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Global University

ODISHA BHUBANESWAR INDIA

CGU
ODISHA

Syllabus

for **Ph.D.**

CGET-2026



P.hD Syllabus

MECHANICAL ENGINEERING:

Section 1: Engineering Mathematics

- a) **Linear Algebra:** Matrix algebra, systems of linear equations, eigenvalues and eigenvectors.
- b) **Calculus:** Functions of single variable, limit, continuity and differentiability, mean value theorems, indeterminate forms; evaluation of definite and improper integrals; double and triple integrals; partial derivatives, total derivative, Taylor series (in one and two variables), maxima and minima, Fourier series; gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, applications of Gauss, Stokes and Green's theorems.
- c) **Differential equations:** First order equations (linear and nonlinear); higher order linear differential equations with constant coefficients; Euler-Cauchy equation; initial and boundary value problems; Laplace transforms; solutions of heat, wave and Laplace's equations.
- d) **Probability and Statistics:** Definitions of probability, sampling theorems, conditional probability; mean, median, mode and standard deviation; random variables, binomial, Poisson and normal distributions.

Section 2: Applied Mechanics and Design

- a) **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.
- b) **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.
- c) **Theory of Machines:** Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.
- d) **Vibrations:** Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.
- e) **Machine Design:** Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

Section 3: Fluid Mechanics and Thermal Sciences

- a) **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.
- b) **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.
- c) **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.
- d) **Applications: Power Engineering:** Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. *I.C. Engines:* Air-standard Otto, Diesel and dual cycles. *Refrigeration and air-conditioning:* Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes. *Turbomachinery:* Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines.

Section 4: Materials, Manufacturing and Industrial Engineering

- a) **Engineering Materials:** Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials. Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding.
- b) **Machining and Machine Tool Operations:** Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, design of jigs and fixtures.
- c) **Metrology and Inspection:** Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.
- d) **Computer Integrated Manufacturing:** Basic concepts of CAD/CAM and their integration tools. Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning.

- e) **Inventory Control:** Deterministic models; safety stock inventory control systems. Operations Research: Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

ELECTRICAL ENGINEERING:

- a) **Electric Circuits:** Network graph, KCL, KVL, Node and Mesh analysis, Transient response of dc and ac networks, Sinusoidal steady state analysis, Resonance, Passive filters, 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.
- b) **Electromagnetic Fields:** Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magneto motive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.
- c) **Signals and Systems:** Representation of continuous and discrete-time signals; shifting and scaling operations; linear, timeinvariant and causal systems; Fourier series representation of continuous periodic signals; sampling theorem; Fourier, Laplace and Z transforms.
- d) **Electrical Machines:** Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, parallel operation; Autotransformer, Electromechanical energy conversion principles, DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control; Operating principle of single phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance, regulation and parallel operation of generators, starting of synchronous motor, characteristics; Types of losses and efficiency calculations of electric machines.
- e) **Power Systems:** Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per unit quantities, Bus admittance matrix, Gauss Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over current, differential and distance protection; Circuit breakers, System stability concepts, Equal area criterion.
- f) **Control Systems:** Mathematical modelling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady state analysis of linear time invariant systems, 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.

- g) **Electrical and Electronic Measurements:** Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multimeters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.
- h) **Analog and Digital Electronics:** Characteristics of diodes, BJT, MOSFET; Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: Biasing, Equivalent circuit and Frequency response; Oscillators and Feedback, amplifiers; Operational amplifiers: Characteristics and applications; 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, 8085 Microprocessor: Architecture, Programming and Interfacing.
- i) **Power Electronics:** Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost converters; Single and three phase configuration of uncontrolled rectifiers, Line commutated thyristor based converters, Bidirectional ac to dc voltage source converters, Issues of line current harmonics, Power factor, Distortion factor of ac to dc converters, Single phase and three phase inverters, Sinusoidal pulse width modulation.

