

**M.G.S. UNIVERSITY BIKANER,  
BIKANER**

# **SYLLABUS**

**SCHEME OF EXAMINATION AND  
COURSES OF STUDY**

**FACULTY OF SCIENCE**

**M.SC. (ENVIRONMENTAL SCIENCE)  
(SEMESTER)**

**M.Sc. Environmental Science (Previous) - 2018**

**M.Sc. Environmental Science (Final) - 2019**



**सूर्य प्रकाशन मन्दिर**

दाऊजी रोड़ (नेहरू मार्ग), बीकानेर 5 (राज.)

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## M.Sc. Environmental Science

Scheme of examination and courses of study

1. Candidates for admission to the Master of Science (Environmental Science) degree shall be required to have passed the B.Sc. Degree (Pass/ Honours) with at least one subject of Biological Science.
2. Admission will be given on the basis of Merit. The Merit will be drawn on aggregate marks received in the qualifying examination by the candidate.
3. The duration of the course is of two academic years (Four semesters). The course work of the M.Sc. degree in Environmental Science shall be in accordance with the scheme of examinations and syllabus prescribed.
4. The minimum attendance required by a candidate will be as per university rules.
5. A candidate for a pass at each of the Semester Examination shall be required to obtain.
  - a. at least 36% mark in the aggregate of the papers prescribed for the examination and.
  - b. at least 36% marks in the practical(s)
6. Wherever prescribed at the examination, provided that a candidate fails to secure at least 25% marks in each individual theory paper at the examination he/she shall be deemed to have failed at the examination notwithstanding having obtained the minimum percentage of marks required in the aggregate for the examination.
7. Division shall be awarded at the end of the fourth semester examination and combined marks obtained after two years examinations taken together as noted below:

**First Division**          60% of aggregate of above marks taken together.  
**Second Division**      48% of aggregate of above marks taken together.  
All the rest will be declared to have passed the examination
8. There will be 4 theory papers of 50 marks each in each semester, except for Fourth semester wherein there will be three theory papers and one dissertation of 50 marks each.
9. An educational tour may be organized for M.Sc. students to important places of environmental interest within or outside the State under the supervision of faculty members of the department. The expenses will be borne by the participating student. However, the university will provide train/bus travel concessions as per necessity and university rules. Traveling expenses of the teacher/s will be borne by the university as per rules of TA and DA.
10. Each paper will be divided into three units and at least one question will have to be attempted from each unit. All questions will carry equal marks.

### **M.Sc. First Semester**

Paper ES 101	Environment & Ecology
Paper ES 102	Environmental Geoscience
Paper ES 103	Environmental Chemistry
Paper ES 104	Environmental Biology I

#### **ES 101 Environment & Ecology**

**Time: 3 Hours**

**M.M. 40+10**

##### **Unit I**

Earth, man and environment. Environmental factors: Atmosphere, Hydrosphere, Lithosphere and Biosphere, and their interrelationships. Holistic concept, environmental complex, tolerances, ecological amplitude, limiting and inhibiting effects. Climatic factors: Pressure, temperature, RH, precipitation, radiation, wind. Edaphic factors: physical, chemical and biological characteristics.

##### **Unit II**

Ecology- Definition, principles, and scope. Human ecology and settlement. Ecosystems: Structure and functions. Abiotic and Biotic components, Energy flows, Food chains, Food web, Ecological pyramids. Ecosystem types- Aquatic (freshwater, marine) and terrestrial (grassland, forest) ecosystems. Concept of Population and Community. Ecotones and their importance.

##### **Unit III**

Biogeochemical cycles and regulation, pools and flexes, basic cycles: hydrologic, carbon, oxygen, nitrogen, phosphorus and sulphur cycles; Nutrient cycling in forest and aquatic ecosystems.

#### **ES 102 Environmental Geoscience**

**Time: 3 Hours**

**M.M. 40+10**

##### **Unit I**

The earth systems and Biosphere: Conservation of matter in various geospheres- lithosphere, hydrosphere atmosphere and biosphere. Energy budget of the earth. Earth's thermal environment and seasons. General relationship between landscape, biomes and climate. Climates of India. Indian Monsoon. El Nino. Droughts. Tropical cyclones and Western Disturbances.

