SEMESTER-II

COURSE 3: DATA STRUCTURES USING C

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. Understand fundamental concepts of algorithms and data structures with focus on complexity analysis and abstract data types.
2. Explore various types of linked lists and their dynamic memory representations and operations.
3. Analyze and implement linear data structures, such as stacks and queues, and examine their real-world applications.
4. Apply sorting and searching algorithms, understanding their performance implications and optimization strategies.
5. Design and manipulate hierarchical and graph-based structures, applying traversal algorithms and understanding their practical uses in computing.

Course Outcomes:

Learners will be able to:

1. Explain algorithm characteristics, time and space complexity, and asymptotic notations with clarity.
2. Implement and analyze different types of linked lists, including insertion, deletion, and traversal operations.
3. Develop stack and queue data structures using arrays and linked lists, and apply them in expression evaluation.
4. Apply efficient searching and sorting algorithms to solve computational problems and evaluate performance trade-offs.
5. Construct and traverse tree and graph structures, using them to solve problems like shortest path and spanning trees.

Unit 1. Basic Concepts:

Algorithm: Definition and characteristics, Complexity analysis: Space Complexity, Time Complexity, Asymptotic Notations.

Introduction to Data structures: Definition, Types of Data structures, Abstract Data Types (ADT), Introduction to Linked Lists, Representation of linked lists in Memory, Comparison between Linked List and Array.

Unit 2. Linked Lists:
Types of Linked Lists - Singly Linked list, Doubly Linked list, Circularly Singly Linked list, Circularly Doubly Linked list; Implementation of Single Linked List ADT: Creating a List, Traversing a linked list, Searching in linked list, Insertion and deletion into linked list (At first Node, Specified Position, Last node).

Unit 3. Stacks and Queues:
Introduction to stack ADT, Implementation of stacks using array and Linked List, Application of stacks - Polish Notations - Converting Infix to Post Fix Notation - Evaluation of Post Fix Notation.

Queues: Introduction to Queue ADT, Implementation of Queues using array and Linked List, Application of Queues Types of Queues- Circular Queues, De-queues, Priority Queue, Heaps.

Unit 4. Searching and Sorting:
Linear or Sequential Search, Binary Search, Hashing and collision resolution.

Sorting: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort and Merge Sort

Unit 5. Trees and Graphs:
Tree Terminology, Binary Tree Representation, Traversal techniques, Expression Tree, Binary Search Tree- Definition, Operations on a Binary Search Tree: Creation, Search, Insertion & deletion.

Graphs: Introduction to Graphs, Terminology, Representation (Adjacency Matrix, Adjacency List), Traversal of Graphs (DFS, BFS), Applications of Graphs, Concept of Shortest Path Problems, Concept of Minimum Cost Spanning Tree

Textbooks:

1. Data Structures Using C, Balagurusamy E. Tata MCGraw Hill
2. Data Structures using C, Reema Thareja, Third Edition, Oxford University Press

Reference Books:

1. Data Structures, Lipschutz, Schaum's Outline Series, Tata Mcgraw-hill
2. Data Structures Using C, Ch. Vijay Kumar, Pen Press International

Activities:

Outcome: Explain algorithm characteristics, time and space complexity, and asymptotic notations with clarity

Activity: Create a comparative chart of algorithms with different notations related to time and space complexities.

Evaluation Method: Rubric-based assessment of the chart for correctness, clarity, and depth of explanation on a 10-point scale.

Outcome: Implement and analyze different types of linked lists, including insertion, deletion, and traversal operations

Activity: Code a menu-driven program in C to implement single linked lists with all basic operations.

Evaluation Method: Practical lab assessment with test cases and Viva-style questioning to explain pointer manipulation.

Outcome: Develop stack and queue data structures using arrays and linked lists, and apply them in expression evaluation

Activity: Build a program to convert infix expressions to postfix and evaluate them using stacks; Implement queues using both arrays and linked lists with enqueue/dequeue operations.

