Department Of Computer Science
School of Engineering & Technology
Islamic University of Science and Technology
Entrance Syllabus for Ph.D. Programme
(Computer Science)

Unit I (C/C++ & Data Structure) **(Max Marks 05)**

Input/output Statements, Expressions, Operator Precedence, Loops, Conditional statements, Arrays, Pointers, Structures and unions, functions, File Handling in C and C++, Classes, Operator overloading; Function overloading; function overriding, Inheritance: Single & Multiple, Polymorphism, Static and Dynamic Binding, Templates.

Stack, Queues, Linked Lists and Doubly Linked List, Sorting and Searching Algorithms. Polynomial, Sparse Matrices. Trees: Binary Trees - Binary Tree Traversal & Tree Iterators- Additional Binary Tree Operations - Threaded binary Trees - Binary Search Trees - Selection Trees - Forests - Set Representation - An Object- Oriented System of Tree Data Structures - Counting Binary Trees, Complexity Analysis. Graphs: Graph Theory, Spanning trees, Minimum Spanning trees, Transitive closure, Warshall's Algorithms, Eularian and Hamiltonian graphs. Hashing: Static Hashing - Dynamic Hashing, Heap and Heap Structures.

Unit II (Discrete Mathematics & Numerical Techniques) **(Max Marks 05)**

Proposition, Logic, Truth tables, Propositional Equivalence, Logical Equivalence, Predicates and Quantifiers, The growth of functions. Methods of Proof: Different methods of proof, Direct Proof, Indirect Proof, Mathematical Induction for proving algorithms. Principles of counting, the Pigeon-Hole Principle, Permutation, combinations, repetitions. Discrete probability, Advanced Counting Techniques: Inclusion- Exclusion, Applications of inclusion-exclusion principle, recurrence relations, solving recurrence relation. Relations: Relations and their properties, Binary Relations, Equivalence relations, Diagraphs, Matrix representation of relations and digraphs, Computer representation of relations and digraphs, Transitive Closures. Partially Ordered Sets, Lattices. Finite Boolean algebra, Groups and applications: Subgroups, Semigroups, Monoids, Product and quotients of algebraic structures, Isomorphism, Homomorphism.

Numerical Techniques: Errors, Types of Equations, Algorithms to Compute Roots of Equation, Algorithms to Solve Systems of Linear Algebraic Equations, Algorithms to solve Ordinary

Differential Equations, Algorithms to find integrals. Linear Equations, Types of Methods to find solutions to linear equations. Algorithms to Solve Linear Algebraic Equations: Gauss Elimination, Gauss Jordan, Gauss Seidel, L.U. Decomposition, Lagrange Interpolated Polynomial, Newton's Methods of INTERPOLATION. Differential Equations – Concepts and Terminology, Algorithms to solve Ordinary Differential Equations – Euler Method and Modification. The trapezoidal Rule, Simpson's Rule. 4th order R-K Method.

Unit III (Algorithms) (**Max. Marks 05)**

Asymptotic notations, Time and Space Complexity, Substitution method, Iteration method, Recursion, Randomized algorithms: Basics of Probability Theory, Randomized Algorithms, Identifying the repeated element, primarily testing, Advantages and Disadvantages. Divide & Conquer: General Method, Binary Search, Max & Min, Merge Sort, Quick sort. Greedy Method: Greedy strategy ,General Method, Optimal Storage on Tapes, Knapsack Problem, Optimal Merge Pattern, Single Source Shortest Paths. Dynamic Programming, General Methods, Multistage Graphs, All pair Shortest Paths, Traveling Salesman Problem. Backtracking, General Method, 8-Queen Problem, Generalized algorithm For N-Queen problem, Knapsack Problem. Branch & Bound, General Method, Basic Concepts of BFS & DFS, Least Cost Branch & Bound, 8 Queen Problem, Traveling Salesperson Problem. Lower Boundary Theory: Comparison Trees for Sorting & Searching, Lower bound theory through reductions, P and NP problems. NP hard and NP complete problems: basic concepts, Parallel Algorithms, Parallel Computation Model, Parallelism-PRAM & Other Models, Effect of Parallelism on Efficiency. Illustrations of Problems Suitable for Parallel Implementation

Unit IV (Computer Architecture & Operating System) (**Max. Marks 05)**

Computer Architecture and organization, Hardwired / Micro-Programmed Control, Control Memory, Address Sequencing Register organization, addressing modes, Memory Hierarchy, memory architecture, Associative Memory, Computational Models, programming language & architecture, Basic Computational models, Granularity. Computer Architectures. Parallel architectures and pipelining. Peripheral Devices: I/O Interfaces, Asynchronous Data Transfer, Modes of Transfer, Direct Memory Access.

Overview of an Operating system, Process Management Concepts, Inter-process Communication, Process Scheduling, Synchronization, Deadlocks. Memory Management: Linking, Loading, Memory Allocation, Design Issues & Problems, Fragmentation, Virtual Memory: Design Technique, Demand Paging, Page Replacement Algorithms, Allocation

Algorithms, Thrashing. File Management: File Structure, File Protection, File System Implementation, Directory Structure, Free Space Management, Allocation Methods, Efficiency and Protection. Disk Management: Disk Structure, Disk Scheduling Algorithm, Disk Management, Swap Space concept and Management, RAID Structure, Disk Performance issues.

