

**Department of Computer Science
Punjabi University, Patiala**

**Syllabus for Ph.D. Executive Entrance Test
Session-2026-2027
Section-A
(Research Methodology)**

Basics of Research methodology: objectives and types of research, research approaches, research methods versus methodology, research process. Defining the research problem: techniques involved in defining a problem. Research design: features of good research design, concepts relating to research design, different research designs, basic principles of experimental designs, and various experimental designs.

Design of sample surveys: Sample design, sampling and non-sampling errors, types of sampling designs. Data collection and preparation: Experiments and surveys, collection of primary and secondary data, data cleaning, data adjusting, problems in data preparation process, missing values and outliers, types of analysis.

Measures of central tendency, measures of dispersion, measures of skewness, measures of kurtosis.

Probability: Random variables and probability distribution: Discrete probability distributions: Binomial and multinomial distributions, geometric distributions, Poisson distribution. Continuous probability distributions: Normal distribution, exponential distribution, chi-squared distribution.

Mathematical expectation: Mean of a random variable, variance and co-variance of random variables, means and variances of linear combinations of random variables..

Sampling distributions and data descriptions: Sampling distribution of means and central limit theorem, sampling distribution of χ^2 , Student's t-distribution, F-distribution. Single sample estimation: estimating mean, estimating the variance, standard error of a point estimate, prediction intervals. Two samples estimation: estimating the difference between two means, estimating the ratio of two variances.

Tests of hypotheses: Significance level, types of errors in tests, null hypothesis, alternative hypothesis, test for mean with and without known variance, comparison of means and variances, choice of sample size for testing means.

Correlation: Karl Pearson's coefficient of correlation, correlation coefficient for bivariate frequency distribution, probable error of correlation coefficient, rank correlation.

Regression: Linear regression, regression coefficient, properties of regression coefficients, standard error of estimate, curvilinear regression, and regression curves.

Section-B

Subject

- I. Computer System Architecture:** Combinational Circuit Design, Sequential Circuit Design, Hardwired and Micro-programmed processor design, Instruction formats, Addressing modes, Memory types and organization, Interfacing peripheral devices, Interrupts. Microprocessor architecture, Microprocessor applications.
- II. Computer Arithmetic:** Propositional Logic, Predicate Logic, Well-formed-formulae (WFF), Satisfiability and Tautology. Logic Families: TTL, ECL and C-MOS gates. Boolean algebra and Minimization of Boolean functions, Flip-flops—types, race condition and comparison. Design of combinational and sequential circuits. Representation of Integers: Octal, Hex, Decimal, and Binary. 2's complement and 1's complement arithmetic. Floating point representation.
- III. Relational Database Design and SQL:** Database Concepts, Data Models, Design of Relational Database, E-R diagrams and their transformation to relational design, Normalization. SQL and QBE, Database objects—Views, indexes, sequences, synonyms, data dictionary. Query Processing and Optimization, Centralized and Distributed Database, Security, Concurrency and Recovery in Database Systems, Object Oriented Database Management Systems, Spatial and temporal databases.
- IV. Data structures and Algorithms:** Linear Data structures: Arrays, Stacks, Queues, Linked List, Doubly linked list, Circular linked list. Non Linear Data structures: Binary Search Tree, AVL Tree, Heaps, B-trees. Graphs: Basic terminology, representation, Traversal and algorithms. Analysis of Algorithms, Asymptotic notations—big O, omega and theta. Recursion. Design of Algorithms- Divide and Conquer, Greedy method, Dynamic programming, Backtracking, Branch and Bound. Lower bound theory, Non-deterministic algorithm—Non-deterministic programming constructs. Simple non-deterministic programs.
- V. Computer Networks:** Data communication Techniques, Synchronous-Asynchronous Transmission, Digital Transmission, Transmission Media, Impairments, Data encoding Techniques. Multiplexing and Concentration, Switching techniques. X. 25, LAN Technologies, Virtual Circuits. Topologies, Networking Devices, Wireless Networks, Internetworks. Network Reference models – OSI and TCP/IP, Layered architecture. ATM, High speed LANS. Cellular Radio. Internetworking: Tunneling, Fragmentation, Firewalls. Routing algorithms, Congestion control. Network Security: Cryptography and other techniques. Domain Name System (DNS)—Electronic Mail and Worldwide Web (WWW). Resource Records, Name servers. E-mail-architecture and Servers. Network administration.
- VI. Operating Systems:** OS Structure, services and components, Process management, CPU scheduling, Memory Management, threads, Inter-process Communication, Concurrent Processing and concurrency control. I/O and Device management, buffering and spooling file management, file storage, Access methods and free space management. Operating system security and privacy. Distributed & Multiprocessor system, Recovery and Fault Tolerance.

- VII. Software Engineering:** Approaches to software development. Software Metrics, Software Project Management: Principles of software projects management; Organizational and team structure; Project planning; Project initiation and Project termination; Technical, quality, and management plans; Project control; Cost estimation methods. Software Design: function-oriented design, object-oriented design, user-interface design. Design level metrics. Coding and Testing: Testing level metrics. Software quality and reliability. Software Quality Management: verification & validation; Total quality management; SEI maturity model. CASE tools. Configuration Management. Software reengineering.
- VIII. Cloud Computing:** Web Service as distributed application, SOAP Based Web Services, Web Services Security, Wire-Level Security, WS-Security. Architecting on AWS, Building complex solutions with Amazon Virtual Private Cloud (Amazon VPC), Leverage bootstrapping and auto configuration in designs, Architect solutions with multiple regions.
- IX. Data Science and Machine Learning:** Basic probability, Random variables, Sampling, Parameter estimation, Regression. Machine learning tasks, Overfitting, Parameter estimation, Gradient descent, etc. Supervised, Unsupervised and Reinforcement Learning; Single Perceptron, Multi-Layer Perceptron Classification and regression algorithms, clustering techniques. Feature Engineering
- X. Current Trends and Technologies:** Parallel Computing: Parallel virtual machine and message passing interface libraries and calls. Advanced architectures. Mobile Computing: Mobile connectivity—Cells, Framework, wireless delivery technology and switching methods, mobile information access devices, mobile data internetworking standards, cellular data communication protocols, mobile computing applications. Mobile databases—protocols, scope, tools and technology. M-business. E-Technologies: Electronic Commerce Framework, Media Convergence of Applications, Consumer Applications. Electronic Payment Systems, Risks in Electronic Payment System. Electronic Data Interchange and Electronic Commerce, Standardization and EDI, EDI Envelope for Message Transport, Internet-Based EDI. Digital Libraries and Data Warehousing: Concepts, Types of Digital documents, Issues behind document Infrastructure, Corporate Data Warehouses. Data Mining. Software Agents: Characteristics and Properties of Agents, Technology behind Software Agents (Applets, Browsers and Software Agents). Cloud computing.