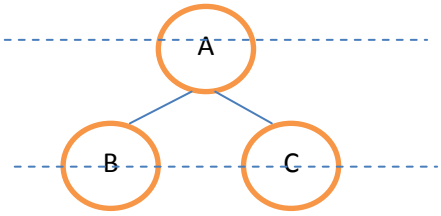
WINTER– 18 EXAMINATION

Subject Name: Data Structure using C **Model Answer** Subject Code: 22317

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any FIVE of the following :**	**10 M**
	a	**Define the term algorithm.**	2 M
	Ans	Algorithm is a stepwise set of instructions written to perform a specific task.	Correct definition 2M
	b	**List any 4 applications of queue.**	2 M
	Ans	• In computer system to maintain waiting list for single shared resources such as printer, disk, etc. • It is used as buffers on MP3 players, iPod playlist, etc. • Used for CPU scheduling in multiprogramming and time sharing systems. • In real life, Call Center phone systems will use Queues, to hold people calling them in an order, until a service representative is free. • Handling of interrupts in real-time systems. • Simulation	Any four apllications- 1/2 M each
	c	**Describe following terms w.r.to tree:** **(i) Leaf node** **(ii) Level of node**	2 M
	Ans	**Example:**	Description of each term 1M



(i) Leaf node: A node without any child node is called as leaf node.

Nodes B and C are leaf node as shown in above example.

(ii) Level of node: Position of a node in the hierarchy of a tree is called as level of node.

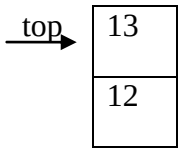
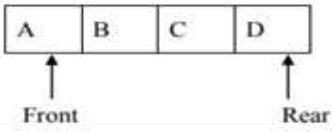
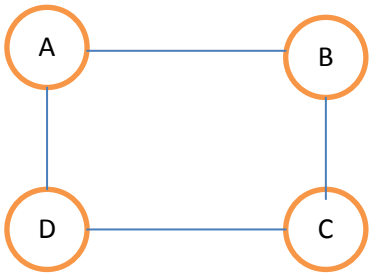
Level of node B is 1 as shown in above example.

d **Differentiate between stack and queue.(Any two points)** — 2 M

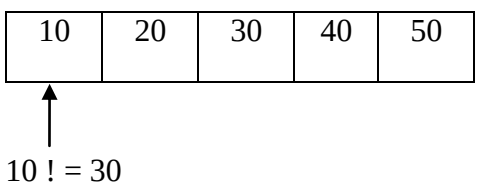
Ans

Stack	Queue
1. Stack is a data structure in which insertion and deletion operations are performed at **same end**.	1. Queue is a data structure in which insertion and deletion operations are performed at **different ends**.
2. In stack an element inserted last is deleted first so it is called **Last In First Out list.**	2. In Queue an element inserted first is deleted first so it is called **First In First Out list.**
3.In stack only one pointer is used called as **stack top**	3.In Queue two pointers are used called as **front** and **rear**
4. **Example**: Stack of books	4. **Example**: Students standing in a line at fees counter
5.**Application**: • Recursion • Polish notation	5. **Application**: • In computer system for organizing processes. • In mobile device for sending receiving messages.

Any two correct differences- 1M each

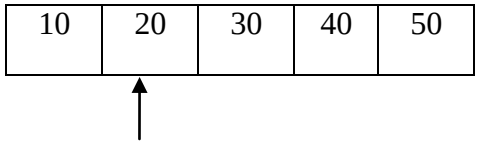
		6. Representation: Using array  **6. Representation:** Using array  	
	e	**Describe undirected graph with suitable example.**	2 M
	Ans	Undirected graph: A graph in which the edges do not have any direction associated with them is known as undirected graph. In undirected graph, if an edge exists between two nodes A and B then the nodes can traverse from A to B as well as from B to A. Each edge is bidirectional. Example:-  In the above example, each edge is bidirectional.	Definition-1M, example-1M
	f	**Define the terms: Linear data structure and non-linear data structure.**	2 M
	Ans	Linear Data Structure: A data structure in which all data elements are stored in a particular sequence is known as linear data structure. Example: stack, queue Non-Linear data structure: A data structure in which all data elements are not stored in any particular sequence is known as nonlinear data structure. Example: graph and tree.	Each term definition 1M
	g	**convert infix expression into prefix expression:** **(A+B)*(C/G)+F**	2 M
	Ans		Correct prefix expression - 2M

Infix expression	**Read Character**	**Stack contents**	**Prefix expression**
(A+B)*(C/G)+F	**F**	-	**F**
(A+B)*(C/G)+	**+**	**+**	**F**

		(A+B)*(C/G)	**)**	**+)**	**F**	
		(A+B)*(C/G	**G**	**+)**	**GF**	
		(A+B)*(C/	**/**	**+)/**	**GF**	
		(A+B)*(C	**C**	**+)/**	**CGF**	
		(A+B)*(	**(**	**+**	**/CGF**	
		(A+B)*	*****	**+***	**/CGF**	
		(A+B)	**)**	**+*)**	**/CGF**	
		(A+B	**B**	**+*)**	**B/CGF**	
		(A+	**+**	**+*)+**	**B/CGF**	
		(A	**A**	**+*)+**	**AB/CGF**	
		(	**(**	**+***	**+AB/CGF**	
					***+AB/CGF**	
					+*+AB/CGF	
2		**Attempt any THREE of the following :**				**12 M**
	a	**Describe working of linear search with example.**				4 M
	Ans	In linear search, search element is compared with each element from the list in a sequence. Comparison starts with first element from the list and continues till number is found or comparison reaches to the last element of the list. As each element is checked with search element, the process of searching requires more time. Time complexity of linear search is O (n) where n indicates number of elements in list. Linear search on sorted array:-On sorted array search takes place till element is found or comparison reaches to an element greater than search element. Example:- Using array representation Input list 10, 20, 30, 40, 50 and Search element 30, Index =0 **Iteration 1**  10 ! = 30				Relevant description 2M, Any correct example- 2M

Index = Index + 1

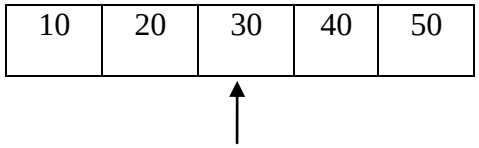
Iteration 2



20 ! = 30

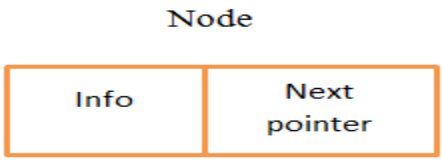
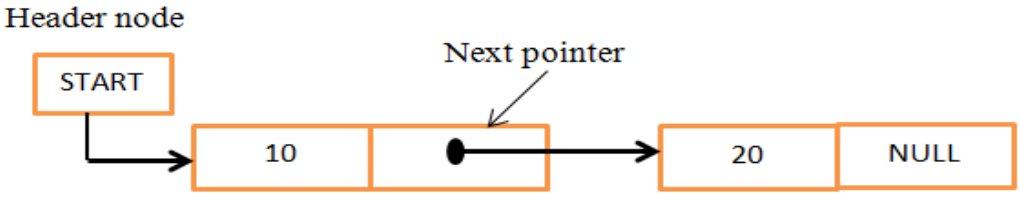
Index = Index + 1

