Accident recording, analysis, investigation and reporting; Onsite and off-site emergency preparedness and response plans; rules and regulations dealing with chemical accidents.
- Protection from Hazardous Materials: Personal protective equipment and clothing; Fire safety; Noise and vibrations; and Principles of noise control.
- Hazardous Material – Storage, Disposal and Safety: Notification of sites; Safety reports; and safety audits.

- Documentation requirements – policy formulation, targets and objectives, standard operating procedure (SOP), record keeping etc. Training requirements.

Practical

- Visit to a factory for exposure to application of safety regulations

Reading materials

1. Robert Friis, Essentials of Environmental Health
2. Charles Reese, Occupational Health and Safety Management – A Practical Approach
3. Government of India, National Occupational Health and safety in India

EDM- 313

ENVIRONMENTAL IMPACT ASSESSMENT

2+2 credit (36+36 hours)

Module-1: Concept of Environment Impact Assessment 8 hrs

- Definition of EIA –objectives - Types of EIA
- Grouping of environmental impacts – direct, indirect, cumulative and induced impacts
- EIA principles and processes –EIA benefits and flaws

Module-2: EIA study planning and management 8 hrs

- Documentation requirements – policy formulation, targets and objectives, standard operating procedure (SOP), record keeping etc. Training requirements
- Questionnaire design on on-site and off-site emergency plans
- Quantitative environmental risk analysis, safety audit and preparation of report and notification of sites

Module-3: EIA standards in India 12 hrs

- EIA regulations in India
- Standards of environmental management in different sectors
- Environmental impact on air, water, soil, noise
- Biological and socio-economic impacts

Module-4: EIA practice in India 8 hrs

- Application of EIA in different sectors

- Case studies on EIA

Practical

- Field study and project work on Environmental Impact Assessment

Reading materials

1. Anji Reddy Mareddy, Environmental Impact Assessment – Theory and Practice

EDM- 315

ADVANCED APPLICATIONS OF RS/GIS FOR ENVIRONMENT AND DISASTER MANAGEMENT

2+2 credit (36+36 hours)

Module-1: RS/ GIS for environment and disaster management 6 hrs

- Advanced GIS softwares for applications for environmental and disaster risk management – an overview
- Role of space faring nations and the UNOOSA
- Role of ISRO, NRSC and the Decision Support System for disaster management

Module-2: RS/GIS for Hazard, Vulnerability and Risk Assessment 10 hrs

- Remote sensing applications in agricultural drought monitoring and forecasting
- Landslide hazard mapping
- Flood hazard mapping
- Storm surge hazard mapping
- Tsunami vulnerability mapping and risk assessment
- Forest fire monitoring

Module-3: Other applications of RS/ GIS for disaster management 10 hrs

- Disaster management planning
- Emergency response
- Damage and loss assessment

Module-4: RS/GIS for environmental management 10 hrs

- Air quality monitoring
- Ground water monitoring
- Watershed management

- Monitoring of forests and grasslands
- Monitoring of river and sea erosion

Practical:

- Case studies
- Exercises

EDM- 317

RESEARCH METHODOLOGY AND STATISTICS

2+2 credit (36+36 hours)

Module-1: Fundamentals of Research 4 hrs

- Concepts related to Science and Research – Definitions, Aims, Characteristics, Types
- Scientific research vs. Commonplace explanation
- Methods, Methodology, Techniques

Module-2: Research Problem and Design 6 hrs

- Research Process: Concept, Major Steps of Research
- Selection and Identification of Research Problem; Research Issue, Problem, Questions, Objectives
- Hypothesis and variables – concept and types
- Research Design – Definitions and Concepts; Types of research design – experimental, quasi-experimental, ex-post facto

Module-3: Measurements and Data Collection procedure 10 hrs

- Tools of Data Collection - Secondary information, Observation – Participant and Non-participant, Interview, Administering written questionnaire, Focus Group Discussion
- Interview - Group interview, Panel interview, Focused interview, Repetitive interview
- Questionnaire – Typology; Procedure of questionnaire development; Pre-testing
- Scaling techniques - Ranking and rating scale, Thurstone’s Equal Appearing Interval Scale, Likert’s Summated rating Scale;
- Measurement – Concepts, Types, Examples, Levels of measurement, Problems of measurement, Reliability and Validity of Measurement

