SECTION-II

Syllabus for PhD Admission Test

Chemical Engineering

**Process Calculations and Thermodynamics:** Laws of conservation of mass and energy; Use of tie components; recycle, bypass and purge calculations; Degree of freedom analysis. First and Second laws of thermodynamics. First law application to close and open systems. Second law and Entropy; Thermodynamic properties of pure substances: Equation of state and departure function. Properties of mixtures: Partial molar properties, fugacity, excess properties and activity coefficients; Phase equilibria; Chemical reaction equilibria.

**Fluid Mechanics and Mechanical Operations:** Fluid statics; Newtonian and non-Newtonian fluids; Bernoulli equation; Friction factor; Energy balance; Dimensional analysis; Shell balances; Flow through pipeline systems; Flow meters, Pumps and compressors, Packed and fluidized beds, Elementary boundary layer theory, Size reduction and size separation; Free and hindered settling; Centrifuge and cyclones; Thickening and classification; Filtration; Mixing and agitation; Conveying of solids.

**Heat Transfer:** Conduction, convection and radiation; Heat transfer coefficients, Steady and unsteady heat conduction; Boiling, condensation and evaporation; Types of heat exchangers and evaporators and their design.

**Mass Transfer:** Fick’s laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; Momentum, heat and mass transfer analogies; stagewise 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:** Theories of reaction rates; Kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, nonideal reactors; Residence time distribution, single parameter model; Non-isothermal reactors; Kinetics of heterogeneous catalytic reactions; Diffusion effects in catalysis.

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

**Plant Design and Economics:** Process design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; Principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in design.

**Chemical Technology:** Inorganic chemical industries: sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); Natural products industries (Pulp and Paper, Sugar, Oil, and Fats); Petroleum refining and petrochemicals; Polymerization industries; Polyethylene, polypropylene, PVC and polyester synthetic fibers.
SECTION-II

Civil Engineering

**Structural Engineering:**
**Mechanics:** Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr’s circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

**Structural Analysis:** Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

**Concrete Structures:** Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns isolated footings); basic elements of prestressed concrete: Construction Technology and Management- CPM/PERT analysis, Cost Analysis, Mass Haul Diagram.

**Steel Structures:** Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

**Geotechnical Engineering:**
**Soil Mechanics:** Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

**Foundation Engineering:** Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

**Water Resources Engineering:**
**Fluid Mechanics and Hydraulics:** Hydrostatics applications of Bernoulli equation, Laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of Momentum equation, Potential flow, Kinematics of flow; Velocity triangles and specific speed of pumps and turbines.

**Hydrology:** Hydrologic cycle; Rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.
**Irrigation:** Duty, delta, Estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Design of weirs on permeable foundation, Irrigation methods.

**Environmental Engineering:**
Water Requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: Quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

**Transportation Engineering:**
Highway planning, Geometric design of Highways, Testing and specifications of paving materials, Design of flexible and rigid pavements.
SECTION-II

Syllabus for PhD Admission Test
Computer Science and Engineering

Data Structures :

Algorithms :

Computation Theory :
Regular Languages and Finite Automata (Mealy, Moore, Hybrid FSM, Exposed FSM, Encapsulated FSM, Static State Instantiation FSM). Context free Languages and Pushdown Automata. Recursively Enumerable sets and Turing Machines. Undecidability.

Operating Systems :

Database Systems :
**Computer Organisation and Architecture:**


**Software Engineering:**


**Computer Networks:**


**Compiler Design:**


**Computer Graphics and Web technologies:**

Geometrical Objects and Transformations in 2D and 3D, Objects representation, Coordinates transformation, windows and viewports, Viewing in 3D, Orthogonal and projective views, hidden surface removal, Light, Shading, Web multimedia technologies, HTML, XML, basic concepts of client-server computing.
Syllabus for PhD Admission Test

Electronics and Communication Engineering

**Communication Systems:**

**Digital Signal Processing:**

**Electromagnetic Theory, Microwave Techniques and Antenna:**

**Satellite Communication:**

**Optical Communication:**

**Wireless & Mobile Communication:**

**Telecommunication Networks:**

**Information and Coding Theory:**
VLSI Circuits and Systems:
Building Blocks of VLSI and Simulation Tools. MOS, CMOS and MOSFET Transistors, Circuits and Applications. CMOS Logic Circuits. Semiconductor Memories. VLSI Digital ICs. Fabrication Techniques.
SECTION-II
Syllabus for PhD Admission Test
Mechanical Engineering

MACHINE DESIGN

Theory of Machines: Mechanisms and Machines, Gear and Gear Trains, CAMs, Engine Dynamics, Governors, Balancing, Gyroscope

Design of Machine Elements: Design for Production, Belt, Rope and Chain Drives, Design of Shafts, Bearings, Springs, Tribology


THERMAL ENGINEERING


PRODUCTION ENGINEERING


SECTION-II

SYLLABUS FOR THE PH.D. ADMISSION TEST

CHEMISTRY

Physical Chemistry:


Inorganic Chemistry


Organic Chemistry


**Interdisciplinary topics**
Chemistry in nanoscience and technology. Catalysis and green chemistry. Medicinal chemistry. Supramolecular chemistry. Environmental chemistry.
Syllabus and Format for PhD Admission Test: Humanities & Social Sciences

General
The Ph.D. Program at Department of Humanities & Social Science offers the opportunity for highly motivated students to pursue research in areas such as Economics, Human Resource Management and Behavioural sciences, Marketing management and General Management. Students must exhibit the ability to think and write analytically and the eagerness to explore new vistas of knowledge. Strong written and verbal communication skills are mandatory with a commitment to the focused pursuit of a doctoral degree program.

Economics
Demand, Supply and Equilibrium, Cost, Production Theory, Indian economy, Market Structure, Pricing, National Income Accounting, Inflation, Monetary & Fiscal Policy, International Trade and Relations

Human Resource Management and Behavioural sciences

Marketing

General Management
Syllabus for PhD Admission Test

Mathematics

Algebra :

Analysis :

Differential Equations :

Operations Research :
Linear programming problems, convex set, convex functions, Simplex method and its variants, duality, sensitivity analysis. Transportation problems, initial basic feasible solution and optimal solution, degeneracy. Assignment problems, applications of TP and AP. Nonlinear programming problems, Kuhn-Tucker conditions.

Numerical Analysis :

Probability and Statistics:
SECTION-II

Syllabus for PhD Admission Test

Physics

Solid State Physics:
Crystal structure; space lattice, basis, bravais lattice, space, coordination number, lattice plane, Miller Indices, inter planar distance, atomic radii, lattice constant and density, reciprocal lattice, Bragg’s Law, X-ray diffraction, atomic scattering factor. Origin of energy gap; Bloch theorem, Kronig Penney Model, effective mass of electron. Tight binding approximation; Brillouin zone, nearly free electron model. Polarization mechanism & Dielectric Constant; behavior of polarization under impulse and frequency switching, dielectric loss, spontaneous polarization, piezoelectric and ferroelectric effect. Classification of – dia-, para-, ferro-, antiferro- and ferri-magnetic materials, hysteresis, magnetic storage and surfaces. Photoconductivity.

Atomic and Statistical Physics:
Black body radiation; Rayleigh - Jeans law, Wien’s law, Plank’s law of radiation ,Stefan’s law, Compton scattering, Origin of spectral lines, Atoms in magnetic field; Normal Zeeman effect, Distributions; classical distribution (MB), quantum distributions (BE , FD), applications of quantum distributions (electron gas, average energy). Spectra of one- and many-electron atoms; Stern-Gerlach experiment, LS and JJ coupling, hyperfine structure, Zeeman and Stark effects, electric dipole transitions and selection rules, rotational and vibrational spectra of diatomic molecules, electronic transition in diatomic molecules, Franck-Condon principle, Raman effect, NMR and ESR. Lasers-spontaneous and stimulated emission, optical pumping, population inversion, coherence (temporal and spatial)

Quantum and Advanced Physics:
Wave-particle duality, uncertainty principle. Schrodinger’s time dependent and time-independent equations. One, two and three dimensional potential problems, particle in a box, harmonic oscillator and second quantization , concept of Hilbert space, hydrogen atom, angular momentum and spin; time independent perturbation theory. Quantum Wells, quantum dots, quantum wires. Amorphous materials; Electronic density of states.

Electronics:
p-n junction, abrupt junction, linearly graded junction, diffused junction, Diodes; ideal and real diodes, temperature dependence of I-V characteristics, injection, tunnel diode, backward diode, Schottky barrier diode, Ohmic contacts, heterojunctions. Semiconductor surfaces. CV characteristics of MOS capacitor,
Si-SiO$_2$ system, basic structure and operating principle, I-V characteristics, frequency limitations, short-channel effects. Solar Cell, Photo detectors, LED, Semiconductor lasers.

**Electromagnetism:**
Gradient, Divergence and Curl, Coulomb’s law and related numerical, Gauss’s law, it proof for the charge inside and outside the Gaussian surface, applications of Gauss law i.e. spherical and cylindrical symmetries (all important cases), electric field due to charged conductor, force per unit area on the surface of the charged conductor. Treatment of electrostatic problems by solution of Laplace and Poisson’s equations, Biot Savart law, Ampere’s law, Maxwell’s equations (derivations) in free space and dielectric media. Energy in electromagnetic waves (Poynting vector and Poynting theorem), plane electromagnetic waves in free space, Solution, transverse nature, wave impedance and energy flow, derivations of expressions for energy density and energy flux (Poynting vector) in an electromagnetic field, radiation pressure, boundary conditions across the medium. Optical Fibers; light propagation in fibers and graded index fibers, numerical aperture and attenuation, single and multimode. Wave guides.