

Department of Environmental Science
Maharshi Dayanand University, Rohtak
Ph.D Entrance Syllabus

Maximum marks:100

Time allotted: 1 hour 15 minutes

Instruction to the paper Setter: There will be 100 questions to be set in the paper. The paper should be evenly distributed throughout the syllabus with at least five questions from each unit.

Instructions to the candidate: All questions are compulsory and carry equal marks. There will be one mark for each correct answer and 0.25 will be deducted for every wrong answer.

Unit – I :

- Definition, principles and scope of Environmental Science.
- Earth, Man and Environment. Ecosystems, Pathways in Ecosystems.
- Physico-chemical and Biological factors in the Environment.
- Geographical classification and zones.
- Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Mass and Energy transfer across the various interfaces, material balance. First and Second law of thermodynamics, heat transfer processes. Scale of Meteorology, pressure, temperature, precipitation, humidity, radiation and wind. Atmospheric stability, inversions and mixing heights, wind roses.
- Natural resources, conservation and sustainable development.

Unit – II :

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

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.

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.

Toxic Chemicals in the environment – Air, Water: Pesticides in water. Biochemical aspects of Arsenic, Cadmium, Lead, Mercury, Carbon Monoxide, Ozone and PAN, Pesticides, Insecticides, MIC, carcinogens in the air.

Principles of Analytical Methods: Titrimetry, Gravimetry, Colourimetry, Spectrophotometry, Chromatography, Gas Chromatography, Atomic Absorption Spectrophotometry, GLC, HPLC, Electrophoresis. X – ray fluorescence, X – ray diffraction, Flame photometry.

Unit – III :

Definition, Principles and scope of ecology, Human ecology and Human settlement, Evolution, Origin of life and speciation.

Ecosystems :

- Structure and functions, Abiotic and Biotic components, energy flows, Food chains, Food web, Ecological pyramids, types and diversity.
- Ecological Succession, Population, Community ecology and Parasitism, Prey – predator relationships.

Common flora and fauna in India:**Aquatic :** Phytoplankton, Zooplankton and Macrophytes.**Terrestrial :** Forests

Microflora of Atmosphere : Air Sampling techniques. Identification of aeroallergens. Air – borne diseases and allergies.

Biodiversity and its conservation : Definition, ‘Hotspot’s of Biodiversity, Strategies for Biodiversity conservation. National Parks and Sanctuaries. Gene pool. Biodiversity conservation and Agenda – 21, Endangered and Threatened Species.:

Unit – IV :

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

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

Water Resources and Environment : Global Water Balance. Ice sheets and fluctuations of sea levels. Origin and composition of seawater. Hydrological cycle. Factors influencing the surface water. Types of water. Resources of oceans. Ocean pollution by toxic wastes. Human use of surface and groundwaters. Groundwater pollution.

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, photovoltaics, 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 – V :

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 SO₂, NO_x, CO, SPM. Effects of pollutants on human beings, plants, animals, materials and on climate. Acid Rain. Air Quality Standards.

Water : Types, sources and consequences of water pollution. Physico – chemical and Bacteriological sampling and analysis of water quality. Standards, sewage and waste water treatment and recycling. Water quality standard.

Soil : Physico – chemical as bacteriological sampling as analysis of soil quality. Soil Pollution Control. Industrial waste effluents and heavy metals, their interactions with soil components. Soil micro – organisms and their functions, degradation of different insecticides, fungicides and weedicides in soil. Different kinds of synthetic fertilizers (N P & K) and their interactions with different components of soil.

Noise : 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.

Marine : Sources of marine pollution and control. Criteria employed for disposal of pollutants in marine system-coastal management. Radioactive and Thermal Pollution.

Unit – VI :

Solid waste and its management: 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) Recycling of waste material. Waste minimization technologies.

Resource Management, Disaster Management and Risk analysis.

