

2023-24

SYLLABUS*of***PhD Entrance Examination***for***Admission***in*

**DEPARTMENT OF ENVIRONMENTAL SCIENCES
SCHOOL OF BIOLOGICAL SCIENCES**



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Unit-I: Fundamentals of Environmental Sciences

Definition; Principles and Scope of Environmental Science; Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere; Laws of thermodynamics; Meteorological parameters: pressure, temperature, precipitation, humidity, mixing ratio, saturation mixing ratio, radiation and wind velocity, adiabatic lapse rate, environmental lapse rate; Wind roses. Biogeographic provinces of the world and agro-climatic zones of India; Concept of sustainable development.

Principles and applications of remote sensing and GIS; digital image processing and ground truthing; waste management and climate change; Environmental education and awareness; Environmental ethics.

Unit-II: Environmental Chemistry

Classification of elements; Stoichiometry; Gibbs' energy; Chemical potential; Chemical kinetics; Chemical equilibria; Solubility of gases in water; Carbonate system; Radioisotopes; Composition of air; Particles, ions and radicals in the atmosphere; Chemical speciation; Chemical processes in the formation of inorganic and organic particulate matters; Thermochemical and photochemical reactions in the atmosphere; Oxygen and Ozone chemistry; Photochemical smog; Hydrological cycle; Inorganic and organic components of soils; Biogeochemical cycles: nitrogen, carbon, phosphorus and sulphur.

Toxic chemicals: Pesticides and their classification and effects; Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se), CO, O₃, PAN, VOC and POP. Carcinogens in the air.

Principles of analytical methods: Titrimetry, Gravimetry, Bomb Calorimetry, Chromatography (Paper Chromatography, TLC, GC and HPLC), Flame photometry, Spectrophotometry (UV-VIS, AAS, ICP-AES, ICP-MS), Electrophoresis, XRF, XRD, NMR, FTIR, GC-MS, SEM, TEM.

Unit-III: Environmental Biology

Ecosystem Structure and functions; Biogeochemical cycles. Ecological succession; Ecotone; Edge effects. Keystone species; Niche; Types of Ecosystem and biomes; Population ecology: characteristics, carrying capacity, population growth and regulations, concept of 'r' and 'K' species; community interactions; Biodiversity and its conservation: definition, types, values and threats, hotspots, measures of biodiversity, biopiracy and bio-prospecting; Restoration ecology; IUCN red list classification.

Toxicology, Microbiology and Biotechnology: Absorption, distribution and excretion of toxic agents, threshold limit value, therapeutic index, biotransformation; Major water borne diseases and air borne microbes; Bioremediation: definition, types and role of plants and microbes for *in situ* and *ex situ* remediation; Bioindicators; Biofertilizers; Biofuels and Biosensors.

Unit-IV: Environmental Geosciences

Origin of earth; Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere; Concept of minerals and rocks; Formation of igneous and metamorphic rocks; Controls on formation of landforms; tectonic including plate tectonic

and climatic: Coriolis force, pressure gradient force, frictional force, geo-strophic wind field, gradient wind; Climates of India, western disturbances, Indian monsoon, droughts, *El Nino*, *La Nina*; Concept of residence time; Weathering and erosion, transportation and deposition of sediments; Process of soil formation, physical and chemical properties of soil, soil types, cation exchange capacity; Geochemical classification of elements, abundance of elements in bulk earth, crust, hydrosphere and biosphere; Partitioning of elements during surficial geologic processes. Geochemical recycling of elements; Paleoclimate; Distribution of water in earth, Darcy's law hydraulic conductivity, effects of excessive use of groundwater. Pollution of groundwater resource; Natural resource exploration and exploitation and related environmental concerns; Historical perspective and conservation of non-renewable resources; Natural Hazards; floods, landslides, earthquakes, volcanism, avalanche, tsunami; Prediction of hazards and mitigation of their impacts.

Unit-V: Energy and Environment

Solar radiation and its spectral characteristics; Fossil fuel: classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas, shale oil, coal bed, methane, gas hydrates; Gross-calorific value and net-calorific value; Hydro-power, tidal energy, ocean thermal energy conversion, wind power, geothermal energy, solar collectors, photo-voltaic modules, solar ponds; Nuclear energy: fission and fusion, nuclear fuels; Bioenergy; Environmental implications of energy use, energy use pattern in India and the world; emissions of CO₂ in developed and developing countries including India.

