



Unit - I

Chapter 1 : An Overview of C Language 1-1 to 1- 7

1.1	C Language : An Overview	1-1
1.2	C Programming	1-1
1.2.1	Constants in C.....	1-1
1.2.2	Variables	1-2
1.2.3	Keywords in C	1-3
1.2.4	Comments.....	1-3
1.2.5	Use of \n.....	1-3
1.2.6	C Statements	1-3
1.2.7	Storing Data	1-4
1.2.8	Reading a Keyboard Input.....	1-4
1.2.9	C- Operators.....	1-5
1.2.10	Decision Making with if Statement.....	1-5
1.2.11	Looping in C	1-5
1.3	Overview of Data Types	1-6
1.3.1	Primary or Built in Data Types	1-6
1.3.1(A)	Size and Range of Basic Data Types	1-6
1.3.2	User - Defined Type	1-6
1.3.3	Derived Data Types.....	1-7
1.3.3(A)	Structure.....	1-7
1.3.3(B)	Union.....	1-7

Chapter 2 : Operators and Expressions in 'C' 2-1 to 2-9

2.1	Operators and Expressions	2-1
2.2	Arithmetic Operators	2-1
2.2.1	Converting Algebraic Expression to 'C' Expression	2-1
2.2.2	Integer Arithmetic	2-2
2.2.3	Real Arithmetic.....	2-2
2.2.4	Mixed-Mode Arithmetic	2-2
2.3	Relational Operators.....	2-2

2.3.1	An Arithmetic Expression Containing Relational Expression	2-2
2.4	Logical Operators	2-2
2.5	Assignment Operator	2-3
2.6	Increment and Decrement Operators	2-3
2.7	Conditional Operator	2-4
2.8	Type Casting Operators	2-4
2.9	Bitwise Operators	2-5
2.10	Special Operators.....	2-7
2.10.1	Comma Operator.....	2-7
2.10.2	sizeof Operator.....	2-8
2.11	Operator Precedence and Associativity.....	2-8

Chapter 3 : Control Structure in 'C' 3-1 to 3-14

3.1	Control Flow in 'C'	3-1
3.2	if() Statement.....	3-1
3.3	if() else Statement	3-2
3.3.1	Nested if Statements	3-3
3.4	Switch Statement	3-3
3.5	Conditional Operator Statement	3-4
3.6	goto Statement.....	3-4
3.7	while Statement.....	3-5
3.8	do while Statement.....	3-7
3.9	for Statement.....	3-7
3.10	Nesting of Loops	3-7
3.11	Break Statement to End the Loop.....	3-8
3.12	Using the Continue Statement.....	3-8
3.13	Functions and Program Structure in C.....	3-9
3.13.1	Program Structure in C.....	3-11
3.13.2	Form of a C Function.....	3-11
3.13.3	Declaring Functions using Prototypes	3-11
3.13.4	Passing Arguments to Function.....	3-12
3.13.5	Returning Values from Functions	3-12
3.13.6	Scope of a Function	3-12



