Data Structures with C

Part A

UNIT 1

1. What is an algorithm? Briefly explain the criteria that an algorithm must satisfy.
2. Write an recursive function to sum a list of numbers and also show the total step counts for the function.
3. Define three asymptotic notations and give the asymptotic representation of function lOn+5 in all the three notations.
4. What are pointier variables? How to declare a pointer variable?
5. What are the various memory allocation techniques? Explain how dynamic allocation is done using malloc( ) ?
6. What is recursion? What are the various types of recursion?
7. What is an ADT? Briefly explain the categories that classify the functions of a data type. Write an ADT for natural number.
8. What is time complexity? Determine the time complexity of an iterative and recursive functions that adds n elements of the array using tabular method. i. What is pointer? How pointers are declared and initialized in C?
9. What is dangling pointer reference and how to avoid it?
10. Estimate the space complexity of a recursive function for summing a list of numbers.
11. Define the term "space and time complexity". Apply program step counter method to estimate the time complexity of a function to add two matrices.
12. Define recursion. Give two conditions to be followed for successive working of recursive program. Given recursive implementation of binary's search with proper comments.
13. Define three asymptotic notation, and give the asymptotic representation of function 3n + 2 in all the three notations and prove the same from first principle method.
14. Define a pointer. Write a C function to swap two numbers using pointers.
15. Explain the functions supported by C to carryout dynamic memory allocation.
16. Explain performance analysis and performance measurement.
17. Write a recursive function to implement binary search.
18. Define 'Big Oh' notation. Show that 3n+2 = O(n) is correct.

UNIT 2

1. What is a structure? Give three different ways of defining structure with example to each.
2. What is the degree of the polynomial? Consider the two polynomials A(x) = x1000+ 1 and B(x) = 10x3 + 3x 2 + 1. Show diagrammatically how these two polynomials can be represented in a array.
3. For the given sparse matrix and its transpose, give the triplet using one dimensional array, A is the given sparse matrix, B will b its transpose.

$$A = \begin{bmatrix} 15 & 0 & 0 & 22 & 0 & -15 \\ 0 & 11 & 3 & 0 & 0 & 0 \\ 0 & 0 & 0 & -6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 91 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 28 & 0 & 0 & 0 \end{bmatrix}$$

Fig. Q2 (c)

4. Define structure and union with suitable example
5. Write a C program with an appropriate structure definition and declaration to store information about an employee, using nested structures. Consider the following fields like: ENAME, EMP1D, DOJ (Date, Month, Year) and Salary(Basic, DA,HRA).
6. Develop a structure to represent planet in the solar system. Each planet has fields for the planet's name, its distance from the sun in miles and the number of moons it has. Write a program to read the data for each planet and store. Also print the name of the planet that has less distance from the sun.
7. What is a polynomial? What is the degree of the polynomial? Write a function to add two polynomials?
8. For the given sparse matrix A and its transpose, give the triplet using one dimensional array, A is the given sparse matrix, B will b its transpose.

$$A = \begin{bmatrix} 15 & 0 & 0 & 22 & 0 & -15 \\ 0 & 11 & 3 & 0 & 0 & 0 \\ 0 & 0 & 0 & -6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 91 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -28 & 0 & 0 & 0 \end{bmatrix}$$

Fig. Q2 (c) Sparse Matrix

9. With a suitable example, explain dynamic memory allocation for 2-d arrays.
10. Define a structure for the employee with the following fields: Emp_ld(integer), Emp_Name(string), Emp_Basic(float), Emp_Dept(string) and Emp_Age(integer).

    Write the following functions to process the employee data:
    i) Function to read an employee record
    ii) Function to print an employee record.
11. Write the "fast transpose" algorithm of a sparse matrix. Why the name "fast transpose"?
12. What is u structure? Give three different ways of defining structure and declaring variables and method of accessing members of structures using student structure with roll number, name and marks in 3 subjects as member of that structure as example.
13. Give ADT sparse matrix and show with a suitable example sparse matrix representation storing as triples. Give simple transpose function to transpose sparse matrix and give its complexity.
14. How would you represent two sparse polynomials using array of structure and also write a function to add that polynomials and to store result in the same array.
15. What is the difference between int *a and int a[5) and int *[5] ?
16. What is a structure? How to declare and initialize a structure?
17. Write a program in C to read a sparse matrix of integer values and search this matrix for an element specified by the user.
18. Consider two polynomial 2x1000 + 1 and B(x) = X4 + 10x3 + 3x2 + 1, show diagrammatically how these two polynomials can be stored in a single 1-D array. Also give its C representation.