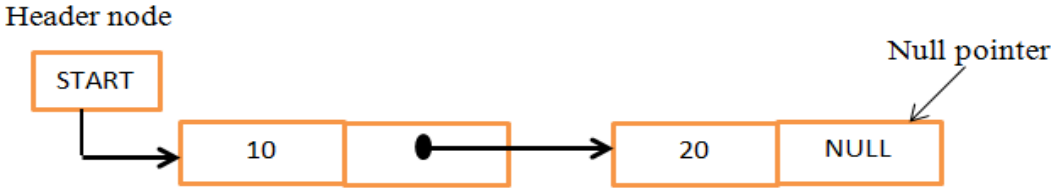
Iteration 3



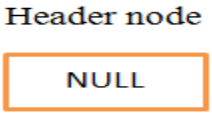
30 = 30

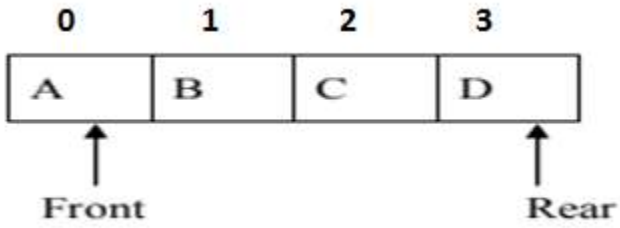
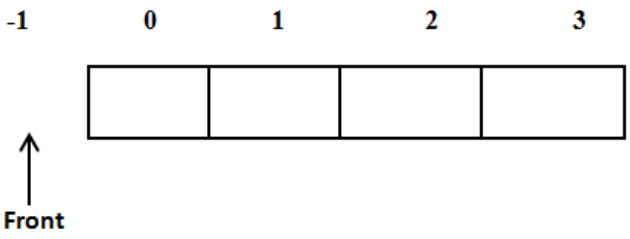
Number found

	b	**Describe the concept of linked list with the terminologies: node, next Pointer, null pointer and empty list.**	4 M
	Ans	**Node**: Each data element in a linked list is represented as a node. Node contains two parts- one is info (data) and other is next pointer (address). Info part stores data and next pointer stores address of next node.  **Next pointer**: It is a pointer that holds address of next node in the list i.e. next pointer points to next node in the list  **Null pointer**: It is a pointer that does not hold any memory address i.e. it is pointing to nothing. It is used to specify end of the list. The last element of list contains NULL pointer to specify end of list.	Description of each terminology -1M



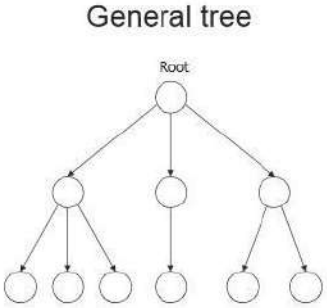
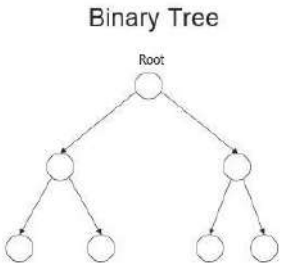
Empty list: Each linked list has a header node. When header node contains NULL value, then that list is said to be empty list.



	c	**Describe queue full and queue empty operation conditions on linear queue with suitable diagrams.**	4 M
	Ans	**Queue full**:-A queue is full when its rear pointer points to max -1 position. Max is maximum number of elements in a queue. If rear pointer is not equal to max-1 then a new element can be added to a queue. If queue is full then new element cannot be added to a queue. Example:- Consider max=4. First element is stored at 0th position and last element is stored at 3rd position in queue. In the diagram given below rear pointer is pointing to max-1 (3) position so queue is full.  **Queue empty**: A queue is empty when its front pointer points to -1 position. When front pointer is -1 then one cannot delete any data from a queue. Example:-In the diagram given below front pointer points to -1 value i.e. it points no location inside queue so queue is empty.  	Description of queue full-1M, diagram-1M, Description of queue empty-1M, diagram-1M

d **Differentiate between general tree and binary tree. (any four points)** — 4 M

Ans — Any four relevant differences -1M each

Sr. no	General Tree	Binary Tree
1	A general tree is a **data structure** in which each node can have infinite number of children	A Binary tree is a data structure in which each node has at most **two nodes** i.e**.** left and right
2	In general tree, root has **in-degree 0** and maximum **out-degree n**.	In binary tree, root has **in-degree 0** and maximum **out-degree 2**.
3	In general tree, each **node** have in-degree **one** and maximum out-degree **n**.	In binary tree, each node have in-degree **one** and maximum out-degree **2**.
4	**Height** of a general tree is the length of longest path from root to the leaf of tree. Height(T) = {**max**(height(child1) , height(child2) , … height(child-n)) +1}	Height of a binary tree is : Height(T) = { **max** (Height(Left Child) , Height(Right Child) + 1}
5	Subtree of general tree are **not ordered**	Subtree of binary tree is **ordered**.
6		

3 **Attempt any THREE of the following :** — **12 M**

a **Write a C program for deletion of an element from an array.** — 4 M

Ans — 4M for correct logic & program code

```
#include <stdio.h>
int main()
{
  int array[100], position, c, n;
  printf("Enter number of elements in array\n");
  scanf("%d", &n);
  printf("Enter %d elements\n", n);
  for (c = 0; c < n; c++)
    scanf("%d", &array[c]);
  printf("Enter the location where you wish to delete element\n");
  scanf("%d", &position);
  if (position >= n+1)
```

```
      printf("Deletion not possible.\n");
    else
    {
      for (c = position - 1; c < n - 1; c++)
        array[c] = array[c+1];

      printf("Resultant array:\n");

      for (c = 0; c < n - 1; c++)
        printf("%d\n", array[c]);
    }
    return 0;
  }
```

b **Convert following expression into postfix form. Give stepwise procedure.** 4 M

A+B↑C*(D/E)-F/G.