3.14	Inline Functions	3-12	5.4.1	Deletion.....	5-4
3.15	Storage Class.....	3-13	5.4.2	Insertion	5-4
3.16	Macros	3-14	5.4.3	Search.....	5-6
3.16.1	Comparison between Macro and Function.....	3-14	5.4.4	Merging of Sorted Arrays.....	5-6
Chapter 4 : Algorithm and its Analysis 4-1 to 4-12			5.5	Two-Dimensional Arrays	5-8
4.1	Introduction to Algorithms.....	4-1	5.5.1	Initializing Two-Dimensional Arrays	5-9
4.1.1	Definition and Characteristics	4-1	5.5.2	Address Calculation	5-9
4.1.2	Algorithm Design Tools	4-3	5.6	Multi-Dimensional Arrays.....	5-11
4.1.2(A)	Flowcharting	4-3	5.7	Application of Arrays	5-11
4.1.2(B)	Pseudo-Language	4-3	5.7.1	Addition of Two 2-D Matrices.....	5-11
4.1.3	Relation between Data Structure and Algorithm	4-5	5.7.2	Transpose of Square Matrix	5-13
4.2	Program Development.....	4-5	5.7.3	Finding whether a given Square Matrix is Symmetrical	5-14
4.2.1	Different phases of creating program.....	4-5	5.7.4	Multiplication of Two Matrices $A_{m \times n}$ and $B_{n \times p}$	5-16
4.3	Algorithm Analysis.....	4-6	Chapter 6 : ADT and Recursion 6-1 to 6-17		
4.3.1	Measuring the Running Time of a Program (Time Complexity)	4-8	6.1	Data	6-1
4.3.2	Measurement of Growth Rate (Asymptotic Growth Rate)	4-8	6.1.1	Data Types.....	6-1
4.3.2(A)	Asymptotic Consideration.....	4-8	6.1.2	Abstract Data Types (ADT)	6-1
4.3.2(B)	Constant Factor in Complexity Measure	4-8	6.1.3	Data Object	6-3
4.3.3	Notation O : (Pronounced as Big-Oh), ($O(n^2)$) is Pronounced as Big-Oh of n^2	4-9	6.2	Data Structures	6-3
4.3.4	Best Case, Worst Case and the Average Case Behaviour	4-11	6.2.1	Types of Data Structures.....	6-3
4.3.5	Different Algorithm Asymptotic Notation	4-12	6.2.1(A)	Primitive and Non-Primitive	6-3
4.3.5(A)	The Notation O (Big-Oh).....	4-12	6.2.1(B)	Linear and Non-Linear	6-4
4.3.5(B)	The Notation Ω (Omega).....	4-12	6.2.1(C)	Static and Dynamic.....	6-4
4.3.5(C)	The Notation θ (Theta).....	4-12	6.3	Passing Parameters by Value	6-5
Chapter 5 : Arrays 5-1 to 5-18			6.3.1	Relationship among Data Object, Data Type, Data Structure and Data Representation	6-6
5.1	Introduction to Arrays	5-1	6.4	Introduction to Recursion.....	6-6
5.2	Representation and Analysis	5-1	6.5	Converting a Recursive Function to an Equivalent C- Function.....	6-6
5.3	One-Dimensional Arrays	5-2	6.5.1	Finding Factorial of an Integer Number	6-6
5.4	Operations with Arrays	5-3	6.5.2	Finding n^{th} Term of Fibonacci Sequence Recursive Definition	6-7



6.5.3	Finding GCD of given Numbers	6-8	7.6.2	Reversing a String.....	7-11
6.5.4	Calculation of x^n using Recursion.....	6-8	7.6.3	String Searching.....	7-11
6.6	Examples of Recursion.....	6-8	7.6.4	String Concatenation.....	7-12
6.6.1	Finding Sum of the Elements Stored in an Array	6-8	7.6.5	A Complete Program for String Manipulation (without Pointers)	7-14
6.6.2	Finding Length of a String	6-8	7.6.6	A Complete Program for String Manipulation (with Pointers)	7-18
6.6.3	Reversing a String.....	6-9	7.7	A Function Returning a Pointer.....	7-23
6.6.4	Searching a Number in an Array.....	6-9	7.7.1	Pointer to a Function	7-24
6.6.5	Finding Largest Element in an Array.....	6-9	7.8	Command Line Arguments.....	7-24
6.6.6	Binary Search.....	6-9	7.9	Structures.....	7-25
6.6.7	Tower of Hanoi Problem	6-10	7.9.1	Difference between Array and Structure	7-25
6.7	Solved Examples.....	6-12	7.9.2	Declaring Structures.....	7-25
6.8	Dynamic Memory Management.....	6-16	7.9.3	Structure as a Function Argument	7-26
6.8.1	Memory Management Function during Runtime	6-16	7.9.4	Array of Structures	7-26