##### **Unit II**

Earth's Processes and Geological Hazards: Earth's processes; concept of residence, time and rates of natural cycle. Catastrophic geological hazards. Study of floods, landslides, earthquakes, volcanism and avalanche. Prediction and perception of the hazards and adjustments to hazardous activities.

### **Unit III**

Environmental Geochemistry: Concept of major, trace and REE. Classification of trace elements. Mobility of trace elements. Geochemical cycles. Biogeochemical factors in environmental health. Human use, trace elements and health. Possible effects of imbalance of some trace elements.

### **Paper 103 Environmental Chemistry**

**Time: 3 Hours**

**M.M. 40+10**

#### **Unit I**

Fundamentals of Environmental Chemistry: Stoichiometry, Gibbs' energy, Chemical potential, chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides.

#### **Unit II**

Chemical composition of Air: Classification of elements, chemical speciation. Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermochemical and photochemical reactions in the atmosphere. Oxygen and ozone chemistry, Chemistry of air pollutants, Photochemical smog.

#### **Unit III**

Water Chemistry: Chemistry of water, concept of DO, BOD, COD, sedimentation, coagulation. filtration, Redox potential.  
Soil Chemistry: Inorganic and organic components of soil, Nitrogen pathways and NPK in soils.

### **Paper 104 Environmental Biology I**

**Time: 3 Hours**

**M.M. 40+10**

#### **Unit I**

Concepts and Scope Environmental Biology. Impact of environment at cellular level. Eco-physiological adaptations in plants and animals for stressed environments. Biosphere as an ecosystem, its ecological processes and life support systems. Anthropogenic impact on the biosphere and its life support systems (including flora, fauna, soil, climate, atmosphere, terrestrial and aquatic ecosystems). Role of biological processes in remedial measures and restoration.

#### **Unit II**

Population Ecology: Factors determining population. Factors leading to the commonness, rarity and vulnerability of extinction of a species. Population Dynamics: Patterns of survival, age distribution, dispersal and rates of change. Attributes of K-selected and r-selected species.

Population Growth. Common approaches in population density measurement.

### **Unit III**

Community Ecology: Concept and types of communities. Interspecific and intraspecific interactions. Concepts of niche and keystone species. Role of nutrients, water and energy in determining community. Succession, development, climax and stability of ecosystems.

### **M.Sc. Second Semester**

Paper ES 201	Environmental Biology II
Paper ES 202	Desert Ecology
Paper ES 203	Environmental Pollution
Paper ES 204	Environmental Toxicology

### **Paper 201 Environmental Biology II**

**Time: 3 Hours**

**M.M. 40+10**

#### **Unit I - Biomes:**

Climatic and edaphic factors of terrestrial biomes. Heinrich Walter's Biome Climate Diagrams.

Classification of land biomes with their soil, climate and vegetation characteristics. Their natural history, wildlife, geography and human influences.

Mountain Biome: Replication of latitudinal changes in the altitudes of high mountains.

Terrestrial biomes, ecosystem diversity, forest and vegetation types in India.

#### **Unit II - Freshwater and Marine biomes:**

Challenges and adaptations of life in aquatic biomes (freshwater: lentic and lotic; marine).

Freshwater Biomes (Rivers, streams, lakes, ponds) and their natural history.

Marine Biomes (including mangroves, coral islands, kelp forests, saltwater marshes, seashores, estuaries) and their natural history.

Estuaries, their characteristics and biota.

Wetlands- definitions, types, ecological functions and resources.

#### **Unit III- Biogeography: India & World:**

Major biogeographic (zoogeographic and phytogeographic) regions of the world and India, extent, characteristics and species composition.

Continental Drift: Its causes and consequences for distribution of life on earth.

India's biogeographical history, current geographical position and their impact on biodiversity.

India's forests and vegetation types. Protected Area Network.

## ES 202 Desert Ecology

**Time: 3 Hours**

**M.M. 40+10**

### Unit I

Definition and types of deserts. Major deserts of the world- Distribution and characteristics. Causes of desertification.