COMPUTER SCIENCE & ENGINEERING

- a) **Operating System:** Introduction to OS, Process Management: Deadlock Memory Management: File System & Storage Management
- b) **Database Management Systems / Database Engineering:** Data Base Management System and ER Data Model, Relational Data Model, Relational Algebra and Relational Calculus, Normalization, Transaction Management
- c) **Computer Networking:** Data Communication Fundamentals, Modulation and Switching Techniques, Physical & Data Link Layer, Network and Transport Layer, Application Layer
- d) **Programming in C:** C Programming Basics, Arrays and Strings, Functions and Pointers, Structures and Unions, File Handling in C
- e) **Theory of Computation:** Finite automata, RG, CFG, CSG, Push down automata, Complexity Classes
- f) **Design and Analysis of Algorithm:** Asymptotic notations, Design techniques, Complexity Classes
- g) **Software Engineering:** Software models, Software requirements engineering, Software design, Software construction, Software Maintenance, Software engineering process
- h) **Compiler Design:** Process of compilation, Design of NFA/DFA for Regular expression, Parser, Symbol table Management, Error handling
- i) **Computer organization:** Basic Organization, Memory Organization, Machine, Instruction, RISC and SISC, Performance of Computer
- j) **Discrete math:** Group, Logics, Lattice, Probability and Statistics

ELECTRONICS & COMMUNICATION ENGINEERING

Section 1: Engineering Mathematics

- a) **Linear Algebra:** Vector space, basis, linear dependence and independence, matrix algebra, eigen values and eigen vectors, rank, solution of linear equations – existence and uniqueness.
- b) **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.
- c) **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.
- d) **Vector Analysis:** Vectors in plane and space, vector operations, gradient, divergence and curl, Gauss's, Green's and Stoke's theorems.
- e) **Complex Analysis:** Analytic functions, Cauchy's integral theorem, Cauchy's integral formula; Taylor's and Laurent's series, residue theorem.
- f) **Numerical Methods:** Solution of nonlinear equations, single and multi-step methods for differential equations, convergence criteria.
- g) **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 \square Delta transformation; Time domain analysis of simple linear circuits; Solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits; Linear 2 \square 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: Analog and Digital 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. 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. Number systems; Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaughmap, 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 4: 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 5: Analog and digital 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, intersymbol interference and its mitigation; Basics of TDMA, FDMA and CDMA.

Section 6 General Aptitude: Verbal Ability: English grammar, sentence completion, verbal analogies, word groups, instructions, critical reasoning and verbal deduction. Numerical Ability: Numerical computation, numerical estimation, numerical reasoning and data interpretation.

MATHEMATICS:

Section 1: Linear Algebra

Finite dimensional vector spaces; Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton Theorem, diagonalization, Jordan-canonical form, Hermitian, Skew- Hermitian and unitary matrices; Finite dimensional inner product spaces, Gram-Schmidt orthonormalization process, selfadjoint operators, definite forms.

Section 2: Complex Analysis

Analytic functions, conformal mappings, bilinear transformations; complex integration: Cauchy's integral theorem and formula; Liouville's theorem, maximum modulus principle; Zeros and singularities; Taylor and Laurent's series; residue theorem and applications for evaluating real integrals.

Section 3: Real Analysis

Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima; Riemann integration, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, compactness, completeness, Weierstrass approximation theorem; Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Section 4: Ordinary Differential Equations

First order ordinary differential equations, existence and uniqueness theorems for initial value problems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients; method of Laplace transforms for solving ordinary differential equations, series solutions (power series, Frobenius method); Legendre and Bessel functions and their orthogonal properties.

Section 5: Algebra

Groups, subgroups, normal subgroups, quotient groups and homomorphism theorems, automorphisms; cyclic groups and permutation groups, Sylow's theorems and their applications; Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domains, Principle ideal domains, Euclidean domains, polynomial rings and irreducibility criteria; Fields, finite fields, field extensions.

Section 6: Functional Analysis

Normed linear spaces, Banach spaces, Hahn-Banach extension theorem, open mapping and closed graph theorems, principle of uniform boundedness; Inner-product spaces, Hilbert spaces, orthonormal bases, Riesz representation theorem, bounded linear operators.

