University of Rajasthan
Jaipur

SYLLABUS

M.Sc. Environmental Science

(Semester Scheme)

I & II SEMESTER 2020-21
III & IV SEMESTER 2021-22

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.

Dy. Registrar (Academic-I)
University of Rajasthan
Jaipur
### M.Sc. Environmental Science

#### I<sup>st</sup> Semester

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Subject Code</th>
<th>Course Title</th>
<th>Course Category</th>
<th>Credit</th>
<th>Contact hour per week</th>
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<td></td>
<td>Lecture</td>
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<tr>
<td>1.</td>
<td>ENV 701</td>
<td>Fundamentals of Ecology and Environmental Science</td>
<td>CCC</td>
<td>4</td>
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<tr>
<td>2.</td>
<td>ENV 702</td>
<td>Ecosystem Diversity</td>
<td>CCC</td>
<td>4</td>
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<tr>
<td>3.</td>
<td>ENV 703</td>
<td>Environmental Pollution and Human Health</td>
<td>CCC</td>
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<td>4.</td>
<td>ENV 711</td>
<td>Core Lab</td>
<td>CCC</td>
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<tr>
<td>5.</td>
<td>ENV A01</td>
<td>Elective-1. Biodiversity Conservation</td>
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<td>6.</td>
<td>ENV A02</td>
<td>Elective-2. Environmental Instrumentation</td>
<td>ECC</td>
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<td>7.</td>
<td>ENV A03</td>
<td>Elective-3. Environmental Chemistry</td>
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#### II<sup>nd</sup> Semester

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<td>ENV 801</td>
<td>Environmental Biotechnology</td>
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<td>ENV 802</td>
<td>Water Pollution Monitoring, Control Technology and Management</td>
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<td>Environmental Geoscience</td>
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<td>ECC</td>
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<td>Air Pollution monitoring, Control Technology and Management</td>
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<td>ECC</td>
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**M.Sc. Environmental Science**

**IIIrd Semester**
### IV<sup>th</sup> Semester

<table>
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<td>Elective-1. Hazardous Waste Management</td>
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</table>

### 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.

[Signature]

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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.

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

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.

ENV 702: Ecosystem Diversity

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.

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.

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.

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.

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ENV 703: Environmental Pollution and Human Health

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.

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.

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

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

ENV 711: Core Lab based on theory papers

Elective-1

ENV A01: Biodiversity Conservation

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.

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

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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.

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.

Elective-2

**ENV A02: Environmental Instrumentation**

<table>
<thead>
<tr>
<th>60 Hours</th>
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<tbody>
<tr>
<td>Sampling Protocol: Planning a Sampling Strategy, Sample Collection of soil, air and water, Devices and Containers for soil, air and water sampling and preservation.</td>
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<tr>
<td>Spectrophotometry: Visible and UV spectrophotometer, Atomic Absorption Spectrophotometry, Chromatography: Paper chromatography, thin layer chromatography, Gas chromatography, HPLC.</td>
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<tr>
<td>Electrophoresis; X-ray diffraction; Flame photometry; Centrifugation.</td>
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<tr>
<td>Titrmetric; Gravimetric; Colourimetry; Chemistry of Environmental Trace Elements: Pb, As, Hg and Cd; Concept of green chemistry.</td>
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Elective-3

**ENV A03: Environmental Chemistry**

<table>
<thead>
<tr>
<th>60 Hours</th>
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<tbody>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>
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 15 Hours environmental significance; Water quality parameters – physical, chemical and biological; Concept of DO, BOD, COD, Sedimentation, Coagulation, Filtration.

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

**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**

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

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.

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.

Microelectromechanical systems (MEMs), Genosensor technology, 15 Hours Integrated Treatment System, PCB treatment process, Enzymes contributing to sustainable industrial development.
ENV 802: Water Pollution Monitoring, Control Technology and Management

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

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.

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


ENV 803: Environmental Geoscience

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.

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.

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.

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.
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.  15 Hours

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.  15 Hours

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


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.

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.


ENV B11: Elective Lab based on theory papers
**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**

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.

Air sampling and monitoring (Ambient) collection of gaseous pollutants, collection of particulate pollutants, stack sampling monitoring and analysis of air pollutants.

Air pollution control techniques and equipments, particulate emission control by gravitational settling chambers, cyclone separators, fabric filters, electrostatic precipitator, wet scrubbers.

Control of specific gaseous pollutants; control of SOx, control of NOx, control of hydrocarbons and controls of carbon mono-oxide.

**ENV 902: Energy and Environment**

Fundamentals of energy: Earth’s energy budget; Energy use pattern, Indian energy scenario for different sectors, Need for new and alternate energy resources.

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).

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.

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.
ENV 903: Municipal Solid Waste Management

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.
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.
Composting process and technology, classification and factors affecting the process Incineration technology, gasification, pyrolysis, Environmental concerns of composting and thermal processes of waste disposal.


ENV 911: Core Lab based on theory papers

Elective-1

ENV C01: Environmental Organizations, Movements and Laws


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.


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.

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


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

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

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

**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**

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.


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

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.
ENV X02: Environmental Impact Assessment (EIA) 60 Hours

Procedure and methodologies of EIA, Cost-benefit analysis, 15 Hours
Environmental clearance procedure with particular reference to India.ISO, sustainable Development.

Environmental Impact Assessment, Environmental Auditing and 15 Hours
Monitoring of Thermal Power projects.

Environmental Impact Assessment, Environmental Auditing and 15 Hours
Monitoring of Nuclear Power Projects, siting and mitigation of adverse impacts of Nuclear Power Projects.

Environmental Impact Assessment, Environmental Auditing and 15 Hours
Monitoring of mining projects, River Valley Projects, Tourism, Irrigation and Dams.

ENV X03: Disaster Management 60 Hours


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.

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.

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.

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ENV X11: Core Lab based on theory papers  
Elective-1  

ENV D01: Hazardous Waste Management  


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. 

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

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

Elective- 2  

ENV D02: Environmental Modeling and Biostatistics  

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. 

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

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

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

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Dy. Registrar (Academic-I) 
University of Rajasthan 
Jaipur
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.

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.

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.

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.

ENV D11: Elective Lab based on theory papers