

University of Rajasthan Jaipur

SYLLABUS

M.Sc. Environmental Science

(Semester Scheme)

I & II SEMESTER 2020-21

III & IV SEMESTER 2021-22

Raj / Tai
Dy. Registrar (Acad.)
University of Rajasthan

**INDIRA GANDHI CENTRE FOR HUMAN ECOLOGY,
ENVIRONMENTAL AND POPULATION STUDIES,
UNIVERSITY OF RAJASTHAN, JAIPUR-302004**

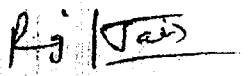
M.Sc. ENVIRONMENTAL SCIENCE (SEMESTER SCHEME)

Eligibility for Admission

Bachelor Degree in Science, Medicine, Engineering, Technology and Agriculture with minimum 50% (45% for SC and ST) in aggregate.

Scheme of Examination - Grade System

M.Sc. will include Four Semester with Six papers in each semester excluding practicals.

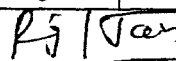

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M.Sc. Environmental Science
Ist Semester

S. No.	Subject code	Course Title	Course category	Credit	Contact hour per week		
					Lecture	Tutorial	Practical
1.	ENV 701	Fundamentals of Ecology and Environmental Science	CCC	4	4	0	0
2.	ENV 702	Ecosystem Diversity	CCC	4	4	0	0
3.	ENV 703	Environmental Pollution and Human Health	CCC	4	4	0	0
4.	ENV 711	Core Lab	CCC	6	0	0	6
5.	ENV A01	Elective-1. Biodiversity Conservation	ECC	4	4	0	0
6.	ENV A02	Elective-2. Environmental Instrumentation	ECC	4	4	0	0
7.	ENV A03	Elective-3. Environmental Chemistry	ECC	4	4	0	0
8.	ENV A11	Elective Lab	ECC	6	0	0	6
Total				36	24	0	12

IInd Semester


S. No.	Subject code	Course Title	Course category	Credit	Contact hour per week		
					Lecture	Tutorial	Practical
1.	ENV 801	Environmental Biotechnology	CCC	4	4	0	0
2.	ENV 802	Water Pollution Monitoring, Control Technology and Management	CCC	4	4	0	0
3.	ENV 803	Environmental Geoscience	CCC	4	4	0	0
4.	ENV 811	Core Lab	CCC	6	0	0	6
5.	ENV	Elective-1.	ECC	4	4	0	0


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	B01	Climate Change and Atmospheric Issues					
6.	ENV B02	Elective-2. Desert Ecology	ECC	4	4	0	0
7.	ENV B03	Elective-3. Environmental Policies, Conventions and Protocols	ECC	4	4	0	0
8.	ENV B11	Elective Lab	ECC	6	0	0	6
		Total		36	24	0	12

M.Sc. Environmental Science
IIIrd Semester

S. No.	Subject code	Course Title	Course category	Credit	Contact hour per week		
					Lecture	Tutorial	Practical
1.	ENV 901	Air Pollution monitoring, Control Technology and Management	CCC	4	4	0	0
2.	ENV 902	Energy and Environment	CCC	4	4	0	0
3.	ENV 903	Municipal Solid Waste Management	CCC	4	4	0	0
4.	ENV 911	Core Lab	CCC	6	0	0	6
5.	ENV C01	Elective-1. Environmental Organizations, Movements and Laws	ECC	4	4	0	0
6.	ENV C02	Elective-2. Environmental Bioremediation	ECC	4	4	0	0
7.	ENV C03	Elective-3. Occupational Health and Toxicology	ECC	4	4	0	0
8.	ENV C11	Elective Lab	ECC	6	0	0	6
		Total		36	24	0	12


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IVth Semester

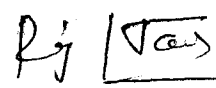
S. No.	Subject code	Course Title	Course category	Credit	Contact hour per week		
					Lecture	Tutorial	Practical
1.	ENV X01	Environmental Management	CCC	4	4	0	0
2.	ENV X02	Environmental Impact Assessment (EIA)	CCC	4	4	0	0
3.	ENV X03	Disaster Management	CCC	4	4	0	0
4.	ENV X11	Core Lab	CCC	6	0	0	6
5.	ENV D01	Elective-1. Hazardous Waste Management	ECC	4	4	0	0
6.	ENV D02	Elective-2. Environmental Modeling and Biostatistics	ECC	4	4	0	0
7.	ENV D03	Elective-3. Natural Resource Management	ECC	4	4	0	0
8.	ENV D11	Elective Lab	ECC	6	0	0	6
Total				36	24	0	12

Semester - I

Note: Each paper will have five questions. Questions No.1 containing short answer type questions from the entire syllabus and will be compulsory.

