R&D Officers

Test Structure

Type	No. of Questions	Marks	Time Duration
Domain	85	85	150 mins
Aptitude	85	85	

Aptitude Syllabus

Verbal Ability	Quantitative Aptitude	Intellectual Potential Test
• Articles	• Ratio and Proportion	• Data Interpretation
• Prepositions	• Time and Work	• Coding & Decoding
• Vocabulary	• Speed and Distance	• Deductive Logic
• Reading Comprehension	• Percentages & Averages	• Inductive Logic
• Synonyms	• Profit, Loss & Discount	• Data Sufficiency
• Jumbled Sentences	• Probability	• Series Completion
	• Algebra, Calendar	• Puzzles
		• Pattern Completion

Domain Syllabus Overview

Bioprocess	
S.No.	**Topics**
1.	Basic Microbiology and Biotechnology
2.	Lignocellulosic Biofuel Processes
3.	Biomass composition and pre-treatment
4.	Advanced Biofuels
5.	Enzymes and their production
6.	Microbial and Fungal Fermentations
7.	Molecular Biology Fundamentals and Techniques
8.	Basic analytical techniques
9.	Microbial Biochemistry Basics
10.	Basics and techniques of Separation and Purification of Biomolecules
11.	Bioremediation
12.	Biosurfactants
13.	Bioprocess Scale-up
14.	Upstream and Downstream bio-processing

Chemical/ Nanotechnology	
S.No.	**Topics**
1	**Process Calculations and Thermodynamics** Steady and unsteady state mass and energy balances including multiphase, multicomponent, reacting and non-reacting systems.

	Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis. 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.
2	**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.
3	**Heat Transfer** Steady and unsteady heat conduction, convection and radiation Thermal boundary layer and heat transfer coefficients Boiling, condensation and evaporation Types of heat exchangers and evaporators and their process calculations, cooling towers, furnace calculations. Design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.
4	**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 (flash, multi-component distillation etc), absorption and stripping, leaching, liquid-liquid extraction, drying, membrane separation, humidification, dehumidification and adsorption
5	**Chemical Reaction Engineering** Theories of reaction rates Kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors Development of rate laws, Residence time distribution, single parameter model Non-isothermal reactors Catalysis and catalytic reactions, catalyst deactivation and regeneration, Kinetics of heterogeneous catalytic reactions Diffusion effects in catalysis. Different type of industrial reactors - Fixed bed, fluidized bed, trickle bed, slurry bed
6	**Instrumentation and Process Control** 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.
7	**Plant Design and Economics** Principles of process economics and cost estimation including depreciation and total annualized cost, cost indices, rate of return, payback period, discounted cash flow, Interest and investment costs, taxes and insurance, material selection and equipment fabrication Computer aided design, Optimization in process design and sizing of chemical engineering equipments such as compressors, heat exchangers, multistage contactors, reactors etc.
8	**Chemical Technology** Inorganic chemical industries (sulfuric acid, phosphoric acid, chlor-alkali industry) 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).
9	**Transport Phenomena** Transport of momentum, heat and mass by molecular motion – Newton's law of viscosity, Fourier's law of heat conduction and Fick's law Transport properties – Viscosity, Thermal conductivity and Mass diffusivity. One-dimensional mathematical models for transfer processes using shell balance of momentum, heat and mass. Development of general differential equations for transfer of momentum, heat and mass and their applications in solving one-dimensional steady and unsteady problems. Boundary layer theories. Turbulent transport and Interphase transport.
10	**Nano Technology** Introduction to Nanomaterials, Properties of nanomaterials, Role of size in nanomaterials, nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and coprecipitation; Metal nanocrystals by reduction, Sol-gel synthesis; Microemulsions or reverse micelles, Solvothermal synthesis; Photochemical synthesis, Synthesis in supercritical fluids, Fabrication of Nanomaterials by Physical Methods: -Inert gas condensation, Arc discharge, Plasma arc technique, RF plasma, MW plasma, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy, Chemical vapour deposition method and Electro deposition Nanostructures: Zero-, One-, Two- and Three- dimensional structure, Size control of metal Nanoparticles and their properties: Optical, Electronic, Magnetic properties; Surface plasmon Resonance, Change of bandgap; Application: catalysis, electronic devices

Note: The Syllabus/Topics mentioned are indicative in nature. Candidates are also expected to possess significant Knowledge/Proficiency pertaining to their Qualifying Degree/Post-Graduation degree