Section 7: Numerical Analysis

Numerical solution of algebraic and transcendental equations: bisection, secant method, Newton-Raphson method, fixed point iteration; interpolation: error of polynomial interpolation, Lagrange, Newton interpolations; numerical differentiation; numerical integration: Trapezoidal and Simpson rules; numerical solution of systems of linear equations: direct methods (Gauss elimination, LU decomposition); iterative methods (Jacobi and Gauss-Seidel); numerical solution of ordinary differential equations: initial value problems: Euler's method, Runge-Kutta methods of order 2.

Section 8: Partial Differential Equations

Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems; solutions of Laplace, wave in two dimensional Cartesian coordinates, Interior and exterior Dirichlet problems in polar coordinates; Separation of variables method for solving wave and diffusion equations in one space variable; Fourier series and Fourier transform and Laplace transform methods of solutions for the above equations.

Section 9: Topology

Basic concepts of topology, bases, subbases, subspace topology, order topology, product topology, connectedness, compactness, countability and separation axioms, Orison's Lemma.

Section 10: Probability and Statistics

Probability space, conditional probability, Bayes theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties (Discrete uniform, Binomial, Poisson, Geometric, Negative binomial, Normal, Exponential, Gamma, Continuous uniform, Bivariate normal, Multinomial), expectation, conditional expectation, moments; Weak and strong law of large numbers, central limit theorem; Sampling distributions, UMVU estimators, maximum likelihood estimators; Interval estimation; Testing of hypotheses, standard parametric tests based on normal, distributions; Simple linear regression.

Section 11: Linear programming

Linear programming problem and its formulation, convex sets and their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods; infeasible and unbounded LPP's, alternate optima; Dual problem and duality theorems, dual simplex method and its application in post optimality analysis; Balanced and unbalanced transportation problems, Vogel's approximation method for solving transportation problems; Hungarian method for solving assignment problems.

BUSSINSS ADMINISTARTION**Section 1: Managerial Economics:**

Introduction to Managerial Economics: Demand Analysis; Production Function; Cost-Output Relation; Market Structures; Pricing Theories; Macro Economics-concepts of GDP, GNP, Consumption, Saving, Investment, Business cycle, Monetary and Fiscal policy, LPG; FDI, Public Private participation.

Section 2: Organizational Behavior:

Meaning, Scope, Importance of OB; Evolution of OB; Organizational Design; Understanding and Managing Individual Behaviour -Personality, Perception, Values, Attitudes, Learning and Motivation; Understanding Group Behavior-Leadership, Formation of group and group behaviour; Managing Change; Organizational Culture.

Section 3: Human Resource Management:

Functions of HRM – Job Analysis: Job Description and Job Specification, HRP, Recruitment, Selection, Performance Appraisal, Training & Development, Promotion, Job Evaluation, Wage & Salary Administration; Introduction to Industrial Relations.

Section 4: Financial Management:

Nature and Scope of Financial Management; Valuation of Securities; Capital Budgeting Decisions; Capital Structure; Cost of Capital; Dividend Policies; Working Capital Management; Corporate valuation.

Section 5: Marketing Management:

Core concepts of Marketing; Marketing Environment and Environmental Scanning; Marketing Planning; Marketing information System; Marketing Research; Demand measurement and Forecasting; STP; Marketing Mix; Understanding Consumer and Organizational buying behaviour.

CHEMISTRY

Section 1 Physical Chemistry:-

Basic principles and applications of quantum mechanics – hydrogen atom, angular momentum. Variational and perturbational methods. Basics of atomic structure, electronic configuration, shapes of orbitals, hydrogen atom spectra. Theoretical treatment of atomic structures and chemical bonding. Chemical applications of group theory. Basic principles and application of spectroscopy – rotational, vibrational, electronic, Raman, ESR, NMR. Chemical thermodynamics. Phase equilibria. Statistical thermodynamics. Chemical equilibria. Electrochemistry – Nernst equation, electrode kinetics, electrical double layer, Debye-Hückel theory. Chemical kinetics – empirical rate laws, Arrhenius equation, theories of reaction rates, determination of reaction mechanisms, experimental techniques for fast reactions. Concepts of catalysis. Polymer chemistry. Molecular weights and their determinations. Kinetics of chain polymerization. Solids – structural classification of binary and ternary compounds, diffraction techniques, bonding, thermal, electrical and magnetic properties Collids and surface phenomena. Data analysis.

