

Department of Computer Science and Engineering
Punjabi University Patiala
(Established under Punjab Act No 35 of 1961)

Syllabus for Ph. D. Entrance Test-2026
SECTION-A
(RESEARCH METHODOLOGY)

Introduction to Research: Meaning, objectives and significance of research, Ethics in Research, Types of research: application perspective, objective perspective, mode of enquiry perspective; Research Approaches; Research Methods versus Methodology; Research and Scientific Method; Research Process: characteristics and requirements; Criteria of good research.

Research Problem Formulation: Problem identification process; Defining the Research problem; Components of the research problem; Writing a research proposal: Contents of a research proposal, Types of research proposals.

Research Design: Nature and Classification of Research Designs; Exploratory Research Designs: Secondary Resource analysis, Case study Method, Expert opinion survey, Focus group discussions; Descriptive Research Designs: Cross-sectional studies, longitudinal studies; Experimental Designs, Errors affecting Research Design.

Sampling Design: Census and Sample Survey; Steps in Sampling Design; Types of Sample Designs; Characteristics of a Good Sample Design; Selection of random sample.

Measurement and Scaling Techniques: Measurement Scales; Sources of Measurement Errors; Tests of Sound Measurement; Important Scaling Techniques.

Data Collection: Classification of Data; Collection of Primary data: Observation Method, Interview Method, Questionnaires, Schedules; Secondary data: Uses, Advantages, Disadvantages, Types and sources.

Data Processing Operations: Field Editing, Centralized editing, Coding closed ended structured Questions, Coding open ended structured Questions, Classification and Tabulation of Data.

Sampling Fundamentals: Need for Sampling; Important Sampling Distributions; Central Limit Theorem; Sampling Theory; Concept of Standard Error; Estimation: Estimating the Population Mean, Estimating Population Proportion; Sample Size and its Determination.

Data Analysis: Statistical analysis, Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry, Measures of Relationship, Simple Regression Analysis.

Random Variables and Probability Distribution: Probability and probability distributions; Binomial, Poisson

Interpretation and Report Writing: Meaning of Interpretation, Techniques of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different steps in Report Writing, Layout of the Research Report, Types of Reports, Oral Presentation.

SECTION-B (SUBJECT)

1. Database Systems:

Database System Concepts and Architecture: Data Independence, Data Models, Schemas and Instances, Database Languages: DDL, DML, and DCL.

Data Modeling: Entity Relationship Diagram, Relational Algebra, Relational Calculus, Codd Rules.

Normalization: Functional Dependencies, 1NF, 2NF, 3NF, BCNF, 4NF, 5NF, Transaction processing, Concurrency Control Techniques: Locking Methods, Time stamping Methods. **Backup and Recovery Techniques:** Types of Database Failures, Types of Database Recovery, Recovery Techniques: Deferred Update, Immediate Update, Shadow Paging, Checkpoints, and Buffer Management.

SQL: Data Definition and Data Types, Constraints, Queries, Insert, Delete, Update statements, Views, Stored Procedures and Functions, Database Triggers, SQL Injection.

2. C Language and Object Oriented programming:

Data types, Variable declarations, expressions and control structures, Operators, Functions, structures, classes and objects, input/output statements, referencing variables in functions, Constructors and Destructors, Operator overloading and types of operator overloading. Inheritance, Pointers, virtual functions and polymorphism. I/O operations and files: Classes for files, operations on a file, file pointers.

3. Data Structures and Algorithms:

Data Structures: Arrays and their applications, Stacks, Queues, Priority Queues, Sparse matrices, Linked Lists, Trees, Binary Tree, Binary Search Trees, Threaded Binary Trees, AVL Trees, B-Trees, Sets and Graphs, Minimum Spanning Trees, Heap, Min-Max Heap.

Performance Analysis: Time and Space Complexity, Asymptotic notations.

