



Gujarat University

Department of Environment Science

M.Sc. Syllabus

Effective from-

JUNE 2022



Let's keep our world Clean and Green.

Save Trees, Save the Environment!!

Clean city, Green city.

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GUJARAT UNIVERSITY
SYLLABUS OF M. Sc. ENVIRONMENTAL SCIENCE
Effective from JUNE 2022

Outcome of the course:

This curriculum is intended to provide a fundamental understanding of the Earth's life-sustaining, ecological systems, as well as the threats to those systems. The goal of Environmental Science is to provide students with a broader understanding of how science and the scientific method can be used to solve environmental problems. Furthermore, the course includes an extremely important feature of training programmes in the form of field work, measurements, and data analysis, which encourages students to think critically, evaluate and solve problems, as well as understand and communicate science to address societal needs. As part of this programme, students can apply for research positions in government agencies. Candidates with a M.Sc. in Environmental Science can find many lucrative career opportunities both in India and abroad. Candidates with a master's degree in environmental science can find a variety of jobs in both the public and private sectors. They can work for the Pollution Control Board, the Water Authority, or the Department of Urban Planning or in the institutes like Gujarat Environment Management Institute, Gujarat Institute of Disaster Management (GIDM), Gujarat Ecological Educational and Research foundation, NEERI, CEE etc. They can also work for the federal or state governments as an environmental consultant. They may also be able to work for the Indian Forestry Services. They may be able to find work in the field of research and development. Several government research organisations have positions available such as Research Assistant and Research Fellow. These positions are open to MSc Environmental Science graduates. Another option for these graduates is to take on teaching positions in government institutions.

Outline of the Course

1. At the Semester Examination, there will be four papers and two practical worth one hundred (70 external + 30 internal) marks each.
2. Field Excursions are important for studying the environment in its natural state. The candidate must submit the field visit report at the end of the semester during the practical examination.
3. The laboratory practical journal, field visit report, seminar, presentations, assignments, and dissertation should all be turned in on time according to the syllabus.

Seminar:

- Topics will be assigned at the start of each semester;
- On the due date, students must deliver a seminar on the assigned topic as well as submit compiled literature.
- The effectiveness of the presentation would be assessed.

Assignment / Submission:

- The student must prepare / collect specific literature / material relevant to the topics in Environmental Science as part of their assignment / submission.
- Students may conduct surveys under the supervision of the department.
- The assignment/submission will be graded.

Project:

- Based on the papers and topics studied, students must choose a research topic for a project proposal/dissertation. This section will include an introduction, a literature review, a problem, objectives, materials and methodology, a likely outcome/results, and dissertation references.
- The project report will be evaluated.

Question Paper Pattern (for External Examination)

Theory:

Q.1 (A)	[14]
OR	
Q.1 A (i)	[07]
Q.1 A (ii)	[07]
Q.1 (B) Answer the following in one or two lines. (Any Four out of six)	[04]
Q.2 (A)	[14]
OR	
Q.2 A (i)	[07]
Q.2 A (ii)	[07]
Q.2 (B) Answer the following in one or two lines. (Any Four out of six)	[04]
Q.3 (A)	[14]
OR	
Q.3 A (i)	[07]
Q.3 A (ii)	[07]
Q.3 (B) Answer the following in one or two lines. (Any Three out of Five)	[03]
Q.4 (A)	[14]
OR	
Q.4 A (i)	[07]
Q.4 A (ii)	[07]
Q.4 (B) Answer the following in one or two lines. (Any Three out of Five)	[03]

*Multiple choice / match A & B / fill in the blank / True or false / give one word / expand abbreviations, etc. are examples of objective type questions.

Practical:

Q – 1. Major experiment	20 Marks.
Q – 2. Minor experiment	14 Marks.
Q – 3. General experiment	10 Marks.
Q – 4. Comment	16 Marks.
Q – 5. Viva – voce and journal	10 Marks.

(*Pattern may change slightly depending upon the practical topics.)

Note: Examining the situation of the Corona virus, can be rescheduled and paper style can be changed.