Unit V (Data Communication & Computer Networks) (**Max. Marks 05)**

Bandwidth & Channel Capacity, Quantifying Channel Capacity for Noiseless Channel & Noisy Channel. Data Rate versus Baud Rate. Sampling and its types. Nyquist's Criterion for Sampling, Data Transmission Concepts, Characteristics of Signals. NRZ-L, NRZ-I, Bipolar AMI, Psuedo Ternary, Manchester & Differential Manchester Encoding Techniques & their implementations. ASK, FSK, PSK & QPSK. PCM Concepts: Sampling, Quantization & Modulation. Delta Modulation, Amplitude Modulation. Asynchronous & Synchronous Transmission. Error & its types, Parity Based (1D & 2D), CRC-Based, Checksum Based. ARQ.

Networks: LAN, MAN & WAN architectures. OSI Reference Model Architecture, TCP/IP architectural model. Autonomous systems and Internetwork Routing. Classfull/Classless IP addresses. Subnetting, IP Multicasting. Internet Protocol (IP), Internet control protocols: ICMP, ARP and RARP. Routing algorithms: Interior (OSPF), Exterior (BGP). Transport Layer: UDP and TCP concepts. Network Security.

Unit VI (Software Engineering & Information Systems) (**Max. Marks 05)**

Software Engineering: Definition & Evolution, its Role & Impact in Computer Science. Software Process, Characteristics of a SW Process, CMMI, TSP & PSP, Software Product, Characteristics of a Good Software Product, Software Process Models, Comparative Study & Applications. Basic concepts of Agile Process. Software Requirements Analysis (SRA): Requirements - Types, Steps Involved in SRA. SW Requirements Specification (SRS). Structured Analysis: DFD'S, Control Flow Diagrams, Data Dictionary, State Transition Diagrams, and Entity - Relationship Diagrams. Software Design: Concepts & Principles, Effective Modular Design (Functional Independence, Cohesion, Coupling). Design: Architectural, Procedural, Interface, & Data Design. SW Architecture Styles: (Dataflow, Call & Return Architectures, Independent Process Architectures, Virtual Machine Architectures). Verification & Validation. Goals of SW Testing, Testing Principles. Black Box & White Box

Testing, Techniques used by these Approaches: Basis Path & Loop Testing, Graph Based Testing, Equivalence Partitioning, Phases in Testing Activity. Software Reuse, Reengineering, Reverse Engineering, Restructuring, Client/Server Software Engineering, CASE. Introduction to System Theory: Types of Systems; Concepts of Data, Information, Knowledge & Intelligence; Attributes of Information. Role of Information Systems, Dimensions & Categories of Information Systems, Contemporary Approaches to Information Systems; Technical, Behavioral & Socio-technical Understanding of Information .Management Information Systems. Decision Support Systems. Introduction to Expert system and Executive support system.

Unit VII (DBMS, Data Mining & Data Warehousing) (**Max. Marks 05)**

Basic Concepts and Conceptual Database Design: Database Users, Characteristics of the Database, Advantage of using Database Systems, Data Models, schemas and instances, Three Tier Architecture & Data Independence, Database Languages & Interfaces. Overview of Legacy Data Base Management Systems. Data Modeling Using The Entity-Relationship Model – Entities, Attributes and Relationships, Cardinality of Relationships, Strong and Weak Entity Sets. Relational Algebra, SQL – A Relational Database Language, Data Definition & Manipulation in SQL, Queries in SQL, Specifying Constraints in SQL, Practicing SQL commands using ORACLE.

Data Mining Basics: What is Data Mining, Data Mining Defined, The knowledge discovery process, OLAP versus data mining, data mining & the data warehouse, Applications of data Mining, Major Data Mining Techniques, Cluster detection, decision trees, memory-based reasoning, link analysis, neural networks, and genetic algorithms. Data warehouse – The building Blocks: Defining Features, data warehouses & data marts, overview of the components, metadata in the data warehouse. Principles of dimensional modeling: Objectives, From Requirements to data design, the STAR schema, STAR Schema Keys, Advantages of the STAR Schema. Dimensional Modeling.

Unit VIII (Theory of Formal Languages & System Software) (**Max. Marks 05)**

Theory of Computation: Introduction: Strings and their properties, Formal Languages, Types of Grammars and Languages, Chomsky classification of Languages, Recursive and recursively enumerable sets, Operations. Theory of Automata: Finite State Models, Minimization, Regular sets and Regular Grammars, Pumping Lemma, Closure properties, Applications of Finite automata. Context Free Languages: Context Free Grammar and Push Down Automata,

equivalence of PDA and CFG, Deterministic PDA, Normal forms, Applications of CFG. Turing machines and Linear Bounded Automata: TM model, Representation and Design of TM, Halting problem, Universal TM and modifications, Linear bounded automata.

Introduction to Machine Structure, Evolution of the System Programming Components. Assemblers: General Design Procedure: Problem Statement, Data Structures, Format of Databases, Algorithms, Modularity Lookup. Table Processing: Review of Searching & Sorting Techniques. Macros: Macro Instructions, Features, Conditional Macro Instructions, Macro Calls within Macros, Single & Two Pass Algorithm, Implementation of Macro Calls within Macros. Implementation within an Assembler. Loaders: Schemes: Compile & Go Loaders, General Loader Scheme, Absolute Loaders, Subroutine Linkages, Relocating Loaders. Other Loader Schemes & Binders: Linking Loaders, Overlays & Dynamic Binders. Compilers: Statement of Problem, Phases of Compiler: Lexical Phase, Syntax Phase, Interpretation Phase, Optimization Phase, Storage Assignment & Code Generation Phase & Assembly Phase.