Ans Consider input expression as (A+B↑C*(D/E)-F/G) Correct Postfix Expression 4M

Scanned Symbol	Operation stack	Postfix Expression
(	(	
A	(	A
+	(+	A
B	(+	AB
↑	(+↑	AB
C	(+↑	ABC
*	(+*	ABC↑
(	(+*(	ABC↑
D	(+*(	ABC↑D
/	(+*(/	ABC↑D
E	(+*(/	ABC↑DE
)	(+*	ABC↑DE/
-	(-	ABC↑DE/*+
F	(-	ABC↑DE/*+F

/	(-/	ABC↑DE/*+F	
G	(-/	ABC↑DE/*+FG	
)	EMPTY	ABC↑DE/*+FG/-	

POSTFIX EXPRESSION: ABC↑DE/*+FG/-

	c	**Find the position of element 29 using binary search method in an array 'A' given below. Show each step.** **A={11,5,21,3,29,17,2,43}**	4 M
	Ans	An array which is given A[ ]= {11,5,21,3,29,17,2,43} is not in sorted manner, first we need to sort them in order; So an array will be A[ ]={2,3,5,11,17,21,29,43} and the value to be searched is VAL = 29. The binary search algorithm will proceed in the following manner.	1M for taking sorted input & 1M each for every iteration

A[0]	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]
2	3	5	11	17	21	29	43

Iteration 1:

BEG = 0, END = 7, MID = (0 + 7)/2 = 3

Now, VAL = 29 and A[MID] = A[3] =11

A[3] is less than VAL, therefore, we now search for the value in the second half of the array.

So, we change the values of BEG and MID.

Iteration 2:

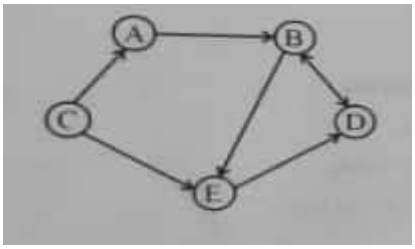
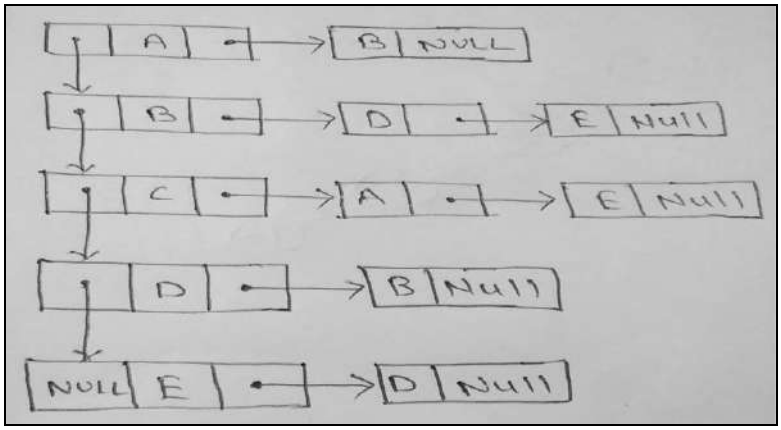
Now, BEG = MID + 1 = 4, END = 7, MID = (4 + 7)/2 =11/2 = 5; VAL = 29 and A [MID] = A [5] = 21

A[5] is less than VAL, therefore, we now search for the value in the second half of the segment.

So, again we change the values of BEG and MID.

Iteration 3:

Now, BEG = MID + 1 = 6, END = 7, MID = (6 + 7)/2 = 6 Now, VAL = 29 and A [MID] = A [6]=29

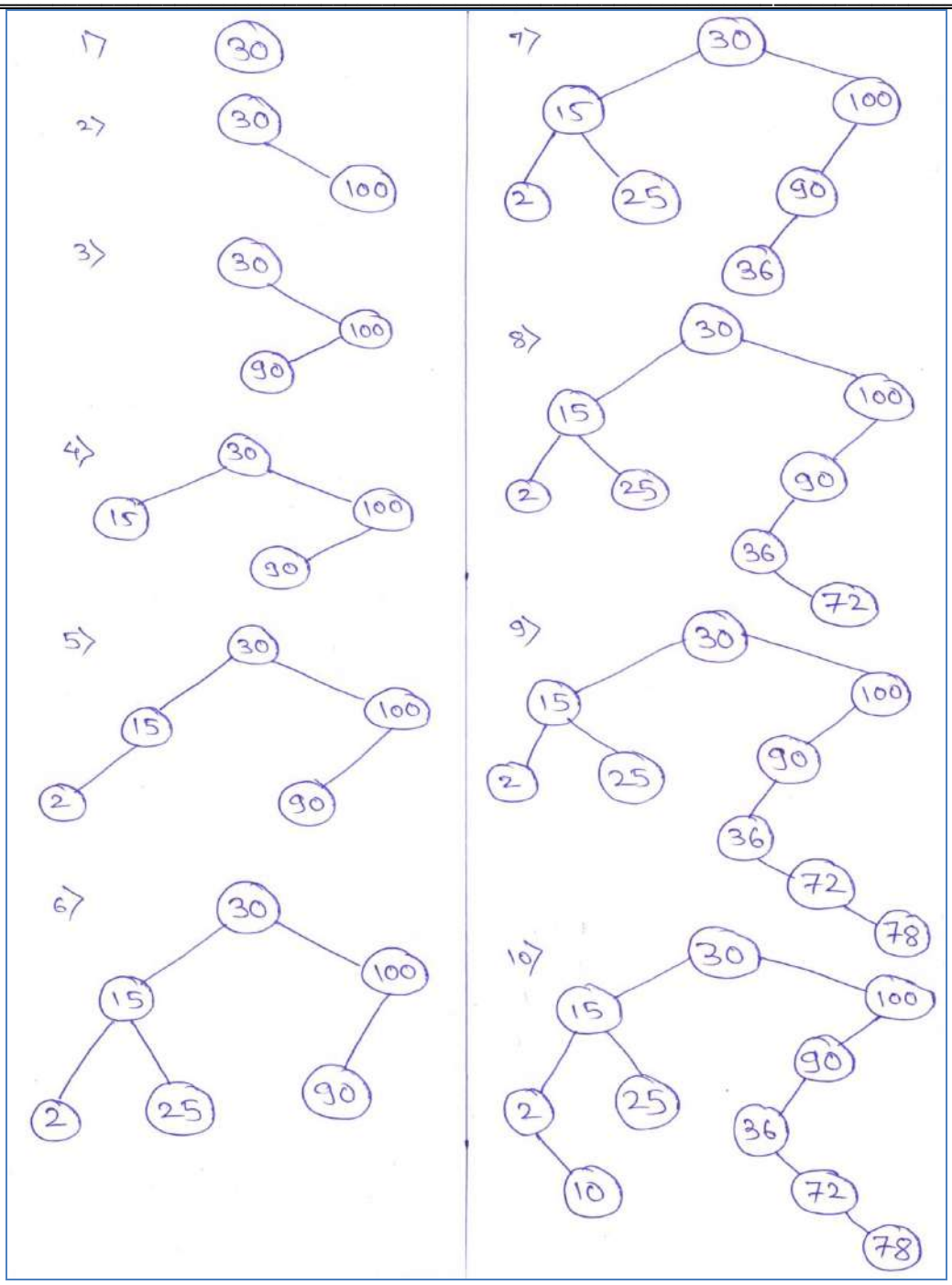
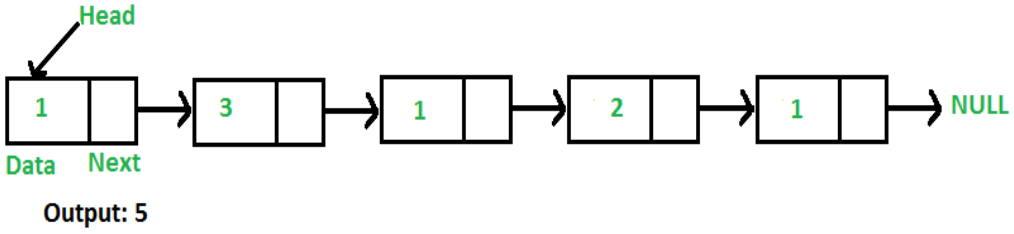
		So, Element 29 is found at 6th location in given array A[]={2,3,5,11,17,21,29,43}.	
	d	give adjacency list and adjacency matrix for given graph: 	4 M
	Ans	Adjacency List: (Using Linked List) Here, we use doubly linked list for storing header node list and singly linked list for storing respective adjacent node to it.  **OR** **Adjacency List** **Nodes** | **Adjacent Nodes** **A** | **B** **B** | **D,E** **C** | **A,E** **D** | **B** **E** | **D**	2M for Correct List and 2M for Correct matrix

