

# Savitribai Phule Pune University

## Online Entrance Exam 2025

### Syllabus for MSc in Environmental Sciences

#### **Unit 1: Environmental Issues**

**Global warming and climate change:** Introduction of Greenhouse gas (GHG) effect, sources, major GHGs its impact and consequences, remedial measures; Ozone depletion and causes and associated chemical reactions; Carbon emissions, Carbon Sequestration; Eutrophication; Acid Rain

#### **Natural calamities:**

**Hazards:** Environmental Hazards; Chernobyl disaster, Bhopal gas tragedy, Epidemiological issues (e.g. Goitre, Fluorosis, Arsenic). Occupational Health & Safety

**Conflicts and Environmental movements/protocols:** Genesis of global environmental movement, Depletion of Nature resources; Tehri Dam conflicts, Almatti Dam, Resources depletion and pollution (case studies) Copenhagen outcome, The green revolution, Ecological conflicts and the environmental movements in India: Narmada Bachao Andolan, Appiko Movement, Chipko movement, Silent Valley Movement, Bishnoi Movement, Jungle Bachao Andolan; Paris Agreement; Un Climate Change Conference (COP 21), Ganga Action plan, Interlinking of rivers

**Environmental management:** Rehabilitating degraded lands; E- waste management; Eco-tourism, Eco-journalism, issues related to shipping. Land use policy for India; Urban planning for India; Rural planning and land use pattern; Concept and strategies of sustainable development; Cost-Benefit analysis. development., Handling of Solid waste management, Tribal community problems and their rehabilitation, Natural disasters and their management. Waste lands and their reclamation; Desertification and its control; Vehicular pollution and urban air quality; Biodiversity conservation; Waste disposal, recycling and power generation; Fly ash utilization; Water Crises-Conservation of water; restoration of Indian lakes;

#### **Unit 2: Biology, Biodiversity, and Wildlife**

**Basic Biology:** The evolution of life on earth: Origin of life - Microbes, Plants and Animals, fossils and sediments, distribution and pattern of life in past, Paleontological evidences, Mass extinction. Life forms on Earth (all forms of plants and animals), Life in Water, Life on Land, Microbial life in air, water and soils, microbes and diseases, decomposing soil microbes, marine biology. Taxonomic principles: hierarchy and kingdoms, identification and nomenclature. Classification of plants and animals based on form-relationship, species concept, organization of living things, microbial classification, Ecological Classification Systems, Collection and Herbarium, Preservation, flora, fauna, preservation of insects. Ecological adaptation under various environmental conditions, Hydrophytes, Xerophytes, Halophytes, Mesophytes, Epiphytes. Distribution of life on earth and factors responsible for present day distribution; Continental drift and its results.

**Biological Diversity:** Biodiversity concept, Definition, Organisms evolution and distribution in space and time; types of biodiversity – ecosystem, species and genetic, Biodiversity at local, national and international level, History and origin of species diversity, Species variation, convergence and divergence in species, number of species of microbes, plants and animals, Centers of diversity, concept of endemism, types and endemic species with examples. Origin and evolution of species diversity; Brief introduction to genetic variation in species, concept of genetic drift, gene pool; measurement of genetic diversity using DNA, chromosomes, molecular markers. Concept of hotspots and the basis of hotspot identification, detailed account of Western Ghats as a hotspot, India as mega-biodiversity nation, Mayrs system and latest estimates.

**Value of biodiversity:** direct and indirect value as food, fodder, timber, forage, medicinal and ornamental, other benefits of biodiversity.

**Loss of biodiversity:** Factors responsible for degradation of ecosystem, fragmentation, pollution and overexploitation, change in habitat, effects of climate change, genetically modified organisms and their effects on ecosystem, human-wildlife conflict.

**Conservation of biodiversity:** need and awareness, In-Situ and Ex-Situ conservation with examples, traditional methods of conservation, International and national efforts for biodiversity conservation

**Wildlife Biology:** Concept of Wildlife Biology, Definition of Wildlife (Refer to Wildlife Protection Act), examples of protected wildlife species.

**Diversity of major groups of plants and animals** **Plants:** Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms (Monocots and Dicots) **Animals:** Invertebrates- Arthropods (Insects, Arachnids, Crustaceans, Millipedes, Centipedes). Vertebrates- (Mammals, Birds, Fish, Reptiles, Amphibians), habitats of faunal species.

**Wildlife Habitats:** Aquatic (Marine, Freshwater, Brackish) Terrestrial habitats (Vegetation types- forest, grassland, arid zones, hot and cold deserts, agriculture, landscape patterns Examples of food chain in each type of habitat.