### Unit II

Desert ecosystem with special reference to the Indian desert: environment, flora, fauna. Desert adaptations among plants and animals. Drought and famine, migration. Aridity index. Endangered plant and animal species of the Indian desert and their conservation strategies.

### Unit III

Resource management in deserts- traditional and modern approaches. Saline tracts of the Rajasthan desert. Impact of canal irrigation on the ecology of the Indian desert. Approaches for combating desertification. Dry land farming. Waterbodies in arid and semiarid lands and their management strategies.

## Paper 203 Environmental Pollution

**Time: 3 Hours**

**M.M. 40+10**

### Unit I

Overview of Environmental Pollution-Definition, types of pollutants, causes, effects, monitoring, prevention and control of pollution.

Air : Natural and anthropogenic sources of pollution. Primary and Secondary pollutants. Transport and diffusion of pollutants. Gas laws governing the behaviour of pollutants in the atmosphere. Methods of monitoring and control of air pollution. SO<sub>2</sub>, NO<sub>2</sub>, CO, SPM. Effects of pollutants on human beings, plants, animals, materials and on climate. Acid Rain. Air Quality Standards. Global warming.

### Unit II

Water : Types, sources and consequences of water pollution. Physico-chemical and Bacteriological sampling and analysis of water quality. Sewage and waste water treatment and recycling. Water quality standards.

Marine : Sources of marine pollution and control. Criteria employed for disposal of pollutants in marine system, coastal management.

Soil : Physico-chemical and bacteriological sampling and analysis of soil quality. Industrial waste/effluents and heavy metals, their interactions with soil components. Soil microorganisms and their functions, degradation of different insecticides, fungicides and weedicides in soil. Different kinds of synthetic fertilizers (NP & K) and their interactions with different components of soil. Soil Pollution Control.

### Unit III

Sources and generation of solid wastes, their characterization, chemical composition and classification. Different methods of disposal and management of solid wastes (Hospital Wastes and Hazardous Wastes) Sources of noise pollution, measurement of noise and Indices, effect of meteorological parameters on noise propagation. Noise exposure levels and standards. Noise control and abatement measures. Impact of noise on human health. Radioactive waste and radioactivity from nuclear reactors; Thermal Pollution. Impacts of large-scale exploitation of Solar, Wind, Hydro and Ocean energy.

### Paper 204 Environmental Toxicology

Time: 3 Hours

M.M. 40+10

#### Unit I

Toxic Chemicals in the environment--Air, Water: Pesticides in water. Bio-chemical aspects of Arsenic, Cadmium, Lead, Mercury, Carbon monoxide, O<sub>3</sub> and PAN Pesticides, Insecticides, MIC, carcinogens in the air.

#### Unit II

Occupational Health: Definition, Occupational Health Hazards, Common hazards: Pneumoconiosis. Silicosis, Anthracosis, Byssinosis, Bagassosis, Asbestosis, Farmers's Lung, Lead poisoning, Occupational Cancer, Occupational Dermatitis, and Radiation Hazards. Measures for health protection of workers and Role of WHO in Occupational Health. Occupational Health in India.

#### Unit III

History and scope of toxicology. Toxicology of aquatic and terrestrial environments. Acute and chronic toxicity. Toxicity testing in field and enclosure. Toxic dose: Approximate acute LD<sub>50</sub> /LC<sub>50</sub> of some representative chemical agents. The use of biomarkers in assessing the impact of environmental contaminants. Bioassay. Trophic level transfer of contaminants. Bioindicators of environmental quality.

### M.Sc. Third Semester

Paper ES 301	Natural Resources & Management
Paper ES 302	Biodiversity & Conservation
Paper ES 303	Environmental Legislation
Paper ES 304	Environmental Issues and Awareness

### ES 301 Natural Resources & Management

Time: 3 Hours

M.M. 50

#### Unit I

Principles of Remote sensing and their application in Environmental Sciences. Application of GIS in Environmental Management. Landuse



Planning: The landuse plan. Soil surveys in relation to landuse planning. Methods of site selection and evaluation.