Search and Sorting Techniques: Linear Search, Binary Search, Breadth First search, Depth First search, Selection sort, Bubble sort, Quick sort, Heap Sort, Shell Sort, Radix Sort and Merge Sort, Topological Hashing, Collision Resolution and Open Addressing.

Design Techniques: Divide and Conquer, Dynamic Programming, Greedy Algorithms, Backtracking, Branch and Bound.

4. Digital logic and Computer Architecture:

Logic Circuits: Logic gates, Boolean algebra, Map Simplifications, Sequential and Combinational circuits, Flip Flops, Decoders, Encoders, Multiplexers, Registers and Counters, Error detection codes.

Computer Organization: Instruction codes, Instruction Cycle, Timing and Control, Input-Output, Interrupt.

Memory Hierarchy: Main memory, Auxiliary memory, Associative memory, Set Associative memory, Cache memory, Virtual memory, DMA.

Pipeline and Vector Processing: Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, Vector Processing.

5. Software Engineering Concepts and Methodologies:

Software development process models: waterfall, rapid prototyping, incremental development, spiral models, Agile Software Development.

Software Development Methods: Formal, semi-formal and informal methods, Requirements elicitation, requirements specification, event-based modeling, CASE standards.

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: Function points and COCOMO model.

Software Quality Management: Quality control, Quality assurance and quality standards with emphasis on ISO 9000, Interactions with developers, Quality plans, Total quality management, SEI maturity model, Software metrics.

6. Theory of Computation:

Deterministic Finite Automata (DFA), Non-Deterministic Finite Automata (NDFA), Moore and Mealy Machine, Chomsky Classification of Languages, Finite Automata and Regular Expression. Parse Trees, Ambiguity in Grammar and Languages, Construction of Reduced Grammars, Chomsky Normal Form (CNF), Greibach Normal Form (GNF), Pushdown Automata, Turing Machines.

7. Compiler Design:

Introduction to Compilers, Lexical Analysis, Syntax Analysis, Parsing Techniques, Semantic Analysis, Syntax-Directed Translation, Type Checking, Run-Time Environments, Intermediate Code Generation, Code Generation, Code Optimization, Error Handling in phases of Compiler, Compiler Construction.

8. Computer Network Technologies:

Data Communication Techniques: Synchronous and Asynchronous Transmission, Digital Transmission, Transmission Media, Data encoding Techniques.

Communication Networks: Circuit switching; Message switching, Packet Switching, X.25, LAN Technologies, Virtual Circuits, and Network Reference models-OSI and TCP/IP, Layered architecture.

Data Link Layer: Design issue, framing, error control, flow control, HDLC, SDLC, SLIP, and PPP.

Network Layer: Routing Algorithms, shortest path, distance vector routing, Link state routing, multicast routing, Congestion control, traffic shaping, leaky bucket, token bucket, choke packets, load shedding, internetworking-connection oriented and connectionless, fragmentation, internet architecture and addressing, IP protocol, ICMP, ARP, RARP, OSPF, BGP, CIDR, IPv6.

Transport Layer: Transport Service, quality of service, connection management, addressing, flow control and buffering, multiplexing, Internet transport protocols-TCP and UDP.

9. Design Principles of Operating System:

OS Structure, Services and components, multitasking, multiprogramming, timesharing, multithreading, Process Management, CPU scheduling, Deadlocks, Inter-process Communication, Concurrent Processing and concurrency control, Memory management, Virtual memory, Demand Paging and Page Replacement Algorithms. I/O and Device management, buffering and spooling, file management, file storage, Access methods and free space management.

Distributed & Multiprocessor system: Introduction to Distributed Operating system, Multiprocessor operating system, Recovery and Fault Tolerance.

10. Network Security:

Malwares, Cryptography and Steganography; Secret-Key Algorithms, Public-Key Algorithms, Digital Signature, Virtual Private Networks, Firewalls.

11. Cloud Computing and IoT:

SaaS, PaaS, IaaS, Public and Private Cloud; Virtualization, Virtual Server, Cloud Storage, Database Storage, Resource Management, Service Level Agreement, Basics of IoT.