UNIT 3

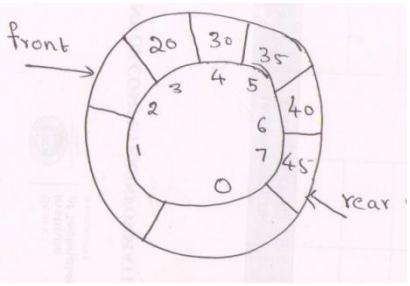
1. Convert the following infix expression into postfix expression using stack:
   i) a*(b+c)*d

   ii) $\frac{(a+b)*d+e}{(f + a*d) + c}$
2. Write a C function to evaluate a postfix expression and apply the same to evaluate AB + CDE - * / , A = 5, B = 6, C = 4, D = 3, E = 7.
3. Define Stack. Give the C implementation of push and pop functions. Include check for empty and fill conditions of stack.
4. Write an algorithm to convert infix to postfix expression and apply the same to convert the following expression from infix to postfix

i) (a * b) + c/d ii) (((a/b(-c)+(d*e))-(a * c))

5. Implement addq and deleteq functions for the circular queue.
6. Write the postfix form of the following expressions
   i) (a+b)*d+e/(f+a*d)+c
   ii) ((a/(b-c+d))*(e-a)*c)
   iii) a/b - c + d * e - a * c
7. What is the advantage of circular queue over linear queue? Write the insert and delete functions for circular implementation of queues.
8. Explain infix to postfix expression algorithm & trace it for an expression "a * (b + c) * d".
9. How multiple stacks implemented using one dimensional array? Explain with suitable example.
10. Give ADT stack and with necessary functions, explain implementing stacks to hold record with different types of field in stack.
11. Give the disadvantages of ordinary queue and how it is solved in circular queue. Explain the same. Explain with suitable example how would you implement circular queue using dynamically allocated arrays.

    postfix expression and trace that for given data a=6, b=3, c=1,d=2,e=4.
12. Define stack. List the operations on stack.
13. Obtain the postfix and prefix expression for (((A+(B-C)*D)^E)+F)
14. What is system stack? How the control is transferred from the function with the help activation record?
15. Write a C program to implement the two primate operations on stack using dynamic memory allocation.
16. For the given circular queue shown in Fig.Q2(c), write the values of front and rear in the table after each specified operation is performed. Queue full/empty conditions must be considered. Indicate the array indices



Operation	Rear	Front
Insert 0		
Insert 10		
Insert 15		
Delete		

Fig. Q2 (c)

UNIT 4

1. Write a C function to insert a node at front and rear end in a circular linked list.
2. i) Write a C function to reverse the given singly linked list.
   ii) Write a C function to concatenate two singly linked list.
3. Define linked list. Write a C program to implement the insert and delete operation on queue using linked list.
4. Explain the different types of linked list with diagram.
5. Write the different polynomial representation, with an example.
6. For the given sparse matrix write the diagrammatic linked list representation

$$A = \begin{matrix} 5 & 0 & 0 & 0 \\ 3 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 8 & 0 & 0 & 2 \\ 0 & 0 & 7 & 0 \end{matrix}$$

Fig. Q4 (b) : 5x4 Sparse Matrix

7. Define equivalence class. Write the linked list representation for the twelve polygons numbered 0 through 11 using the following pairs overlap?
   0= 4, 3 =1, 6 =10, 8 =9, 7 =4, 6 =8, 3 =5, 2 =11, 11 =O.
8. Write the following functions for singly linked list:
   i) Reverse the list ii) Concatenate two list