### **Unit II**

Sun as source of energy, solar radiation and its spectral characteristics. Fossil fuels- classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas. Principles of generation of hydroelectric power, tidal, Ocean Thermal Energy Conversion, wind, geothermal energy; solar collectors, photovoltaic, solar ponds; nuclear energy- fission and fusion; magnetohydrodynamic power, bio-energy-energy from biomass and biogas, anaerobic digestion; energy use pattern in different parts of the world.

### **Unit III**

Water Resources and Environment: Global Water Balance. Ice sheets and fluctuations of sea levels. Types of water. Origin and composition of seawater. Hydrological cycle. Factors influencing the surface water. Resources of oceans.

Mineral Resources and Environment: Resources and Reserves. Minerals and Population. Oceans as new areas for exploration of mineral resources. Environmental impact of exploitation, processing and smelting of minerals.

## **Paper 302 Biodiversity and Conservation**

**Time: 3 Hours**

**M.M. 50**

### **Unit I**

Definition, classification and importance of Biodiversity; Causes of biodiversity reduction and strategies for biodiversity conservation. Endangered and Threatened Species (Flora and fauna) of India and Rajasthan, Hotspots of Biodiversity. Strategies of biodiversity conservation in India and the world (in situ and ex situ).

1. Magnitude and distribution of Biodiversity (global and Indian) and its characterization.
2. Rapid assessment of biodiversity and its valuation, skill, trained personnel and resources needed for the task.
3. Evaluating nature, scale and intensity of the threats to biodiversity.

### **Unit II**

1. Role of plants in natural ecosystems and life support system (terrestrial, freshwater and marine)
2. Importance of traditional cultivars and wild species in agriculture.
3. Role of plants in modern and traditional medicine.
4. Value of plants in scientific research and technological inventions.
5. Value of microbes in medicinal, scientific and technological research solutions and inventions.
6. Vegetation zones of India and Rajasthan

### **Unit III**

1. Role of animals in conservation of natural ecosystems.
2. Role of wild and domesticated fauna in human nutrition.
3. Importance of animal species (terrestrial and marine) in medicine.
4. Important wild animals of India and their distribution, Sanctuaries and National parks, Red data book. Gene pool.
5. Ecotourism in wilderness and protected area network.

### **Paper 303 Environmental Legislation**

**Time: 3 Hours**

**M.M. 50**

#### **Unit I**

Overview of the ISO 14000 family, Key aspects of the International Standard ISO 14001. Environmental Management Systems: Benefits, Principles and elements of successful environmental management. Comparison between EMAS, BS77560 and ISO 14001. Auditing of EMS. Occupational Health and safety Management System (OHSMS), OHSAS 18001.

#### **Unit II**

Provision in Constitution of India regarding Environment (Article 48A and 51G). Environmental (Protection) Act, 1986 and Rules 1986. Air (Prevention and Control of Pollution) Act, 1981 as amended by Amendment Act 1987 and Rule 1982. Water (Prevention and Control of Pollution) Act, 1974 as amended up to 1988 and Rules 1975. Wildlife (Protection) Act, 1972 amended 1991. Indian Forest Act (Revised) 1982. Biological Diversity Act, 2002.

#### **Unit III**

Scheme of labelling of environmentally friendly products (Ecomark). Life Cycle Assessment. Ecological Footprinting. Public Liability Insurance Act, 1991 and Rules 1991. Bio-Medical Waste (Management and Handling) Rules- 1975; Hazardous Waste (Management and Handling) Rules- 1989.

### **Paper 304 Environmental Issues and Awareness**

**Time: 3 Hours**

**M.M. 50**

#### **Unit I**

Environmental Issues: Environmental Ethics and Global imperatives. Global Environmental problems: Ozone depletion, global warming and climatic change, Greenhouse gases, Acid rains, Oil spills, Water Crises- Conservation of water, Rain water harvesting and Groundwater recharge. Flooding, Eutrophication and restoration of lakes. Wetlands conservation.

Nuclear fallout, Nuclear and radiation accidents, Nuclear safety , Electronic waste.