Section 2 Inorganic Chemistry:-

Chemical periodicity, Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules. Concepts of acids and bases. Chemistry of the main group elements and their compounds. Allotropy, synthesis, bonding and structure. Chemistry of transition elements and coordination compounds – bonding theories, spectral and magnetic properties, reaction mechanisms. Inner transition elements – spectral and magnetic properties, analytical applications. Organometallic compounds - synthesis, bonding and structure, and reactivity. Organometallics in homogenous catalysis. Cages and metal clusters. Analytical chemistry- separation techniques. Spectroscopic electro- and thermoanalytical methods. Bioinorganic chemistry – photosystems, porphyrines, metalloenzymes, oxygen transport, electron- transfer reactions, nitrogen fixation. Physical characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-, NQR, MS, electron spectroscopy and microscopic techniques. Nuclear chemistry – nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

Section 3 Organic Chemistry:-

IUPAC nomenclature of organic compounds. Principles of stereochemistry, conformational analysis, isomerism and chirality. Reactive intermediates and organic reaction mechanisms. Concepts of aromaticity. Pericyclic reactions. Named reactions. Transformations and rearrangements. Principles and applications of organic photochemistry. Free radical reactions. Reactions involving nucleophilic carbon intermediates. Oxidation and reduction of functional groups. Common reagents (organic, inorganic and organo-metallic) in organic synthesis. Chemistry of natural products such as steroids, alkaloids, terpenes, peptides, carbohydrates, nucleic acids and lipids. Selective organic transformations – chemo selectivity, regioselectivity, stereo selectivity, enantioselectivity. Protecting groups. Chemistry of aromatic and aliphatic heterocyclic compounds. Physical characterisation of organic compounds by IR, UV-, MS, and NMR..

PHYSICS

Section 1: Mathematical Methods of Physics

Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Green's function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Tensors: covariant and contravariant tensor, Levi-Civita and Christoffel symbols. Introductory group theory: SU(2), O(3).

Section 2: Classical Mechanics

Dynamical systems, Phase space dynamics, Central force motions. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: Coupled oscillations, normal modes. Special theory of relativity-Lorentz transformations, relativistic kinematics and mass-energy equivalence. Poisson brackets and canonical transformations.

Section 3: Electromagnetic Theory

Solutions of electrostatic and magnetostatic problems including boundary value problems, Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel's law,

interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields. Poynting vector, Poynting theorem, Dispersion relations in plasma. Lorentz invariance of Maxwell's equation. Transmission lines and wave guides. Radiation from moving charges and dipoles and retarded potentials.

Section 4: Quantum Mechanics

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time-independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection. Spin-orbit coupling, fine structure. WKB approximation.

Section 5: Thermodynamic and Statistical Physics

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law. first and second order phase transitions, phase equilibria, critical point.

Section 6: Condensed Matter Physics & Electronics

Elements of crystallography; diffraction methods for structure determination; bonding in solids; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids: nearly free electron and tight binding models; metals, semiconductors and insulators; conductivity, mobility and effective mass; optical, dielectric and magnetic properties of solids; elements of superconductivity: Type-I and Type II superconductors, Meissner effect, London equation. Semiconductor devices: diodes, Bipolar Junction Transistors, Field Effect Transistors; operational amplifiers: negative feedback circuits, active filters and oscillators; regulated power supplies; Opto- electronic devices (solar cells, photo-detectors, LEDs), Logic fundamentals, Boolean theorem, Logic gates-RTL,DTL,TTL, RS flip flop, JK flip-flops Boolean algebra, De Morgan theorem, AND, NAND, NOT, NOR gates Logic Circuits.

Section 7: Atomic & Molecular Physics

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle.