ENV 701: Fundamentals of Ecology and Environmental Science 60 Hours

History and scope of Ecology and Environmental Science, Structure and Functional aspects of Ecosystem (Food Chain, Food Web, Energy flows) Pyramids of energy, number and biomass, productivity and Biogeochemical cycling. 20Hours


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Definition and components of environment, structure and composition of atmosphere, hydrosphere, lithosphere and biosphere, Mass and energy transfer across the various interfaces, materials balance. First law and second law of thermodynamics heat transfer process, Scale of meteorology- Pressure, Temperature, Precipitation, Humidity, Radiation and Wind. 20 Hours

Human Ecology and Human settlement, evolution, origin of life and specification. 10 Hours

Population ecology- density, distribution, fertility, mortality, survivorship curves, age distribution, growth curves and models, r & k selection, population interactions- Mutualism, Parasitism, Predator-Prey relations, System Theory. 10 Hours

ENV 702: Ecosystem Diversity

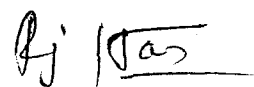
**60
Hours**

The ecological principles and factors determining survival of life on earth, The global ecosystem and the place of man in it; human food chain and the energy requirements for the maintenance of human ecosystems on earth, mathematical modeling of ecosystem. 15Hours

Forest ecosystem- Forest as an ecosystem, economics and ecology of forest, role of forests in protection of species, regulation of climate and production of various produce, Depletion of biodiversity from forest and the world forest conservation policies. 15 Hours

Grassland ecosystem - Distribution and types of grasslands, rangelands and biodiversity in grassland, and productivity in grasslands, Wetland Ecosystem- Distribution, energetic and productivity in wetlands, Biodiversity and economic importance of wetlands. 15 Hours

Desert Ecosystem and Wastelands-Desert as ecosystems, hot and cold deserts, productivity, characteristics and global distribution of deserts, Desertification process, adaption in desert, fauna and flora, Types and distribution of wastelands in India, Aquatic Ecosystem: Lentic and lotic ecosystem, structure, energy flow and productivity in estuaries, marine ecosystem, structure, biodiversity and productivity in marine ecosystem. 15 Hours



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ENV 703: Environmental Pollution and Human Health 60 Hours

Air Pollution and Human Health, Atmospheric composition and stratification, types of air pollutants, sources of emissions of air pollutants, air pollution and impacts on plants, air pollution and impacts on animals, air pollution and impacts on buildings and monuments. 15Hours

Types of water resources and water pollutants, sources of water pollutants, adverse impacts of water pollution on plants and animals, water standards for different kinds of uses. Economics of water, management of water resources. Water Borne, Water washed, water based and water related diseases. Diseases caused due to fluoride, nitrate and different metals. Control of water (borne, based, washed and related) diseases. 15 Hours

Noise Pollution, Source, causes and biochemical aspects of noise pollution, sources and impacts of radiations on environment and human beings. 15 Hours

Causes of thermal pollution and related adverse impacts, Soil and land pollution, causes, sources and adverse impacts on human health. 15 Hours

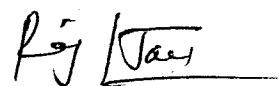
ENV 711: Core Lab based on theory papers

Elective-1

ENV A01: Biodiversity Conservation 60 Hours

Concepts of Biodiversity, Economics of Biodiversity, causes of losses of Biodiversity, Endangered and threatened species, Red data book, Hot spots of Biodiversity, modern techniques of Measurements and monitoring of biodiversity, Levels of biodiversity, Alpha, Beta and Gamadiversity, Shannon Index, The concept of global "ecological balance" and the threats of its imbalances due to rising human population. 15Hours

In-situ biodiversity and conservation, conservation of biodiversity in Biosphere Reserves, Reserve Forests, National Parks, Tiger Projects, Sanctuaries, places around shrines, sacred grooves etc. 15 Hours



