

Syllabus for PhD Admission Test Computer Science and Engineering

Part-I: Mathematical Techniques

Linear Algebra: Matrix algebra; Systems of Linear Equations; Eigen Values and Eigenvectors.

Calculus: Functions of Single Variable; Limit, Continuity and Differentiability; Mean value Theorems; Evaluation of Definite and Improper Integrals; Partial derivatives, Total Derivative, Maxima and Minima, Gradient, Divergence and Curl, Vector Identities, Directional Derivatives, Line, Surface and Volume Integrals, Stokes, Gauss and Green's Theorems.

Differential equations: First Order Equations (Linear and Nonlinear); Higher Order Linear Differential Equations with Constant Coefficients; Initial and Boundary Value Problems, Laplace and Fourier Transforms; Solutions of one Dimensional Diffusion and wave Equations and Laplace Equation.

Complex variables: Analytic Functions; Cauchy's Integral Theorem; Taylor and Laurent Series; Residue Theorem.

Probability and Statistics: Definitions of Probability and Sampling Theorems; Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Poisson, Normal and Binomial Distributions. Least Squares, Correlation and Regression and Covariance.

Numerical Methods: Numerical Solutions of Linear and Non-Linear Algebraic Equations; Finite Differences, Numerical Integration, Runga – Kutta Methods.

Part-II: Computer Science and Engineering

Data Structures:

Complexity of Algorithm. Algorithm Design Paradigms. Stack. Queues. Hash Table. Binary Search, AVL. Red-black. Splay. Skip. B-Trees. Skip-lists. Priority Queue. Graph: Shortest Path, MST, Depth-first and Breadth-first Algorithms. Advanced Sorting Methods. Multi-Dimensional, Kinetic Data Structures.

Algorithms:

Analysis, Asymptotic notation, Notions of space and time complexity, Worst and average case analysis; Design: Greedy approach, Dynamic programming, Divide-and-conquer; Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching. Asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, Basic concepts of complexity classes - P, NP, NP-hard, NP-complete. Series Evaluation, Algorithm Correctness and Efficiency. Growth of Functions. Amortized Analysis. Recurrences. Search Pruning. Matrix Operations. String Matching. Computational Geometry, Heuristic Methods.

Computation Theory:

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

Operating Systems:

Synchronization Mechanisms. Process Deadlocks. Resource Models. Local and Global states. Distributed Operating Systems. Event Ordering. Timestamps. Distributed Mutual Exclusion. Token and Non-token based Algorithms. Comparative Performance Analysis. Concurrency Control. Shared Memory. File Systems. Agreement Protocols for handling Processor Failures.

Coordination of Processes and related Algorithms. Failure Handling and Recovery Mechanisms. Multiprocessor Operating Systems and related Thread Handlings.

Database Systems:

Database design (integrity constraints, normal forms). ER-model, Relational model (relational algebra, tuple calculus) Storage and File Structures. Indexing and Hashing. Transactions and Concurrency control. Recovery. Query Processing. Query Optimization. Object Oriented DBMS. Extended Relational Model. Spatial databases. Multimedia Databases. Distributed Databases. Active Databases. Temporal Databases. Deductive Databases. Mobile Databases and Web-enabled Database Systems.

Computer Organisation and Architecture:

Logic functions, Minimization, Design and synthesis of combinational and sequential circuits; Number representation and computer arithmetic (fixed and floating point). Machine instructions and addressing modes, ALU and data-path, CPU control design, Memory interface, I/O interface (Interrupt and DMA mode), Instruction pipelining, Cache and main memory, Secondary storage. Performance Analysis, Fault Tolerance and Scalability. Modeling Performance. Pipelined Systems. Interconnection Networks. Processor Array. Multi-computers. Multiprocessors. Systolic Array. Vector Processors. Structured Memory Design for Parallel Systems – Symmetric Shared, Distributed Shared, Synchronization. Grid computing.

Software Engineering:

Requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance. Personal Software Process. Team Software Process. Usability. Agile Methods. Process Models- Iterative, Scrum, XP, and Evo. Advanced UML, Petri net. Domain specific modeling. Systems Modeling Language. Meta modeling. Software architecture and design patterns. Software metrics. Software reliability. Advanced testing techniques. Aspect oriented programming.

Computer Networks:

ISO/OSI stack, TCP/IP, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IP(v4), Application layer protocols (icmp, dns, smtp, pop, ftp, http); Basic concepts of hubs, switches, gateways, and routers. Network security.. IPv6 Protocols and its Applications. Real Time Communication Protocols. High speed local and wide area networks. Virtual networks. Broadband networks. Introduction to intelligent networking. Performance analysis of networks.

Compiler Design:

Lexical analysis, Parsing, Syntax directed translation, Runtime environments, Intermediate and target code generation, Basics of code optimization. Operating System: Processes, Threads, Inter-process communication, Concurrency, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security.

Computer Graphics and Web technologies:

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