SECTION A - RESEARCH METHODOLOGY

Unit 1: Introduction: Definition and Meaning, Objective, Motivation, Approaches and Signification of Research, Importance and Characteristics of Research.

Unit 2: Research Design and Planning: Meaning of Research Design, Need for Research Design, Feature of Good Design, Selection of a Problem for Research, Formulation of the Selected Problems, Hypothesis, Measurement, Feasibility Study, Developing a Research Design/Plan. Formulation of Problem and sources, Definition of Research Objectives.

Unit 3: Methodologies of Research: Classification of Research, Pure and Applied Research, Exploring Research, Descriptive Research, Diagnostic Research/Study, Evaluation research/Studies, Action Research, Experimental Research, Analytical Study of Statistical Method, Historical Research, Surveys.

Unit 4: Review of Literature: Purpose, Literature Survey, Function of Literature Survey, Maintain a Notebook, Developing a bibliography, Locating Relevant Information, Use of Library & Electronic Databases, Preparation and Presentation of Literature Review, Research Article Reviews, Theoretical Models and Framework, Identification of Gaps in Research, Role of Online Tools.

Unit 5: Sampling Techniques: Choice of sampling Techniques, Sample size, Sampling and Non-Sampling errors, Estimation of Population Proportion and Population Mean, Estimation of Standard Error and Confidence Interval.

Unit 6: Techniques of Data Collection: Meaning and Importance of Data, Sources of Data, Use of Secondary Data, Methods of Collecting Primary Data, Observation Method, Experimentation, Design of Experiments, Simulation, Tools for Data Collection, Construction of Schedules and Questionnaires, Measurement of Scales and Indices, Pilot Studies, Pre-tests, Experimental Data Sets, Check Sheet.

Unit 7: Statistical Analysis of Data: Parametric and Non-parametric Methods, Measures of Central Tendency, Measures of Dispersion, Measures of Association/Relationship, Correlation and Variances, Probability distributions, Binomial, Poisson, Uniform, Normal and Exponential, Hypothesis Testing, Confidence Interval, Test of Significance, Comparison of two Proportions, Comparison of Means (z test, t test, two sample t test, paired-t test), Chi-square Test, ANOVA, ANOCOVA, Multivariate Analysis.

Unit 8: Processing of Data: Editing, Classification and Coding, Transcription, Tabulation, Introduction to Statistical Software -MINITAB, SPSS, Graphical Representation, Regression Analysis and Correlation: Multiple, Partial Correlation.

Unit 9: Numerical Methods: Introduction Numerical Computing and Computer, Computer Codes and Arithmetic, Approximation and Errors, Root of Nonlinear Equations, Direct and Iterative Solution of Linear Equations, Curve Fitting Methods for Interpolation and Regression, Numerical Differentiation and Integration, Boundary-value and Eigen-value Problems, Solution of Ordinary and Partial Differential Equations.

Unit 10: Research Ethics: Issues related to plagiarism. Collaborative Models and Ethics, Acknowledgements, Intellectual Property Rights, Copy rights, Patents, Industrial designs, Trademarks.

Ph. D. Entrance Examination: 2025-26

Syllabus: Computer Science and Engineering

Unit - 1: Discrete Mathematics

Propositional and Predicate Logic, Normal Forms, Predicates and Quantifiers, Rules of Inference, Sets and Relations, functions, Partial orders. Basics of Counting, Pigeonhole Principle, Permutations and Combinations, Inclusion- Exclusion Principle, Mathematical Induction, Probability, Bayes' Theorem. Groups, Subgroups, Semi-Groups, Product and Quotients of Algebraic Structures, Isomorphism, Homomorphism, Automorphism, Rings, Fields, Applications of Group Theory, Graph Theory. Boolean Functions and Their Representation, Simplifications of Boolean Functions.

Unit - 2: Computer System Architecture

Logic Gates, Map Simplifications, Combinational Circuits, Flip-Flops, Sequential Circuits, Integrated Circuits, Decoders, Multiplexers, Registers and Counters, Memory Unit, Computer Arithmetic Algorithms. Register Transfer and Microoperations, Stored Program Organization and Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory-Reference Instructions. Input-Output, Interrupt. Machine Language, Assembly Language, Assembler, Program Loops, Subroutines, and Input-Output Programming. Control Memory, Address Sequencing. General Register Organization, Stack Organization. Instruction Formats, Addressing Modes, RISC and CISC Computers. Parallel Processing, Pipelining, Vector Processing, and Array Processors. Input-Output Interface, Asynchronous Data Transfer. Modes of Transfer, Priority Interrupt, DMA, Serial Communication. Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory, Memory Management Hardware. Characteristics of Multiprocessors, Interconnection Structures, IPC and Synchronization, Cache Coherence, and Multicore Processors.