Chapter 7 : Pointers and Structures in C 7-1 to 7-56

7.1	Pointers in C.....	7-1	7.9.5	Nested Structure	7-29
7.2	Declaring a Pointer.....	7-1	7.10	Unions.....	7-30
7.3	Accessing a Variable Through a Pointer.....	7-1	7.10.1	Structure Vs. Union	7-30
7.4	Advantages of Pointers	7-2	7.11	Enumerations	7-30
7.5	Pointers to Array and Pointer Arithmetic.....	7-2	7.12	Pointer to Structure	7-31
7.5.1	Adding an Integer Value to a Pointer	7-3	7.13	Dynamic Memory Allocation	7-36
7.5.2	Subtracting an Integer Value from a Pointer	7-4	7.14	An Array of Pointers	7-37
7.5.3	Difference of Two Pointers	7-4	7.15	Ordered List	7-38
7.5.4	Operations not Permitted on Pointers.....	7-4	7.15.1	Polynomial as an Ordered List.....	7-39
7.5.5	Comparison of Two Pointers	7-4	7.15.1(A)	Function for Initialisation of a Polynomial.....	7-39
7.5.6	Pointers as Function Arguments.....	7-4	7.15.1(B)	Insert a Term.....	7-39
7.5.6(A)	Result of Passing Parameter by Value and by Reference	7-6	7.15.1(C)	Reading a Polynomial.....	7-40
7.5.7	Unidimensional Integer Arrays as Function Arguments	7-7	7.15.1(D)	Printing a Polynomial.....	7-40
7.5.8	Unidimensional Character Array as Function Arguments : String Functions.....	7-8	7.15.1(E)	Addition of Two Polynomials	7-40
7.6	Character String in C-Language	7-9	7.15.1(F)	Multiplication of Two Polynomials.....	7-41
7.6.1	String Comparison.....	7-10	7.15.1(G)	Evaluation of a Polynomials	7-42
			7.15.1(H)	Polynomial Representation in an Array.....	7-45
			7.15.2	Representing a Polynomial A(x, y).....	7-45



7.15.3	Representing a Polynomial A (x, y, z).....	7-46
7.15.4	Various Methods of Representation of a Polynomial in 1 Variable	7-46
7.16	Introduction to Files	7-48
7.17	Files I/O in 'C'	7-48
7.18	Compare Text File and Binary File	7-50
7.19	Basic File Operations	7-50
7.20	Sequential and Random Access Files	7-52
7.21	Comparison between Sequential File and Random Access File	7-53
7.22	Program for Various Operations on a Sequential File	7-54
7.23	Binary Files	7-55

Unit - II

Chapter 8 : Searching	8-1 to 8-10	
8.1	Searching.....	8-1
8.2	Sequential - Linear Search	8-1
8.2.1	Sequential Search on a Sorted Array	8-2
8.3	Binary Search.....	8-3
8.4	Fibonacci Search.....	8-8
8.4.1	Binary Search versus Fibonacci Search	8-8
8.4.2	Selection of Searching Algorithm.....	8-9
8.4.3	Timing Complexity of Fibonacci Search.....	8-10

Chapter 9 : Sorting	9-1 to 9-34	
9.1	Sorting.....	9-1
9.1.1	Sort Stability	9-1
9.1.2	Sort Efficiency	9-2
9.1.3	Passes	9-2
9.2	Insertion Sort.....	9-3
9.2.1	'C' Function for Insertion Sort	9-3
9.2.2	Time Complexity of Insertion Sort in Best Case and Worst Case.....	9-4

9.2.3	Sorting an Array of Strings using Insertion Sort	9-4
9.2.4	Sorting an Array of Records on the given Key using Insertion Sort.....	9-5
9.3	Bubble Sort	9-9
9.4	Selection Sort.....	9-16
9.5	Two-Way Merge Sort.....	9-18
9.5.1	Merging	9-20
9.5.2	Analysis of Merge Sort	9-22
9.5.3	Non-Recursive Merge Sort	9-23
9.6	Hash Tables	9-25
9.6.1	What is Hashing ?	9-25
9.6.2	Hash Table Data Structure	9-26
9.6.2(A)	Open Hashing Data Structure.....	9-26
9.6.2(B)	Closed Hashing Data Structure	9-26
9.7	Hashing Functions.....	9-26
9.7.1	Characteristics of a Good Hash Function	9-27
9.7.2	Division-Method.....	9-27
9.7.3	Midsquare Methods	9-27
9.7.4	Folding Method.....	9-27
9.7.5	Digit Analysis.....	9-27
9.7.6	Length Dependent Method	9-27
9.7.7	Algebraic Coding	9-27
9.7.8	Multiplicative Hashing.....	9-28
9.8	Collision Resolution Strategies (Synonym Resolution)	9-28
9.8.1	Separate Chaining.....	9-28
9.8.2	Open Addressing.....	9-29
9.8.2(A)	Linear Probing	9-29
9.8.2(B)	Quadratic Probing	9-32
9.8.2(C)	Double Hashing.....	9-33
9.8.3	Primary Clustering.....	9-34