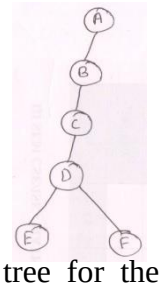
9. Write the node structure for linked representation of polynomial. Explain the algorithm to add two polynomials represented using linked lists.
10. What is the advantage of doubly linked list over singly linked list? Illustrate with an example.
11. Give the mode structure to create a linked list of integers and write C functions to perform the following:
    i. Create the three node list with data 10,20,30
    ii. Insert a node with data value 15 in between the nodes having data values 10 and 20
    iii. Delete the node which is followed by a node whose data value is 20
    iv. Display the resulting singly linked list.
12. With node structure show how would you store the polynomials in linked list? Write a function for adding two polynomials represented as circular lists.
13. Write a note on :
    i) Linked representation of sparse matrix
    ii) Doubly linked list.
14. Write a function to insert a node at front and rear end in a circular linked list. Write down sequence of steps to be followed.
15. Write a C function to adding two polynomials using linked list representation. Explain with suitable example.
16. Explain how a chain can be used to implement a queue. Write the functions to ins delete elements from such a queue.
17. Describe the doubly linked lists with advantages and disadvantages. Write a C function to delete a node from a doubly linked list. ptr is the pointer which points to the node to be deleted. Assume that there are nodes on either side of the node to be deleted.
18. For the given sparse matrix, give the diagrammatic linked representation.

$$a = \begin{matrix} 0 & 1 & 2 \\ 3 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$$

Part B

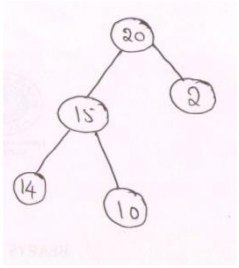
UNIT 5

1. What is a binary tree? Show the array representation and linked representation for the following binary tree.

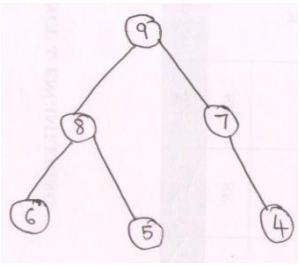


2. Write an expression tree for the expression A/ B * C * D + E. Give the C function for inorder, preorder, postorder traversals and apply the traversal methods to the expression tree and give the result of traversals
3. What is a max heap? Construct the max heap for 7,8,3,6,9,4, 10,5 .
4. Define the following
    i) Binary tree
    ii) Complete binary tree
    iii) Almost complete binary tree
    iv) Binary search tree
    v) Depth of a tree
5. In brief describe any five application of tree.
6. What is threaded binary tree? Explain right and left in threaded binary tree.
7. What is a tree? Explain
    i. Degree
    ii. Sibling
    iii. ancestors using structure representation
    iv. Depth of a tree and give example.
    v. Root node

8. What is a binary tree? State its properties? How it is represented using array and linked list, give example?
9. Define a max heap? Write a C function to insert an item into max heap?
10. Illustrate with a suitable example define :
    i) Binary tree
    ii) Degree of a binary tree
    iii) Level of a binary tree
    iv) Sibling.
11. For any nonempty binary tree, T, if n0 is the number of leaf nodes and n2 the number of nodes of degree 2, then prove that n0 =n2 + I.
12. What is the advantage of threaded binary tree over binary tree? Explain threaded binary tree construction with a suitable example.
13. Define a max heap. Explain clearly inserting an element that has value 21 for the heap shown in fig. Q5(c) given below and show the resulting heap.



14. What is a heap? Explain the different types of heap.
15. Write the C-routines to traverse the given tree using i) inorder ii) preorder iii) postorder.
16. With reference to the Fig.Q5(a), answer the following:



    i) Is it a binary tree?
    ii) Is it a complete tree?
    iii) Give the preorder
    iv) Give the inorder
    v) Give the postorder
    vi) Give the list
    vii) Where will be left child of node 4 pointing to, if it is converted to a threaded b-tree?
    viii) Is it a max heap?
17. Write the following C functions for
    i) Counting the number of
    ii) Finding the inorder successor of a node in a threaded b-tree.
18. Show that for any non-empty b-tree T, if n0 is the number of leaf nodes and n2 is the number of nodes of degree 2, then n0 =n2+1.

UNIT 6

1. What is a binary search tree? Draw the binary search tree for the input: 14,15,4,9,7,18,3,5,16,4,20,17,9
   Give recursive search function to search an element in that tree.
2. Construct the binary tree from the given traversals:
   Preorder : A B D G C E H IF
   Inorder : D G BAH E I C F
3. What is a winner tree? Explain with suitable example a winner tree for k= 8.
4. Write C function for the following tree traversals:.
   i) inorder
   ii) preorder
   iii) postorder.

5. Explain min and max heap with example.
6. Explain the following, with an example
   i) Selection trees
   ii) Forests and its traversals
7. Describe the binary search tree, with an example. Write a recursive function to search for a key value in a binary search tree.