Module-4: Data presentation and interpretation

16 hrs

- Basic Probability: definitions, event and sample space, random variable, joint and conditional probabilities, expectations.
- Measures of Central Tendency, dispersion, skewness and kurtosis: mean, median, mode, range, mean deviation, quartile deviation, standard deviation - definition, properties, advantage and disadvantages, uses; interpretation and conclusion
- Tests of hypothesis –z-test, t-test, X^2 -test, One-way/two-way ANOVA; test significance and confidence limits
- Presentation of data: meaning and importance, characteristics. Data definition, types (qualitative vs. quantitative, primary vs secondary, experimental vs. survey), analysis and interpretation, presenting quantitative data - graphical presentation (bar diagram, histogram, frequency polygon, ogive, pie chart etc.); tabular presentation (univariate, bivariate, multivariate).
- Writing technical/scientific reports: Aims, Types, Format, Language, use of Style Manual

Practical

- Collection of data –Questionnaire development and collection of field data through Personal Interviews/Group interview
- Using computer software for data analysis
- Graphical presentation (Bar diagram, histogram, frequency polygon, ogive, pie chart, etc.); tabular presentation (univariate, bivariate, multivariate).
- Measures of Central Tendency, Dispersion, Skewness and Kurtosis
- Tests of Hypothesis – Z, t, Chi-square, F (ANOVA)
- Scientific report writing

Reading materials

1. Anol Bhattacharjee, Social Science Research: Principles, Methods, and Practices
2. C. R Kothari and G Garg, Research Methodology: Methods and Techniques
3. A. M Gun and A K Gupta, Fundamentals of Statistics. Vol. 1 and Vol-3

OPTIONAL PAPERS

(Students shall have the option to select one out of the optional papers)

EDM-318

Environment Management

1+1 credit (18+18 hours)

Module-1: Management **2 hrs**

- Management – Concept, Process, Theories and Approaches
- Principles and functions of management – Planning – Organising – Staffing – Coordinating - Controlling

Module-2: Environmental Management **4 hrs**

- Identification of environmental issues in an management
- Environmental management in transportation, storage, production, effluent treatment, marketing
- Occupational health and safety in management
- Compliance of environmental laws and regulations
- Roles and responsibilities in environment management

Module-3: Preventive Environment Management **2 hrs**

- Pollution control Vs Pollution Prevention - Opportunities and Barriers
- Cleaner production and Clean technology, closing the loops, zero discharge technologies
- Four Stages and nine approaches of Pollution Prevention
- Technical, economical and environmental feasibility evaluation of Pollution Prevention options in selected industries –
- Preventive Environmental Management over Product cycle.

Module-4: Standards of Environmental Management Systems **4 hrs**

- ISO standards (ISO 14001, 14004, 14005,14006, 14015, 9001, 15001)
- PDCA cycle in ISO 14001:2015 – Plan, Do, Check, Act
- Components of ISO 14001:2015 – Context – Leadership – Planning – Support – Operation - Performance evaluation – Improvement
- EMAS (Eco-Management and Audit Scheme) Standards

Module-5: Environmental audit

2 hrs

- Environmental management system audits
- Roles and qualifications of auditors
- Compliance audits
- Waste audits and waste minimization planning
- Environmental performance indicators and their evaluation

Module- 6: ESG Framework

4 hrs

- Environmental, Social and Governance Framework
- Environment management and Sustainable Development Goals
- Environment sustainability and Corporate Social Responsibility

Practical

Visit to an organization, company, or industry to observe their Environmental Management System and reporting

Reading Materials

1. Environmental Management: Principles and Practice by A. K. Ghosh
2. Introduction to Environmental Management by C. S. Rees
3. Environmental Management in India: Current Status and Future Prospects by P. K. Joshi
4. Principles of Management by Peter Drucker
5. Management: Tasks, Responsibilities, Practices by Peter Drucker
6. Management and Organizational Behavior by Laurie J. Mullins
7. Strategic Management: Concepts and Cases by Fred R. David
8. Environmental Management Systems: An Implementation Guide for Small and Medium-Sized Organizations by William J. R. McLaughlin
9. Environmental Management Accounting: Informational and Operational Benefits by Michael Bennett and Peter James

EDM-319

Environment Economics and Ethics

1+1 credit (18+18 hours)

Module: 1: Environmental Economics

2 hrs

- Definition, Concept and Scope; Historical Development; Importance of environmental economics; Ecological economics; Fundamentals of the economics of environmental resources and common property resources; External costs; Environmental externalities and externality theory; Economic efficiency.