Born- Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

Section 8:. Nuclear and Particle Physics

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semiempirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions. Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

English Language/ELT, Literature

1. Short British (1558-1980), American(17th Century to Post-War II), Indian English (19th & 20th Century), Post-colonial and Diaspora Literature
 - i. British Literature: Important features of British literature, Christopher Marlowe, William Shakespeare, John Donne, Francis Bacon, John Dryden, Alexander Pope, Samuel Johnson, Jonathan Swift, Charles Lamb, William Wordsworth, S.T. Coleridge, John Keats, P.B. Shelley, A.L. Tennyson, Matthew Arnold, Robert Browning, R.L. Stevenson, Charles Dickens, Thomas Hardy, W.B. Yeats, T.S. Eliot, James Joyce, H.G. Wells, Samuel Beckett, Harold Pinter, Graham Greene,
 - ii. American Literature: Highlights of American Literature, Nathaniel Hawthorne, Walt Whitman, Herman Melville, Richard Wright, Robert Frost, R.W. Emerson, Eugene O'Neil, Arthur Miller, Edgar Allan Poe, O'Henry, Alice Walker, Tony Morrison
 - iii. Post-Colonial Literature: Basic features of post-colonial literature, Chinua Achebe, Gabriel García Márquez, Derek Walcott, Anita Desai, Salman Rushdie
 - iv. Diaspora Literature: Features of Diaspora Literature, Rohinton Mistry, Jhumpa Lahiri, V.S. Naipaul, etc.
2. Genres and subgenres of literature: Lyric, ode, ballad, epic, pastorals, satire, elegy, sonnet, dramatic monologue, tragedy, comedy, melodrama, fantasy, sci-fi, stream of consciousness novel, short story, essays, biography and autobiography, etc.
3. Literary terms, devices, trends, concepts and movements: Figures of speech based on similarity, association, contrast, imagination, indirectness, sounds, construction, myth, symbolism, surrealism, realism and naturalism, expressionism, existentialism, feminism, eco-centric, gyno-centric, form and structure, formalist, humanism, imagism, modernism and post-modernism, motif and theme, magic realism, abrogation, aboriginal, allegory,

alterity, binarism, catalysis, Fanonism, Dependency theory, essentialism, hegemony, imperialism

4. Research methodology in language and literature: Types of literary research, extrinsic and intrinsic approaches, criteria of good research, research problem, primary and secondary sources, literature review, research design, tools of research, data collection, research format, qualitative and quantitative, validity and reliability, plagiarism, documentation, draft preparation, reference, etc.
5. Introduction to linguistics and ELT: Features of language, fundamentals of human speech sounds, building words and sentences, different types of meaning, language and society, language and mind, language and technology, linguistic diversity, methods and approaches of teaching ESL/EFL, syllabus and materials design, psychological, socio-cultural and pedagogic components of ESL/EFL teaching and learning

Syllabus for Entrance Test for admission to Ph. D (Research) in Civil Engineering, CGU

Environmental Engineering

a) **Water Supply Engineering:**

Characteristics of water (physical, chemical and biological), Purification of water (screening, sedimentation, coagulation, filtration, softening, desalination, adsorption, disinfection), Laboratory experiments in water supply engineering

b) **Sanitary Engineering:**

Wastewater disposal standards, Treatment of wastewater, Concept of BOD and its calculations, Physico-chemical and Biological treatment of wastewater (activated sludge process), Anaerobic process and anaerobic digester, Sludge digestion, Tertiary treatments of wastewater (Adsorption, ion exchange)

Geotechnical Engineering

a) **Soil Mechanics:**

Origin of soils, soil structure and fabric; Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability – one dimensional flow, Darcy's law; Seepage through soils – two-dimensional flow, flow nets, uplift pressure, piping; Principle of effective stress, capillarity, seepage force and quicksand condition; Compaction in laboratory and field conditions; One-dimensional consolidation, time rate of consolidation; Mohr's circle, stress paths, effective and total shear strength parameters, characteristics of clays and sand; Soil stabilization, Reinforced earth, introduction to Geosynthetics, Introduction to grouting, Concepts of waste containment facilities; Cover and liner system; Introduction to soil dynamics and earthquake engineering.

b) **Foundation Engineering:**

Sub-surface investigations – scope, drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories – Rankine and Coulomb; Stability of slopes finite and infinite slopes, method of slices and Bishop's method; Stress distribution in soils – Boussinesq's and Westergaard's theories, pressure bulbs; Foundation classification, choice of foundations, Shallow foundations – Terzaghi's and Meyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; bearing capacity theory for special cases of shallow foundations. Deep foundation. Pile design for compressive load, uplift, lateral load, design of pile groups, concept of negative skin friction. Soil structure interaction: an introduction.