**National Parks in India:** Sanctuaries (27 Sanctuaries of India) and National Park of India, Zoological parks and Biosphere reserves, Project tiger, project elephant, and wildlife legislation, Various Government and private agencies involved in wildlife conservation, wildlife values and conflict and protected area management. Important features of Tiger, Lion, leopard, antelopes, Black Buck, Rhinoceroses, Elephant, Alligators. Guidelines for declaration of Big Cats as man eaters. Management strategies

**Threats to Wildlife:** Habitat destruction, developmental projects, urbanization, agricultural expansions, excessive harvesting and poaching, human wildlife conflict, examples of excessive exploitation of plants and animals.

**Wildlife Management Techniques:** Population assessment techniques for flying insects, Birds and Mammals: Transects, Point Counts, net swipes, census from pug marks, camera trapping. Diversity assessment for plants- Determination of sampling area, quadrates, transects, point centre method, Diversity Indices and its applications.

**Application of GIS and Remote Sensing:** Radio tagging in monitoring of Wildlife and wildlife planning and

management.

**Biodiversity hotspots:** reasons for biodiversity formation, contribution to adaptive evolution, land races of crop plants, conservation of genetic resources, highly productive and unique habitats, examples of wetlands and mangrove ecosystem

### **Unit 3: Environmental Chemistry**

Stoichiometry, Gibb's energy, chemical potential, chemical equilibria, acid-base reactions, solubility product, carbonate system. Chemistry of water, unusual physical properties, changes in water properties by addition of solute, hydrogen bonding, gases present in water, basic reversible and irreversible reactions in water, sources of cations and anions in water, changes in water properties by addition of solute. Chemistry of carcinogenic compounds and their effects on human body.

**Surfactants:** Cationic, anionic and non-ionic detergents, modified detergents.

**Pesticides:** Classification, degradation, analysis, pollution due to pesticides and DDT problems.

**Lead and its compounds:** Physical and chemical Properties, behavior, human exposure, absorption, influence.

**Mercury and its compounds:** Physical and chemical Properties, behavior, human exposure, absorption, influence.

**Hydrocarbons:** Chemistry of hydrocarbon decay, environmental effects, effects on macro and microorganism.

**Destruction of some hazardous substances:** acid halide, anhydrides, cyanides and cyanogens bromides, chromium, aflotoxins, halogenated compounds.

### **Unit 4: Earth Sciences**

**Basic Geology:** Internal structure of earth; Geological evolution; Plate tectonic; Formation of lithosphere Continental and oceanic crust formation; Types of rocks; Rock cycle; basic minerals of rock; clay minerals; Mineral chemistry.

#### **Study of toposheets and mapping:**

**Soil Science** - Definition of soil, classification, types, soil formation; Physical, chemical and biological weathering; Main components of soil profile - Introduction, horizons - A, B, C and D; Soil morphology - texture, structure, and other physical, chemical, and biological properties; Macro and micro plant nutrients in soil; Role of soil nutrients (major, minor and trace) in plant growth, various forms of nutrients in soil, soil moisture; Soil microbes and other organisms, types and their role in soil fertility, nitrate and phosphate solubilizing microbes; Soil organic matter, its decomposition and effects on soil fertility; Soil chemistry - reactions in soil, acidic and alkaline soils; organic manures and green manures, biofertilizers, effects of fertilizers on soil properties; Soil erosion, types of agents, factors affecting erosion; Soil pollution, types, sources, and effects of soil pollution, bioremediation of soils with examples; Soil conservation - Methods, engineering practices and land treatment, land drainage; Need and practices for agricultural lands: physical, mechanical and biological practices; Soils of India in general.

**Hydrology:** Definition and Scope; Sources, Occurrence and distribution of surface and groundwater; Origin of

water – meteoric, juvenile, magmatic and sea waters; chemical composition of groundwater, river water, sea water; Hydrological process - Surface run off, interception, infiltration, evaporation, evapotranspiration, groundwater flow, primary and secondary aquifers.

**Water Harvesting:** Definition and Introduction to watershed; characters of materials for catchment apron; Rainwater harvesting - Techniques for preparation of water harvesting catchments, storage of harvested water, traditional methods of water harvesting, some issues related to rain water harvesting.

**Groundwater Chemistry:** Groundwater quality - physical, chemical and biological properties of water; quality criteria for different uses; Groundwater quality in different provinces of India.