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Bio-geographical zones of India, Diversity and distribution of major forests at National and Global level, Status of biodiversity in India, Agro-ecological regions of crop diversity in India, Biodiversity conservation in folk-beliefs in Rajasthan, Biotechnology and its application in biodiversity conservation, Ex-situ conservation of biodiversity, gene bank, germ plasm storage, live museum etc. 15 Hours

Wildlife; Distribution of Wildlife at National and Global level, Wildlife trade, Elephant Projects, Crocodile Project, Rhino Project, Protected Area Networks, Traditional and modern tools of Identification of plants, animals and microbes. 15 Hours

Elective-2

ENV A02: Environmental Instrumentation 60 Hours

Sampling Protocol: Planning a Sampling Strategy, Sample Collection of soil, air and water, Devices and Containers for soil, air and water sampling and preservation. 15Hours

Spectrophotometry: Visible and UV spectrophotometer, Atomic Absorption Spectrophotometry, Chromatography: Paper chromatography, thin layer chromatography, Gas chromatography, HPLC. 15 Hours

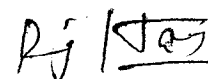
Electrophoresis; X-ray diffraction; Flame photometry; Centrifugation. 15 Hours

Titrimetric; Gravimetric; Colourimetry; Chemistry of Environmental Trace Elements: Pb, As, Hg and Cd; Concept of green chemistry. 15 Hours

Elective-3

ENV A03: Environmental Chemistry 60 Hours

Concept and scope of Environmental chemistry; acid base reactions, chemical equilibrium, pH and pOH, ionic product of water, common ion effect, buffer solutions, hydrolysis, chemical equilibrium, oxidation and reduction, chemical speciation, Stoichiometry, Gibb's energy, Chemical potential, solubility products, solubility of gases in water, carbonate system, unsaturated and saturated hydrocarbons, radionuclides. 15Hours



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Atmospheric Chemistry: Chemical composition of the atmosphere; 15 Hours
 Chemical process for formation of inorganic and organic particulate matter, Thermo-chemical and Photochemical reaction in the atmosphere, Oxygen and Ozone chemistry, Chemistry of Air, Greenhouse gases, acid rain.

Water Chemistry: Physical and chemical properties of water and their environmental significance; Water quality parameters – physical, chemical and biological; Concept of DO, BOD, COD, Sedimentation, Coagulation, Filtration. 15 Hours

Soil Chemistry: Inorganic and Organic components of soil; Nitrogen pathways and NPK in soil; Physical properties of soil – texture, bulk density, permeability etc. 15 Hours

ENV A11: Elective Lab based on theory papers

Semester - II

Note: Each paper will have five questions. Questions No.1 containing short answer type questions from the entire syllabus and will be compulsory.

ENV 801: Environmental Biotechnology

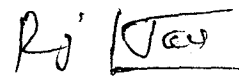
**60
Hours**

Genetic engineering for Environmental Conservation, Plasmids, isolation of plasmids, cloning of DNA. 15Hours

Recombinant DNA technology and development of genetically engineered microorganisms (GEMS), Polymerase Chain Reaction (PCR) and development of Gene probes for environmental remediation, use of GEM in bioremediation. 15 Hours

Emerging technology for environmental bioremediation, Microbial interactions with xenobiotic and inorganic pollutants, microbial accumulation of heavy metals and radionuclides, Biodegradability and ecological side effect testing and monitoring in the bioremediation of xenobiotic pollutants, biotechnological production of hydrogen to reverse global warming. 15 Hours

Microelectromechanical systems (MEMs), Genosensor technology, Integrated Treatment System, PCB treatment process, Enzymes contributing to sustainable industrial development. 15 Hours


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ENV 802: Water Pollution Monitoring, Control Technology and Management **60 Hours**

Generation of waste water, Categories of waste water and their characteristics, water resource management. 15Hours

Waste water sampling and monitoring; methods of analysis, determination of organic matter, inorganic substances, physical characteristics, concept of oxygen demand -DO, BOD, COD and bacterial measurements. 15 Hours

Waste water treatment, Basic processes of primary treatments; Pre-treatment, sedimentation and floatation. 15 Hours

Secondary treatments; Activated sludge process, Trickling filter, Rotating biological contractors, sludge treatment and disposal. Advanced waste water treatment, N-removal, P-removal, Advanced Biological Systems, Chemical oxidation, Removal of suspended solids, dissolved solids. 15 Hours