Adjacency Matrix: (Using Array)

A	0	1	0	0	0
B	0	0	0	1	1
C	1	0	0	0	1
D	0	1	0	0	0
E	0	0	0	1	0

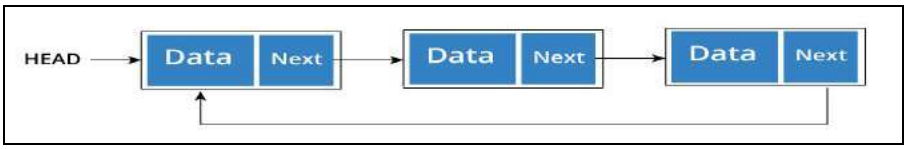
4		**Attempt any THREE of the following :**	**12 M**
	a	**Describe working of bubble sort with example.**	4 M
	Ans	Bubble sort is a simple sorting algorithm. This sorting algorithm is comparison-based algorithm in which each pair of adjacent elements is compared and the elements are swapped if they are not in order. This algorithm is not suitable for large data sets as its average and worst case complexity is of O (n^2) where **n** is the number of items. **Bubble Sort Working:** We take an unsorted array for our example as A[]={19, 2, 27, 3, 7, 5, 31}. Bubble sort takes $O(n^2)$ time so we're keeping it short and precise. {{**Note: Pass 4 onwards optional**}} Pass 1: 2,19,27,3,7,5,31 2,19,27,3,7,5,31 2,19,3,27,7,5,31 2,19,3,7,27,5,31 2,19,3,7,5,27,31 Pass 1 Completed Pass 2: 2,19,3,7,5,27,31 2,3,19,7,5,27,31 2,3,7,19,5,27,31	2M for description & 2M for example

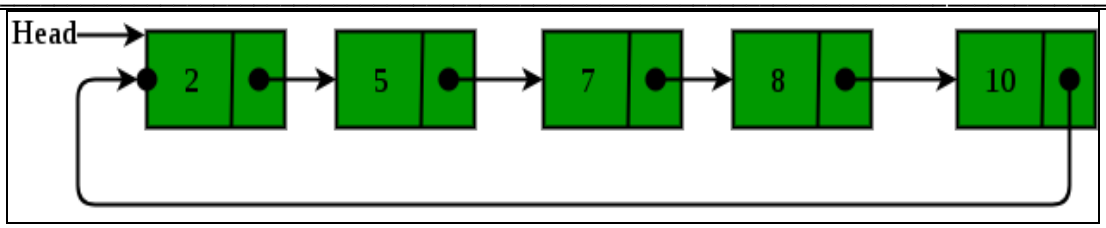
		2,3,7,5,19,27,31 2,3,7,5,19,27,31 Pass 2 Completed Pass 3: 2,3,7,5,19,27,31 2,3,7,5,19,27,31 2,3,5,7,19,27,31 Pass 3 Completed Pass 4: 2,3,5,7,19,27,31 Pass 4 Completed Pass 5: 2,3,5,7,19,27,31 Pass 5 Completed Pass 6: 2,3,5,7,19,27,31 Pass 6 Completed	
	b	**Construct a binary search tree for following elements:** **30,100,90,15,2,25,36,72,78,10 show each step of construction of BST.**	4 M
	Ans	Stepwise construction of Binary search tree for following elements: 30,100,90,15,2,25,36,72,78,10 is as follows:	4M for all correct steps

			
	c	**Write an algorithm to count number of nodes in singly linked list.**	4 M
	Ans	Function to count number of nodes in a given singly linked list.  **Output: 5**	4M for correct algorithm

		For example, the function should return 5 for linked list 1->3->1->2->1. **Algorithm: Using Iterative Solution** 1) Initialize count as 0 2) Initialize a node pointer, current = head. 3) Do following while current is not NULL a) current = current -> next b) count++; 4) Return count	
	d	**Write a program in 'C' to insert an element in a linear queue.**	4 M
	Ans	// C program to insert an element in a linear queue using array #include<stdio.h> #include<conio.h> #define n 5 void main() { int queue[n],ch=1,front=0,rear=0,i,j=1,x=n; //clrscr(); printf("Queue using Array"); printf("\n1.Insertion \n2.Display \n3.Exit"); while(ch) { printf("\nEnter the Choice:"); scanf("%d",&ch); switch(ch) { case 1: if(rear==x) printf("\n Queue is Full"); else { printf("\n Enter no %d:",j++); scanf("%d",&queue[rear++]); } break; case 2: printf("\n Queue Elements are:\n "); if(front==rear) printf("\n Queue is Empty");	4M for correct logic & program code

```
            else
            {
               for(i=front; i<rear; i++)
               {
                  printf("%d",queue[i]);
                  printf("\n");
               }
               break;
            case 3:
               exit(0);
            default:
               printf("Wrong Choice: please see the options");
            }
         }
      }
      getch();
}
```

	e	**Describe circular linked list with suitable diagram. Also state advantage of circular linked list over linear linked list.**	4 M
	Ans	**Circular Linked List** A circular linked list is a variation of linked list in which the last element is linked to the first element. This forms a circular loop.  A circular linked list can be either singly linked or doubly linked. • for singly linked list, next pointer of last item points to the first item • In doubly linked list, prev pointer of first item points to last item as well. We declare the structure for the circular linked list in the same way as follows: Struct node { Int data; Struct node *next; }; Typedef struct node *Node; Node *start = null; Node *last = null; For example:	2M for description 1M for diagram and 1M for any one advantage