**Water Pollution:** Definition; consequences; groundwater contamination; effects on man and environment problems of Arsenic, nitrate and Fluoride with case studies; saline water intrusion in aquifer and its prevention.

**Groundwater problems and Management:** Groundwater problems related to foundation work, mining, canals and tunnels, agriculture. Problems of over exploitation, remediation, groundwater balance and methods of estimation, legislation, sustainability criteria and managing renewable and non-renewable groundwater resources and groundwater development in urban area and artificial recharge methods.

**Atmosphere:** Evolution and structure of atmosphere; Chemistry of atmosphere, Phenomena: Global Warming, Ozone Hole, El Nino, La Nina; Chemical reactions involved in atmosphere; chemistry in ozone depletion; chemical reactions of global warming; Temperature measurement and controls; Environmental lapse rate, dry and wet adiabatic lapse rate; inversion of temperature and atmospheric stability. Atmospheric factors – wind, pressure, temperature, rainfall, humidity, etc., hydrological cycle - Forms of condensation and precipitation.

**Ocean:** World oceans and distribution; Coastal ecosystems; Mangroves and Coral reefs; Importance in oceanic resources, Oceans in global climate and how climate change affects the oceans, Ballast Water and Marine Pollution, conservation and wildlife. Desalination, coastal erosion, reclamation of land; Coastal Regulation Zone (CRZ), Sea Water intrusion;

## **Unit 5: Ecology and Ecosystems**

**Levels of organization:** Individual, population, ecosystem, biome, and biosphere; Types of ecology - Autecology, Synecology; Component of ecosystem - biotic and abiotic.

**Population Ecology:** Basic concepts of population ecology, size and distribution of population. (Random, Aggregate and uniform populations with examples).

**Population dynamics:** characteristic features, Natality Mortality, fecundity, density, fluctuation, age distribution, biotic potential, prey-predator relationship, Environmental resistance in relation to absolute maximum and realized minimum carrying capacity.

**Characteristics of community:** composition and structure, origin and development, ecotone, edge effect, ecological niche, interspecific and intra specific competition, examples.

**Ecological Succession:** Stages and type of succession; Mechanism of succession; trends of succession, Pioneer and climax community; edaphic and climatic succession, models of succession, hydrosere and xerosere.

**Concept of food chain and food web:** Introduction; Energy flow; Biomass productivity; Gross and net productivity; ten percent rule, energy transformation from producer to consumers.

**Concept of Biogeochemical cycles:** Gaseous and sedimentary cycles; Hydrological cycle; nutrient budget; human impact on nutrient cycles.

## **Unit 6: Terrestrial Ecosystem and Management**

**The terrestrial environment:** terrestrial biota and biogeographic regions, general structure of terrestrial communities.

**The soil subsystem:** the vegetation subsystem, parameters of the terrestrial environment, hotspots in India: Western Ghats and Eastern Himalaya.

**Distribution:** major terrestrial communities, patterns, structure and classification, ecotone and edge effect, keystone species and control of community structure, types of interactions: predation, parasitism, antibiosis, commensalism, cooperation, and mutualism.

**The biomes:** introduction, concept, types: Tundra, northern conifer forests, Temperate deciduous and rain forests, temperate grassland, chaparral, desert, tropical rain forest, tropical deciduous forest, tropical scrub forest, tropical grassland and savanna, mountains.

**Terrestrial ecosystem services and management:** aesthetic and cultural benefits, tourism and recreation, industry, drugs and medicines, carbon pool and sequestration potential, etc. Bio- geocycles, importance, applications, Bio-geocycles as a source of plant nutrients for ecosystem maintenance

**Methods of terrestrial ecosystem management:** remote sensing, geographical information system, Joint Forest Management, Eco-development program, community-based forest management, traditional methods, Forest fire: reasons, effects, control measures and management.

**Methods of vegetation sampling and data analysis:** sampling approaches, quadrat methods, line and belt transect, the point frame method, vegetation classification, species association.

**Management:** Exploitation and Consequences of terrestrial natural resources, Sustainable management of the same, Role of Local Government and people in conservation, Impact of Tourism, Eco-tourism Managing rain for the Future, Conservation and Sustainable use of India's Forest resources.

## **Unit 7: Aquatic Ecosystem and Management**

Limnology, the aquatic environment, the aquatic biota and water resources, water and plant functioning, structure of aquatic communities, the parameters of the aquatic environment. Distribution of major aquatic ecosystems, patterns, structure and classification, ecotone and edge effect.