PG Courses for credit Based Semester System to be implemented from June 2022

M.Sc. Environment Science			Semester- I				
Course		Paper name	No. of Hours per Week				
No.	Type		Lectures	Others	Practical	Total	Credit
ENV 401	CORE	Principles of environment & ecology	3	1	-	4	4
ENV 402	CORE	Atmospheric chemistry and air pollution	3	1	-	4	4
ENV 403	CORE	Energy and environment	3	1	-	4	4
ENV 404	CORE	Natural resources and environment management institutes	3	1	-	4	4
ENV 405 PR	CORE	Practical-1: based on paper ENV 401 and 402	-	1	6	6	4
ENV 406 PR	CORE	Practical-2: based on paper ENV 403 and 404	-	1	6	6	4
		TOTAL	12	06	12	28	24
			Semester – II				
Course		Paper name	No. of Hours per Week				
No.	Type		Lectures	Others	Practical	Total	Credit
ENV 407	CORE	Current environmental issues and treaties	3	1	-	4	4
ENV 408	CORE	Aquatic pollution and wastewater treatment Techniques	3	1	-	4	4
ENV 409	CORE	Soil, noise and radiation pollution	3	1	-	4	4
ENV 410	CORE	Solid waste and disaster management	3	1	-	4	4
ENV 411 PR	CORE	Practical-3: based on paper ENV 407 and 408	-	1	6	6	4
ENV 412 PR	CORE	Practical-4: based on paper ENV 409 and 410	-	1	6	6	4
		TOTAL	12	06	12	28	24
			Semester – III				
Course		Paper name	No. of Hours per Week				
No.	Type		Lectures	Others	Practical	Total	Credit
ENV 501	CORE	Biodiversity conservation and bioprospecting	3	1	-	4	4
ENV 502	CORE	Environmental legislation and environment impact assessment	3	1	-	4	4
ENV 503	CORE	Environmental toxicology & health	3	1	-	4	4
ENV 504	CORE	Environmental biotechnology and remote sensing	3	1	-	4	4
ENV 505 PR	CORE	Practical-5: based on paper ENV 501 and 502	-	1	6	6	4
ENV 506 PR	CORE	Practical-6: based on paper ENV 503 and 504	-	1	6	6	4
		TOTAL	12	06	12	28	24
			Semester – IV				
Course		Paper name	No. of Hours per Week				
No.	Type		Lectures	Others	Practical	Total	Credit
ENV 507 PT	CORE	Dissertation / Project Work	1	1	18	20	16
ENV 508 M	ELECTIVE	Field Visit/Industrial Visit And Report Writing				4	4
ENV 509 S	CORE	Assignment / Seminar/ Case Studies				4	4
		TOTAL				28	24

M.Sc. Semester I:

Paper No.	Paper name	Hours per week	Credit	Marks		
				Internal	External	Total
ENV 401	PRINCIPLES OF ENVIRONMENT & ECOLOGY	04	04	30	70	100
ENV 402	ATMOSPHERIC CHEMISTRY AND AIR POLLUTION	04	04	30	70	100
ENV 403	ENERGY AND ENVIRONMENT	04	04	30	70	100
ENV 404	NATURAL RESOURCES AND ENVIRONMENT MANAGEMENT INSTITUTES	04	04	30	70	100
ENV 405 PR	PRACTICAL-1: BASED ON PAPER ENV 401 AND 402	09	04	30	70	100
ENV 406 PR	PRACTICAL-2: BASED ON PAPER ENV 403 AND 404	09	04	30	70	100
	Library	02				
	TOTAL	36	24	180	420	600

M.Sc. Semester II:

Paper No.	Paper name	Hours per week	Credit	Marks		
				Internal	External	Total
ENV 407	CURRENT ENVIRONMENTAL ISSUES AND TREATIES	04	04	30	70	100
ENV 408	AQUATIC POLLUTION AND WASTEWATER TREATMENT TECHNIQUES	04	04	30	70	100
ENV 409	SOIL, NOISE AND RADIATION POLLUTION	04	04	30	70	100
ENV 410	SOLID WASTE AND DISASTER MANAGEMENT	04	04	30	70	100
ENV 411 PR	PRACTICAL-3: BASED ON PAPER ENV 407 AND 408	09	04	30	70	100
ENV 412 PR	PRACTICAL-4: BASED ON PAPER ENV 409 AND 410	09	04	30	70	100
	Library	02				
	TOTAL	36	24	180	420	600

M.Sc. Semester III:

Paper No.	Paper name	Hours per week	Credit	Marks		
				Internal	External	Total
ENV 501	BIODIVERSITY CONSERVATION AND BIOPROSPECTING	04	04	30	70	100
ENV 502	ENVIRONMENTAL LEGISLATION AND ENVIRONMENT IMPACT ASSESSMENT	04	04	30	70	100
ENV 503	ENVIRONMENTAL TOXICOLOGY & HEALTH	04	04	30	70	100
ENV 504	ENVIRONMENTAL BIOTECHNOLOGY AND REMOTE SENSING	04	04	30	70	100
ENV 505 PR	PRACTICAL-5: BASED ON PAPER ENV 501 AND 502	09	04	30	70	100
ENV 506 PR	PRACTICAL-6: BASED ON PAPER ENV 503 AND 504	09	04	30	70	100
	Library	02				
	TOTAL	36	24	180	420	600

M.Sc. Semester IV:

Paper No.	Paper name	Hours per week	Credit	Marks		
				Internal	External	Total
ENV 507 PT	DISSERTATION / PROJECT WORK	24	16	120	280	400
ENV 508 M	FIELD VISIT/INDUSTRIAL VISIT AND REPORT WRITING	06	04	30	70	100
ENV 509 S	ASSIGNMENT / SEMINAR/ CASE STUDIES	06	04	30	70	100
	Total	36	24	180	420	600
GRAND TOTAL		144	96	740	1660	2400

SEMESTER I:

Paper Number	Paper Name	Course credit
ENV 401	PRINCIPLES OF ENVIRONMENT & ECOLOGY	4
ENV 402	ATMOSPHERIC CHEMISTRY AND AIR POLLUTION	4
ENV 403	ENERGY AND ENVIRONMENT	4
ENV 404	NATURAL RESOURCES AND ENVIRONMENT MANAGEMENT INSTITUTES	4
ENV 405 PR	PRACTICALS BASED ON PAPER ENV 401 AND 402	4
ENV 406 PR	PRACTICALS BASED ON PAPER ENV 403 AND 404	4

SEMESTER I**ENV 401: PRINCIPLES OF ENVIRONMENT AND ECOLOGY****UNIT- 1: NATURE OF ENVIRONMENTAL STUDIES**

- Concepts of Environmental Science, definition,
- Scope and Importance of Environmental Studies;
- The natural environment and its elements;
- Types, components and Structure of the Environment;
- World Environment Day and National Earth Day and their relevance;
- Environmental education and need for public awareness;
- Concept of sustainability and sustainable development;
- Environmental movements in India.

UNIT-2: ENVIRONMENTAL STRUCTURE AND FACTORS

- Environmental and Climatic Factors: Light, Temperature of Air (atmospheric temperature), Rainfall (precipitation), Humidity of air, atmosphere (gases and wind), fire;
- Topographic Factors: height of mountains, direction of mountains and valleys, steepness of slope and exposure of slope;
- Edaphic factors: Soil: soil formation, soil profile;
- Biotic factors: Intraspecific interactions; Interspecific interactions: Neutralism, Commensalism, Mutualism, proto co-operation, Parasitism, Predation.

UNIT 3: PRINCIPLES OF ECOLOGY AND ECOLOGICAL ADAPTATIONS

- Definition Principles and Scope of Ecology;
- Energy Flows, Ecological Pyramids, Food Chains and Food Webs;
- Homeostasis: Theories of Limiting Factors; Ecological Succession; Population and Communities- Structure, Species Diversity and Species Interaction
- Reproductive Strategies: r and k Factors;
- Ecological adaptations of plants (Hydrophytes, mesophytes, xerophytes, and halophytes), Animals (aquatic conditions- hydrocoles; amphibious conditions or sec. hydrocoles) and Terrestrial (mesocoles and xerocoles).

UNIT 4: ECOSYSTEM AND ITS TYPE

- Ecosystem Structure and Functions of an Ecosystem;
- Biogeochemical cycles;
- Ecosystem Types and Diversity- Terrestrial and Aquatic (Fresh water and Marine) Ecosystems;
- Ecotones: Concept of Edge Effect;
- Ecological Niche;
- Climate Zones and Biomes.

ENV 402: ATMOSPHERIC CHEMISTRY AND AIR POLLUTION**UNIT 1: ATMOSPHERIC CHEMISTRY:**

- Atmospheric structure and composition, Temperature and pressure, humidity;
- Evolution of the Earth's atmosphere,
- Chemical composition of Air: Chemical speciation. Particles, ions and radicals in the atmosphere;
- Chemical processes in the formation of inorganic and organic particulate matters;
- Thermochemical and photochemical reactions in the atmosphere.

UNIT 2: STRATOSPHERIC OZONE AND TROPOSPHERIC CHEMISTRY

- The ozone layer, Formation and destruction of ozone, Chlorofluorocarbons,
- CFC replacement compounds,
- Nitrogen oxides as ozone depleters,
- Tropospheric concentration of OH, The hydroxyl radical as an oxidant,
- Oxidation of carbon monoxide by OH, Oxidation of methane,
- Photochemical smog, London smog,
- Particles in the atmosphere, Particles and climate, Control of particles.

UNIT 3: GLOBAL WARMING AND CLIMATE CHANGE

- Introduction, Greenhouse Gases and Global Climate Changes,
- Global Warming Potential, Possible Impact of Global Warming,
- Greenhouse Effect, El Niño- Climate Cycle,
- Ozone in the Atmosphere, Ozone Hole, Worldwide Ozone Trends, Consequence of Ozone Depletion,
- Consequences of global CO₂ changes, Strategies for Conservation of Environmental Changes Induced by CO₂ Rise,
- Recent records of climate change. Impact of climate change on Indian environment. Measures to cope with climate change.

UNIT 4: AIR POLLUTION

- Natural and anthropogenic sources of pollution. Primary and Secondary pollutants.
- Transport and diffusion of pollutants;
- Types of Pollutant Sampling and Measurement;
- Collection of Gaseous Air Pollutants and Particulate Pollutants;
- Methods of monitoring and control of air pollution- SO₂, NO_x, CO, SPM.
- Indoor air pollution and effects of pollutants on human beings, plants, animals, materials and on climate.
- Air quality Standards- Regional, Indian, International

ENV 403: ENERGY AND ENVIRONMENT**UNIT-1 ENERGY FLOW AND EQUILIBRIUM**

- Defining energy; forms and importance,
- The laws of energy flow, Dynamic equilibrium and spontaneous change,
- Chemical kinetics, Atoms and elements, Molecules and covalent compounds,
- Valency and periodic table of the elements,
- Oxidation states, Compound mixtures,
- Chemical species and chemical reactions,
- The atomic nucleus and nuclear reactions.