Unit - III		Chapter 11 : Queue	11-1 to 11-19
Chapter 10 : Stack	10-1 to 10-33		
10.1	Introduction	11.1	Array and Linked Representation and Implementation of Queues
10.2	Operations on Stacks	11.1.1	Definition
10.3	Array Representation.....	11.1.2	Application of Queues
10.3.1	'C' Functions for Primitive Operations on a Stack.....	11.1.3	Array Representation and Implementation of Queues
10.3.2	Program Showing Stack Operations (Reversing Data)	11.1.4	Linked Representation of a Queue
10.3.3	Well Formedness of Parenthesis.....	11.1.5	Comparison between Array Representation and the Linked Representation of a Queue
10.3.4	Operations on Stack Considering Overflow and Underflow	11.2	Operations on Queue
10.3.5	Stack as an ADT	11.2.1	Operations on Queue Implemented using Array.....
10.4	Applications of Stack.....	11.2.1(A)	Realization of Queue Operations through 'C' Function
10.4.1	Expression Representation.....	11.2.1(B)	'C' Function to initialize()
10.4.2	Evaluation of a Postfix Expression using a Stack.....	11.2.1(C)	'C' Function to Check whether Queue is Empty or Not
10.4.3	Evaluation of a Prefix Expression	11.2.1(D)	'C' Function to Check whether Queue is Full or Not
10.4.3(A)	Conversion of an Expression from Infix to Postfix.....	11.2.1(E)	'C' Function for Insertion in a Queue using Array
10.4.4	Conversion of an Expression from Infix to Prefix.....	11.2.1(F)	'C' Function for Insertion in a Queue
10.4.5	Conversion of Expression from Postfix to Infix.....	11.2.1(G)	'C' Function for Deletion in a Queue using Array
10.4.6	Conversion of Expression from Postfix to Prefix	11.2.1(H)	'C' Function for Deletion in a Queue
10.4.7	Expression Conversion (A Fast Method)	11.3	Circular Queues
10.4.7(A)	Infix to Postfix.....	11.3.1	Queue using a Circular Array
10.4.7(B)	Infix to Prefix.....	11.3.1(A)	Implementation of a Circular Movement Inside a Linear Array.....
10.4.7(C)	Postfix to Prefix	11.4	Applications of Queue
10.4.7(D)	Prefix to Infix.....	11.4.1	Categorizing Data.....
10.4.8	Algorithm to Check Well-Formedness of Parenthesis	11.4.2	Job Scheduling.....
10.5	Removal of Recursion	11.4.3	Queue Simulation.....
10.6	Tail Recursion	11.5	Priority Queue
		11.5.1	Implementation of Priority Queues
		11.5.1(A)	Implementation of a Priority Queue using a Circular Array

**Unit - IV****Chapter 12 : Linked List 12-1 to 12-51**

12.1	Representation and Implementation of Singly Linked Lists.....	12-1
12.1.1	Comparison between Array (Sequential) and Linked Lists	12-1
12.1.2	Representation	12-1
12.1.3	Implementation.....	12-2
12.1.4	Types of Linked List	12-3
12.1.4(A)	Singly Linked List	12-3
12.1.4(B)	Doubly Linked List	12-3
12.1.4(C)	Circular Linked List.....	12-3
12.2	Basic Linked List Operations	12-4
12.2.1	Creating a Linked List.....	12-4
12.2.2	Traversing a Linked List	12-5
12.2.3	Counting Number of Nodes in a Linked List through Count Function	12-5
12.2.3(A)	A Recursive C-Function to Count Nodes in DLL/SLL.....	12-6
12.2.4	Printing a List through Print Function.....	12-7
12.2.5	Inserting an Item	12-7
12.2.5(A)	Inserting an Item at the End of a Linked List.....	12-8
12.2.5(B)	Inserting a Data 'x' at a given Location 'LOC' in a Linked List, Referenced by 'Head'.....	12-8
12.2.5(C)	Inserting an Element in a Priority Linked List.....	12-9
12.2.6	Deleting an Item	12-10
12.2.6(A)	Deletion of the Last Node of a Linked List	12-10
12.2.6(B)	Deletion of a Node at Location 'LOC' from a Linked List	12-11
12.2.6(C)	Delete a Linked List, Referenced by the Pointer Head.....	12-12
12.2.6(D)	C Function to Traverse a Linked List in Reverse Order.....	12-12

