Chemical Engineering–Syllabus

Topic 1: Fluid Mechanics and Mechanical Operations

Fluid Mechanics, Fluid statics, Newtonian and non-Newtonian fluids, shell-balances including differential form of Bernoulli equation and energy balance, Macroscopic friction factors, pumps and compressors, elementary boundary layer theory, 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.

Topic 2: Process Calculations and Thermodynamics

Steady and unsteady state mass, reacting and non-reacting systems, Gibb's phase rule and degree of freedom analysis, First and Second laws of thermodynamics, Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, phase equilibria, chemical reaction equilibrium.

Topic 3: Heat Transfer & Mass Transfer

convection and radiation, boiling, condensation and evaporation; types of heat exchangers and evaporators, Fick's laws, molecular diffusion in fluids, penetration and surface renewal theories; momentum, heat and mass transfer analogies.

Topic 4: Chemical Reaction Engineering

Theories of reaction rates; kinetics of homogeneous reactions, ideal reactors, non-ideal reactors; non-isothermal reactors; kinetics of heterogeneous catalytic reactions.

Topic 5: 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).

Topic 6: Chemical Electives

Polymer Science & technology, Bio Chemical Engineering, Fertilizer Technology, Nano Technology, Pharmaceutical Technology.

Civil Engineering–Syllabus

Topic 1: Structural Engineering

Solid Mechanics, Strength of Materials, Mechanics of Materials, Structural Analysis, Construction Materials and Management, Concrete Structures, Steel Structures, Optimization in Engineering Design, Analysis of Indeterminate structures, Structural Dynamics, Steel Concrete Composite Structures, Structural System Analysis, Earthquake resistant Structures, Pre-stressed Concrete Structures, Maintenance & Rehabilitation of Structures.

Topic 2: Geotechnical Engineering

Soil Mechanics and Foundation Engineering, Geotechnical Engineering, Earth & Earth retaining structures, Reinforced Earth & Geo Textiles, geotechnical Earthquake Engineering.

Topic 3: Water Resources Engineering

Fluid Mechanics, Hydraulics, Hydrology, Irrigation, Groundwater Hydrology, Applied Hydraulics Engineering, Design of Hydraulics Structures, Design of Offshore & Coastal structures, Marine Foundation Engineering, Ocean Energy.

Topic 4: Environmental Engineering

Water and Waste Water, Air Pollution, Municipal Solid Wastes, Noise Pollution, Models for Air & Water quality, Industrial Wastewater treatment, Environmental Management & Impact Assement, Air pollution Management,

Topic 5: Transportation Engineering

Transportation Infrastructure, Highway Pavements, Traffic Engineering & Safety, Pavement Analysis & Design, Transportation Planning, Railway, Airport & harbour Engineering.

Topic 6: Geomatics Engineering

Principles of surveying; Errors and their adjustment; Maps - scale, coordinate system; Distance and angle measurement - Levelling and trigonometric levelling; Traversing and triangulation survey; Total station; Horizontal and vertical curves.

Photogrammetry - scale, flying height; Remote sensing - basics, platform and sensors, visual image interpretation; Basics of Geographical information system (GIS) and Geographical Positioning system (GPS).

Topic 7: Civil Electives

Urban & Regional Planning, Experimental Stress Analysis, Health Monitoring of Structures, Forensic Engineering.

Mechanical Engineering–Syllabus

Topic 1: Engineering Mechanics & Design

Solid Mechanics, Strength of Materials, Mechanics of Machines, Design of Mechanical Drives, Turbomachines, Mechanics of Materials, Theory of Machines, Vibrations, Machine Design, Optimization in Engineering Design.

Topic 2: Fluid Mechanics and Thermal Sciences

Fluid Mechanics, Heat-Transfer and Thermodynamics, Combustion Engineering, refrigeration & Air Conditioning, Fundamentals of Heat & Mass Transfer, Thermal Engineering.

Topic 3: Materials, Manufacturing and Industrial Engineering

Engineering Materials, Casting, Forming and Joining Processes, Machining and Machine Tool Operations, Metrology and Inspection, Computer Integrated Manufacturing (CAD/CAM), Production Planning and Control, Inventory Control and Operations research.

Topic 4: Mechanical Electives -I

Advanced IC Engines, Mechatronics, Industrial Robotics, Dynamics of Machinery, Vehicle Dynamics, Nano Technology, Industrial tribology, MEMS Devices – Design & fabrication, Principles of Turbo machinery.