ENV 803: Environmental Geoscience **60 Hours**

Introduction to environmental Geo-science, Earth's processes, the Rock cycle, basic concept of plate tectonics and continental drift, sea floor spreading, mountain formation, rock deformation and evolution of continents. 15Hours

Concept of major, trace and Rare Earth Elements (REE), Classification of trace elements, Mobility of trace elements, Human use, trace elements and health. Possible effects of imbalance of some trace elements. Biogeochemical factors in environmental health. Diseases induced by human use of land. 15 Hours

Weathering and soil formation, soil profile, soil classification, soils of India. Soil organic matter, Humus formation, Soil microorganisms and their roles in soil quality, C: N ratio, Land use planning. 15 Hours

Global water balance, ice sheet and fluctuations of sea levels, Origin and composition of seawater, Climates of India, Indian Monsoon, El Nino, Droughts, Tropical cyclones and Western Disturbances. 15 Hours

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ENV 811: Core Lab based on theory papers**Elective-1****ENV B01: Climate Change and Atmospheric Issues 60 Hours**

Greenhouse gases, Chemistry and Physics of Global warming, Climatic Models. 15Hours

Climatic Change, Climate Change factors, carbon foot prints, carbon credits, carbon sequestration process. 15 Hours

Chemistry of upper, lower and middle stratosphere, Chemicals responsible for ozone depletion, process of ozone depletion at different latitudes, impacts of ozone depletion, Alternative chemicals. 15 Hours

Chemistry of Acid rain, global quantum of acid rain, adverse impacts of acid rain, mitigation methods against acid rain. 15 Hours


Elective-2**ENV B02: Desert Ecology 60 Hours**

Ecological, Geological, Geographical and Geomorphological aspects of the Thar desert, wildlife (fauna and flora) in Thar desert, ecosystem diversity, habitat diversity, indigenous flora and medicinal plants of Thar desert, saline tract vegetation, Endemic, rare, threatened species of desert, human-animal interactions and conservation in Thar desert. 15Hours

Formation of desert, Sand dune characterization, sand dune stabilization techniques, exploitation of ground water resources and its consequences in desert region, Surface water resources of the Thar, Renewable energy potential in Arid areas of Rajasthan (wind and solar energy harvesting). 15 Hours

Desertification causes (anthropogenic, natural, zoogenic), ecosystem and landscape consequences of desertification, effect of human settlement, ecological impacts of canal irrigation in desert and overgrazing, deterioration of desert ecosystem due to problems of mining, pollution, tourism and poaching, detection and monitoring of desertification using remote sensing. 15 Hours

Change in land use pattern due to introduction of canals and environmental consequences, Conservation efforts for ecological restoration of Thar Desert, greening the desert, traditional practices of people in Thar Desert and their importance in restoration of desert ecosystem, Economic potential of Thar Desert, Desert national Park. 15 Hours


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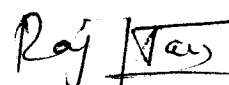
Elective-3**ENV B03: Environmental Policies, Conventions and Protocols** **60 Hours**

National Environment Policy (NEP): Key environmental challenges, causes and impacts, Principles, Objectives of NEP, Strategies and actions: Regulatory reforms, Enhancing and conserving environmental resources, environmental standards- EMS, Ecolabelling and certification, Environmental Awareness and education, Partnership and stakeholder involvement, International Cooperation, Environment and development Policies: Industrial policies, Land use policies, Land and agricultural policies, resettlement and rehabilitation policies. 15Hours

National forest policy, National water policy, National Action Plan on Climate Change: Overview, Principles and approach, Mission for Solar, water enhanced efficiency, Sustainable habit and green India. 15 Hours

Rajasthan State Environmental Policy: Objectives and Principles of the State environmental policies, Conserving and enhancing environmental resources- Water resources, air, desertification and land degradation, forest and biodiversity. Assuring environmental sustainability of key economic sectors- Mining, Industry, Tourism, Energy etc. 15 Hours

International Environmental Policies, Stockholm Conference 1972, UNCED and Earth Summits, World Summit on Sustainable Development (WSSD) 2002, International Conventions: CITES, Ramsar Convention on Wetlands, World Heritage Convention 1972, London Convention 1972, Vienna Convention 1985, Basel Convention 1989, Convention on Biological Diversity 1992, United Nations Framework Convention on Climate Change 1992, Stockholm Convention on POP 2001, Protocols: Kyoto Protocol, Montreal Protocol, Cartagena Protocol on Biosafety. 15 Hours

ENV B11: Elective Lab based on theory papers


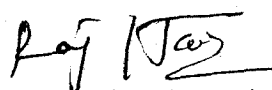
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Semester - III

Note: Each paper will have five questions. Questions No.1 containing short answer type questions from the entire syllabus and will be compulsory.

