

**PONDICHERY UNIVERSITY**  
**DEPARTMENT OF GREEN ENERGY TECHNOLOGY**  
**Madanjeet School of Green Energy Technologies**

**Ph.D. Green Energy Technology Programme**

**Entrance Examination Syllabus – Academic Year 2026-27**

**Mathematics:** Vector algebra, Matrix algebra, systems of linear equations, rank of a matrix, eigenvalues and eigenvectors, maxima and minima, gradient, divergence and curl, directional derivatives. Integration, Line, surface, and volume integrals, First-order linear and nonlinear differential equations, higher-order linear ODEs with constant coefficients, Mean, median, mode, and standard deviation; random variables; Poisson, normal and binomial distributions; correlation and regression analysis

**Chemistry:** Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg's law, ionic crystals, band theory, metals and semiconductors, structure and isomerism, theories of bonding, (VBT, CFT, and MOT). Energy level diagrams in various crystal fields, Concept of energy and various forms of energy; internal energy, enthalpy; specific heats; Thermodynamic properties of pure substances in solid, liquid and vapor phases, ideal and real gases, ideal gas equation of state and van der Waals equation of state. Synthesis, reactions, mechanisms and selectivity involving the following classes of compounds: alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, nitriles, halides, nitro compounds, amines, amides and biopolymers. Chemical Kinetics: Factors affecting rate of reaction, basic rate laws and rate constants. Monomers, functionality, polymer synthesis, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness. 0D, 1D, 2D structures – Size Effects – synthesis of nanomaterials. Photochemistry of alkenes, arenes and carbonyl compounds. Photo oxidation and photo reduction. Spectroscopy: Applications of UV-visible, IR, NMR, and Mass spectrometry in the structural determination of organic molecules. Electrochemistry –electromotive force, batteries and fuel cells.

**Physics:** Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; Electromagnetic waves and their reflection, refraction, interference, diffraction and polarization, Laws of thermodynamics; macro states and microstates; phase space; ensembles; partition function, free energy; Crystal growth techniques, zone refining, Concept of amorphous, single crystals and polycrystalline materials, crystallinity and its effect on physical properties, metal, ceramic; nanomaterials and their optical properties -quantum dots. Free electron theory, Fermi energy, density of states, elements of band theory, semiconductors: Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; Generation and recombination of carriers; Poisson and continuity equations; P-N junction, Zener diode, Hall effect, Specific heat, thermal conductivity and thermal expansion, thermoelectricity.

**Engineering:** Stress-strain response of metallic, ceramic, and polymer materials, yield strength, tensile strength and modulus of elasticity, toughness, plastic deformation, fatigue, creep, and fracture; Electric field and potential – electricity - capacitors – LCR, LR, CR circuits – transformers – batteries – electromagnetism - generators and motors – magnets and magnetic materials - thermoelectricity – ohms law – Kirchhoff’s law and their applications; Semi conductor devices: diodes, Bipolar Junction Transistors, Field Effect Transistors; MOSFET. Operational amplifiers: negative feedback circuits, active filters, and oscillators; regulated power supplies; basic digital logic circuits, sequential circuits, flip-flops, counters, registers, A/D and D/A conversion; Properties of steam - heat transfer - heat engines heat- pumps/refrigerators; Renewable energy technologies - solar energy production and storage – Solar Thermal energy production and storage issues, biomass energy, bioethanol, biodiesel biogas energy generation, potential and challenges, wind energy potential and challenges, concepts of energy audit and energy efficiency; Cogeneration power plants – Small hydropower plants; Carbon sequestration – Carbon credits. Different modes of energy storage, Technology Types– Mechanical energy storage: flywheels, compressed air, and pumped hydro; Electrical and Magnetic Energy storage: Batteries, Capacitors, electromagnets, Chemical energy storage. Building and Energy: Need for energy in buildings. Grid Connected Energy Systems: Power generation, transmission, distribution systems concepts; power factor correction; economic operation; fault analysis. Principles of over-current, differential and distance protection; solid state relays and circuit breakers

**Biological Science:** DNA packaging; DNA replication; Central dogma; Transcription, genetic code, translation; Gene expression and regulation-Lac Operon; Genome and human genome project; DNA fingerprinting; Transport and transpiration in plants - Photosynthesis - Photochemical and biosynthetic phases of photosynthesis; Cyclic and non-cyclic and photophosphorylation; Photorespiration -glycolysis, fermentation - TCA cycle and electron transport system – Energetics -C3 and C4 pathways; Nitrogen metabolism-Nitrogen cycle, biological nitrogen fixation; Biocatalysis by enzymes and pathways - Fermentation and bioprocess engineering – Chemical kinetics – Bioreactors; Biodegradation; anaerobic digestion; Bioconversion of lignin and carbohydrates to biofuels; Pathogens; parasites causing human diseases; Concepts of immunology- vaccines; Organisms and environment: Habitat and niche; Population and ecological adaptations; concept of biodiversity and biodiversity conservation; Hotspots; Air pollution and its control; Water pollution and its control; Agrochemicals and their effects; Solid waste management; Greenhouse effect and global warming; Ozone depletion; Deforestation.

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