- Module- 2: Sustainable Development and Economic Growth** **2 hrs**
- Economics of sustainable development
 - Hartwick-Solow approach
 - Ecological-economical approach
 - Safe minimum standard approach
 - Measuring Sustainable Development: Indicators and Metrics
 - Green Growth - decoupling economic growth from environmental impact
- Module- 3: Poverty, environment and growth** **2 hrs**
- Poverty, Environment and Economic Growth Linkages
 - Environmental Kuznets Curve
- Module- 4: Environmental Cost-benefit analysis** **2 hrs**
- Direct and indirect environmental costs
 - Direct and indirect environmental benefits
 - Intangible and incomparable environmental costs and benefits
- Module- 5: Economics of Climate Change** **2 hrs**
- Economic Impacts of Climate Change
 - Costs and benefits of mitigation Strategies
 - Costs and benefits of adaptation Strategies and Costs
 - Innovative tools for financing climate change mitigation and adaptation
- Module- 6: Resource Economics** **2 hrs**
- Renewable vs. Non-Renewable Resources
 - Resource Management and Conservation
 - The Tragedy of the Commons
 - Policy Approaches to Resource Management
- Module- 7: Environmental Taxes and Polices** **2 hrs**
- Concept of green tax and green subsidy
 - Polluter pays principles
 - Carbon trading
 - Assessing worthiness of environmental project
 - Legal, fiscal and market policies.
- Module-8: Environmental ethics** **2 hrs**
- Concept of environmental ethics – equity and harmony in nature
 - Equity in production and consumption – consumption and distribution
 - Inter-generational and intra-generational equity
 - Gender equity in environmental management

- Conservation ethics and rights of nature

Practical

- Emerging Issues in Environmental Economics
- Innovations in Policy and Technology
- Future Trends and Research Directions

Reading materials

1. Environmental Economics: An Introduction by Barry Field and Martha Field
2. Environmental Economics and Policy by Ian Bateman et al.
3. Principles of Environmental Economics and Sustainability: An Introduction by Ahmed Hussen
4. Environmental Economics: Theory and Practice by David A. Anderson
5. The Economics of Natural Resources and the Environment by David W. Pearce and R. Kerry Turner
6. Environmental Economics: An Introduction by Barry C. Field and Martha K. Field
7. Risk Analysis and Environmental Decision Making by Dan M. Kahan and Keith H.
8. Green Taxes and Subsidies: Concepts and Practices by David M. P. Brooks
9. Carbon Trading: A Critical Introduction by Peter Newell
10. Environmental Economics: Theory and Practice by Jonathan M. Harris
11. Ecological Economics: Principles and Applications by Herman E. Daly and Joshua Farley
12. Climate Change Economics: Mitigation and Adaptation, Simon Dietz and Nicholas Stern
13. The Economics of Climate Change: The Stern Review” by Nicholas Stern
14. Measuring Sustainable Development: Indicators and Metrics” by Paul Ekins
15. Green Growth and Economic Decoupling” by David C. Stern

EDM- 320

ENVIRONMENTAL BIOTECHNOLOGY AND BIOREMEDIATIONS

1+1 credit (18+18 hours)

Module-1: Macrophytes for Waste Water Treatment

2 hrs

- Sewage and waste water treatment, solid waste management, chemical control of water pollution, role of microphyte and macrophytes in water treatment; recent approaches to biological waste water treatment, treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries. Thin film techniques for waste water treatment using aquatic plants.
- Anaerobic digestion: anaerobic digestion of high-solid wastes.

Module-2: Vermi-composting for Solid Waste Management **2 hrs**

- Solid waste management with vermin composting:
- Concept of vermicomposting, Importance of earthworms, Classification of earthworms, Techno-economic aspect of vermicomposting.
- Detail of vermicomposting technology
- Organic waste processing.

Module-3: Biological nitrogen fixation **2 hrs**

- Biological nitrogen fixation: nitrogen fixing organisms, biochemistry of nitrogenase, genetics of nitrogen fixation, different types of biological nitrogen fixation.
- Estimation of nitrogen fixing ability of microbes.

Module-4: Biosensor and pollution management **4 hrs**

- Biosensors: types and applications; Bio-molecules; membrane and transducer; Bio-augmentation: estimation of microbial load; Methods of Inorganic and Organic waste removal; treatment of Oil pollution at sea;
- Biodegradation of natural and synthetic waste materials; methods in determining bio-augmentation and bio-magnification; Separation, purification and bio removal of pollutants; fermented products and Biogas from wastes; utilization of aquatic slurry for salt-resistant paddy cultivation.

Module-5: Biomass production technology **2 hrs**

- Biomass production technology: sources of biomass, crop residues (cereals, leguminous crops, sugarcane etc.), composition of plant biomass, wastes as a source of energy, (cellulose, hemicellulose and lignins), biomass conversion,

Module-6: Bioremediation **2 hrs**

- Fundamentals, methods and strategies of application (bio-stimulation, bio-augmentation): examples, bioremediation of metals (Cr, As, Se, Hg), radio nuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.),
- technological aspects of bioremediation (*in situ*, *ex situ*); Application of bacteria and fungi in bioremediation;
- Phyto-remediation: Fundamentals and description of major methods of application (phyto-accumulation, phyto-volatilization, rhizo filtration, phyto-stabilization).