Structural Engineering:

a) Mechanics of Solids

Shear Force and Bending Moment for Simple Beams, Theory of Simple Bending of Beams - Bending stresses, Shear stresses in bending, Distribution of normal and shear stress, Composite beams. Deflection of Beams.

b) RCC Structures

Properties of concrete and reinforcing steel, Concept and methods of reinforced concrete design, Limit state method, Limit state of collapse and limit state of serviceability. Application of limit state method for flexure, shear, bond and torsion.

c) Steel Structures

Connections: Bolted Connections, Welded connections. Tension members, Compression members

d) Structural Analysis

Static and Kinematic Indeterminacy – For Beams, Truss and Frames, Plastic Analysis of Beams, Two Hinged and Three Hinged Arches, Slope Deflection Method – Analysis of Beam and Frames, Moment Distribution Method – Analysis of Beam and Frames

e) Civil Engineering Materials

Stones, Bricks, Cement, Mortar and Plasters

Transportation Engineering:

a) Highway Engineering –

Cross sectional elements, geometric design, types of pavements, pavement materials – aggregates and bitumen, different tests, Design of flexible and rigid pavements – Water Bound Macadam (WBM), Pavement maintenance, Highway drainage,

b) Traffic Engineering –

Different traffic survey, Fundamental traffic flow parameters, speed-flow-density and their interrelationships, intersections and interchanges, traffic signals, traffic operation, traffic signs and markings

c) Railway Engineering-

Components of permanent way – sleepers, ballast, fixtures and fastening, track geometry, points and crossings, track junction, stations and yards.

Water Resources Engineering

a) Irrigation Engineering

Techniques of water distribution in farms, Water requirement of crops, Crops and crop season, Duty and Delta, Consumptive use, Irrigation requirements, Estimation of consumptive use of water, Irrigation efficiencies, Soil moisture-irrigation relationship.

Classification of canals, Canal losses, Alignment of canals, Design of stable channels using Kennedy's and Lacey's theory. Design of lined canals. Causes and control of water logging. Reclamation of saline and alkaline land.

Types of weirs and barrages, different components of a diversion head work, creep theory, Khosla's theory, Exit gradient.

Falls in canal, Cross drainage works in canal

Gravity dam and various forces acting on it, combination of forces for design, Modes of failure and criteria for structural stability. Types of earth dams and causes of failure.

b) Fluid mechanics and hydraulic machines

Properties of Fluid, Pressure and its Measurement, Hydrostatic pressure on submerged surface.

Classification of fluid flow, acceleration of fluid particles, flow rate and continuity equation, flow net

Bernoulli's equation and its application to venturi meter, orifice meter, pitot tube.

Reynold's number, laws of fluid friction, energy losses in pipes

Total energy line (TEL), Flow through nozzles.

Hydraulic turbines and its classification, impact of jets, velocity triangles.

Pelton wheel and its efficiency.

Francis turbine and Kaplan turbine and their efficiencies

Centrifugal pumps, efficiencies, multistage centrifugal pumps, NPSH and cavitation.

Reciprocating pump, work done and power requirement, slip, Indicator diagram.

c) Hydrology

Precipitation, its Measurement, Average rainfall over a catchment, Evapo-transpiration, Pan evaporation, Infiltration, W-Index, and ϕ -Index.

Discharge Measurement, Flow rating curve, Estimation of discharge.

Hydrograph, Unit hydrograph, S-hydrograph, Instantaneous Unit hydrograph, Synthetic Unit hydrograph.

Flood frequency studies, Statistical analysis for flood prediction, Method of flood control, Flood routing, Reservoir routing and Channel routing, River training works

d) Open channel flow

Uniform flow, most economical section, specific energy, critical, subcritical, supercritical flow, Non-uniform flow, Gradual varied flow, Hydraulic jump.

