Syllabus for the post of Assistant Environmental Engineer, Class I (on Contract basis) in HPSPCB under the Department of Environment, Science & Technology

Screening test (either online or offline) shall be of two hours' duration consisting of 100 objective type Multiple Choice Questions covering the syllabus in the ratio of 80:10:10:-

Ecosystem: Types of ecosystem; ecosystem processes- energy transfer, food chain, food-web; Eltonian pyramids; structural and functional characteristics of an ecosystem; ecological succession; Population ecology; metapopulation dynamics; growth rates; density independent growth; density dependent growth; Plant-animal interactions; mutualism, commensalism, competition and predation; trophic interactions; functional ecology; ecophysiology; behavioural ecology; Community assembly, organization and evolution; biodiversity: species richness, evenness and diversity indices; endemism; species-area relationships.

Mathematics and statistics in ecology; Simple functions (linear, quadratic, exponential, logarithmic, etc.); concept of derivatives and slope of a function; permutations and combinations; basic probability (probability of random events; sequences of events etc.); frequency distributions and their descriptive statistics (mean, variance, coefficient of variation, correlation, etc.)

Natural Resources: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Interrelationships among different types of natural resources. Concern on Productivity issues. Ecological, social and economic dimension of resource management. Forest resources: forest vegetation, status and distribution, major forest types and their characteristics. Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people, forest management. Developing and developed world strategies for forestry. Land resources: Land as a resource. Dry land, land use classification, land degradation, man induced landslides, soil erosion and desertification. Landscape impact analysis, wetland ecology & management. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Water ecology and management. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. Resource Management Paradigms: Resource management -the evolution and history of resource management paradigms.

Biodiversity: Definition, components, scope, and constraints of biodiversity (genetic diversity, species diversity, ecosystem diversity – agro-biodiversity, urban– peri-urban biodiversity), forest biodiversity; biodiversity indices, threats to biodiversity; Landscape approach to biodiversity conservation, Corridor approach, individual species approach, habitat conservation approaches, National Biodiversity Strategy and Action Plan.

Environmental Pollution: Types and major sources of air pollutants, effects of air pollutants on physico-chemical and biological properties surrounding atmosphere, air borne diseases and their effects on health. Types and major sources of water pollutants, effects of water pollutants on physico-chemical and biological properties of water bodies, water-

borne diseases with special reference to water pollution, Types and major sources of soil pollutants, effects of soil pollutants on physico-chemical and biological properties of soil. Air, drinking water and waste water quality standard. Major sources of noise pollution, effects of noise pollution on health, noise level standard in industrial, commercial, residential and silence zones. Radioactive and thermal pollution: sources and their effects on surrounding environment, Solid waste disposal and its effects on surrounding environment.

Pollution Control: Process modification, alternative raw material, recovery of by co-product from industrial emission effluents, recycle and reuse of waste, energy recovery and waste utilization. Material and energy balance for pollution minimization. Water use minimization, Fugitive emission/effluents and leakages and their control-housekeeping and maintenance, Air Pollution Control: Particulate emission control by mechanical separation and electrostatic precipitation, wet gas scrubbing, gaseous emission control by absorption and adsorption, Design of cyclones, ESP, fabric filters and absorbers. Water Pollution Control: Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration, centrifugation, coagulation and flocculation. Biological Treatment: Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge and lagoons, aeration systems, sludge separation and drying.

Waste Management: Municipal solid waste (management and handling) rules; hazardous waste (management and handling) rules; biomedical waste handling rules; fly ash rules; recycled plastics usage rules; batteries (management and handling) rules; Municipal Solid Waste Management – Fundamentals Sources; composition; generation rates; collection of waste; separation, transfer and transport of waste; treatment and disposal options; Hazardous Waste Management – Fundamentals Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects; Radioactive Waste Management – Fundamentals Sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options;

Environmental Risk Assessment Defining risk and environmental risk; methods of risk assessment; case studies; Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation; Biological Treatment of Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation; Landfill design Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration.

Water Resource Engineering: Multipurpose uses of water, river basins and their potential; irrigation systems; water demand assessment; resources-storage and their yields; water logging; canal and drainage design; gravity dams; falls; weirs; energy dissipators; barrage distribution works; cross drainage works and head works and their design; concepts in canal design; construction and maintenance; measurement and

analysis of rainfall.

Non-conventional energy systems: solar energy its radiation, collection, storage and application. It also introduces the Wind energy, Biomass energy, Geothermal energy and ocean energy as alternative energy sources; Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data; Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors; Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/ cooling technique, solar distillation and drying, photovoltaic energy conversion; WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics; BIO-MASS: Principles of Bio-Conversion, Anaerobic/ aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C. Engine operation and economic aspects; GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy, potential in India; OCEAN ENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics; DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, principles of DEC. Thermoelectric generators, seebeck, peltier and joule Thomson effects, Figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD Engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principles, faraday's laws, thermodynamic aspects, selection of fuels and operating conditions.

Fluid Mechanics: Open Channel flow; pipe flow; fluid properties; dimensional analysis and modelling; flow kinematics and measurements; flow-net; viscosity; boundary layer and control; drag; lift; principles in open channel flow; flow controls; hydraulic jump; surges; pipe networks; pumps, air vessels; hydraulic turbines; classification and layout of power house, storage, pondage; control of supply.