Unit-VI: Environmental Pollution and Control

Air Pollution: Sources and types of Pollutants; Criteria air pollutants; Sampling and monitoring of air pollutants (gaseous and particulates); Indian National Ambient Air Quality Standards; Impact of air pollutants; Dispersion of air pollutants; Mixing height/depth; lapse rates; Gaussian plume model; line source model and area source model; Control devices for particulate matter and gaseous pollutants; Indoor air pollution; Vehicular emissions.

Noise Pollution: Sources, weighting networks, measurement of noise indices (Leq, L10, L90, L50, L0N, TNI). Noise dose and Noise Pollution standards, Noise control and abatement measures; Vibrations and their measurements; Impact of noise and vibrations on human health.

Water Pollution: Types, sources and impact; water quality parameters: pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants, Microbiological analysis; Indian standards for drinking water (IS:10500, 2012); Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening; Wastewater Treatment: Primary, Secondary and Advanced treatment methods.

Soil Pollution: Physico-chemical and biological properties of soil; Analysis of soil quality; Soil Pollution control; Industrial effluents and their interactions with soil components; Soil micro-organisms degradation of pesticides and synthetic fertilizers.

Thermal, Marine Pollution and Radioactive: Sources, causes, consequences and abatement.

Unit-VII: Solid and Hazardous Waste Management

Solid Waste: Types, sources and characteristics, proximate and ultimate analyses of solid wastes; **Solid waste management practices:** collection, transportation, processing and

recovery; Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and vermicomposting, biomethanation; **Disposal:** sanitary land filling and its management, incineration; Hazardous waste management and handling, **e-waste, fly ash and plastic waste:** classification, methods of handling and disposal.

Unit-VIII: Environmental Assessment, Management and Legislation

Environmental Impact Assessment (EIA): Aims and objectives; Environmental Impact Statement (EIS) and Environmental Management Plan (EMP); EIA Guidelines; Impact Assessment Methodologies; Life-cycle analysis; cost-benefit analysis; Environmental Audit; Environmental Management System Standards (ISO14000 series); EIA Notification, 2006 and amendments from time to time; Eco-labeling.

Environmental Laws in India and amendments: Wildlife Protection Act, 1972; Forest Conservation Act, 1980; Indian Forest Act, Revised 1982; Biological Diversity Act, 2002; Water (Prevention and Control of Pollution) Act, 1974 and Rules 1975; Air (Prevention and Control of Pollution) Act, 1981 and Rules 1982; Environmental (Protection) Act, 1986; The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016; The Plastic Waste Management Rules, 2016; The Bio-Medical Waste Management Rules, 2016; The Solid Waste Management Rules, 2016; The e-waste (Management) Rules 2016; The Batteries (Management and Handling) Rules, 2010; Noise Pollution (Regulation and Control) Rules, 2000; Coastal Regulation Zones (CRZ), 1991; National Forest Policy, 1988; National Water Policy, 2002; National Environmental Policy, 2006.

Environmental Conventions and Agreements: Stockholm Conference on Human Environment 1972; Montreal Protocol, 1987; Conference of Parties (COPs); Basel Convention (1989, 1992); Ramsar Convention on Wetlands (1971); Earth Summit at Rio de Janeiro, 1992; Agenda-21; Global Environmental Facility (GEF); Convention on Biodiversity (1992); UNFCCC, Kyoto Protocol, 1997; Clean Development Mechanism (CDM); Earth Summit at Johannesburg, 2002; RIO+20; UN Summit on Millennium Development Goals, 2000; Copenhagen Summit, 2009; IPCC; UNEP; and IGBP.

Unit-IX: Statistical Approaches and Modelling in Environmental Sciences

Attributes and Variables; scales of measurement, measurement of Central tendency and Dispersion, Standard error, Moments, Skewness and Kurtosis; Basic concept of probability theory, Sampling theory; Distributions: Normal, Binomial, Poisson, t , χ^2 and F-distribution; Correlation, Regression, tests of hypothesis (t-test, ANOVA); significance and confidence limits; Lotka-Volterra model and Leslie's matrix model.

Unit-X: Contemporary Environmental Issues

Global Environmental Issues: Biodiversity loss, Climate change, acid rain, Ozone layer depletion, Sea level rise; National Action Plan on Climate Change (Eight National missions: National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a 'Green India', National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change); Environmental issues related to water resource projects; development of watersheds, Rain water harvesting and ground water recharge; National river conservation plan; Conservation of wetlands; Ramsar sites in India; Soil erosion; reclamation of

degraded land; Desertification and its control; Climate change: adaptability, energy security, food security and sustainability; Carbon sequestration and carbon credits; Forest Conservation: Chipko movement, Appiko movement, Silent Valley movement and Gandhamardhan movement; People Biodiversity register; Wild life conservation projects: Project tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision.

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