8. Write the adjacency matrix and adjacency list for the following graph.

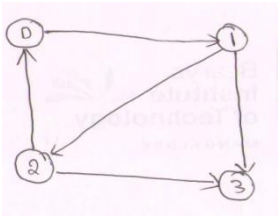
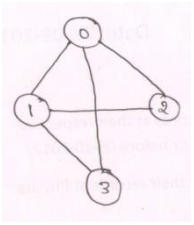
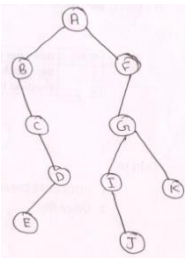


Fig. Q6(c) Directed graph

9. What is binary search tree? Write a recursive search routine for a binary search tree.
10. Explain selection trees, with suitable example.
11. What is a forest? With a suitable example illustrate how you transform a forest into a binary tree.
12. Define a binary search tree and construct a binary search tree with elements { 22, 28, 20, 25, 22, 15, 18 10, 14). Give recursive search algorithm to search an element in that tree.
13. Give the adjacency matrix and adjacency list representation for the graph shown in the figure Fig. Q6(d).



14. What is a binary search tree? Draw the binary search tree for the following input: 14, 5, 6,2,18, 20,16,18,-1,21
15. What is a forest? Explain the different method of traversing a tree with following tree: Fig. Q6(b)



16. Define ADT of binary search tree. Write the iterative search function of BST.
17. Construct the binary tree for the given expressions:
    i) Preorder: / + * 1 $ 2 3 4 5
       ABDGCEHIF
    ii) In order: 1 + 2 * 3 $ 4 - 5
       DG BAHEICF
18. Explain the forest with example.
19. Explain the following with an example
    i) Forest ii) Graph ii) Winner tree

20. Construct the b-tree from a given traversals
    Preorder : ABDCEF
    Inorder : BDAEFC
    Postorder : DBFECA

UNIT 7

1. What is Fibonacci Heap? Give example. Give the step for the deletion of node and decrease key of specified node in F-heap.
2. Write a short note on:) Binomial heaps ii) Leftist trees
3. Implement Fibonacci Heap.
4. What is binomial heap? Explain the steps involved in the deletion of min element from a binomial heap.
5. Briefly explain the following, with an example:
   i) HBLT ii) WBL
6. Write short notes on:
   i) Priority queues
   ii) Binomial heaps
   iii) Fibonacci heaps
7. Define priority queue. List the single - ended and double-ended priority queue operations.
8. Define the following :
   i) Leftist trees
   ii) Min leftist trees and
   iii) Weighted leftist trees.
9. What is binomial heap? Explain the following associated with binomial heap:
   i)Insertion into a binomial heap
   ii) Melding two binomial heaps and
   iii) Deletion of min element.
10. Define the following
    i) Single ended priority queue
    ii) Double ended priority queue
    iii) Height based Leftist trees
    iv) Weight based Leftist trees
    v) A Binomial tree
    vi) Extended binary tree
11. With suitable example explain leftist trees and give structure of nodes.
12. What is priority queue? Explain the various types of priority queues.
13. Explain leftist trees? Explain the various types of leftist trees.
14. Define Fibonacci heap? Explain the various types of Fibonacci heap.

UNIT 8

1. Starting with an empty A VL tree perform following sequence of insertion, MARCH, MAX, NOVEMBER, AUGUST, APRIL, JANUARY, DECEMBER, JULY. Draw the AVL tree following each insertion and state rotation type if any for insertion operation.
2. Explain the red-black tree with example and state its properties.
3. Let h be the height of a red-black tree, let n be the number of internal nodes in the tree and r be the rank of the root then, prove that
   i) $h <= 2r$ ii) $n >= 2 r - 1$
4. Explain AVL tree. Write the algorithm to insert an item into AVL tree.
5. What is splay tree? Briefly explain the various types of splay tree.

6. Write a shore note on
   i) Optimal binary search tree
   ii) AVL tree
   iii) Red-black tree
   iv) Splay tree
   v) Height balanced trees
7. Define BLACK trees and give its additional properties starting with an empty red-black tree insert the following keys in the given order {50,10,80,90,70,60,65,62}, giving color changing and rotation instances.
8. Explain different types of rotations of an AVL tree.
9. Define AVL trees. Write a C-routine for
   i) Inserting into an AVL tree
   ii) LL and LR rotation.