

# KERALA STATE COUNCIL FOR SCIENCE, TECHNOLOGY AND ENVIRONMENT

## Research Fellowship

### ENVIRONMENTAL SCIENCES

1. Definition, principles and scope of Environmental Sciences, Earth, Man and Environment. Ecosystems. Pathway 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.
2. 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, Colorimetry, Spectrophotometry, Chromatography, Gas Chromatography, Atomic Absorption Spectrophotometry, GLC, HPLC, Electrophoresis, X-ray fluorescence, X-ray diffraction, Flame photometry.
3. 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 relationship.  
**Common flora and fauna in India**  
**Aquatic:** Phytoplankton, Zooplankton, and Macrophytes  
**Terrestrial:** Forests  
**Endangered and Threatened species, Biodiversity and its conservation:** Definition, Hotspots of Biodiversity, strategies for biodiversity conservation. Natural parks and Sanctuaries. Gene pool.  
**Microflora of Atmosphere:** Air sampling techniques. Identification of aeroallergens. Airborne disease and allergies.  
**Environmental Biotechnology:** Fermentation Technology, Vermiculture technology. Biofertilizer technology

4. **Environmental Geosciences** –Fundamental concepts

**The earths systems and biosphere:** Conservation of matter in various geosphere-lithosphere, hydrosphere, atmosphere and biosphere. Energy budget of the earth. Earth's thermal environment and seasons. Ecosystems flow of energy and matter. Coexistence in communities- food web, Earth's major ecosystems-terrestrial and aquatic. General relationship between landscape, biomes and climate. Climate of India, Indian Monsoon, El Nino, Droughts, Tropical cyclones and western disturbances

**Earth's process and geological hazards:** Earth's processes; concept of residence, time and rates of natural cycles. Catastrophic geological hazards, study of floods, landslides, earth quakes, 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 and 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 sea water. Hydrological cycle. Factors influencing the surface water. Types of water. Resources of oceans. Ocean pollution by toxic wastes. Human use of surface and ground waters. Ground water pollution.

**Landuse planning:** The land use plan. Soil surveys in relation to landuse planning. Methods of site selection and evaluation

**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. Disease induced by human use of land. Principles of remote sensing and its application in Environmental Sciences. Application of GIS in Environmental management.

5. 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 bio gas, anaerobic digestion, energy pattern in different parts of the world. Environmental implication of energy use; CO<sub>2</sub> emission, global warming, air and thermal pollution, radioactive waste and radioactivity from nuclear reactors; impact of large-scale exploitation of solar, wind, hydro and ocean energy.

6. **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>x</sub>, CO, SPM. Effects of pollutants on human beings, plants, animals, materials and on climate. Acid rain. Air quality standards

**Water:** type, 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 interaction with soil components. Soil micro-organisms 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.

**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

7. Introduction of environmental impact analysis. Environmental impact statement and environmental Management Plan. EIA guidelines 1994, Notification of Government of India. Impact Assessment Methodologies. Generalized approach to Impact analysis. Procedure for reviewing environmental impact analysis and statement. Guidelines for environmental audit . Introduction to Environmental planning. Baseline information and predictions (land, water, atmosphere, energy etc), Restoration and rehabilitation technologies, Land use for India. Urban planning for India. Rural Planning and land use pattern. Concept and strategies of sustainable development. Cost-benefit analysis. Environmental priorities in India and sustainable development.
8. 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 materials. Waste minimization technologies. Hazardous wastes management and handling rules, 1989. Resource management, Disaster management and risk analysis.  
Environment protection-issues and problems. International and National efforts for Environment protection, Provision of constitution of India regarding environment (Article 48A and 58A)  
Environmental policy resolution, Legislation, Public Policy Strategies in Pollution Control, Wildlife protection Act 1972 amended 1991, Forest conservation Act 1980, Indian forest Act (Revised) 1982, Air (Prevention and Control of pollution) Act 1981 as amended by amendment act, 1987 and rule 1982, Motor vehicle act 1988, The water (prevention and control of pollution) Act 1974 as amended upto 1988 and rules 1975, the environment (protection) Act, 1986 and rules 1986.  
Schemes and labelling of environmentally friendly products (Ecomark), Public Liability Insurance Act 1991 and rules 1991.
9. Basic elements and tools of statistical analysis; probability, sampling, measurement and distribution of attributes, distribution-normal, t and  $\chi^2$ , 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.
10. Environmental education and awareness. Environmental Ethics and Global imperatives. Global environmental problems-ozone depletion, global warming and climate change. Current Environmental issues 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. Biodiversity conservation and agenda 21. Waste disposal, recycling and power generation, fly ash utilisation. Water crises- Conservation of water. Environmental hazards. Eutrophication and restoration of Indian lakes. Rain water harvesting. Wet land conservation. Epidemiological issues (eg. Goitre, Fluorosis, Arsenic)