Evaluation Method: Code review and execution of programs for sample cases and evaluation based on correctness and efficiency.

Outcome: Apply efficient searching and sorting algorithms to solve computational problems and evaluate performance trade-offs

Activity: Implement and compare sorting algorithms (e.g., selection sort and bubble sort) and searching algorithms (e.g., Linear vs. Binary Search) on datasets of varying sizes. Record number of swaps and iterations for preparing a chart to assimilate the results.

Evaluation Method: Performance report with graphs and analysis. Oral presentation or peer review discussing trade-offs and algorithm selection rationale.

Outcome: Construct and traverse tree and graph structures, using them to solve problems like shortest path and spanning trees

Activity: Implement binary trees and graphs using adjacency lists/matrices.

Evaluation Method: Lab demo with sample inputs and visual output (e.g., tree traversal order, graph paths).

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COURSE 3: DATA STRUCTURES USING C

Practical **Credits: 1** **2 hrs/week**

List of Experiments

1. Write a program to read 'N' numbers of elements into an array and also perform the following operation on an array
   a. Add an element at the beginning of an array

   b. Insert an element at given index of array

   c. Update an element using a values and index

   d. Delete an existing element

2. Write a program to implement Single Linked List with insertion, deletion and traversal operations
3. Write a program to implement Doubly Linked List with insertion, deletion and traversal operations
4. Write a program to implement the Stack operations using Arrays and Linked Lists.
5. Write a program to convert a given infix expression to a postfix expression using stacks.
6. Write a program to implement the Queue operations using Arrays and Linked Lists.
7. Write a program to implement the Circular Queue operations using Arrays.
8. Write a program for Binary Search Tree Traversals
9. Write a program to search an item in a given list using the following Searching Algorithms
   a. Linear Search

   b. Binary Search.

10. Write a program for implementation of the following Sorting Algorithms
    a. Bubble Sort

    b. Insertion Sort

    c. Quick Sort

    d. Merge Sort

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COURSE 4: DIGITAL LOGIC DESIGN

Theory **Credits: 3** **3 hrs/week**

Course Objectives

1. Introduce the fundamentals of number systems, their conversions, and binary arithmetic operations.
2. Explore digital logic through gates, Boolean algebra, and simplification techniques for logic functions.
3. Develop proficiency in designing basic combinational circuits like adders and subtractors.
4. Equip students with the skills to implement advanced combinational components such as multiplexers, encoders, and decoders.
5. Foster understanding of sequential circuits, flip-flops, counters, and shift registers for system-level design.

Course Outcomes

At the end of the course, students will be able to:

1. Apply concepts of number systems to perform radix conversions and binary arithmetic using signed and unsigned formats.
2. Simplify logic functions using Boolean algebra, Karnaugh maps, and universal gates.
3. Design and analyze combinational circuits such as half adders, full adders, and subtractors.
4. Construct advanced combinational logic modules, including multiplexers, demultiplexers, encoders, decoders, and their hierarchical versions. Realize complex Boolean functions using combinations of logic modules.
5. Develop and evaluate sequential circuits such as flip-flops, latches, counters, and shift registers.

Unit 1: Number Systems:

Conversion of numbers from one radix to another radix, r's, (r-1)'s complements, signed binary numbers, addition and subtraction of unsigned and signed numbers, weighted and unweighted codes.

Unit 2. Logic Gates and Boolean Algebra:

NOT, AND, OR, universal gates, X-OR and X-NOR gates, Boolean laws and theorems, complement and dual of a logic function, canonical and standard forms, two level realization of logic functions using universal gates, minimizations of logic functions (POS and SOP) using Boolean theorems, K-map (up to four variables), don't care conditions.

Unit 3. Combinational Logic Circuits – 1:
Design of half adder, full adder, half subtractor, full subtractor, ripple adders and subtractors, ripple adder / subtractor.