**Freshwater ecology:** The freshwater environment - types and limiting factors; Ecological classification of freshwater organisms, the freshwater biota (flora and fauna), lentic (lakes and ponds) and lotic (rivers, streams, springs, etc) communities, planktons.

**Marine ecology:** the marine environment, the marine biota (flora and fauna), zonation in the sea, study of planktons, communities in the marine environment. Ecology in estuaries.

**Aquatic ecosystem services and management:** aesthetic and cultural benefits, tourism and recreation, pollution, etc. Methods of aquatic ecosystem management: remote sensing, geographical information system, Eco-development program, traditional methods, Methods of aquatic sampling and data analysis: sampling approaches, species association. Exploitation and Consequences of wetlands, Sustainable management of the same, Role of Local Government and people in conservation, Impact of Tourism, Eco-tourism Conservation and Sustainable use of India's aquatic resources.

## **Unit 8: Natural Resources and Nature Conservation**

**Renewable resources:** Forest and wildlife resources; forest wealth of India; animal resources; livestock and fisheries.

**Non-renewable resources:** Fossil fuels - coal, oil and natural gas; Consequences of rapid consumption of fossil fuels.

**Food Resources:** World food problems; agricultural resources; agricultural potential of India; effects of modern agriculture.

**Fresh and marine water resources:** Global distribution of fresh water and its limits; The sources of fresh water for terrestrial life; fresh water resources of India; man's water requirement; floods and droughts.

**Soil and Mineral resources:** global and national status of metals and minerals

**Man's interactions with natural resources Conservation-** Concept of Nature Conservation; Convention on Biological Diversity (CBD); Protected Area Network (PAN) in India; Details of Protected Area Network in Maharashtra state; Challenges (Social, Political, and Economical); In-situ and ex-situ Concept, Principles, Protected area types.

**International efforts for Conservation-** IUCN, WWF and other large organizations, Governments, International Conventions and Protocols, Role of NGOs, Green Peace, International Whaling Mission, BNHS, Reindeers, Tigers, Crocodile farms, Examples of extreme activism, and practical sustainable efforts.

## **Unit 9: Water Quality**

**Characteristics of water:** physical, chemical and biological, effects of water on rock and minerals, Sewage water: its characteristics and effects.

**Water pollution-** definition, types of water pollution based on source (point and non- point), characteristics (physical, chemical, physiological and biological) Lake water pollution: eutrophication, River water pollution, Groundwater pollution, marine water pollution: with special reference to oil spill and Ballast water.

**Water quality standards:** Criteria and standards for water qualities by different agencies; water analysis methods for physical, chemical and biological parameters; history of water resources development as related to current and future sustainability of water quality and quantity. Role of science and policy in solving water problems.

**Control measures:** Treatment methods - primary, secondary, tertiary, through law; Classification of water pollutants based on characteristics, physical, chemical, and biological with special reference to fertilizers,

pesticides, and toxic compounds and heavy metals.

**Water borne diseases:** bacterial, and viral, potential and wide spread effects, epidemics, preventive and curative measures.

**Characterization of waste water:** quality of various industrial effluents; sources of pathogens; human risks.

**Fundamentals of waste water treatment technologies:** insoluble and soluble material, concept of BOD and COD, tests for metals and biologically degradable organic matter, Water crisis.

### **Unit 10: Air and Soil Quality**

**Air pollution:** Definition, Sources and Types of air pollutants, major air pollutants; Global and national status of air pollution, Effects of air pollution on plants, animals, human, and materials, Smog and Acid rains, Control of air pollution; Emission Standards.

**Assessment and Monitoring air pollution:** Air and aerosol sampling, analysis and monitoring (Carbon Monoxide, Nitrogen Oxides, Sulphur Dioxide, Hydrogen Sulphide, Hydrocarbons, Particulate Matter, metals) and mitigation strategies.

**Soil analysis and management:** Soil texture; pH, Lime, Silica and Phosphorous, Total Nitrogen, Total Manganese, Total Sulphur, Soluble Salts, Pesticides, soil pollution remediation technologies (biological technologies - bioremediation and phytoremediation); Physical treatment technologies - Sparging, Bioventing, and Bioleaching; Advantages and disadvantages.

### **Unit 11: Environmental Biotechnology & Eco-restoration**

**Gardening and kitchen gardening:** Historical Background, Types of gardens and practices, Panning design of house garden, Kitchen garden

**Environmental Biotechnology:** Definition, history, and scope.

**Organic and plant-based pesticides:** Classification of biological pest, their control agents, manufacturing processes, stabilization of biopesticide, formulation, mode of action, selectivity of bacteria.