Module-7: Environmental biotechnology in agriculture **2 hrs**

- Bioinsecticides: *Bacillus thuringiensis*, Baculoviruses, uses, genetic modifications and aspects of safety in their use;

- Bio-fungicides: Description of mode of actions and mechanisms (e.g. *Trichoderma*, *Pseudomonas fluorescens*);
- Biofertilizers: Symbiotic systems between plants-microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis),
- Plant growth promoting rhizobacteria (PGPR): uses, practical aspects and problems in

Module-8: Polymers and plastic degradation

2 hrs

- Polymers and plastic degradation: polymer degradation, photo chemical degradation, disposable synthetic polymers, polymer recycling, role of microorganisms in degradation

Practical

- Aseptic techniques
- Microbial culture techniques
- Culture media preparation
- Isolation of environmentally beneficial bacteria and morphological characterization
- Mass production and Bio fertilizers
- Biofertilizers production technology
- MIC study of microorganisms

Reading materials

1. Maier, Pepper and Gerba, Environmental microbiology
2. Evans and Furlong, Environmental biotechnology-theory and application
3. P.D. Sharma, Environment and Ecology
4. S. C. Santra Environmental Science
5. Central Pollution Control Board Guideline for recognition of environmental laboratories under the environmental (Protection)Act, 1986
6. Flanagan, Braithwaite, Brown and Widdop, Wolff, Basic analytical toxicology
7. Singh, BKP..Biotechnological Applications in Environment and Agriculture.
8. R.C.Dubey and Maheshwari, Practical Microbiology
9. J.G. Cappuccino and N Sherman, Microbiology A laboratory manual
10. K.R.Aneja, Experiments in microbiology plant pathology and biotechnology

EDM-321

Disaster Risk Profiling and Risk Management of Organizations

1+1 credit (18+18 hours)

Module- 1: Profiling an organization **2 hrs**

- Type of organisation – history – vision – mission – activities
- Location of the organisation – registered, functional and operational units
- Management structure – strength of management, workers and other workforce at various locations
- Turn-over, operational profits
- CSR activities

Module- 2: Risk profiling **4 hrs**

- Hazard profile – natural hazards – manmade hazards – organization specific hazards
- Vulnerability profile – physical vulnerability – financial vulnerability – environmental vulnerability
- Exposure profile – exposure of assets – personnel – communities – market
- Risk profile of organisation – measuring risks
- Quantifying damage and loss – actual and probabilistic

Module- 3: Strategic framework for risk reduction **2 hrs**

- Risk management policy
- Risk management framework
- Risk management strategy

Module- 4: Risk management plan **4 hrs**

- Risk prevention
- Risk mitigation
- Risk transfer
- On-site and Off-site risk management plan
- Emergency management plan
- Recovering from catastrophic disasters

Module- 5: Risk reduction in project cycle management **4 hrs**

- Project cycle management
- Programming
- Identification
- Appraisal

- Financing
- Execution
- Evaluation

Module- 6: Integrating Environment and Risk Management Plans 2 hrs

- Environment Management Plan – areas of convergence and divergence with Risk Management Plan
- Integration of Environment Management and Risk Management Plan

Practical

Students will do Risk Profiling and prepare Disaster Risk Management Plan of an organization

Reading Materials

1. Handbook of Hazards and Disaster Risk Reduction by Ben Wisner, JC Gaillard, Ilan Kelman
2. Risk Modeling for Hazards and Disasters by Gero Michel
3. Disaster Risk by Irasema Alcántara-Ayala, Christopher Gomez, Ksenia Chmutina, Dewald van Niekerk, Emmanuel Raju, Victor Marchezini, Jake Rom Cadag, JC Gaillard
4. Understanding Disaster Risk: A Multidimensional Approach by Pedro Pinto Santos, Ksenia Chmutina, Jason Von Meding, Emmanuel Raju
5. Disaster Management and Private Sectors: Challenges and Potentials by Takako Izumi, Rajib Shaw

SEMESTER-IV

EDM - 404: Dissertation work

(0+24 credit)

- Selection of theme of dissertation
- Identification of issues for research
- Literature survey
- Hypothesis of the study
- Research methodology
- Data collection plan and analysis

EDM - 405: Presentation of dissertation work

(0+2 credit)

- Presentation of Dissertation
- Viva Voce