Environment laws: Provision of constitution of India regarding environment (article 48 A & 58A). Scheme of labelling of environmentally friendly products (ecomark). Public liability Insurance Act. 1991. Wild life protection act, 1972 amended 1991 and 2002. Forest conservation act, 1980. Indian forest act (Revised) 1982. Air (prevention & control of pollution) Act 1981 as amended by amendment 1987 & rule 1982. The water (prevention & control of pollution) Act, 1974 as amended by amendment 1988 & rules 1975, The environment (protection) Act, 1986, rules 1986. Motor vehicle act, 1988,

Unit- VII:

Basic elements and tools of statistical analysis; Probability, sampling, measurement and distribution of attributes; Distribution-Normal, t and χ^2 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.

Unit – VIII :

- Environmental Education and Awareness. Environmental Ethics and Global imperatives.
- Global Environmental problems- ozone depletion, global warming and climatic change.
- Current Environmental issue in India.
- Context : Narmada Dam, Tehri Dam, Almetti Dam, Soil Erosion, Formation and reclamation of Usar, Alkaline and Saline Soil.
- Waste lands and their reclamation.
- Desertification and its control.

- Vehicular pollution and urban air quality.
- Depletion of Nature resources.
- Waste disposal, recycling and power generation, Fly ash utilization. Water Crises- Conservation of water. Environmental Hazards.
- Eutrophication and restoration of Indian lakes. Rain water harvesting. Wet lands conservation.
- Epidemiological issues (e.g., Goitre, Fluorosis, Arsenic).
- Principles of Remote sensing and its application of Environmental Sciences. Application of GIS in Environmental Management.

Unit: IX:

Microbiology: Prokaryotic and eukaryotic cell structure; Morphology and cell structure of major groups of microorganisms e.g. bacteria, fungi, algae, protozoa and viruses. Microbial nutrition, growth and control; Growth curve (normal and biphasic) and generation time. Measurement of growth; Nutritional categories of microorganisms; Media Formulation; Sterilization; Microbial growth: Batch, fed-batch, continuous mode. Microbial metabolism (aerobic and anaerobic respiration, photosynthesis); Nitrogen fixation; Chemical basis of mutations and mutagens; Microbial genetics (plasmids, transformation, transduction, conjugation)

Biochemistry: Biomolecules and their conformation; Weak inter-molecular interactions in biomacromolecules; Chemical and functional nature of enzymes; Kinetics of single substrate enzyme catalyzed reactions; Bioenergetics; Metabolism (Glycolysis, TCA and Oxidative phosphorylation); Membrane transport and pumps; Cell cycle and cell growth control. Photosynthesis: Light absorption and energy conversion; Calvin cycle; Hatch-Slack Pathway; Photorespiration.

Molecular Biology and Genetics: Molecular structure of genes and chromosomes; DNA/RNA as the genetic material, Organelle DNA, DNA replication and control; Transcription and its control; Translational processes; Regulatory controls in prokaryotes and eukaryotes; Extrachromosomal inheritance; Transposons.

Unit- X:

Process Biotechnology: Bioprocess technology for the production of cell biomass and primary/secondary metabolites, such as baker's yeast, ethanol, citric acid, amino acids, exopolysaccharides, antibiotics, Biofertilizers and pigments etc.; Microbial production,

purification and bioprocess application(s) of industrial enzymes; Production and purification of recombinant proteins on a large scale; Chromatographic and membrane based bioseparation methods; Immobilization of enzymes and cells and their application for bioconversion processes.

Recombinant DNA Technology: Restriction and modification enzymes; Vectors: plasmid, bacteriophage and other viral vectors, cosmids, Ti plasmid, yeast artificial chromosome; cDNA and genomic DNA library; Gene isolation; Gene cloning; Expression of cloned gene; Transposons and gene targeting; DNA labeling; DNA sequencing; Polymerase chain reactions; DNA fingerprinting; Southern and northern blotting; In-situ hybridization; RAPD; RFLP; Site-directed mutagenesis; Gene transfer technologies; Gene therapy.

Intellectual Property: Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs.

Biosafety : Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Environmental release of GMOs.