**Unit II**

Blast fishing, Illegal, unreported and unregulated fishing, Environmental effects of over fishing, Deforestation, Invasive species, Pollinator decline, Species extinction, Poaching, Wildlife trade

Intensive farming, Overgrazing, Soil conservation, Soil erosion, Soil salination, Landslide

Current Environmental issue in Indian Context: Narmada Dam, Tehri Dam, Almetti Dam, Soil Erosion. Formation and reclamation of Usar, Alkaline and Saline Soil. Waste lands and their reclamation, Floods and Drought.

**Unit III**

Environmental priorities in India and sustainable development.

Environmental education and awareness, role of governmental and non-governmental organizations. Environmental issues with war, Genetically modified food controversies, Overpopulation, Gender Imbalance. Epidemiological issues (e.g., Goitre, Fluorosis, Arsenic)

**M.Sc. Fourth Semester**

Paper ES 401	Environmental Monitoring
Paper ES 402	Environmental Impact Assessment
Paper ES 403	Environmental Technology
Paper ES 404	Dissertation

**Paper ES 401 Environmental Monitoring****Time: 3 Hours****M.M. 50****Unit I**

Principles of Analytical Methods and their application in Environmental monitoring, with special reference to: Titrimetry, Gravimetry, Colourimetry, Spectrophotometry, Chromatography, Gas Chromatography, Atomic Absorption Spectrophotometry, GLC, HPLC, Electrophoresis, X-ray fluorescence, X-ray diffraction, Flame photometry.

**Unit II**

Systems analysis for Environmental problems. Environmental monitoring for Air, Water, Soil, Radiation and Microbiology: Common parameters, sampling procedures and analytical techniques.

**Unit III**

Basic elements and tools of statistical analysis; Probability, sampling. Measurement and distribution of attributes; Distribution-Normal, t and x', Poisson and Binomial; Arithmetic, Geometric and Harmonic means; moments: matrices, simultaneous linear equations. Tests of hypothesis and significance.

Introduction to environmental system analysis; Approaches to development of models; linear simple and multiple regression models,

validation and forecasting. Models of population growth and interactions- Lotka-Volterra model, Leslie's matrix model, point source stream pollution model, box model. Gaussian plume model.

### **Paper 402 Environmental Impact Assessment**

**Time: 3 Hours**

**M.M. 50**

#### **Unit I**

Introduction to environmental impact analysis. Environmental impact Statement and Environmental Management Plan. EIA guidelines 2006, Notifications of Government of India. Impact Assessment Methodologies, their strengths and weaknesses. Generalized approach to impact analysis. Procedure for reviewing Environmental impact analysis and statement.

#### **Unit II**

Guidelines and basic principles of Environmental auditing -Definition, functions, benefits and costs of Environmental Auditing. Introduction to Environmental planning. Base line information and predictions (land, water, atmosphere, energy, etc.). Landuse policy for India. Urban planning for India. Rural planning and landuse pattern. Concept and strategies of sustainable development. Cost-Benefit analysis.

#### **Unit III**

Environmental Appraisal with particular reference to:

1. Mining Projects
2. Industrial Projects
3. Thermal Power Projects
4. River Valley, Multipurpose, Irrigation and H.E. Projects
5. Infrastructure Development and Miscellaneous Projects
6. Nuclear Power Projects

### **Paper ES 403 Environmental Technology**

**Time: 3 Hours**

**M.M. 50**

#### **Unit I**

Scope, Purpose and Objectives of Air Quality Monitoring Programme; Guidelines and Design of an air quality surveillance network; Period, frequency and duration of sampling; Principles and instruments for sampling and measurement of -(i) ambient air pollutants, and (ii) stack emissions (monitoring).

Dispersion of Pollutants: maximum mixing depth, lapse rate, stability conciliations, plume behaviour, calculation of effective stack height.

#### **Unit II**

General methods of control of Gaseous pollutants-scrubbers, condensers, control equipment for particulate matter-gravity settling chambers, cyclone, fabric filters, electrostatic precipitators, case study

of thermal power plants. Control of Mobile Source Emissions. Automobile Exhausts.