ENV 901: Air Pollution monitoring, Control Technology and Management	60 Hours
Meteorological aspects of Air Pollutants dispersion, Temperature lapse rate and stability, wind roses, plume behaviour, Dispersion of air pollutants, solution to the atmospheric dispersion equation; Air Pollution management.	15Hours
Air sampling and monitoring (Ambient) collection of gaseous pollutants, collection of particulate pollutants, stack sampling monitoring and analysis of air pollutants.	15 Hours
Air pollution control techniques and equipments, particulate emission control by gravitational settling chambers, cyclone separators, fabric filters, electrostatic precipitator, wet scrubbers.	15 Hours
Control of specific gaseous pollutants; control of SO _x , control of NO _x , control of hydrocarbons and controls of carbon mono-oxide.	15 Hours

ENV 902: Energy and Environment	60 Hours
Fundamentals of energy: Earth's energy budget; Energy use pattern, Indian energy scenario for different sectors, Need for new and alternate energy resources.	15Hours
Energy Resources: Classification of energy resources, Fossil fuels: Origin, classification and characteristics of coal, petroleum, natural gas; Nuclear energy; Renewable energy resources- Solar energy; Wind energy; Geo-thermal energy; Hydropower and micro-hydel power; Tidal energy; Ocean Thermal Energy Conversion(OTEC).	15 Hours
Biomass energy: Sources, Bioconversion technologies, bio-ethanol and bio-hydrogen, Energy plantations, Biodiesel, Petro-plants, Production of biogas from organic wastes, biogas digesters and technology, Hydrogen as fuel.	15 Hours
Concept and principle of energy conservation, Bureau of energy efficiency and star rating, Energy efficiency in buildings: Green building concept; Sustainable energy technologies and energy efficiency, Passive solar heating, Energy intensity, energy conservation policies.	15 Hours



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ENV 903: Municipal Solid Waste Management	60 Hours
Definition and Classification of solid waste; Characteristics of municipal solid waste, Essential elements of Municipal Solid Waste management-generation, segregation of waste, methods of collection, transportation, treatment.	15Hours
Municipal Solid Waste disposal, Criteria for selection of disposal sites, volume reduction, Sanitary land filling, types of landfills, landfill gases, leachate and its management, landfill closure and remediation; Environmental concerns of landfilling of municipal solid waste.	15 Hours
Composting process and technology, classification and factors affecting the process Incineration technology, gasification, pyrolysis, Environmental concerns of composting and thermal processes of waste disposal.	15 Hours
Integrated solid waste management: minimization of municipal solid waste, Recycle and Recovery, Community participation in waste management, Municipal Waste (Management & Handling) Rules, 2000.	15 Hours

ENV 911: Core Lab based on theory papers

Elective-1

ENV C01: Environmental Organizations, Movements and Laws	60 Hours
Provisions of Environment in Indian Constitution, International organizations for Conservations of Environment: UNEP, WWF, UNESCO, IGBP, IUCN, GEF, ETF.	15Hours
Environmental ethics, Religion and Environment, Eco-Imperialism with regard to global distribution of resources, eco-fund, Chipko movement, Appiko movement, KSSP, Scheme of labelling of environmentally friendly products (Ecomark), Current environmental issues in India: Narmada Dam, Tehri Dam, Almetti Dam, Silent valley, Doon Valley, Sariska and Narayan Sarovar.	15 Hours
Indian Forest Act, 1927, Indian Forest Act (Revised 1982), Forest (Conservation) Act, 1980, Wildlife (Protection) Act, 1972, amended in 1991, Biological Diversity Act, 2002, Water (Prevention and Control of Pollution) Act, 1974, as amended up to 1988 and rules 1975.	15 Hours