Advantages of Circular Linked Lists:

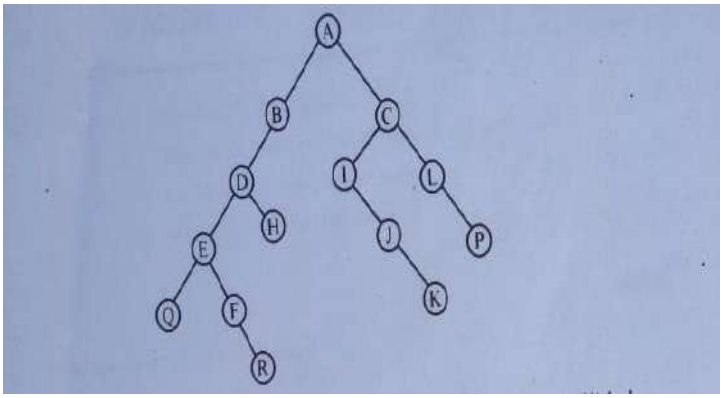
1) Any node can be a starting point. We can traverse the whole list by starting from any point. We just need to stop when the first visited node is visited again.

2) Useful for implementation of queue. Unlike this implementation, we don't need to maintain two pointers for front and rear if we use circular linked list. We can maintain a pointer to the last inserted node and front can always be obtained as next of last.

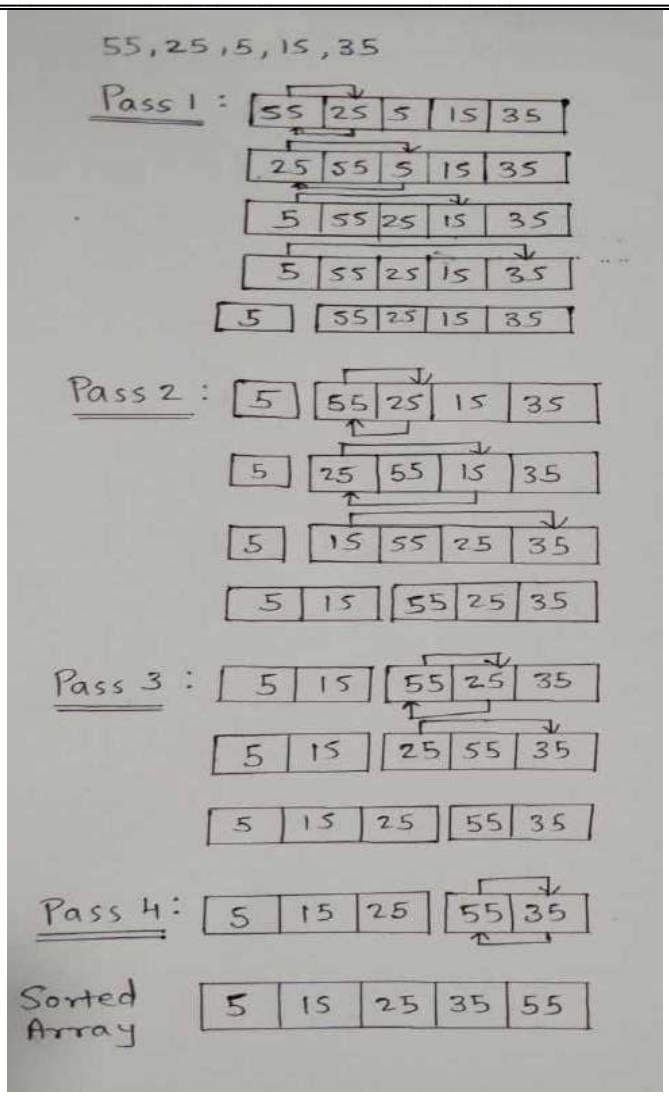
3) Circular lists are useful in applications to repeatedly go around the list. For example, when multiple applications are running on a PC, it is common for the operating system to put the running applications on a list and then to cycle through them, giving each of them a slice of time to execute, and then making them wait while the CPU is given to another application. It is convenient for the operating system to use a circular list so that when it reaches the end of the list it can cycle around to the front of the list.

4) Circular Doubly Linked Lists are used for implementation of advanced data structures like Fibonacci Heap.