Unit 4. Combinational Logic Circuits – 2:
Design of decoders, encoders, priority encoder, multiplexers, demultiplexers, higher order decoders, demultiplexers and multiplexers, realization of Boolean functions using decoders, multiplexers.

Unit 5. Sequential Logic Circuits:
Classification of sequential circuits, latch and flip-flop, RS- latch using NAND and NOR Gates, RS, JK, T and D flip-flops, truth tables and excitation tables, conversion of flip- flops, flip-flops with asynchronous inputs (preset and clear). Registers- shift registers, bidirectional shift registers, universal shift register, design of ripple counters, modulus counters.

Text Books:

1. Digital Design, M. Morris Mano, Michael D Ciletti,5th edition, Pearson.
2. Digital Logic Design, K.C. Rao, Ramana, Pen International Press

Reference Books:

1. Digital Electronics and Logic Design, Jaydeep Chakravorty, Universities Press
2. Digital Logic Design, Sonali Singh, BPB Publications

Activities:

Outcome: Apply concepts of number systems to perform radix conversions and binary arithmetic using signed and unsigned formats

Activity: Design a calculator in a spreadsheet or simulation tool (e.g., Logisim) that performs: Decimal ↔ Binary ↔ Hexadecimal conversions and binary arithmetic (addition, subtraction).

Evaluation Method: Rubric-based evaluation on a 10point scale (conversion accuracy, arithmetic correctness)

Outcome: Simplify logic functions using Boolean algebra, Karnaugh maps, and universal gates

Activity: Provide students with complex Boolean expressions and truth tables. Ask them to: Simplify using Boolean laws, Minimize using Karnaugh maps and Implement using only NAND or NOR gates

Evaluation Method: Worksheet submission with step-by-step simplification and evaluation of gate-level implementation using a 10-point scale.

Outcome: Design and analyze combinational circuits such as half adders, full adders, and subtractors

Activity: Build and simulate: Half adder and full adder using logic gates, and half and full subtractor circuits

Evaluation Method: Evaluate the correctness of the circuits for different inputs on a 10-point scale.

Outcome: Construct advanced combinational circuits, including multiplexers, demultiplexers, encoders and decoders.

Activity: Design Multiplexers for function selection, Decoders for control signal generation and Encoders for input compression

Evaluation Method: Project-based evaluation with functional demo and assessments based on a 10-point scale.

Outcome: Develop and evaluate sequential circuits such as flip-flops, latches, counters, and shift registers

Activity: Implement and test SR, JK, D, T flip-flops, asynchronous and synchronous counters using a simulator (E.g. Logisim, Multisim)

Evaluation Method: Lab assessment on a 10-point scale to understand the correctness of the circuit and presentation of the design.

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COURSE 4: DIGITAL LOGIC DESIGN

Practical **Credits: 1** **2 hrs/week**

List of Experiments

The laboratory work can be done by using physical gates and necessary equipment or simulators.

Simulators: https://sourceforge.net/projects/gatesim/ or https://circuitverse.org/ or any free open-source simulator

1. Introduction to digital electronics lab- nomenclature of digital ICs, specifications, study of the data sheet, concept of Vcc and ground, verification of the truth tables of logic gates using TTL ICs.
2. Implementation of the given Boolean functions using logic gates in both SOP and POS forms
3. Realization of basic gates using universal gates.
4. Design and implementation of half and full adder circuits using logic gates.
5. Design and implementation of half and full subtractor circuits using logic gates.
6. Verification of stable tables of RS, JK, T and D flip-flops using NAND gates.
7. Implementation and verification of Decoder and encoder using logic gates.
8. Implementation of 4X1 MUX and DeMUX using logic gates.
9. Implementation of 8X1 MUX using suitable lower order MUX.
10. Implementation of 7-segment decoder circuit.
11. Implementation of 4-bit parallel adder.
12. Design and verification of 4-bit modulus counter.