UNIT-2 ENERGY RESOURCES, ITS PRODUCTION AND MANAGEMENT

- Global energy resources- renewable and non-renewable resources; distribution and availability;
- Global energy demand: historical and current perspective; energy demand and use in domestic, industrial, agriculture and transportation sector; energy subsidies and environmental costs;
- Energy Production and Consumption, Solar Energy Input, Conventional Fuels, Natural Gas, Uranium, Nuclear Energy and Nuclear Reactions,
- The Risk of Nuclear Accidents.

UNIT-3 NON-CONVENTIONAL AND BIOLOGICAL ENERGY

- Introduction, present status of non-conventional energy;
- Photovoltaic, Solar Heating, Wind Energy, Tidal Power, Geo thermal energy, Hydrogen energy,
- Biomass and Biofuels, Natural Vegetation, Energy Tree Plantations, Specific Energy Crops,
- Power from Biomass, Biomass Programs, Biomass and the Environment.
- Energy conservation and sustainability.

UNIT-4 ENERGY FROM WASTES

- Introduction, Energy from Wastes, Solid Wastes and Water-Based Biomass
- Biogas Plants in Gujarat and in India its use,
- Utilization of Effluent, Cost of Installation and Annual Savings for the energy generation from the waste,
- Financial Assistance from Government Organization of the Biogas Sector,
- Potential for Biogas Generation and Digester Construction,
- Future Energy Scenario of the World;
- Environmental standards for Waste to Energy Plant operations and gas clean-up.

ENV 404: NATURAL RESOURCES AND ENVIRONMENT MANAGEMENT INSTITUTES

UNIT 1: NATURAL RESOURCES

- Introduction and Classification of Natural Resources; Problems associated with natural resources; Plants as a natural resource: a general account with reference to food and medicines; Concept of endemic, extinct and threatened species (endangered, rare, vulnerable and interminate species), Structure of forest; Significance of forest resources;
- Forest types and its resources of India;

UNIT 2: WATER, SOIL AND MINERAL RESOURCES

- Availability of water; Types of Water Resources.
- Water resources of India.
- Conservation of forest and water resources in India.
- Soil as a natural resource: a general account with reference to nutrients & soil biota; Land use patterns; Major soil deposits of India; distribution & uses of economic minerals; Ocean as new area for exploration of mineral resources; India's major mineral resources.

UNIT 3: POLICY AND LAW FOR CONSERVATION OF NATURAL RESOURCES

- Indian Forest Policy, 1952; Forest Conservation Act 1980; Forest policy of 1988; Compensatory afforestation fund Act, 2016;
- Water conservation projects and initiatives in India: Jal Sanchay; Methods of water conservation: Rainwater harvesting, water recycling, Bamboo drip irrigation system; National Water Policy 2012;
- Soil Health Card Schemes;
- The National Mineral Policy (NMP), 2008;
- National River Conservation Programme, sub-schemes of Conservation of Natural Resources and Eco-Systems,

UNIT 4: REGIONAL INSTITUTES AND ENVIRONMENTAL STUDIES

- Regional and national institutes working on environment- Pollution Control Board, the Water Authority, or the Department of Urban Planning or in the institutes like Gujarat Environment Management Institute, Gujarat Institute of Disaster Management (GIDM), Gujarat Ecological Educational and Research foundation, NEERI, CEE, Mahatma Gandhi Labour Institute, Gujarat Institute of Dessert Ecology (GIDE), etc.
- Function and role of CETP
- NABET and NEBOSH, NABL,
- ISO 14001: 2015 Standards, ISO 45001: 2018 standards, ISO 14064 standards, ISO 50001, OHSAS 18001: 2007,
- Environment management system audit, EMS auditor and lead auditor roles

ENV 405 PR: PRACTICALS BASED ON PAPER ENV 401 AND 402**ECOLOGICAL EXPERIMENTS**

- 1) Methods of Sampling Plant Communities: a. Transect Method; b. Bisect; c. Trisect; d. Ring Counts; e. Quadrat Method.
- 2) To determine the minimum size of the quadrat by Species Area Curve Method.
- 3) To determine minimum no. of quadrat to be laid down for study of plant community.
- 4) To study communities by quadrat method and to determine % Frequency, Density and Abundance
- 5) To determine similarity and dissimilarity index of ground vegetation.
- 6) Calculate Importance Value Index (IVI) of different plant species in given plot of vegetation.
- 7) Determine type of dispersion of different plant species in given plot of vegetation.
- 8) Study of Ecological instruments- Hygrometer, Anemometer, Wind vane, Rain gauge, Lux meter, secchi disc,
- 9) Prepare a map of India, showing bio-geographical zones
- 10) Indicate distribution range of a plant and animal species identified as endangered on an Indian map