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Air (Prevention and Control of Pollution) Act 1981, as amended by amendment Act 1987 and rules 1982, Environmental (Protection) Act, 1986, Motor Vehicle Act 1988, Hazardous and waste management and handling rules 1989, Public Liability Insurance Act 1991 and rules 1991, National Environment Tribunal Act, 1995, National Environment Appellate Authority Act, 1997. 15 Hours

Elective-2

ENV C02: Environmental Bioremediation

60
Hours

What is Bioremediation, Types of Bioremediation-*Ex-situ* and *In-situ*, Factor affecting Bioremediation, Microbial degradation of Halocarbons, nitrocarbons, PCB and petroleum hydrocarbon. 15Hours

Atmospheric Environment for Microorganisms, Microbial Degradation of Contaminants in Gas Phase, Biological Filtration Processes for Decontamination of Air Stream- Biofiltration- Biotrickling Filtration- Bioscrubbers. 15 Hours

Contaminants in Groundwater, *Ex-situ* decontamination of groundwater, Characterizing the Site and Contaminant Complexity- Selecting the Bioremediation Option, Process Option, Process Optimization, In-situ Bioremediation of Groundwater-Factors Affecting Bioaugmentation- Delivery Systems for Oxygen, Nutrients, and Inoculation, Landfill Leachate Biotreatment Technologies. 15 Hours


Microbial Transformation of Metals, Biological Treatment Technologies for Metals Remediation, Bioleaching, Bioaccumulation, Oxidation/Reduction Processes, Biological Methylation, Global Application Of Bioremediation Technologies, Successful and Unsuccessful Case Studies, Biomonitoring, Application of Microbial Enzymes. 15 Hours

Elective-3

ENV C03: Occupational Health and Toxicology

60
Hours

Introduction to environmental health, Occupational health and hygiene, Occupational safety, Occupational hazards: Physical, mechanical, biological, chemical and psychological hazards with case studies (power plants, mining, textile, ball bearing, and cement industries). 15Hours


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Risk assessment: hazard identification, dose response analysis, exposure quantification, Occupational diseases: Agents, diseases, Accidents in industries with some case studies. Industrialization and health, 15 Hours

Ergonomics, Measures for health protection of workers, control measures of occupational diseases: Medical and engineering measures, laws. 15 Hours

Toxicology, Environmental dose response relationships, toxicity and threshold limits, acute and chronic toxicity and classes of toxic chemicals. 15 Hours

ENV C11: Elective Lab based on theory papers

Semester - IV

Note: Each paper will have five questions. Questions No.1 containing short answer type questions from the entire syllabus and will be compulsory.

ENV X01: Environmental Management

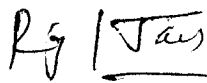
**60
Hours**

Definition, scope and goals of Environmental management, Participants in Environmental management, Tools of environmental management, Core elements of Environmental Management System (EMS), Benefits of EMS. Objectives and scope of environmental auditing, types, general audit methodology, Elements of audit process. Waste audits, Liability Audits and site Assessment, EMS auditing. 15Hours

Elements of Environmental management system (EMS), Documentation for EMS, Benefits of EMS, EMS Standard: ISO 14000 and 14001 series. Life Cycle Assessment (LCA), Stages in Product, Code of Good Conduct for LCA, Procedure for LCA, Applications of LCA in Government and Private Sector. 15 Hours


Environmental management techniques: Environmental monitoring, Forecasting and growth modeling, Application of Remote Sensing and GIS in EM, Environmental technique Assessment, Ecomapping. 15 Hours

Principals of environmental design, benefits and motivation for ED, ED for manufactured products, ED for building construction, Indian examples. Environmental economics definition, environmental cost, benefit taxes, accounting, environmental valuation, economy of natural resources, ecological economics. 15 Hours


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ENV X02: Environmental Impact Assessment (EIA)	60 Hours
Procedure and methodologies of EIA, Cost-benefit analysis, Environmental clearance procedure with particular reference to India.ISO, sustainable Development.	15Hours
Environmental Impact Assessment, Environmental Auditing and Monitoring of Thermal Power projects.	15 Hours
Environmental Impact Assessment, Environmental Auditing and Monitoring of Nuclear Power Projects, siting and mitigation of adverse impacts of Nuclear Power Projects.	15 Hours
Environmental Impact Assessment, Environmental Auditing and Monitoring of mining projects, River Valley Projects, Tourism, Irrigation and Dams.	15 Hours