Unit - 3: Programming Languages and Computer Graphics: Programming Language Concepts, Paradigms and Models, Programming Environments, Virtual Computers and Binding Times, Programming Language Syntax, Stages in Translation, Formal Transition Models. Tokens, Identifiers, Data Types, Sequence Control, Subprogram Control. Arrays, Structures, Union, String, Pointers, Functions, File Handling, Command Line Arguments. Class, Object, Instantiation, Inheritance, Encapsulation, Abstract Class, Polymorphism. Class and Objects, Constructors and Destructors. Overloading, Inheritance, Templates, Exception and Event Handling. Streams and Files. Raster-Scan and Random-Scan Systems, Line Drawing Algorithms, Scan Line Polygon Fill Algorithm, Boundary-Fill, and Flood Fill. Translation, Scaling, Rotation, Reflection, and Shear Transformations. Composite Transforms, Transformations Between Coordinate Systems, Viewing Pipeline, Viewing Coordinate Reference Frame, Window to View-Port Coordinate Transformation, Viewing Functions, Line and Polygon Clipping Algorithms. Spline Representation, Bezier, and B-Spline Curves and Surfaces.

Unit – 4: Database Management Systems Database System Concepts and Architecture:

Databases ER-model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization and indexing (e.g., B- and B+-trees). Transactions and concurrency control.

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Unit – 5: Operating System:

Operating System calls, processes, threads, inter-process communication, concurrency, and synchronization. Deadlock, CPU and I/O scheduling. Memory management and virtual memory. File systems.

Unit – 6: Software Engineering Software Process Models:

Software Process Lifecycle, Prescriptive Process Models, Project Management, Component-Based Development, Agile Process Models, Adaptive Software Development, Dynamic System Development Model, Feature Driven Development. Functional and Non-Functional Requirements, Software Requirement and Specification (SRS) Document. Software Design, Cohesion, and Coupling. McCall's Quality Factors, ISO 9126 Quality Factors, Quality Control, Quality Assurance, Risk Management, Risk Mitigation, Software Reliability. Software Metrics and measurement, Estimation Models, Constructive Cost Model (COCOMO), Project Scheduling and Staffing. Software Testing. Software Re-engineering, Reverse Engineering.

Unit – 7: Data Structures and Algorithms Data Structures:

Arrays and their Applications, Sparse Matrix, Stacks, Queues, Priority Queues, Linked Lists, Trees, Forest, Binary Tree, Binary Search Tree, AVL Tree, B Tree, B+ Tree, B* Tree, Data Structure for Sets, Graphs, Sorting and Searching Algorithms, Hashing. Performance Analysis of Algorithms and Recurrences, Time, and Space Complexities. Asymptotic Notation, and Recurrence Relations. Divide and Conquer, Dynamic Programming. Greedy Algorithms, Backtracking, and Branch and Bound. Graph Algorithms, Minimum Spanning Trees. P and NP Class Problems, NP-completeness, and Reducibility. Number Theoretic Algorithms, Polynomial Arithmetic, Fast Fourier Transform, String Matching Algorithms, Parallel Algorithms for Sorting, Searching, and Merging, Approximation Algorithms, Randomized Algorithms.

Unit – 8: Theory of Computation and Compilers Theory of Computation:

Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and context-free languages, pumping lemma. Turing machines and undecidability. Section Compiler Design: Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation. Local optimization, constant propagation, liveness analysis, and common subexpression elimination.

Unit – 9: Data Communication and Computer Networks Data Communication:

OSI and TCP/IP Protocol Stacks; Basics of packet, circuit, and virtual circuit-switching; Data link layer: framing, error detection, Medium Access Control, Ethernet bridging. Routing protocols: shortest path, flooding, distance vector, and link state routing, Fragmentation and IP addressing, IPv4, CIDR notation, Basics of IP support protocols (ARP, DHCP, ICMP), Network Address Translation (NAT) Transport layer flow control and congestion control, UDP, TCP, sockets; Application layer protocols: DNS, SMTP, HTTP, FTP, Email.

Unit – 10: Artificial Intelligence (AI)

Turing Test and Rational Agent Approaches, State Space Representation of Problems, Heuristic Search Techniques. Game Playing, Min-Max Search, Alpha Beta Cutoff Procedures. Logic, Semantic Networks, Frames, Rules, Scripts, Conceptual Dependency and Ontologies, Expert Systems, Handling Uncertainty in Knowledge. Components of a Planning System, Linear and Non-Linear Planning. Grammar and Language: Parsing Techniques, Semantic Analysis, and Programming. Agents and Objects, Structure of Multiagent Systems, Semantic Web, Agent Communication. Notion of Fuzziness, Membership Functions, Fuzzification and Defuzzification. Operations on Fuzzy Sets, Fuzzy Functions and Linguistic Variables; Fuzzy Relations, Fuzzy Rules, and Fuzzy Inference; Fuzzy Control System and Fuzzy Rule-Based Systems. Encoding Strategies, Genetic Operators, Fitness Functions, and GA Cycle. Supervised, Unsupervised, and Reinforcement Learning. Single Perceptron, Multi-Layer Perceptron, Self-Organizing Maps, Hopfield Network.

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