12.2.6(E)	C Function to Sort Data Stored in a Linked List (SLL / DLL)	12-12
12.2.7	Concatenation of Two Linked Lists.....	12-13
12.2.8	Inversion of Linked List.....	12-14
12.2.9	Searching a Data 'x' in a Linked List, Referenced by the Pointer Head.....	12-15
12.2.10	Searching an Element x in a Sorted Linked List	12-16
12.2.11	New Linear Linked List by Selecting Alternate Element	12-16
12.2.12	Handling of Records through Linked List	12-17
12.2.13	Merging of Sorted Linked List	12-17
12.2.14	Splitting a Linked List at the Middle and Merge with Second Half as First Half.....	12-19
12.2.15	Removing Duplicate Elements from a Linked List....	12-20
12.3	Linked List in Array.....	12-21
12.4	Circular Linked List.....	12-21
12.4.1	'C' Function for Inserting a Number at the Rear of a Circular Linked List.....	12-22
12.4.2	'C' Function for Inserting a Number at the Front of the Circular Linked List.....	12-23
12.4.3	'C' Function for Traversing a Circular Linked List....	12-23
12.4.4	'C' Function to Insert and Delete a N th Element in Circular Linked List.....	12-23
12.5	Doubly Linked List	12-25
12.5.1	Creation of a Doubly Linked List.....	12-25
12.5.1(A)	'C' Function for Inserting a Node Pointed to by P after a Node Pointed to by q.....	12-27
12.5.1(B)	'C' Function for Inserting a Node Pointed to by P before a Node Pointed to by q.....	12-27
12.5.1(C)	'C' Function for Inserting a Value x, at the Beginning of Doubly Linked List	12-28
12.5.1(D)	'C' Function for Inserting a Value x, at the End of a Doubly Linked List	12-28
12.5.1(E)	'C' Function for Inserting a Node at a given Position in a DLL	12-28
12.5.2	Deletion of a Node.....	12-28

12.5.2(A) 'C' Function for Deleting a Node from the given Position in a DLL	12-29	13.6.2 Inorder Traversal	13-10
12.5.2(B) 'C' Function to Delete a Node of DLL with Data Value x.....	12-29	13.6.3 Postorder Traversal.....	13-11
12.5.3 Application of Doubly Linked List.....	12-30	13.6.4 Non-recursive Preorder Traversal.....	13-11
12.6 Doubly Linked Circular List	12-31	13.6.5 Non-recursive Inorder Traversal	13-12
12.7 Applications of Linked Lists	12-33	13.6.6 Non-Recursive Postorder Traversal.....	13-13
12.7.1 Polynomials as Linked Lists	12-33	13.6.7 Tree Traversal Examples	13-16
12.8 Linked Representation of a Stack.....	12-40	13.7 Basic Tree Operations.....	13-20
12.8.1 Functions for Stack Operations	12-42	13.7.1 'C' Function for Counting of Nodes in a Tree	13-20
12.8.2 Operations on Queue Implemented using Linked Structure.....	12-43	13.7.2 'C' Function for Creation of a Tree	13-20
12.8.3 Queue using a Circular Linked List.....	12-47	13.7.3 'C' Function for Counting of Leaf Nodes in a Tree.....	13-20
		13.7.4 'C' Function for Counting of Nodes of Degree 1.....	13-20