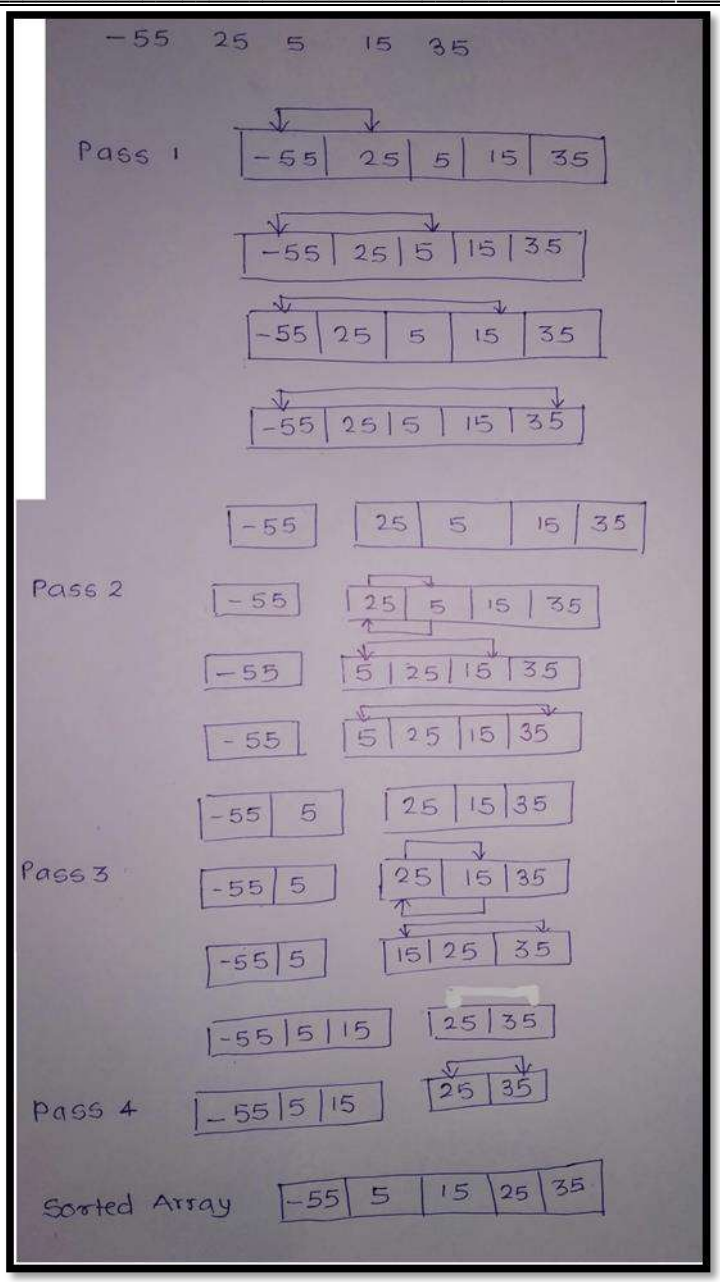
5		**Attempt any TWO of the following :**	**12 M**
	a	**Write algorithm for performing push and pop operations on stack.**	6 M
	Ans	**Push algorithm: -** Max is maximum size of stack. Step 1: [Check for stack full/ overflow] If stack_top is equal to max-1 then Display output as "Stack Overflow" and return to calling function Otherwise Go to step 2 Step 2: [Increment stack_top] Increment stack top pointer by one. stack_top=stack_top +1; Step 3: [Insert element] stack [stack_top] = item; Step 4: return to calling function **Pop algorithm: -** Max is maximum size of stack. Step 1: [Check for stack empty/underflow]	3marks for Push algorithm and 3marks for Pop operation

		If stack_top is equal to -1 then Display output as "Stack Underflow" and return to calling function Otherwise Go to step 2 Step 2: [delete element] stack [stack_top] = item; Step 3: [Decrement stack_top] Decrement stack top pointer by one. stack_top=stack_top -1; Step 4: return to calling function.	
	b	**For given binary tree write in-order, pre-order and post-order traversal.** 	6 M
	Ans	**Inorder Traversal: Q,E,F,R,D,H,B,A,I,J,K,C,L,P** **Preorder Traversal: A,B,D,E,Q,F,R,H,C,I,J,K,L,P** **Postorder Traversal: Q,R,F,E,H,D,B,K,J,I,P,L,C,A**	2marks for each traversal
	c	**Write an algorithm to insert an element at the beginning and end of linked list.**	6 M
	Ans	**Algorithm to insert an element at the beginning of linked list:** **1.** Start **2.** Create the node pointer *temp Struct node * temp **3.** Allocate address to temp using malloc temp = malloc(sizeof(struct node)); **4.** Check whether temp is null, if null then Display "Overflow" else	3marks for each algorithm

		temp-> info=data temp-> next=start **5.** Start=temp **6.** stop **Algorithm to insert an element at the end of linked list:** **1.** Start **2.** Create two node pointers *temp, *q struct node * temp, *q; **3.** q= start **4.** Allocate address to temp using malloc temp = malloc(sizeof(struct node)); **5.** Check whether temp is null, if null then Display "Overflow" else temp-> info=data temp-> next=null **6.** While(q->next!=null) q= q-> next **7.** q->next= temp **8.** stop	
6		**Attempt any TWO of the following :**	**12 M**
	a	**Describe working of selection sort method. Also sort given input list in ascending order using selection sort input list:- 55, 25, 5, 15, 35.**	6 M
	Ans	**Working of Selection sort**: Selection Sort algorithm is used to arrange a list of elements in a particular order (Ascending or Descending). In selection sort, the first element in the list is selected and it is compared repeatedly with remaining all the elements in the list. If any element is smaller than the selected element (for ascending order), then both are swapped. Then we select the element at second position in the list and it is compared with remaining all elements in the list. If any element is smaller than the selected element, then both are swapped. This procedure is repeated till the entire list is sorted.	3marks for description, 3marks for correct solution

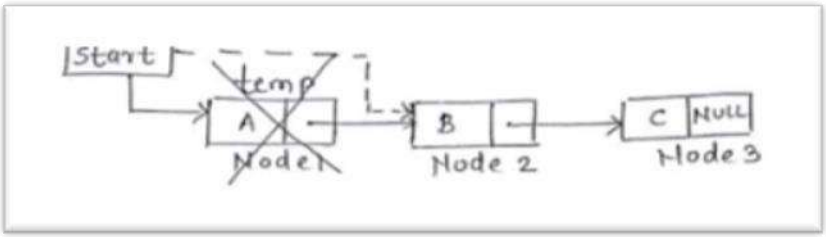

55, 25, 5, 15, 35
Pass 1 :
55 25 5 15 35
25 55 5 15 35
5 55 25 15 35
5 55 25 15 35
5 55 25 15 35
Pass 2 :
5 55 25 15 35
5 25 55 15 35
5 15 55 25 35
5 15 55 25 35
Pass 3 :
5 15 55 25 35
5 15 25 55 35
5 15 25 55 35
Pass 4 :
5 15 25 55 35
Sorted Array
5 15 25 35 55

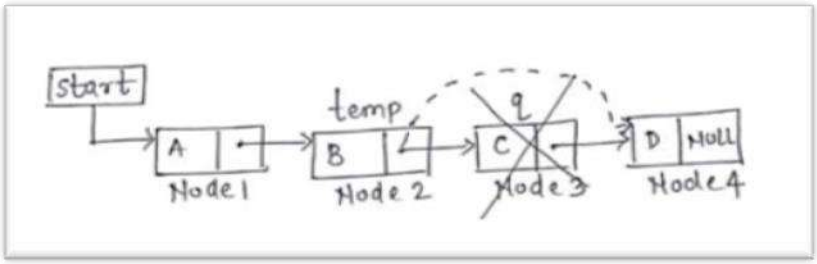
OR



	b	**Define the term recursion. Write a program in C to display factorial of an entered number using recursion.**	6 M
	Ans	**Definition:** Recursion is the process of calling function by itself. A recursive function body contains function call statement that calls itself repeatedly. **Program:** #include<stdio.h> #include<conio.h> int fact(int n); void main()	2marks for definition, 4marks for correct program

```
{
int n;
 clrscr();
 printf("\nThe factorial of % is = %d",n,fact(n));
getch();
}
 int fact(int n)
{
if(n==1)
return 1;
else
return(n*fact(n-1));
}
```

	c	**Describe procedure to delete an element from singly linked list using diagram.**	6 M
	Ans	In a linear linked list, a node can be deleted from the beginning of list, from in between positions and from end of the list. **Delete a node from the beginning:-**  Node to be deleted is node1.Create a temporary node as 'temp'. Set 'temp' node with the address of first node. Store address of node 2 in header pointer 'start' and then delete 'temp' pointer with free function. Deleting temp pointer deletes the first node from the list. **OR** Step 1: Create temporary node 'temp'. Step 2: Assign address of first node to 'temp' pointer. Step 3: Store address of second node (temp->next) in header pointer 'start'. Step 4: Free temp. **Delete a node from in between position:-**	**Note: Correct algorithm or program shall be considered. Any two deletions shall be considered 3marks each



