AMRITA VISHWA VIDYAPEETHAM

DEPARTMENT OF CHEMICAL ENGINEERING AND MATERIALS SCIENCE

PhD Entrance Examination - Syllabus

The research being carried out in the department of Chemical Engineering & Materials Science and Center of Excellence in Advanced Materials & Green Technologies is interdisciplinary in nature. The major disciplines of research are Chemical Engineering, Materials Science and Mechanical Engineering. The Ph.D. candidates who seek admission into Ph.D. program have to take an entrance exam in any of the three areas specified above. As part of the examination, an applicant may opt to write the exam in

1. Chemical Engineering, OR
2. Materials Science, OR
3. Mechanical Engineering

The syllabus for each major area of the entrance exam is given below:

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Syllabus for Materials Science Major

Basics of Materials Structure: Atomic structure, chemical bonding – ionic, covalent, coordinate and metallic bonds, intermolecular forces, crystal systems- space lattice- miller indices of atomic planes and directions- small problems in crystallography- crystal defects- point, line and surface defects- Bragg's law – X-ray diffraction- Metallography- preparation of specimen – micro structure examination- working principle of metallurgical and electron microscope.

Phase Diagrams: solid solution- intermetallic compound, cooling curves, non-equilibrium cooling- phase rule-Equilibrium diagrams- isomorphous- eutectic- peritectic and eutectoid reactions with examples-Iron- Iron carbide diagram. Development of Microstructure and Alteration of Mechanical Properties .

Ceramics: Structures and Properties of Ceramics

Polymeric Materials: Basic principles of polymer structure, synthesis, properties and processing.

Properties of Materials: Electrical Properties, Thermal Properties, Optical Properties.

Thin Film Deposition: Fundamentals of Chemical Vapor Deposition

OR

Syllabus for Chemical Engineering Major

Process Calculations: Steady and unsteady state mass and energy balances including multiphase, multicomponent, reacting and non-reacting systems.

Thermodynamics: First and Second laws of thermodynamics. Applications of first law to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, shell-balances including differential form of Bernoulli equation and energy balance, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop. Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.

Heat transfer: Steady state Heat conduction: One dimensional heat conduction equation – general heat conduction – boundary and initial conditions- Heat generation in solids-generalized thermal resistance network – extended surface heat transfer. Unsteady Heat Conduction: Unsteady state conduction – Lumped heat capacity system, plane wall with convection, infinite cylinder & sphere with convection. Convective heat transfer: Boundary layer theory – physical mechanism of convection- Flow over flat plates, cylinders and spheres. Design of heat exchangers: Types of heat exchangers-Standard Representation-classification – parallel flow and counter flow - LMTD, NTU methods.

Mass Transfer: Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage-wise and continuous contacting and stage efficiencies; HTU & NTU concepts; design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Introduction to chemical reaction engineering, performance equations for ideal reactors, rate parameter estimation for ideal reactors, reactor combinations, multiple reactions, selectivity and yield in multiple reactions, steps in heterogeneous reactions and rate-limiting step, heterogeneous catalytic and non-catalytic reactions and reactor design.

Process Control and Instrumentation: Measurement of process variables; sensors, transducers and their dynamics, process modeling and linearization, transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response, controller tuning, cascade and feed forward control.

Basics of Materials Structure: Atomic structure, chemical bonding – ionic, covalent, coordinate and metallic bonds, intermolecular forces, crystal systems- space lattice-miller indices of atomic planes and directions- small problems in crystallography- crystal defects- point, line and surface defects- Bragg's law – X-ray diffraction- Metallography-preparation of specimen – micro structure examination- working principle of metallurgical and electron microscope.

Syllabus for Mechanical Engineering Major

Engineering Mechanics: Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan-Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behaviour of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

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