Unit - V

Chapter 13 : Trees	13-1 to 13-47
13.1 Basic Terminology.....	13-1
13.1.1 Introduction to Trees	13-1
13.1.2 Basic Terms	13-1
13.2 Binary Tree.....	13-2
13.2.1 Representation of a Binary Tree using an Array	13-2
13.3 Linked Representation of a Binary Tree.....	13-4
13.3.1 Height of a Node	13-5
13.3.2 Height of a Tree.....	13-5
13.4 A General Tree (Forest)	13-6
13.5 Types of Binary Tree	13-7
13.5.1 Full Binary Tree	13-7
13.5.2 Complete Binary Tree.....	13-8
13.5.3 Skewed Binary Tree	13-8
13.5.4 Strictly Binary Tree	13-8
13.5.5 Extended Binary Tree (2-Tree)	13-8
13.6 Binary Tree Traversal	13-8
13.6.1 Preorder Traversal.....	13-9
13.7.7 'C' Function to Create an Exact Copy of a Tree.....	13-21
13.7.8 'C' Function for Checking Equivalence of Two Binary Trees	13-21
13.7.9 'C' Function for Finding Height of a Tree	13-21
13.7.10 Function to List the DATA Fields of the Node of a Binary Tree Level Wise	13-22
13.7.11 Creation of Binary Tree from Preorder and Inorder Traversals	13-23
13.8 Binary Search Tree (BST)	13-25
13.8.1 Definition	13-25
13.8.2 Operations on a Binary Search Tree	13-25
13.8.2(A) Initialize Operation.....	13-26
13.8.2(B) Find Operation.....	13-26
13.8.2(C) Makeempty Operation	13-26
13.8.2(D) Insert Operation.....	13-26
13.8.2(E) Delete Operation	13-28
13.8.2(F) Create	13-30
13.8.2(G) FindMin	13-33
13.8.2(H) FindMax	13-33



13.8.3	Binary Search Tree as an ADT	13-33	14.2	Representation of Graphs	14-5
13.9	Application of Trees.....	13-45	14.2.1	Adjacency Matrix.....	14-5
13.9.1	Expression Trees	13-45	14.2.2	Adjacency List.....	14-6
13.9.1(A)	Conversion of an Expression into Binary Tree	13-46	14.2.3	Path Matrix.....	14-12
13.9.2	Game Tree	13-47	14.3	Traversal of Graphs.....	14-14

Unit - VI**Chapter 14 : Graphs****14-1 to 14-63**

14.1	Terminology and Representation.....	14-1	14.2	Representation of Graphs	14-5
14.1.1	Definition of Graph	14-1	14.2.1	Adjacency Matrix.....	14-5
14.1.2	Undirected Graph	14-1	14.2.2	Adjacency List.....	14-6
14.1.3	Directed Graph	14-1	14.2.3	Path Matrix.....	14-12
14.1.4	A Complete Graph.....	14-2	14.3	Traversal of Graphs.....	14-14
14.1.5	Weighted Graph	14-2	14.3.1	Depth First Search (DFS).....	14-14
14.1.6	Adjacent Nodes	14-2	14.3.1(A)	Algorithm for DFS (Recursive)	14-14
14.1.7	Path.....	14-2	14.3.1(B)	Non-Recursive DFS Traversal.....	14-17
14.1.8	Cycle	14-2	14.3.2	Breadth First Search (BFS)	14-19
14.1.9	Connected Graph	14-2	14.3.2(A)	Algorithm for BFS.....	14-20
14.1.10	Subgraph.....	14-3	14.3.2(B)	BFS and DFS Comparison.....	14-26
14.1.11	Component.....	14-3	14.4	Minimum Cost Spanning Tree	14-26
14.1.12	Degree of a Vertex	14-3	14.4.1	Prim's Algorithm	14-26
14.1.13	Self Edges or Self Loops.....	14-3	14.4.1(A)	Timing Complexity of Prim's Algorithm	14-28
14.1.14	Multigraph	14-3	14.4.2	Kruskal's Algorithm	14-37
14.1.15	Tree.....	14-3	14.4.2(A)	'C' Function for Finding Minimum Cost Spanning Tree of a Graph using Kruskal's Algorithm	14-40
14.1.16	Spanning Trees	14-4	14.4.2(B)	Timing Complexity of Kruskal's Algorithm.....	14-56
14.1.17	Minimal Spanning Tree.....	14-4	14.4.2(C)	Comparison of Time Complexity of Prim's and Kruskal's Algorithm.....	14-56
			14.5	Shortest Path Algorithm	14-56
			14.5.1	Dijkstra Algorithm	14-56
			14.5.1(A)	Timing Complexity	14-57
			14.5.2	Program on Dijkstra's Algorithm	14-57
			14.5.3	Examples on Dijkstra's Algorithm	14-58