Syllabus for Entrance Test for admission to Ph.D in Chemical Engineering Department, CGU

Advanced Heat Transfer: focuses on a deeper understanding of heat transfer mechanisms, including conduction, convection, and radiation. The course covers steady and unsteady heat conduction, multidimensional systems, and numerical methods for solving complex heat transfer problems. Advanced topics such as turbulent convection, boundary layer theory, radiation exchange between surfaces, and phase change processes like boiling and condensation are emphasised. Design and analysis of heat exchangers using LMTD and NTU methods are also included, along with industrial applications in thermal systems.

Petroleum Refinery Engineering: deals with the processing of crude oil into valuable products. It includes crude oil characterisation, atmospheric and vacuum distillation, thermal and catalytic cracking, reforming, alkylation, and isomerisation processes. The course also addresses blending operations, refinery product specifications, and process optimisation. Environmental issues related to refineries and emission control are also discussed.

Pollution Prevention Fundamentals: introduces the concept of minimising waste generation at the source. It covers cleaner production technologies, process modification, recycling and reuse strategies, and life cycle assessment (LCA). The course emphasises sustainable industrial practices and regulatory frameworks for environmental protection.

Advanced Fluid Dynamics: provides an in-depth study of fluid flow phenomena. Topics include laminar and turbulent flow, boundary layer theory, flow in pipes and channels, and compressible flow. Advanced modelling techniques and computational fluid dynamics (CFD) are used to analyse complex fluid systems encountered in industrial applications.

Bioenergy Engineering: focuses on renewable energy derived from biomass. It includes biochemical and thermochemical conversion processes such as fermentation, anaerobic digestion, gasification, pyrolysis, and combustion. The production of biofuels like biodiesel and bioethanol, along with environmental and economic aspects of bioenergy systems, is also covered.

Optimisation Techniques: deals with mathematical methods for optimising engineering systems. It includes linear programming, nonlinear programming, dynamic optimisation, and multi-objective optimisation. Applications in process design, scheduling, resource allocation, and economic optimisation are emphasised.

Solid Waste Technology: focuses on the management and treatment of solid waste. Topics include waste characterisation, collection and transportation systems, treatment methods such as composting, incineration, and landfill design. Waste-to-energy technologies and the environmental impacts of waste disposal are also discussed.

Industrial Pollution Abatement: covers techniques for controlling industrial pollution. It includes treatment of liquid effluents, air emissions, and solid wastes using physical, chemical, and biological methods. The course also discusses regulatory standards and environmental management systems.

Air Pollution Control Equipment Design: emphasises the design and operation of equipment used to control air pollutants. This includes cyclones, bag filters, scrubbers, electrostatic precipitators, and adsorption systems. Design principles, efficiency calculations, and industrial applications are covered in detail.

Advanced Separation Techniques: introduces modern separation processes beyond conventional methods. Topics include membrane separations (RO, UF, NF), adsorption, ion exchange, chromatography, and hybrid separation systems. Industrial applications and process design considerations are highlighted.

Numerical Methods in Chemical Engineering: provides tools for solving complex mathematical models. It includes numerical solutions of linear and nonlinear equations, ordinary and partial differential equations, interpolation, regression, and numerical integration. Applications in process simulation and modelling are emphasised.

Solar Energy Technology: deals with the utilisation of solar energy for power generation and heating applications. It includes solar radiation measurement, photovoltaic systems, solar thermal collectors, and energy storage technologies. Design and performance analysis of solar systems are also covered.

Advanced Process Control: focuses on modern control strategies for chemical processes. Topics include dynamic modelling, stability analysis, feedback and feedforward control, multivariable control systems, and advanced techniques such as model predictive control (MPC) and adaptive control.

Plastic Processing: covers the processing and manufacturing of polymer products. It includes polymer rheology, extrusion, injection moulding, blow moulding, and thermoforming processes. The course also addresses product design, quality control, and industrial applications of plastics.