Topic 5: Mechanical Electives - II

Welding Technology, Industrial Safety Engineering, Coil Hydraulics & Pneumatics, Vibration Analysis & Control, Cryogenic Engineering

Metallurgical Engineering–Syllabus

Topic 1: Thermodynamics and Rate Process

Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, Ellingham and phase stability diagrams, thermodynamics of surfaces, interfaces and defects, adsorption and segregation; basic kinetic laws, order of reactions, rate constants and rate limiting steps; principles of electro chemistry-single electrode potential, electrochemical cells and polarizations, aqueous corrosion and protection of metals, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, selective leaching, oxidation and high temperature corrosion – characterization and control; heat transfer – conduction, convection and heat transfer coefficient relations, radiation, mass transfer – diffusion and Fick's laws, mass transfer coefficients; momentum transfer – concepts of viscosity, shell balances, Bernoulli's equation, friction factors

Topic 2: Extractive Metallurgy

Minerals of economic importance, comminution techniques, size classification, flotation, gravity and other methods of mineral processing; agglomeration, pyro-, hydro-, and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals – aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making – principles, role structure and properties of slags, metallurgical coke, blast furnace, direct reduction processes, primary and secondary steel making, ladle metallurgy operations including deoxidation, desulphurization, sulphide shape control, inert gas rinsing and vacuum reactors; secondary refining processes including AOD, VAD, VOD, VAR and ESR; ingot and continuous casting; stainless steel making, furnaces and refractories.

Topic 3: Physical Metallurgy

Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers, structure of surfaces and interfaces, nano-crystalline and amorphous structures; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, cast iron and aluminium alloys; surface treatments; recovery, recrystallization and grain growth; structure and properties of industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of optical, scanning and transmission electron microscopy; industrial ceramics, polymers and composites; introduction to electronic basis of thermal, optical, electrical and magnetic properties of materials; introduction to electronic and opto-electronic materials.

Topic 4: Mechanical Metallurgy

Elasticity, yield criteria and plasticity; defects in crystals; elements of dislocation theory – types of dislocations, slip and twinning, source and multiplication of dislocations, stress fields around dislocations, partial dislocations, dislocation interactions and reactions; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture – Griffith theory, basic concepts of linear elastic and elastoplastic fracture mechanics, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing – tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability.

Topic 5: Manufacturing Processes

Metal casting – patterns and moulds including mould design involving feeding, gating and risering, melting, casting practices in sand casting, permanent mould casting, investment casting and shell moulding, casting defects and repair; Hot, warm and cold working of metals; Metal forming – fundamentals of metal forming processes of rolling, forging, extrusion, wire drawing and sheet metal forming, defects in forming; Metal joining – soldering, brazing and welding, common welding processes of shielded metal arc welding, gas metal arc welding, gas tungsten arc welding and submerged arc welding; Welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welded joints; Powder metallurgy – production of powders, compaction and sintering; NDT using dye-penetrant, ultrasonic, radiography, eddy current, acoustic emission and magnetic particle methods

Electrical Engineering–Syllabus

Topic 1: Electrical Circuits

Network graph, KCL, KVL, Transient response of dc and ac networks, Ideal current and voltage sources, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Two-port networks, Three phase circuits, Power and power factor in ac circuits.

Topic 2: Electromagnetic Fields

Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magneto motive force, Reluctance, Magnetic circuits

Topic 3: Signals and Systems & Control Systems

Continuous and discrete-time signals, Shifting and scaling operations, Linear Time Invariant and Causal systems, Fourier series representation of continuous periodic signals, Sampling theorem, Fourier Transform, Laplace Transform and z-Transform.

Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, State transition matrix.

Topic 4: Electrical Machines

Single phase transformer: equivalent circuit, open circuit and short circuit tests, Three phase transformers, Auto-transformer, DC machines, Three phase induction motors, single phase induction motors, Synchronous machines, synchronous motor.

Topic 5: Power Systems

Power generation concepts, ac and dc transmission concepts, transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Bus admittance matrix, Gauss-Seidel and Newton-Raphson methods, Voltage and Frequency control, Power factor correction, Symmetrical and unsymmetrical fault analysis,Circuit breakers.

