

Syllabus for Ph.D. Entrance Test

A. Engineering:

Computer Science and Engineering	
Data Structure & Algorithms	Introduction Data Structure, Performance of algorithms; Data structures: arrays, stacks, queues, trees, graphs, heaps, linear and binary search. Bubble sort, insertion sort, selection sort, Merge sort, quick sort, heap sort.
Computer Organization and Architecture	Digital Logic: Boolean Algebra; Combinational and Sequential Circuits; Number Representations, Memory Hierarchy; Cache Memory.
Computer Networks	Concept of layering, Data and Signal, LAN technologies (Ethernet), flow and error control techniques, application layer protocols (DNS, SMTP, POP, FTP, HTTP), packet switching, and circuit switching.
Database Management Systems	Introduction to DBMS, Relational model, Different normal forms, Transaction.
Operating Systems	Processes, CPU Scheduling, Deadlock.
Programming in C	Built-in data types, Operators and expression, Basic Input/ Output statement, Branching & Looping statement, Array, Pointer, Function and parameter passing, Structure & Union.
Engineering Mathematics	Logic, Sets, Relations, Functions, Probability-Mean, median, mode, standard deviation, Poisson and binomial distribution, uniform, normal, exponential distributions.
Electronics & Communication Engineering	
Fundamentals of Electronics and Analog Circuits	Diode Circuits: Simple diode circuits, clipping, clamping and rectifiers. BJT and MOSFET Amplifiers: Biasing, small signal analysis, frequency response. Current mirrors and differential amplifiers, feedback and oscillator circuits. Op-amp Circuits: Amplifiers, summers, differentiators, Integrators.
Fundamentals of Digital Electronics and Microprocessors	Number Systems: Binary, Decimal, Octal, Hexadecimal number systems and their conversions. Combinational Circuits: Boolean algebra, minimization of functions using Boolean identities and K-map, arithmetic circuits, code converters, multiplexers, decoders. Sequential Circuits: latches and flip-flops, counters, shift- registers, finite state machines. Microprocessor (8085): Architecture, programming, memory and I/O interfacing.

Fundamentals of Digital Signal Processing	<p>Continuous-Time Signals: Fourier series and Fourier transform, sampling theorem and applications.</p> <p>Discrete-Time Signals: DTFT, DFT, Z-transform.</p> <p>LTI systems: Definition and properties, causality, stability, impulse response, convolution, poles and zeroes, frequency response.</p>
Fundamentals of Analog and Digital Communication	<p>Analog Communications: Amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, super-heterodyne receivers, Noise in AM and FM.</p> <p>Digital Communications: PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, matched filter receiver, SNR, and BER.</p>
<p>Electrical Engineering & Electrical & Electronics Engineering</p>	
Fundamentals of Circuits and Signals	<p>Basics of electrical and electronics, Circuit Analysis, magnetically coupled circuits, resonance, Time and frequency domain analysis of RLC circuits, 2-port network parameters, Continuous-time and discrete-time signals and systems, LTI systems and representations, Transform domain analysis (Fourier, Laplace, and Z-transforms), Discrete Fourier transforms (DFT).</p>
Fundamentals of Power Electronics and Machine Drives	<p>Power electronics basics, ac to dc converters, dc to dc converters, dc to ac inverters, operation and speed control of electric machines (dc, induction, synchronous, and special machines), pulse width modulation technique (SPWM).</p>
Fundamentals of Control Systems	<p>Mathematical Modeling, Analysis in the time and frequency domain, Controllers and Compensator design, State space model, Controllability/observability.</p>
Fundamentals of Power Systems	<p>AC and DC transmission and distribution, Models and performance of transmission lines and cables, Series and shunt compensation, Power Systems Analysis (Load-flow, admittance matrices, per-unit representation), Economic operation of power systems and unit commitment, Dynamics of synchronous machines, power systems stability, sequence components and fault analysis, power systems protection, Voltage and Frequency control</p>
<p>Electronics & Instrumentation Engineering</p>	
Fundamentals of Electronics and Analog Circuits	<p>Diode Circuits: Simple diode circuits, clipping, clamping, and rectifiers.</p> <p>BJT and MOSFET Amplifiers: Biasing, small signal analysis, frequency response. Current mirrors and differential amplifiers, feedback, and oscillator circuits.</p> <p>Op-amp circuits: Amplifiers, summers, differentiators, integrators.</p>

