

**Department of Computer Science
University of Delhi
Delhi**

The syllabus for the Ph.D. Computer Science Entrance Test would be as follows:

Computer Science (Please refer to the [curriculum of MCA](#) for the depth of coverage of the following topics):

Discrete Structures: Sets, functions, relations, counting; generating functions, recurrence relations and their solutions; algorithmic complexity, growth of functions and asymptotic notations.

Programming, Data Structures and Algorithms: Data types, control structures, functions/modules, object-oriented programming concepts: sub-typing, inheritance, classes and subclasses, etc. Basic data structures like stacks, linked list, queues, trees, binary search tree, AVL and B+ trees; sorting, searching, order statistics, graph algorithms, greedy algorithms and dynamic programming

Computer System Architecture: Boolean algebra and computer arithmetic, flip-flops, design of combinational and sequential circuits, instruction formats, addressing modes, interfacing peripheral devices, types of memory and their organization, interrupts and exceptions.

Operating Systems: Basic functionalities, multiprogramming, multiprocessing, multithreading, timesharing, real-time operating system; processor management, process synchronization, memory management, device management, File management, security and protection; case study: Linux.

Computer Networks: ISO-OSI and TCP/IP models, basic concepts like transmission media, signal encoding, modulation techniques, multiplexing, error detection and correction; overview of LAN/MAN/ WAN; data link, MAC, network, transport and application layer protocol features; network security.

Mathematics:

Algebra: Groups, subgroups, normal subgroups, cosets, Lagrange's theorem, rings and their properties, commutative rings, integral domains and fields, sub rings, ideals and their elementary properties. Vector space, subspace and its properties, linear independence and dependence of vectors, matrices, rank of a matrix, reduction to normal forms, linear homogeneous and non-homogeneous equations, Cayley-Hamilton theorem, characteristic roots and vectors. De Moivre's theorem, relation between roots and coefficient of nth degree equation, solution to cubic and biquadratic equation, transformation of equations.

Calculus: Limit and continuity, differentiability of functions, successive differentiation, Leibnitz's theorem, partial differentiation, Euler's theorem on homogeneous functions, tangents and normal, asymptotes, singular points, curve tracing, reduction formulae, integration and properties of definite integrals, quadrature, rectification of curves, volumes and surfaces of solids of revolution.

Geometry: System of circles, parabola, ellipse and hyperbola, classification and tracing of curves of second degree, sphere, cones, cylinders and their properties.

Vector Calculus: Differentiation and partial differentiation of a vector function, derivative of sum, dot product and cross product, gradient, divergence and curl.

Differential Equations: Linear, homogeneous and bi-homogeneous equations, separable equations, first order higher degree equations, algebraic properties of solutions, Wronskian-its properties and applications, linear homogeneous equations with constant coefficients, solution of second order differential equations. Linear non-homogeneous differential equations, the method of undetermined coefficients, Euler's equations, simultaneous differential equations and total differential equations.

Real Analysis: Neighborhoods, open and closed sets, limit points and Bolzano Weierstrass theorem, continuous functions, sequences and their properties, limit superior and limit inferior of a sequence, infinite series and their convergence. Rolle's Theorem, mean value theorem, Taylor's theorem, Taylor's series, Maclaurin's series, maxima and minima, indeterminate forms.

Probability and Statistics: Measures of dispersion and their properties, skewness and kurtosis, introduction to probability, theorems of total and compound probability, Bayes theorem random variables, and probability distributions and density functions, mathematical expectation, moment generating functions, cumulants and their relation with moments, binomial Poisson and normal distributions and their properties, correlation and regression, method of least squares, introduction to sampling and

sampling distributions like Chi-square, t and F distributions, test of significance based on t, Chi-square and F distributions.

English Comprehension:

Correct usage of English language and reading comprehension.

Selected References:

- G. B. Thomas, R. L. Finney, *Calculus and Analytic Geometry*, Addison Wesley. C. L. Liu, *Elements of Discrete Mathematics*, McGraw-Hill.
- M. Mano, *Computer System Architecture*, Prentice-Hall of India,
- G. Nutt, *Operating Systems: A Modern Perspective*, Pearson Education.
- R. Elmasri, S. B. Navathe, *Fundamentals of Database Systems*, Addison, Wesley. J. F. Blake, *An Introduction to Applied Probability*, John Wiley.
- R. S. Pressman, *Software Engineering: A Practitioner's Approach* McGraw Hill.
- Silberschatz, P.B. and Greg Gargne, Galvin. *Operating System Concepts*, John Wiley.
- S. Tanenbaun, *Computer Networks*, Pearson Education/Prentice Hill of India.
- J. H. Cormen, C. E. Leiserson, R. L. Rivest, *Introduction to Algorithms*, Prentice Hall of India.
- M.T. Goodrich, R. Tamassia and D. Mount, *Data Structures and Algorithms in C++*, John Wiley & Sons.