Fluidization Engineering

This subject focuses on the principles and applications of fluidised bed systems widely used in chemical, petrochemical, and energy industries. Topics include fluidisation regimes, minimum fluidisation velocity, pressure drop characteristics, and particle classification (Geldart classification). Advanced concepts such as bubble dynamics, bed expansion, mixing, segregation, and heat and mass transfer in fluidised systems are covered. Mathematical modelling approaches like two-phase and three-phase models are emphasised. Applications include fluidised bed combustion, gasification, catalytic reactors, and drying processes. CFD-based simulation and scale-up challenges form an important part of research.

Non-Conventional Energy Sources

This course explores renewable and sustainable energy technologies. It includes solar, wind, biomass, geothermal, tidal, and hydrogen energy systems. Solar energy topics include photovoltaic systems, solar thermal collectors, and storage systems. Wind energy covers aerodynamics, turbine design, and energy conversion. Biomass conversion processes such as pyrolysis, gasification, and anaerobic digestion are studied. The course also focuses on hybrid

energy systems, energy economics, and environmental impact assessment. Emphasis is given to the integration of renewable energy into industrial processes and sustainable development.

Thermodynamics in Process Design

This subject provides advanced knowledge of thermodynamics applied to process design and optimisation. Topics include phase equilibrium, chemical reaction equilibrium, and stability analysis. Advanced equations of state, activity coefficient models, and property estimation techniques are discussed. The course emphasises thermodynamic consistency, energy analysis, and exergy analysis in process systems. Applications in separation processes, reactor design, and process integration are explored, along with simulation tools for thermodynamic modelling.

Process Plant Simulation

This course introduces advanced simulation techniques used in process industries. It includes process modelling, flowsheet development, and steady-state and dynamic simulation using software such as Aspen Plus and HYSYS. Topics include thermodynamic model selection, convergence strategies, sensitivity analysis, and optimisation. The course also covers process troubleshooting, design validation, and case studies of industrial plants. Integration of simulation with control and optimisation is emphasised.

Mineral Beneficiation

This subject deals with the processing and upgrading of mineral resources. It includes comminution (crushing and grinding), screening, and classification. Various separation techniques such as gravity separation, flotation, magnetic separation, and electrostatic separation are discussed. The course also covers mineral characterisation, beneficiation plant design, and environmental considerations. Advanced topics include process optimisation and sustainable mineral processing technologies.

Industrial Safety and Management

This course focuses on safety principles and management practices in the chemical industries. Topics include hazard identification, risk assessment techniques (HAZOP, FMEA), safety laws and regulations, and accident analysis. Process safety management, fire and explosion hazards, and safety instrumentation systems are discussed. The course also emphasises safety audits, emergency planning, and human factors in safety. Industrial case studies are used to highlight real-world challenges.

Multiphase Flow

This subject deals with the flow behaviour of systems involving more than one phase, such as gas-liquid, liquid-solid, and gas-solid flows. Topics include flow regimes, interfacial phenomena, pressure drop, and flow measurement techniques. Mathematical modelling of multiphase systems and computational approaches are covered. Applications include pipelines, reactors, fluidised beds, and petroleum systems.

Advanced Mass Transfer

This course provides an in-depth understanding of mass transfer phenomena. Topics include molecular diffusion, convective mass transfer, interphase mass transfer, and mass transfer coefficients. Advanced theories such as film, penetration, and surface renewal theories are discussed. Applications in separation processes such as distillation, absorption, extraction, and membrane separation are emphasised. The course also includes modelling and simulation of mass transfer systems.

Green Technology

This subject focuses on sustainable and environmentally friendly technologies. It includes principles of green chemistry, waste minimisation, pollution prevention, and cleaner production techniques. Life cycle assessment (LCA), carbon footprint analysis, and resource efficiency are covered. The course emphasises the development of eco-friendly processes and materials, renewable feedstocks, and energy-efficient technologies.

Corrosion Engineering

This course deals with the mechanisms and prevention of corrosion in industrial systems. Topics include electrochemical theory of corrosion, types of corrosion (uniform, galvanic, pitting, stress corrosion cracking), and corrosion testing methods. Materials selection, protective coatings, and cathodic protection techniques are discussed. The course also covers corrosion in specific industries such as petroleum, chemical processing, and marine environments.



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