Fundamentals of Digital Electronics and Microprocessors	<p>Number Systems: Binary, Decimal, Octal, and Hexadecimal number systems and their conversions.</p> <p>Combinational Circuits: Boolean algebra, minimization of functions using Boolean identities and K-map, arithmetic circuits, code converters, multiplexers, and decoders.</p> <p>Sequential Circuits: latches and flip-flops, counters, shift registers, finite state machines.</p> <p>Microprocessor (8085): Architecture, programming, memory and I/O interfacing.</p>
Fundamentals of Instrumentation and Control	<p>Sensors & Transducers: Sensors, Transducers and their classification, Resistive, capacitive, inductive type sensors, and associated signal conditioning circuits. Strain gauges, RTD, Thermistor, LVDT, Capacitive Transducers, Bourdon tube, bellows, diaphragm.</p> <p>Control System: Concept of the control system, Definition, Open Loop/Closed-loop, Feedback principles, signal flow graphs, transient response, steady-state errors, phase and gain margins, on-off, P, PI, PID, cascade, optical Sources and detectors.</p>
Fundamentals of Digital Signal Processing and Communication	<p>Signal Processing: Discrete-time signals/systems, Discrete-time signal processing of continuous-time signals. DTFT, DFT and Z-Transform. Design of FIR & IIR filters.</p> <p>Communication Systems: An Overview of Electronic Communication Systems, Amplitude Modulation Systems, Need for Modulation, DSB-SC, SSB-SC, Analog Pulse Modulation, Sampling Theorem, Quantization of signals, Quantization error, Pulse Amplitude Modulation, Pulse Width Modulation and Pulse Position Modulation. Calculation of Signal to Noise Ratio-SSB-SC, DSB-SC.</p>

B. Science, Management, Humanities, and Social Science

Chemistry	
Language of Chemistry	Gram atomic weight, Gram Molecular weight, Equivalent weight, Oxidation Number, Oxidizing and reducing agents, Mole concept, methods of expressing concentrations of solutions (Normality, Molarity, Molality, etc.)
Fundamentals of Solid State Chemistry	Crystal packing, Miller Indices, Bragg's equation. Crystal Structures and defects, Impact of defects on properties of materials, Electronic structure of solids.
Fundamentals of Electrochemistry and corrosion	Types of Electrodes, Nernst Equation, Concentration Cells, Batteries, fuel cells, PV cells, Electrochemical Corrosion and its prevention.
Fundamentals of Colloidal chemistry	Lyophobic and lyophilic sols, Electro-dialysis, Electrophoresis, Electro-osmosis, Zeta potential, Coagulation, Surfactants, Emulsifiers, Flocculation values

Fundamentals of Instrumental Techniques	UV-Vis, IR, DTA, TGA, DSC and XRD
Fundamentals of Polymers	Tacticity, Types of Polymerization, and Determination of Mol. Wt. of polymers, Basic ideas on some polymers like PVA, PVDF, Teflon, PMMA, PET, Nylon, Bakelite, and conducting polymers, Crystalline polymers, Glass Transition Temp.
Mathematics	
Fundamentals of Real & Complex Analysis	Metric Space, limit points, Countable and uncountable sets, Sequences, Convergence and limit of a sequence, Functions, limit, and continuity of a function, differentiability, and behavior of a function. Complex Numbers, Functions of Complex Variables, Analytic functions, Conformal Mapping, Line Integration, Cauchy's theorem, and other theorems and formulas online integration, Taylor series, Laurent's Series, Singularities
Ordinary Differential Equations	Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equations, and Bernoulli's equation, special integrating factors and transformations. General solution of linear homogeneous and non-homogeneous equations of second order with constant coefficients and Euler's equation
Algebra	Algebraic system: Semi group, Monoid and Group, Subgroups, order of a group, order of an element, finite groups, Cosets and Lagrange's theorem, Homomorphism, isomorphism, Normal subgroup, Cyclic group. Vector spaces, subspaces, linear independence, basis and dimension, Linear transformations, Matrices, Determinants, Inverse of a matrix, Eigen values, and Eigen vectors of a matrix
Numerical Analysis	Errors in Computation, Solution of transcendental and polynomial equations by different numerical methods, and their rate of convergence. System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods, Jacobi and Gauss-Seidel iteration method. Interpolation, numerical differentiation, Integration, and solution of ordinary differential equation.
Probability Theory	Axioms of Probability, Conditional probability, Bayes's theorem, Random variables, probability distributions, discrete and continuous random variables, probability functions. Expected value of random variable, moments, Binomial distribution, Geometric distribution, Poisson distribution, Normal distribution
Multivariable Calculus & Vector Calculus	Functions of several variables, limit, and continuity of functions of two variables. Partial differentiation, Chain rule, directional derivatives, the gradient. Divergence and curl, Double integration
Physics	
Classical Mechanics	Orthogonal transformation, transformation matrix; Legendre transformation, Hamilton equation of motion; the equations of canonical transformation, Poisson's bracket and other canonical invariants; conditions for small oscillations.