ENV 406 PR: PRACTICALS BASED ON PAPER ENV 403 AND 404**PRACTICALS BASED ON RENEWABLE ENERGY AND NATURAL RESOURCES**

- 1) To study biogas plants
- 2) To study the production process of biodiesel
- 3) To study the production process of bio-fuels
- 4) Familiarization with different solar energy gadgets
- 5) Case Study: Pirana Landfill, Ahmedabad, India – An Assessment of the Potential for Methane Gas Recovery and its Industrial Applications
- 6) Case Study On Bio CNG Production Plant
- 7) Renewable Energy and Policy Initiatives- Gujarat scenario
- 8) Estimating the Volume of a Standing Tree Using a Scale (Biltmore) Stick
- 9) Measuring tree height with a clinometer
- 10) Measuring canopy closure using spherical crown densitometer and Canopy-scope
- 11) Measurement of Rainfall Using Raingauges
- 12) Ecological Footprint

SEMESTER II:

SEMESTER II		Course credit
ENV 407	CURRENT ENVIRONMENTAL ISSUES AND TREATIES	4
ENV 408	AQUATIC POLLUTION AND WASTEWATER TREATMENT TECHNIQUES	4
ENV 409	SOIL, NOISE AND RADIATION POLLUTION	4
ENV 410	SOLID WASTE AND DISASTER MANAGEMENT	4
ENV 411 PR	PRACTICALS BASED ON PAPER ENV 407 AND 408	4
ENV 412 PR	PRACTICALS BASED ON PAPER ENV 409 AND 410	4

M. Sc. SEMESTER – II**ENV 407: CURRENT ENVIRONMENTAL ISSUES AND TREATIES****UNIT 1: GLOBAL ENVIRONMENTAL PROBLEMS**

- Glacier Melt and Sea Level Rise,
- Drinking water scarcity, food production and equitable distribution, industrialization, population and resources, natural hazards and ECO-DRR, awareness programmes, e-waste generation and its solution, plastic waste, biomedical waste, desertification, deforestation,

UNIT 2: ACID RAIN AND ATMOSPHERE TURBIDITY

- Introduction, Nature and Development of Acid Rain, Acid Rain and Geology;
- Acid Rain and Aquatic Environment, Acid Rain and Terrestrial Environment, Acid Rain and Build Environment; Acid Rain and Human Health, Mitigation of Acid Rain Problems, Aerosol types, Production and Distribution
- Atmospheric Turbidity and Nuclear Winter

UNIT 3: ENVIRONMENTAL CHALLENGES IN INDIA

- Environmental challenges in India
- State wise air quality of India
- Unsustainable Agricultural Practices and Land Use Planning;
- Recent problems like Delhi smog, toxic white foam in the Yamuna River, The degradation of the Mithi River.

UNIT 4: ENVIRONMENTAL TREATIES AND CONVENTIONS

- Ramsar Convention on Wetland, 1971;
- Basel Convention (1989, 1992);
- Kyoto Protocol, 1997; Montreal Protocol, 1987;
- Rotterdam Convention (1998) on Prior informed consent procedure for certain hazardous chemicals and pesticides in International schedule;
- Earth Summit at Johannesburg (2002);
- Paris Agreement (2015); Kigali Amendment (2016)
- COP25 (2019)
- United Nations Framework Convention on Climate Change (UNFCCC)
- Sustainable development goals,
- India's role in various conventions and contributions

ENV 408: AQUATIC POLLUTION AND WASTEWATER TREATMENT TECHNIQUES

UNIT 1: CLASSIFICATION OF WATER POLLUTANTS

- Introduction, Sources of pollutants; Natural Conditions that Influence Water Quality, Utilization of water,
- Origin of Wastewater, Types of Water Pollutants and their Effects.
- Classification of water pollution; Sewage pollution; Agricultural wastes; Pesticides, heavy metal, oil and Thermal pollution in water;
- Pollution of Marine Environment: Status of Coastal and Estuarine Pollution in India, Mitigation of Marine Pollution

UNIT-2 FUNDAMENTALS OF AQUATIC AND MARINE CHEMISTRY

- The Acidity of Water, Metal Complexes in Solution,
- The Complex Medium Called Seawater,
- Oceanic Gases and the Carbon Cycle, Oceanic Gases and Cloud Physics,
- Sources and Nature of pollutants,
- Oil spill and oil Pollution and Marine Biota, Microbial Degradation of Oil and petrochemical in the Sea.

UNIT-3 WASTEWATER AND MONITORING METHODS

- Eutrophication: Major and minor nutrients and their concentration in eutrophicated water,
- Red tide and its causes,
- Algal blooms in Indian waters;
- Sampling, Methods of Analysis,
- Determination of Organic Matter, Determination of Inorganic Substances,
- Physical Characteristics, Bacteriological Measurement,
- Water quality regulations.

UNIT-4 WASTEWATER TREATMENT TECHNIQUES

- Basic Process of Water Treatment, Primary Treatment,
- Secondary (Biological) Treatment,
- Advanced Wastewater Treatment,
- Recovery of Materials from Process Effluents.
- Manufacturing processes, characteristics and composition of wastes - treatment and disposal methods. (E.g. Sugar Industry and Distillery, Pesticides, Drugs and Pharmaceuticals, Pulp and Paper Industry, Tanneries, Dye and Dye Intermediates, Paints and Synthetic Resins, Fertilizer Industry, Dairy Industry)

ENV 409: SOIL, NOISE AND RADIATION POLLUTION**UNIT 1: BASICS OF SOIL POLLUTION**

- Sources and types of Soil pollution; causes of soil pollution; effect of soil pollution;
- Soil pollutants; Transport and behaviour of soil pollutants;
- Sources of soil pollutants: industrial waste, urban waste, hospital wastes, agricultural wastes (fertilizers, pesticides), and radioactive wastes.
- Effects of soil pollutants;
- Prevention and control of soil pollution.