Topic 6: Analog and Digital Electronics

Characteristics of diodes, BJT, MOSFET, Simple diode circuits, clipping, clamping, rectifiers; Amplifiers, Biasing, , Oscillators and Feedback amplifiers, Operational amplifiers, Simple active filters, VCOs and Timers, Combinational and Sequential logic circuits, Multiplexer, Demultiplexer, Schmitt trigger, Sample and hold circuits, A/D and D/A converters,, 8085Microprocessor: Architecture, Programming and Interfacing.

Topic 7: Power Electronics

Diode, Thyristor, Triac, GTO, MOSFET, IGBT; DC to DC conversion, Buck, Boost and Buck-Boost converters, Single and three phase uncontrolled rectifiers, Line commutated thyristor based converters, Bidirectional ac to dc voltage source converters, Single phase and three phase inverters.

Topic 8: Electrical Electives

Fuzzy Systems & genetic Algorithms, High Voltage Engineering, EHV AC DC Transmission, Artificial Neural Networks, Micro Computing Systems.

Electronics Engineering–Syllabus

Section 1: Engineering Mathematics

Linear Algebra: Vector space, basis, linear dependence and independence, matrix algebra, eigen values and eigen vectors, rank, solution of linear equations – existence and uniqueness.

Calculus: Mean value theorems, theorems of integral calculus, evaluation of definite and improper integrals, partial derivatives, maxima and minima, multiple integrals, line, surface and volume integrals, Taylor series.

Differential Equations: First order equations (linear and nonlinear), higher order linear differential equations, Cauchy's and Euler's equations, methods of solution using variation of parameters, complementary function and particular integral, partial differential equations, variable separable method, initial and boundary value problems.

Vector Analysis: Vectors in plane and space, vector operations, gradient, divergence and curl, Gauss's, Green's and Stoke's theorems.

Complex Analysis: Analytic functions, Cauchy's integral theorem, Cauchy's integral formula; Taylor's and Laurent's series, residue theorem.

Numerical Methods: Solution of nonlinear equations, single and multi-step methods for differential equations, convergence criteria.

Probability and Statistics: Mean, median, mode and standard deviation; combinatorial probability, probability distribution functions - binomial, Poisson, exponential and normal; Joint and conditional probability; Correlation and regression analysis.

Section 2: Networks, Signals and Systems

Network solution methods: nodal and mesh analysis; Network theorems: superposition, Thevenin and Norton's, maximum power transfer; Wye-Delta transformation; Steady state sinusoidal analysis using phasors; Time domain analysis of simple linear circuits; Solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits; Linear 2-port network parameters: driving point and transfer functions; State equations for networks.

Continuous-time signals: Fourier series and Fourier transform representations, sampling theorem and applications; Discrete-time signals: discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform, interpolation of discrete-time signals; LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay, digital filter design techniques.

Section 3: Electronic Devices

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, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell; Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography and twin-tub CMOS process.

Section 4: Analog Circuits

Small signal equivalent circuits of diodes, BJTs and MOSFETs; Simple diode circuits: clipping, clamping and rectifiers; Single-stage BJT and MOSFET amplifiers: biasing, bias stability, mid-frequency small signal analysis and frequency response; BJT and MOSFET amplifiers: multi-stage, differential, feedback, power and operational; Simple op-amp circuits; Active filters; Sinusoidal oscillators: criterion for oscillation, single-transistor and op-amp configurations; Function generators, wave-shaping circuits and 555 timers; Voltage reference circuits; Power supplies: ripple removal and regulation.

Section 5: Digital Circuits

Number systems; Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders and PLAs; Sequential circuits: latches and flip-flops, counters, shift-registers and finite state machines; Data converters: sample and hold circuits, ADCs and DACs; Semiconductor memories: ROM, SRAM, DRAM; 8-bit microprocessor (8085): architecture, programming, memory and I/O interfacing.

Section 6: Control Systems

Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

Section 7: Communications

Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems; Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, superheterodyne receivers, circuits for analog communications; Information theory: entropy, mutual information and channel capacity theorem; Digital communications: PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter receiver, calculation of bandwidth, SNR and BER for digital modulation; Fundamentals of error correction, Hamming codes; Timing and frequency synchronization, inter-symbol interference and its mitigation; Basics of TDMA, FDMA and CDMA.

Section 8: Electromagnetics

Electrostatics; Maxwell’s equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector; Plane waves and properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth; Transmission lines: equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart; Waveguides: modes, boundary conditions, cut-off frequencies, dispersion relations; Antennas: antenna types, radiation pattern, gain and directivity, return loss, antenna arrays; Basics of radar; Light propagation in optical fibers.