Quantum Mechanics	Dirac's ket vectors, bra vectors, operators and their properties, operators representing observables; expectation values of operators, Hermitian operators, Eigen values and Eigen functions; time evolution of quantum states and operator; (L^2 , L_z), Application of Schrodinger's wave equation: Particle in a box, finite potential well, potential barrier
Solid State Physics	Lattice dynamics (mono and diatomic lattice), Einstein and Debye model for the specific heat of insulators; free electron model-Sommerfeld model of free electrons, the specific heat of metals, Hall effect; quantum theory of dia, para, ferro, and anti-ferromagnetism; superconductivity
Nuclear and Particle Physics	Binding Energy; radioactivity decay, half-life, nuclear reactions (Fission, Fusion), nuclear reactors in India, types of interactions (strong, weak, gravitational, electromagnetic), classifications of elementary particles and their properties
Management	
Management	Definition and scope, Management functions and process, Management Roles and Skills, Managing -systems and contingency perspective, Historical background of management, Managing Internal (Organizational Culture) and External Environment, Social responsibility and Managerial Ethics, Managerial decision-making, Types of problems and decisions, Decision making conditions & styles
Functions of Management	Planning and its features and process, types of plan, effective planning, Organizing, and its process, formal and informal organization, directing and its elements and importance, staffing and functions, controlling & its features and process, tools of controlling.
Marketing Management	Nature and Scope, Marketing mix; Understanding the customer and competition, Segmentation, Targeting, and Positioning; Product Life Cycle; Brands-Meaning and Role; Brand building strategies; Pricing objectives; Pricing concepts; Pricing methods. New Product Development; Promotion mix-Role and Relevance of Advertising, Advertising-Planning, execution, and evaluation. Distribution channel hierarchy; Role of each member in the channel
Human Resource Management	Significance; Objectives; Functions; A diagnostic model; Organizing HRM function. Recruitment and Selection-Sources of recruits; Recruiting methods; Selection procedure; Placement and Follow-up: Performance Appraisal System-Importance and Objectives; Techniques of appraisal system; Development of Personnel-Objectives; Determining Needs; Methods of Training & Development programs; Compensation and Benefits-Job evaluation techniques; Wage and salary administration; Fringe Benefits
Fundamentals of Accounting and Financial Management	Preparation of Financial Statements, Income Statement and Balance Sheet, Financial Statement Analysis, and Ratio Analysis. Marginal Costing — Concept and Managerial Applications, Cost Volume Profit Analysis, and Break Even Analysis. Objective, scope, and functions of financial management. Sources of Finance Capital, Working Capital management. Risk and return analysis