UNIT 2: BASIC PRINCIPLES OF SOIL SAMPLING

- General steps involved in soil sampling; Selection of sampling approach; Selection of monitoring equipment;
- Physical characterization and climatic conditions;
- Physico-chemical and bacteriological sampling and analysis of soil quality;
- Assessment of soil pollutions, international standards.

UNIT 3: NOISE POLLUTION

- Sources of Noise pollution, measurement of noise and indices,
- Effect of meteorological parameters on noise propagation.
- Noise exposure levels and standards.
- Noise instrumentation and monitoring procedure;
- Noise control and abatement measures.
- Impact of Noise on human health; Noise pollution control technologies.

UNIT 4: RADIATION POLLUTION

- Ionizing radiations; radioactive pollution and its impacts
- Radioactive sources - effect of radiation pollutants on plants, animals and human beings
- Prevention and control measures of radioactive pollution;
- Units of radioactivity and measurement of toxic dose, radioactive processes in use.

ENV 410: SOLID WASTE AND DISASTER MANAGEMENT**UNIT 1: INTRODUCTION OF SOLID WASTE AND DISPOSAL**

- Sources, generation, classification & composition of solid wastes.
- Solid waste management methods - Sanitary land filling- Classification of Landfills, Landfilling Methods,
- Generation and Composition of Landfill Gases, Formation and Composition of Leachate;
- Recycling, Composting- Classification of Compost Process, Vermi-composting, Incineration, energy recovery from organic waste.
- Processing Recyclables: source separated recyclables, glass, plastics, can and metal processing,
- Recycling of PVC and related products, Automotive and Household Batteries.

UNIT 2: SOLID WASTE MANAGEMENT TECHNOLOGIES

- Solid Waste Management Plan,
- Waste minimization technologies,
- Hazardous Waste Management, Sources & Classification, physicochemical properties;
- Concentrating Methods: vacuum filtration, rotary drum precoat filter, pressure filtration, centrifuge dewatering, Incineration of Municipal Sludge.

UNIT 3: HAZARDOUS WASTE

- Introduction, Definition of various Hazardous Waste;
- Transportation of Hazardous Waste, Treatment, Storage and Disposal, Site Remediation,
- Hazardous Waste Minimization;
- Hospital Waste Management;
- Nuclear Pollution and Radio-active Wastes;
- Hazardous Waste Management & Handling rules, 1989 & 2000 (amendments).

UNIT 4: DISASTER MANAGEMENT

- Disaster management cycle; Man- Made Disasters, types, nature of man-made disasters, general effects, concerns for manmade disasters;
- Biological and chemical disasters; Natural disasters;
- Disaster Response; Risk and Vulnerability assessment;
- Disaster mitigation and Recovery.

ENV 411 PR: PRACTICALS BASED ON PAPER ENV 407 AND 408**AIR, WATER AND SOIL ANALYSIS**

- 1) Required glassware apparatus, micropipettes
- 2) Determination of SPM in ambient air by high volume sampler- PM 2.5, PM 10
- 3) Determination of SPM in Ambient air by Respirable dust sampler.
- 4) Sampling and analysis of SO₂, CO₂, NO_x, HC
- 5) Wind Rose Analysis – Interpretation of results
- 6) Estimation of temperature, pH, conductivity and turbidity of water samples.
- 7) Find out the total suspended solids (TSS), total dissolved solids (TDS) and total solids present in given water sample (Gravimetry)
- 8) Determine dissolved oxygen, COD, BOD, Alkalinity/ Acidity, Nitrogen, Phosphorus, chloride and Potassium of water sample.
- 9) Estimation of Hardness, Calcium and Magnesium
- 10) Soil moisture measurement.
- 11) Determination of soil pH and EC
- 12) Determination of calcium and magnesium in soil.
- 13) Determination of chloride, carbonate and bicarbonate in soil.

ENV 412 PR: PRACTICALS BASED ON PAPER ENV 409 AND 410**BASIC INSTRUMENTATION**

To study the principle, construction, working mechanism, application, advantages and disadvantages of given instrument.