ENV X03: Disaster Management	60 Hours
Concept, definition, causes and classification of disasters, Catastrophic geological hazards: Floods- Causes, nature and frequency of flooding, flood hazards, urbanization and flooding, Flood control, Integrated Flood Management and Information System (IFMIS), Landslides and Avalanche- Nature, causes, impacts and mitigation.	15Hours
Earth quakes- Causes and characteristics of ground-motion, seismic waves, earthquake scales, magnitude and intensity, earthquake hazards and risks, nature of destruction, quake resistant buildings and dams, Tsunami: causes and physical characteristics, disturbance in sea floor and release of energy, travel time and impact on fragile coastal environment, mitigation of risks.	15 Hours
Volcanism: Causes of volcanism, types of volcanoes, volcanic materials, Hazardous effects of volcanism, Droughts: Causes, Impacts and mitigation, Cyclones: Structure and nature of tropical cyclone, mitigation, preparedness and Impacts, Hurricane Hazards, Tornado etc.	15 Hours
Prediction and perception of the hazards and adjustments to hazardous activities. Disaster management, pre-disaster phase, actual disaster phase, post-disaster phase. International Decade for Natural Disaster Reduction (IDNDR), Policy for disaster reduction, problems of financing and insurance, Training for emergency, Regulation/guidelines for disaster tolerance building structures.	15 Hours


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ENV X11: Core Lab based on theory papers**Elective-1****ENV D01: Hazardous Waste Management****60
Hours**

Definition and Classification of hazardous waste, Characterization and nature of hazardous waste, household hazardous waste, transportation and storage of hazardous waste. Hazardous Waste Management Options: Reduction (cleaner technologies), Waste minimization, Waste Recycling and Reuse. 15Hours

General treatment scheme for hazardous waste: Chemical, biological and physical treatments, Encapsulation, safe disposal, secure landfills, underground injections, Industrial waste treatment and disposal options in different industries (food and beverage, petroleum refinery, leather, textile, pharmaceutical industries), Hazardous Waste (Management and Handling) Rules. 15 Hours

Biomedical waste, Definition, Sources of generation, categories, segregation (colour coding system), transportation, Treatment methods, Biomedical Waste (Management and Handling) Rules, 1998. 15 Hours

Nuclear waste classification (low level, high level, intermediate level waste), radioactive waste from Nuclear fuel cycle, disposal of LLW, HLW and ILW. 15 Hours

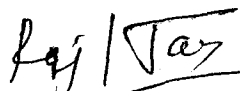
Elective- 2**ENV D02: Environmental Modeling and Biostatistics****60
Hours**

Introduction to environmental system analysis; approach to development of model, Linear simple and multiple regression model, validation and forecasting. Models of population growth and interaction- LotkaVolterra model, Leslie's matrix model, Point source stream Pollution model, Box model, Gaussian Plume model. 15Hours

Basic elements and tools of statistical analysis; Diagrammatic and Graphical Presentation of Data, Sampling, Probability. 15 Hours

Measures of central tendency (mean, median and mode), Measures of Dispersion: Mean deviation, standard deviation, variance, Standard error. 15 Hours

Test of significance: Null hypothesis and alternate hypothesis; student t test; chi square test, analysis of variance. 15 Hours


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Elective- 3**ENV D03: Natural Resource Management****60
Hours**

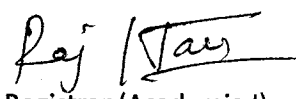
Classification of natural resources: renewable resources, non-renewable resources, classes of earth resources, resources regions: Definition and criteria; resource degradation, depletion of natural resources. 15Hours

Non-mineral resources- land: land use classification, land degradation, land-use planning; soil: soil formation, soil profiles; water: classification and characteristics of water resources, inland water; Bio-resources: concept and definition, plants, animals, microorganisms, the forest produce [timber and non-timber (NTFPs) products], agricultural resources. 15 Hours

Mineral resources- ore, reserve, formation of mineral deposits, classification, Minerals and metals, fuel resources: fossil fuel, coal, petroleum, natural gas, environmental effects of extracting and using mineral resources; Marine resources. 15 Hours

Natural resource management: preservation, conservation and restoration, Common property resources, Sustainable management of natural resources, mine reclamation practices, water conservation with special reference to Rajasthan. 15 Hours

ENV D11: Elective Lab based on theory papers


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