NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Centre for Research on Environment and Water (CREW)

The Syllabus of the CREW for the admission tests to be conducted for admission to the PhD programme for ODD SEM 2021-2022.

Part A (Compulsory area):

- **Basics of Environment:** Atmosphere, Biosphere, Hydrosphere, Lithosphere; Environmental issues and challenges, Natural and anthropogenic sources of organic and inorganic pollutants,
- **Environmental Analysis :** Analysis of water and water quality parameters- Concept of pH, Measurement of acidity, alkalinity, Measurement of hardness, residual chlorine, chlorides, DO, BOD, COD, Fluoride Phosphate-P, Sulphate, turbidity, phenol, cyanide, Different form of nitrogen. Analysis of Soil: soil pH, N:P:K ratio, Organic carbon

- **Environmental Radiochemistry:** Basic of nuclear chemistry; Mass-energy relation of atomic nuclei, Concept of nuclear angular momentum, magnetic dipole moment, nuclear binding energy and stability of atomic nucleus. Liquid drop model, binding energy equation and its application. Radioactive decay and equilibrium, types of reactions.
  Biological effects of radiations, manmade and natural radiation, application of nuclear radiation for medicine, agriculture and environmental sample analysis.

- **Treatment and Management of Water and Wastewater:** Root causes of degradation of water resources, Water resource management issues; Compliance of environmental regulations and ethics in water resource management; Drinking water standards and wastewater characteristics, Sources of water pollution: groundwater and surface water. Chemical and Physico-chemical Treatment of Water: Aeration, Chemical coagulation and precipitation, settling, neutralization, chemical oxidation, water disinfection by chlorine-based disinfectants, ozone-based treatment, UV-radiation and other techniques, advanced chemical oxidation, adsorption.
  Biological Treatment of wastewater : Basics of biodegradation, microbial growth kinetics, unstructured model, bioreactor configurations in biological treatment of wastewater, aerobic and anaerobic processes, biodegradability of wastewater, selection of water treatment option based on biodegradability.

- **Microbiology and Waste Water Engineering :** Analysis of micro-organism present in sediment / soil of waste water treatment (biological) area, Gram Staining, Evaluation of Activated Sludge process through useful parameters like MLSS, MLVSS, SVI, HRT, N/P RATIO, DO, BOD, COD, Specific pollutants, calculation of treatment efficiency. Studies on metal inhibition on immobilized enzyme; Demonstration and experiment of Nano filtration / Membrane filter. Demonstration and application of HPLC, GC, AAS, Ion Meter for waste water analysis.

- **Solid, Nuclear and Hazardous waste Management:** Solid waste sources: Industrial, Mining, Agricultural and Domestic (Urban) wastes. Municipal solid waste

management: Waste generation, collection, storage, transfer, processing (including composting of organic waste), treatment and disposal.
Solid waste characterization and reduction, reuse and recycling, resource recovery and utilization; Life cycle assessment of waste.
Landfill design and operation: site selection, design and operations, equipment, costs, liner and covers, leachate control and treatment, gas recovery and control, landfill monitoring and reclamation; Incinerator.
Biomedical waste categorization, generation, collection, transport, treatment and disposal.
Hazardous waste: Characteristics including classification and generation, Collection, Treatment, Monitoring, Disposal; Remediation of contaminated sites; Radioactive waste management.

- **Conventional and Non-conventional Energy Engineering :** Solid fuel: Coal classification, composition and basis, Coal mining, Coal preparation and washing. Combustion of coal and coke making, Action of heat on different coal samples, Different types of coal combustion techniques, Coal liquefaction, Direct liquefaction, Indirect liquefaction, Coal gasification. Properties, Classification, Natural gas, Methane from coal mines, Producer gas, water gas, coal gas, Blast furnace gas, LPG, Gasification- coal, biomass, oil

  Solar Energy Utilisation (Thermal) :Construction and performance analysis of solar flat plate collectors. Heat losses from FPC by radiation and natural convection, overall heat loss coefficient, collector efficiency factor, tilt factors, collector heat removal factor,