- 1) Water distiller
- 2) Analytical Balances
- 3) pH meter and Conductivity meter
- 4) Nephelometry, turbidimetry and colorimeter
- 5) Hot air oven and Evaporators
- 6) Centrifuge, Desiccator
- 7) Rotary shaker and Magnetic stirrer
- 8) Electric Heating mantle and hot plate
- 9) Dosimeter
- 10) COD digester
- 11) UV/visible Spectrophotometry
- 12) Flame photometer
- 13) Stack emission sampler
- 14) Biofuel analysers

SEMESTER III:

SEMESTER III		Course credit
ENV 501	BIODIVERSITY CONSERVATION AND BIOPROSPECTING	4
ENV 502	ENVIRONMENTAL LEGISLATION AND ENVIRONMENT IMPACT ASSESSMENT	4
ENV 503	ENVIRONMENTAL TOXICOLOGY & HEALTH	4
ENV 504	ENVIRONMENTAL BIOTECHNOLOGY AND REMOTE SENSING	4
ENV 505 PR	PRACTICALS BASED ON PAPER ENV 501 AND 502	4
ENV 506 PR	PRACTICALS BASED ON PAPER ENV 503 AND 504	4

M. Sc. SEMESTER – III**ENV 501: BIODIVERSITY CONSERVATION AND BIOPROSPECTING****UNIT 1: INTRODUCTION**

- Concepts and components of biodiversity,
- Significance, magnitude and distribution; biodiversity indices;
- Uses of biodiversity; Threats to biodiversity,
- Major causes and extinctions; vulnerability of species to extinction;
- Strategies for sustainable exploitation of biodiversity.

UNIT 2: STRATEGIES FOR BIODIVERSITY CONSERVATION

- In-situ conservation: sanctuaries, biospheres reserves, national parks and preservation plots;
- Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium;
- In-vitro Conservation of plant tissue culture; gene bank; pollen and spore bank; DNA bank; National and international programmes for biodiversity conservation.

UNIT 3: MEGADIVERSITY ZONES AND BIODIVERSITY HOTSPOTS

- Concepts; distribution and importance of mega-diversity zones;
- Biodiversity hotspots; National and global red data lists;
- Categories of species and their management;
- Restoration of biodiversity; Acceleration of ecological succession;
- Reintroduction of biota;
- Methods for monitoring biodiversity trends; IPRs; Patent protection and Bio-piracy.

UNIT 4: BIOPROSPECTING

- Concept of bio-prospecting; importance of biodiversity: aesthetic, cultural and ecosystem services;
- Biodiversity informatics; International efforts and issues of sustainability;
- Wildlife values and eco-tourism; wildlife distribution in India; problem in wildlife protection; role of WWF, WCU, CITES and TRAFFIC.

ENV 502: ENVIRONMENTAL LEGISLATION AND ENVIRONMENT IMPACT ASSESSMENT

UNIT 1: ENVIRONMENT AND DEVELOPMENT: LAW & POLICY

- The Idea of Environment: Ancient and medieval writings Concept, kinds, and Factors responsible for Environmental pollutions;
- Policy and Law: Pre-Independent Environmental legislations,
- Five-year Plans, National Policies related to Environment;
- Constitutional Perspectives of Environment Protection; General Laws on Environmental Concern.
- Environmental Legislations: The Water (Prevention and Control of Pollution) Act 1974, The air (prevention and control of Pollution) act, 1981, Environment (Protection), Act 1986, Noise Pollution (Regulation and Control) (Amendment) Rules, 2010, The Biological Diversity Act 2002, Major Rules under Environment Protection Act 1986
- Role of Government: Environment Impact Assessment 2006 & 2020
- Environmental Jurisprudence and Judiciary: Supreme Court – Polluter Pays Principle, Precautionary Principle, Public Trust Doctrine, Absolute Liability, Strict Liability, National Green Tribunal

UNIT 2: ENVIRONMENT JURISPRUDENCE AND INTERNATIONAL INSTRUMENTS

- International Concern for Environment Protection: Stockholm to Rio de Janeiro and after International Obligations towards Sustainable Development: Agenda 21, Sustainable Development Goals;
- Marine Environment Trans - boundary Pollution Hazards;
- Copenhagen and Paris summits
- 19 Role of Ministry of Environment, Forests & Climate

UNIT 3: BASICS OF ENVIRONMENT IMPACT ASSESSMENT

- Concept of environmental impact assessment;
- Nexus between development and environment;
- Origin and development of EIA;
- Measurement of impact: physical, social-economical, natural;
- Concept of significant effect; Short term versus long term effect;
- Relationship of EIA with Sustainable Development.

UNIT 4: IMPACT ASSESSMENT METHODOLOGIES

- Evaluation of proposed actions and determination of impact importance;
- Development of value functions and scoping EIA methodologies;
- Comparison of alternatives and decision making;
- Compensatory actions - green belts; Preparation and writing of EIA/EIS;
- Review of procedures, practices and guidelines for EIA in India;
- Examples of total impact evaluation;
- Role of GIS in EIA – Base line study, risk assessment, risk management, mitigation measures, comparison of alternatives.

ENV 503: ENVIRONMENTAL TOXICOLOGY & HEALTH**UNIT 1: INTRODUCTION TO ENVIRONMENTAL TOXICOLOGY:**

- Definition, concept and scope of Environmental Toxicology;
- Common environmental toxicants;
- Heavy metals: Sources and their effects on life and environment;
- Pesticides: Types, uses and harmful effect of pesticides; brief note on Biopesticides;
- Mutagenic and Carcinogenic Chemicals, Polyaromatic hydrocarbons, nitrosamines, organic solvents, alcohol, carbon tetrachloride, anaesthetic (chloroform, ether, xylocaine); Tobacco chewing and smoking.