Node to be deleted is node3.Create a temporary node as 'temp' and 'q'. Set 'temp' node with the address of first node. Traverse the list up to the previous node of node 3 and mark the next node (node3) as 'q'. Store address from node 'q' into address field of 'temp' node. Then delete 'q' pointer with free function. Deleting 'q' pointer deletes the node 3 from the list.

OR

Step 1: Create temporary node 'temp', 'q'.

Step 2: Assign address of first node to 'temp' pointer.

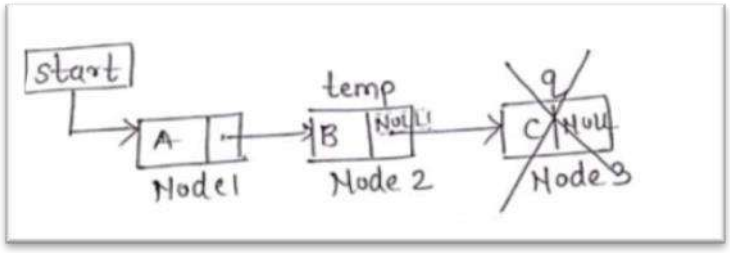
Step 3: Traverse list up to previous node of node to be deleted.

Step 4: Mark the node to be deleted 'q'.

Step 5: Store address from node 'q' in address field of 'temp' node (temp- >next=q->next).

Step 6: Free q.

Delete a node from the end:-



Node to be deleted is node 3.Create a temporary node as 'temp' and 'q'. Set 'temp' node with the address of first node. Traverse the list up to the second last node and mark the last node as 'q'. Store NULL value in address field of 'temp' node and then delete 'q' pointer with free function. Deleting q pointer deletes the last node from the list.

OR

Step 1: Create temporary node 'temp','q'.
Step 2: Assign address of first node to 'temp' pointer.
Step 3: Traverse list upto second last node.
Step 4: Mark last node's address in node 'q'.
Step 5: store NULL value in address field of second last node (temp->next).
Step 6: Free q

SUMMER – 2019 EXAMINATION
MODEL ANSWER

Subject: Data Structure Using 'C' **Subject Code: 22317**

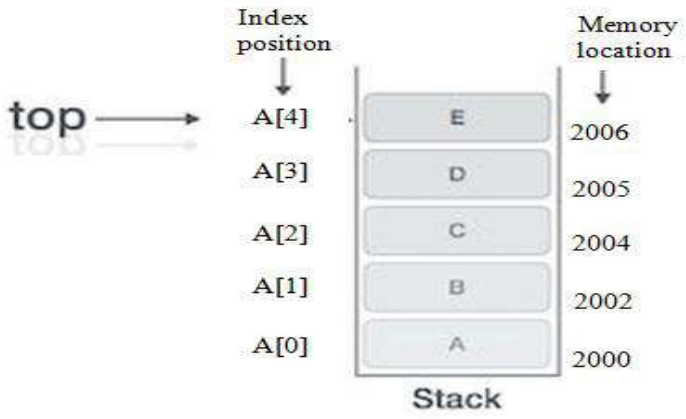
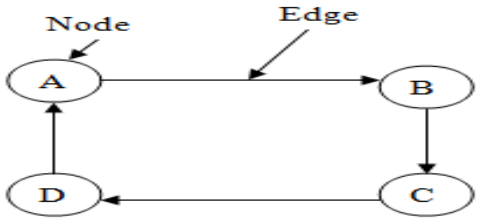
Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q.N.	Answer	Marking Scheme
1.	**(a) Ans.**	**Attempt any FIVE of the following:** **List any four operations on data structure.** **Operations on data structure:** • Insertion • Deletion • Searching • Sorting • Traversing • Merging	**10** **2M** ***Any four operations 1/2M each***
	(b) Ans.	**Enlist queue operation condition.** 1. Queue Full 2. Queue Empty	**2M** ***Two operational conditions 1M each***

SUMMER – 2019 EXAMINATION
MODEL ANSWER

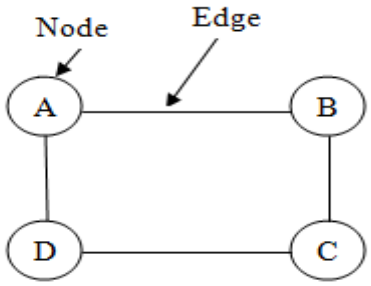
Subject: Data Structure Using 'C' **Subject Code: 22317**

	(c) **Ans.**	**Define:** **(i) Binary tree (ii) Binary search tree** **(i) Binary tree**: It is a nonlinear data structure in which each non-leaf node can have maximum two child nodes as left child ad right child. **(ii)Binary search tree**: It is a nonlinear data structure in which left child of root node is less than root and right child of root node is greater than root.	**2M** ***Each correct definitio n 1M***
	(d) **Ans.**	**Show the memory representation of stack using array with the help of a diagram.** Consider stack contains five integer elements represented with an array A in which each element occupy 2 bytes memory. Array starts with base address of 2000.  	**2M** ***Correct represen tation 2M***
	(e) **Ans.**	**Define given two types of graph and give example.** **(i) Direct graph (ii) Undirected graph** **(i) Direct graph:** A graph in which direction is associated with each edge is known as directed graph. Example:  	**2M** ***Definitio n with example of each1M***

SUMMER – 2019 EXAMINATION
MODEL ANSWER

Subject: Data Structure Using 'C' **Subject Code: 22317**

(ii) Undirected graph: A graph in which the edges do not have any direction associated with them is known as undirected graph.
Example:-



(f) **Ans.**

Differentiate between linear and non-linear data structures on any two parameters. — **2M**

Sr. No.	Linear data structure	Non-linear data structure
1	A data structure in which all data elements are stored in a sequence is known as linear data structure.	A data structure in which all data elements are not stored in a sequence is known as non-linear data structure.
2	All elements are stored in contiguous memory locations inside memory.	All elements may stored in non-contiguous memory locations inside memory.
3	Example:- stack, queue	Example:- tree, graph