English	
General	Beginning to Restoration Age, Enlightenment to Romanticism, 19 th –20 th Century Literature, Indian Writing in English, Literary Theory and Criticism, English Language: Basic Concepts, Theories and Pedagogy, Literature in 21 st Century
Psychology	
Introduction to Psychology	Definition and Goals of Psychology, Key Perspectives in Psychology Behavioral, Cognitive, Humanistic, Psychodynamic, and Socio-cultural, Methods in Psychology
Biological Bases of Behaviour	Structure and functions of Neurons, Structure and functions of the Central Nervous System, and Autonomic Nervous System
Perceptual Process	Perceptual Organization: Gestalt, Figure and Ground, Law of Organization Perceptual Constancy: Size, Shape, and Color; Illusions Perception of Form, Depth and Movement
Learning	Classical conditioning: Procedure, Phenomena, and related issues. Instrumental learning: Phenomena, Paradigms, and theoretical issues. Reinforcement: Basic variables and schedules. Verbal learning: Methods and materials, organizational processes
Memory & Forgetting	Memory Processes: Encoding, Storage, Retrieval. Stages of Memory: Sensory memory, Short-term Memory (STM) and Long-term Memory (LTM), Episodic and Semantic memory. Theories of Forgetting: Interference, decay, retrieval
Motivation	Basic Motivational Concepts: Instincts, needs, drives, incentives, motivational cycle, Need, Process and Reinforcement Theories of Motivation
Emotion	Theories of emotions: James-Lange, Canon-Bard, Schechter and Singer
Thinking and Problem solving	Concept formation: Rules, Types, and Strategies; Role of concepts in thinking, Problem solving: Type, Strategies, and Obstacles
Personality	Determinants of personality: Biological and socio-cultural. Approaches to the study of personality: Psychoanalytic, social learning, trait and type, cognitive. Self-Concept: Origin and development Psychometric and Projective assessment of personality
Human abilities	Intelligence: Biological, Social determinants. Theories of Guilford, Gardner and Sternberg; Genetic and Environmental influences on Intelligence; Measuring Intelligence and Interpretation of Test scores
Economics	
Micro Economics	Demand analysis: Cardinal and Ordinal Approaches; Theory of Production and Costs; Pricing and Output under different forms of market structure; Factor Pricings; Elements of general equilibrium. and new welfare economics

Macro Economics	Determination of output and employment: Classical and Keynesian theories, Consumption Function and hypotheses; Demand for Money: Classical, Keynesian and Post Keynesian; Supply of Money, Money multiplier; Phillips Curve analysis; Business Cycles Models; Samuelson, Hicks, and Kaldor; Monetary and fiscal policies
Statistical and Mathematical Methods	Data and Sampling: Data, Types, sources, the technique of data collection, Sampling versus census, sampling technique, Correlation and Regression Analysis, Probability and distribution, Theoretical distributions, Testing of Hypothesis
Development Economics	Economic Growth, Economic Development, and Sustainable Development; Vicious circle of poverty; Measurement of development conventional, HDI and quality of life indices; Theories of Development. Classical, Marx and Schumpeter; Theories of Economic Growth; Harrod-Domar model; Solow's model, steady state growth; Approaches to development: Balanced growth, critical minimum effort, big push, unlimited supply of labor, unbalanced growth, low equilibrium trap
Public Finance & International Trade	Role of the state in economic activity: Allocation, distribution, stabilization functions; Private, Public, and Merit goods; The Public Budgets, Zero-base budgeting; Public Expenditure; Hypotheses; effects and evaluation; Taxation; Public Debt: Sources, effects, burden, and its management. Theories of International Trade; Terms of Trade and Economic Growth; Disequilibrium in Balance of Payment; Foreign trade-multiplier; Impact of Tariffs, Partial and general equilibrium analysis; Tariff and non-tariff Barriers

C. Research Methodology and Language (Compulsory for all)

Research Methodology and Language	
Introduction to Research	Research and its significance, process of research; types of research-experimental, theoretical, simulation, exploratory. The Scientific Method as the basis for inquiry and research. Research Questions, Hypothesis
Basic Statistics and Data Representation	Basics of statistics - mean, median, mode, standard deviation, correlation and regression, Normal distribution. Representation and interpretation of data, pie-charts, bar graphs, histograms
Journal/Conference Publications	Structure and components of reports, thesis, journal articles, and conference papers - (ILMRAD), title, abstract, keywords. References and bibliography. Citation & Indexing of Journals, Scopus, and SCI
IPR (Intellectual Property Rights)	IPR- patents, copyrights, registered designs, geographical indications & trademarks
English Language Usage in Academic Writing	Correct usage of English with elements of grammar and vocabulary. Sentence structure, use of prepositions, common errors. Elements of academic and formal writing.