UNIT 2: TOXICITY ASSESSMENT:

- Toxic agents: Phytotoxins; animal toxins; Microbial toxin and xenobiotic and their impact;
- In-vivo and in-vitro toxicity assessment; Acute, subacute, sub chronic and chronic toxicity test; Skin and eye test, behavioural, neurotoxic, reproductive, mutagenic and carcinogenic test; LD₅₀, LC₅₀, EC₅₀ and IC₅₀;
- Factors affecting toxicity.

UNIT 3: SYSTEMIC TOXICITY:

- Absorption, Translocation and Excretion Xenobiotics: Membrane permeability and mechanism of chemical transfer, Absorption of xenobiotics, translocation of xenobiotics, membrane barriers,
- Binding of Xenobiotics, excretion of xenobiotics; Neurotoxicity, hepatotoxicity, immune-toxicity, cardio-vascular toxicity, respiratory dysfunction and hypersensitivity.

UNIT 4: ENVIRONMENTAL OCCUPATIONAL HEALTH

- Concept, indicator & determinants of health (Physical, Chemical & Biological),
- Dust Diseases (Pneumoconiosis with reference to silicosis, asbestosis, anthracosis, bagassosis & byssinosis),
- Occupational hazards, pneumoconiosis, lead poisoning (plumbism),
- Occupational cancer, occupational dermatitis, radiation hazards.

ENV 504: ENVIRONMENTAL BIOTECHNOLOGY AND REMOTE SENSING**UNIT 1: ROLE OF BIOTECHNOLOGY IN ENVIRONMENTAL SCIENCE**

- Introduction to biotechnology, concept of environmental biotechnology, Objectives of Environmental Biotechnology (According to Agenda 21);
- Public perception of biotechnology;
- Genetic engineering, Genetic concept in environment management;
- Five Environmental Buzzwords- the 5Rs: 1. Reduce (Reduction of waste), 2. Reuse (Efficient use of water, energy), 3. Recycle (Recycling of wastes), 4. Replace (Replacement of toxic/hazardous raw materials for more environment- friendly inputs), 5. Recover (useful non-toxic fractions from wastes)

UNIT 2: USE OF BIOTECHNOLOGY IN INNOVATIVE PRACTICES

- Concept of bio-leaching: methods of bioleaching, microorganisms involved, advantages and disadvantages of bioleaching.
- Concept of bio-absorption: factors affecting bio absorption, mechanism of bacterial metal resistance, limitations of bio absorption.
- Concept of bioremediation: microorganisms involved, bioremediation processes and technologies.

UNIT 3: USE OF DIFFERENT TECHNOLOGIES

- Aerobic Vs. anaerobic degradation, testing of biodegradability, Bio-oxidation of phenolic compounds,
- Bio-degradation of specific hazardous wastes, biodegradation of hydrocarbons;
- Plant biotechnology; concept and types of bio-pesticides and their significance.

UNIT 4: GIS AND REMOTE SENSING

- Introduction, GIS definition and terminology, data types, raster and vector data, GIS database design, Satellite based navigation systems (GPS, Gallelio, Glonass, IRNSS)
- Principles of remote sensing, EMR and its interaction with matter, types of sensors and platforms,
- IRS satellites and their sensors, aerial photography, satellite imagery, elements of aerial/satellite image interpretation,
- Application of remote sensing in environmental studies.

ENV 505 PR: PRACTICALS BASED ON PAPER ENV 501 AND 502
ADVANCED INSTRUMENTATION

- 1) To study the principle, construction and working of Laminar Air Flow
- 2) Fourier transform infrared spectrometer (FTIR)
- 3) Atomic absorption spectrometer
- 4) Mass spectrophotometers
- 5) GC
- 6) GC-MS
- 7) LC-MS
- 8) ICP-MS
- 9) HPLC
- 10) HPTLC
- 11) SEM, TEM
- 12) NMR
- 13) Thermal analysis: Thermogravimetric Analysis, Differential Scanning Calorimetry, Differential Thermal Analysis.
- 14) Gel Permeation Chromatograph
- 15) Rheometer
- 16) CO₂ incubator
- 17) X-Ray Diffractometer (XRD)
- 18) PCR

ENV 506 PR: PRACTICALS BASED ON PAPER ENV 503 AND 504
ENVIRONMENTAL BIODIVERSITY, TOXICOLOGY AND SCIENTIFIC WRITING

A. Biodiversity experiments

Calculating the Biodiversity Index, Species Richness

Prepare a map of India, showing bio-geographical zones and expanse of territorial waters

Prepare a map of Gujarat showing Protected Area Network (PAN) in it.

Prepare a document of endemic and exotic species of plants and animals for a selected PAN.

B. Scientific writing and communication

Normal and Scientific writings, styles of citing references.

Writing- Review writing

M.Sc. SEMESTER – IV

ENV 507 PT	DISSERTATION/ PROJECT WORK
ENV 508 M	FIELD VISIT/ INDUSTRIAL VISIT AND REPORT WRITING
ENV 509 S	REVIEW PAPER/ CASE STUDIES/ ASSIGNMENT