  Energy from Ocean, Wind, Tides and geothermal sources : OTEC power plants (closed cycle, open cycle, hybrid cycle), operation and technical problems, environmental impact, Tidal power, salinity power plants, Wind energy:

  Energy from biomass: Biomass utilisation: pyrolysis, gasification, anaerobic digestion (biogas production), Biodiesels: Manufacture and characteristics,

  Nuclear Energy: Nuclear fission principles, types of nuclear reactors (BWR, PWR, PHWR, LMCR, GCR, FFR). Nuclear reactor analysis: four factor formula, resonance absorption, reactor buckling, multiplication factor, thermal utilisation coefficient, reflector saving, fast fission factor, optimum moderator to fuel ratio. Radioactive waste disposal.
- **Quantum Mechanics:** Fundamentals of quantum mechanics: operators, functions, basic postulates, timeindependent Schrödinger equation, particle in a box of various dimensions, rigid rotation in a plane, spherical harmonic functions, rotation of diatomic molecule, harmonic oscillator, electronic wave function of hydrogen and hydrogen like atom, magnetic effect on electron movement, many electron theory, raising and lowering operators, Pauli exclusion principle, time-dependent Schrödinger equation.
- **Thermodynamics :** Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV. Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. Second Law of Thermodynamics: Reversible and

Irreversible process with examples. Conversion of Work into Heat and Heat into Work.Heat Engines.Carnot‟s Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics'

- **Solid state physics:** Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors.Lattice with a Basis – Central and Non-Central Elements.Unit Cell.Miller Indices.Reciprocal Lattice.Types of Lattices.Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law.Atomic and Geometrical Factor.

Part B (Optional area):

- **Green Chemistry and Clean Technologies:** Definition and strategy of green chemistry, Why Green Chemistry? Prevention, Atom Economy, Less Hazardous Chemical Syntheses, Designing Safer Chemicals, Safer Solvents and Auxiliaries, Design for Energy Efficiency.

- **Introduction to probability:** Independent random variables: Probability distribution functions; binomial, Gaussian, and Poisson, with examples. Mean and variance. Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing.

- **Partial Differential Equations:** Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation.

- . **Nanotechnology in Energy and Environment**
  Introduction, History of Nanomaterials synthesis approach of nanomaterials, various kind of nanostructures.
  Synthesis of nanomaterials: Physical Methods, Chemical Methods and Biological Methods. Properties of Nanomaterials: Mechanical, Structural, Thermal, Electrical and Optical properties.
  Characterization techniques of nanomaterials: Spectroscopy, XRD, BET, TGA, SEM, TEM and XPS.Application of the nanomaterials in different fields. Nanolithography, Nanocomposites. Nanoparticles as catalyst Nanoparticles in energy and environment application. Nanoparticles in biomedical application

- ## Water Resources Engineering
  Fluid Mechanics:
  Properties of fluids, fluid statics; Continuity, momentum, energy and corresponding equations; Potential flow, applications of momentum and energy equations; Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth.
  Hydraulics:
  Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Kinematics of flow, velocity triangles; Basics of hydraulic machines, specific speed of pumps and turbines; Channel Hydraulics – Energy-depth relationships, specific energy, critical flow, slope profile, hydraulic jump, uniform flow and gradually varied flow.

Hydrology:
Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, flood estimation and routing, reservoir capacity, reservoir and channel routing, surface run-off models, ground water hydrology – steady state well hydraulics and aquifers; Application of Darcy's laws.
Irrigation:
Duty, delta, estimation of evapo-transpiration; Crop water requirements; Design of lined and unlined canals, head works, gravity dams and spillways; Design of weirs on permeable foundation; Types of irrigation systems, irrigation methods; Water logging and drainage; Canal regulatory works, cross-drainage structures, outlets and escapes.

- ## Environmental Engineering

Water and Wastewater:
Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment. Unit operations and unit processes of domestic wastewater, sludge disposal. Ion-exchange; Disinfection of water; Membrane separation, Adsorption
Air Pollution:
Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits, Air pollutants dispersion modelling
Municipal Solid Wastes:
Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).
Noise Pollution:
Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution, Noise characteristics.

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