**Impact of microbes:** microbial impact on agriculture; Sustainable Agriculture.

**Composting:** Composting technology, Design aspect, composting process, Vermicomposting, Earthworm life cycle, Bio-fertilizers - types and their role, agro-based solid waste and its uses.

**Biofuels:** Alternative to non-fossil energy resources, biological energy resources, Combustion of biomass, Biogas, Biodiesel, Ethanol and hydrogen.

**Genetically modified organism (GMO) in the environment:** Importance of GMO, Risk of GMOs and assessment, Directive principles for GMO's. Measures, Deliberate release, and release criteria. Biosafety - Cartagena Protocol, Biosafety regulation. Natural Resource recovery - Oil recovery, recovery of metals, Agricultural biotechnology - Detection and diagnosis, micro-propagation.

**Microbes in Environment:** Soil-microbe interaction; plant-microbe interaction; water-microbe interaction. Ecological Relation of microbes - Enrichment, Isolation and counting method; Measurement of microbial

activity in nature.

**Biomethanation:** Anaerobic treatment for gas generation, microbiology and biochemistry, factors affecting, Problems in biomethanation, Design of digester, biomethanation in industries, Potential of biomethanation from MSW, merits of biomethanation from MSW and Biomass gasification.

**Role of biotechnology in environment protection:** Microbial fundamentals involved in the treatment of industrial wastes, Biochemistry of waste water treatment - impact of pollutants on organisms.

**Aerobic Biological treatments** - activated sludge, biofilm reactors and biological filters, Anaerobic biological treatments – UASB.

**Pollutant removal techniques:** Microbial metabolism of pesticides and other xenobiotic components; Wastewater treatment using aquatic plants; Biotechnology for air pollution and odour control, Biotechnology of solid waste disposal; Use of immobilized enzymes and microbes for pollution abatement; Improvement of microbial strains by conventional and molecular biological techniques; Computer implementation for control and monitoring of waste water; Removal of specific pollutants - nitrate, phosphates, heavy metals, etc.

## **Unit 12: Environmental Law & Policy, Safety & EIA and Environmental Economics Elements of environmental governance**

Stockholm conference, The Earth Summit 1992 – The Rio declaration on environment and development, the Earth Summit agreements. Environmental governance in India since 1972; Environmental protection and Fundamental Rights; India's International Obligations, Public interest litigation, Public participation. The Water (Prevention and Control of Pollution) Act - 1974; The Air (Prevention and Control of Pollution) Act – 1981; The public liability Insurance Act, 1991; The National Environmental Tribunal Act, 1995; Environmental Policy Resolution.; Legislation, public Policy Strategies in Pollution Control; Motor Vehicle Act, 1988; Public Liability Insurance Act, 1991 and Rules 1991. The Indian Wildlife (Protection) Act – 1972 amended 1991; The Biological Diversity Act, 2002; Forest Conservation Act, 1980; Indian Forests Act (Revised) 1982; National Forest Policy; The Environment (Protection) Act, 1986 and Rules 1986; Scheme of labelling of environmentally friendly products (Ecomark). National Environmental Policy - 2006. Environment protection- issues and problems. International and National efforts for Environment Protection. Provision of Constitution of India regarding Environment (Article 48A and 58A).

Environmental governance and Regulation in India: Legislative efforts, Constitutional Directives, Role of the Judiciary, Working of Environmental Regulation, Enforcement, Monitoring, Role of NGOs.

**Environmental Ethics, Standards, Health & Safety:** Introduction, concept; Development of environmental ethics, ethical theories applied to the environment; the ethical dilemma, environmental ethics and population, pollution Value options, environment and technology. Introduction, Generic, Management system, benefits, ISO and the environment, Environmental management and sustainability, ISO/TC 207, Scope of ISO/TC 207's work. Overview of the ISO 14000 family of standards, ISO 14000 essentials, An ISO 14001:2004-based EMS, EMS standards, The ISO 14000 family and the Plan-Do-Check-Act (PDCA) cycle. Environmental and economic benefits; Specific applications: Automotive, Energy, Education, Food safety,



Health care, Ship recycling and risks.

**Environmental standards:** Ambient air quality standards, BIS standards for drinking water, WHO water quality standards. Environmental audits, Compliance and governance mechanism, Environment Status Report, Various instrumental techniques, EIA in detail with case studies, Environmental Economics, CETP. Sustainability and Sustainable Development. ESG.