### Unit III

Water Pollution Control: Drinking Water Treatment Procedures, Flocculation, Settling, Filtration, reverse sand filter, cleaning, chlorination. Methods of Cleaning Potable Water: Filtration, Electro-dialysis, principle & theory of chemical oxidation. Disinfection mechanism: Ozone, permanganate, chlorination. Reverse osmosis. Ultra filtration. Water quality standards.

Environmental Biotechnology: Fermentation, Vermiculture, Biogas, Biofertilizer, Bioremediation technologies.

### Paper ES 404 Dissertation

M.M. 50

#### Practical Work Semester - I

Study of Local Flora & Fauna:

1. Plant species diversity in a given area (one season data only)
2. Species-wise population count of birds in a wetland/ terrestrial habitat.
3. Qualitative and quantitative analysis of zooplankton, phytoplankton, periphyton and benthos.
4. List of bioproducts used by a community living inside or in the proximity of a protected area.

Monitoring of Water: Turbidity, pH, Dissolved oxygen, Free carbon dioxide, Alkalinity, Salinity, Sodium, Potassium, Calcium, Magnesium, Carbonates, Bicarbonates, Chlorides, Sulphates, Nitrate, Phosphate, Silica.

#### Practical Work Semester - II

Monitoring of Soil: Measurement of Bulk density, Specific gravity, Moisture content, Conductivity, pH, Alkalinity, Soluble ions, Nitrogen, Phosphorus, Sulphur.

Geographical data:

1. Meteorological records - Pressure, Temperature, Precipitation, Humidity, wind.
2. Drainage basin and network morphometry
3. Slope and aspect maps, Critical slope for specified activities, Profiles.
4. Climatic maps and diagrams: circular graph, climograph, water budget, wind roses (simple and compound)

#### Visit:

Visit to a terrestrial or aquatic location of ecological importance.

#### Practical Work Semester - III

#### Geoinformatics:

1. Introduction of the GIS software.
2. Georeferencing

3. Base layer preparation / Digitization
4. Preparation of Geodatabase.
5. Mosaicing.
6. Classification of Satellite Image.

#### Solid Waste Analysis

1. Physical composition (by weight)
2. Moisture content
4. pH and Conductivity
5. Calorific value by calculation

#### Environmental Statistics

1. Grouping of data and preparation of frequency distribution. Histogram and frequency polygon.
2. Calculating mean, median and mode for grouped and ungrouped data.
3. Calculating variance, standard deviation and coefficient of variation for grouped and ungrouped data.
4. Fitting simple linear regression. Plotting scatter diagram and regression line.
5. Computing correlation coefficient and testing its significance for grouped and ungrouped data.
6. Comparison between means of two independent samples. Paired t-test.
7. Analysis of variance one way classification.
8. Analysis of variance: two-way classification.

### Practical Work Semester - IV

#### Environmental Monitoring

1. Determination of particle size using respirable dust sampler.
2. Determination of PM 2.5 using fine particle sampler.
3. Respirable Suspended Particulate Matter (RSPM) by Respirable suspended particulate matter sampler (RDS APM 460)
4. Formaldehyde (HCHO) by Colorimetric method.
5. Sulphur dioxide by Colorimetric method.
6. Dust retaining capacity of plants.
7. Measurement of noise.
8. Estimation of BOD
9. Estimation of COD
10. Estimation of Chlorophyll
11. Estimation of Total, organic and inorganic carbon
12. Designing of waste water treatment plant.
13. GPS - Application in field
14. Estimation of Biodiversity
15. Site visit to degraded landscapes/habitats- terrestrial and aquatic.

16. Visit to restored/ managed habitats & study of their practices.
17. Field use of contour Marker for alignment of contour lines on the ground.
18. Visit to watershed area, to study different characteristics of watershed preferably in rainy season.

### **Advanced Instrumental Techniques**

1. Flame photometry
2. UV-Visible Spectrophotometry
3. Atomic Absorption Spectrophotometry

### **Case Study**

Related to Pollution Monitoring, Treatment and Control; Environmental Impact Assessment; Resource recycling and reclamation; Biodiversity and its conservation.