Chemical Engineering: Diffusion Mass Transfer- Molecular diffusion in fluids, molecular diffusion in solids, Numerical methods for steady-state molecular diffusion. Convective Mass Transfer and Mass Transfer Coefficients- Mass transfer under laminar and turbulent flow past solids, boundary layers, theories of mass transfer and their applications interphase mass transfer, material balances and stages. Equipment for Gas-Liquid Operations- sparged and agitated vessels, venture scrubber, wetted wall towers, Tray and packed towers; Distillation- Flash distillation, differential distillation, continuous fractionation multi-component distillation, azeotropic distillation, extractive distillation etc.

Industrial Engineering: Measurement and measurement system: definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, repeatability, linearity, loading effect, system response-times delay. Errors in measurements, classification of errors; Pressure measurement: elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and

piezoelectric pressure sensors, high pressure measurements, bridge man gauge. Vacuum measurement: vacuum gauges viz. McLeod gauge. Temperature measurement: electrical methods of temperature measurement resistance thermometers, thermistors and thermocouples, pyrometer; WORK MEASUREMENT: Definition, objective and benefit of work measurement. Work measurement techniques. Work sampling: need, confidence levels, sample size determinations, random observation, conducting study with the simple problems. TIME STUDY: Time Study, Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information. Rating & standard Rating, standard performance, scale of rating, factors of affecting rate of working, allowances and standard time determination. Predetermined motion time study – Method time measurement (MTM); ERGONOMICS: Introduction, areas of study under ergonomics, system approach to ergonomics model, man-machine system.

Components of man-machine system and their functions – work capabilities of industrial worker, study of development of stress in human body and their consequences. Computer based ergonomics. DESIGN OF MAN-MACHINE SYSTEM: Fatigue in industrial workers, Quantitative qualitative representation and alphanumeric displays, Controls and their design criteria, control types, relation between controls and displays, layouts of panels and machines; Design of work places, influence of climate on human efficiency; Influence of noise, vibration and light.

Planning and Management of Environmental Works: Construction-planning, equipment; site investigation and management including estimation with latest project management tools and network analysis for different types of works; analysis of rates of various types of works; tendering process and contract management; quality control; productivity; operation cost; land acquisition; labour safety and welfare.

Environment Legislation: Environment Protection Act 1986; Air (Prevention and Control of pollution) Act; Water (Prevention and Control of pollution) Act; Mines and Mineral Act; Factories Act; Pesticides Act; Indian Forest Act; Wildlife Act; Ancient Monuments and Archaeological Sites and Remains Act; Hazardous Waste Management and Handling Rules/Biomedical Rules / Solid Waste Management Rules; Environment Tribunal Act; Climate change Protocols and Conventions; MOEF Guidelines and Notifications; Appellate Authority Act; Other related Notifications.

Environment Management System: Introduction to Environmental Management System basic definitions and terms, Framework for Environmental Management Systems, Approach for developing an Environmental Management System; The introduction and implementation of ISO 14001: environmental policy, planning, implementation and operation, checking, management review, etc; Applications EMS in terms of Process flow chart, effluent Generation, composition and treatment of effluents; Introduction to Environmental Auditing, Category "A" & "B" types of projects; Procedures and Guidelines to conduct Environmental Audit.

Current environmental issues in India: Environmental movements and related issues in India: Bishnoism, Silent valley movement, Narmada Dam, Teheri Dam, Almatti Dam, River Linking, Joint Forest Management, Chipko movement, Apikko movement, River cleaning initiatives; Ecological restorations: case studies from Ramsar wetlands

and mines; Waste land and their reclamation; Desertification and its control. Concept of Sustainability: Sustainability indices; Strategies and debates on sustainable development; Concept of Sustainable Agriculture; India's environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice; Urbanization; Urban sprawling and urban growth; Concept and characteristics of smart city; Urban resources and environmental problems; Carrying capacity analysis; Concept of ecological footprints. **Quality management:** Quality– concept and costs; quality assurance; statistical quality control, acceptance sampling, zero defects, six sigma; total quality management; ISO 9000. Reliability and Maintenance: Reliability, availability and maintainability; distribution of failure and repair times; determination of MTBF and MTTR, reliability models; determination of system reliability; preventive maintenance and replacement. **Product Design and Development:** Principles of good product design, tolerance design; quality and cost considerations; product life cycle; standardization, simplification, diversification, value engineering and analysis, concurrent engineering; comparison of production alternatives, green product design and development, green materials, green packaging, concept of 3Rs (reuse, reprocessing, and remanufacturing). **Operation Research:** Linear programming– problem formulation, simplex method, duality and sensitivity analysis; transportation and assignment models; network flow models, constrained optimization and Lagrange multipliers; Markovian queuing models; dynamic programming; simulation– manufacturing applications. **Production control:** Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling; MRP and MRP-II; routing, scheduling and priority dispatching; Push and pull production systems, concept of JIT manufacturing system; Logistics, distribution, and green supply chain management; Inventory – functions, costs, classifications, deterministic inventory models, quantity discount; perpetual and periodic inventory control systems, PERT & CPM. **(80 questions of one marks each)=80 marks**
10 questions consisting of General knowledge of H.P. **10 marks**
10 questions consisting of national/ international affairs. **10 marks**

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