Any two differences 1M each

(g) **Ans.**

Convert the following infix expression to its prefix form using stack A + B – C * D/E + F — **2M**

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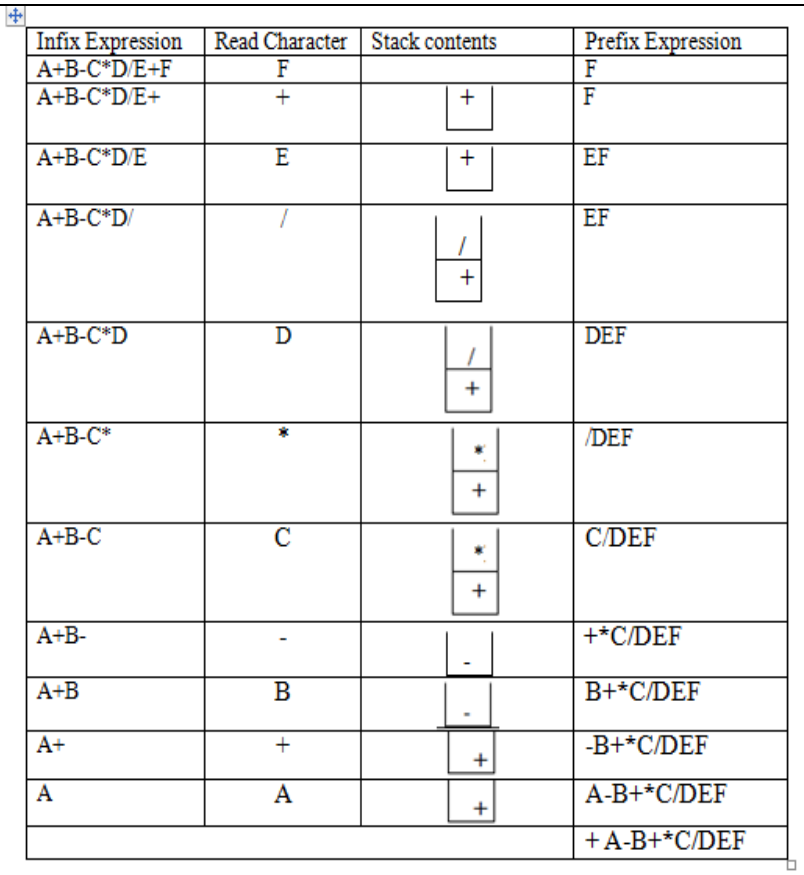
MODEL ANSWER

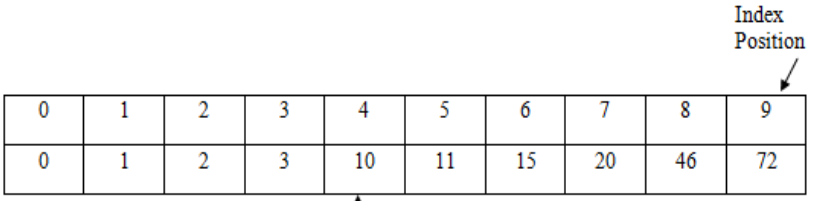
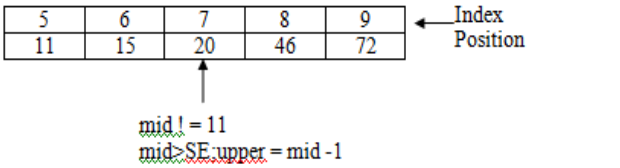
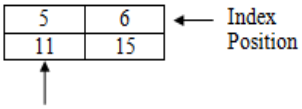
Subject: Data Structure Using 'C' **Subject Code: 22317**

			***Correct prefix expression2M***
2.	**(a) Ans.**	**Attempt any THREE of the following:** **Explain the working of Binary search with an example.** Binary search is performed only on sorted array. Search method starts with calculating mid position from an array and compare the mid position element with the search element. If a match is found thenthe search process ends otherwise divide the i/p list into 2 parts. First part contains all thenumbers less than mid position element and second part contains all the numbers greater than mid position element.Then select one of the part depending on search element is less or greater than mid position element and calculate mid position for selected part.Again compare mid position element with search element. The binary search performs comparison and division task the element is found or division of list gives one element for comparison. To calculate mid element perform (lower + upper) / 2. lower-lower index position of an array(initially 0) upper-upper index position of an array(initially size-1)	**12** **4M** ***Explanation 2M***

Infix Expression	Read Character	Stack contents	Prefix Expression
A+B-C*D/E+F	F		F
A+B-C*D/E+	+	+	F
A+B-C*D/E	E	+	EF
A+B-C*D/	/	/ +	EF
A+B-C*D	D	/ +	DEF
A+B-C*	*	* +	/DEF
A+B-C	C	* +	C/DEF
A+B-	-	-	+*C/DEF
A+B	B	-	B+*C/DEF
A+	+	+	-B+*C/DEF
A	A	+	A-B+*C/DEF
			+A-B+*C/DEF

SUMMER – 2019 EXAMINATION
MODEL ANSWER

Subject: Data Structure Using 'C' **Subject Code: 22317**

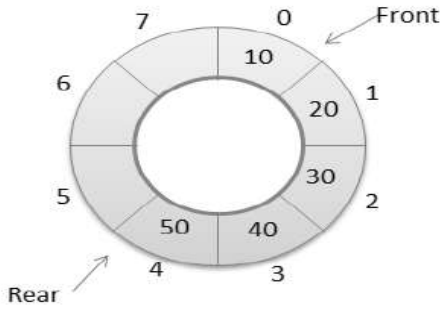
		Example: Consider Input list 0, 1, 2, 9, 10, 11, 15, 20, 46, 72 Search element:11 → Iteration 1 Lower = 0 Upper = 9mid = (lower + upper) / 2= (0 + 9/2)= 4.5  → Iteration 2 Lower = 5 Upper = 9 mid = (Lower + Upper) / 2= (5 + 9) / 2= 7  → Iteration 3 Lower = 5 upper = 6 mid = (Lower + Upper) / 2= (5 + 6) / 2= 5.5  	***Example 2M***
	(b) **Ans.**	**Write a program to traverse a linked list.** ***(Note: create_list and addatbeg are optional)*** #include<stdio.h> #include<conio.h> #include<malloc.h> void create_list(int); void addatbeg(int); void display(); struct node	**4M** ***Correct logic 2M*** ***Correct syntax 2M***

```
{
int info;
struct node *next;
}*start=NULL;

void main()
{
int m;
clrscr();
printf("enter data value\n");
scanf("%d",&m);
create_list(m);
printf("enter data value\n");
scanf("%d",&m);
addatbeg(m);
  display();
getch();
}

void create_list(int data)
{
struct node *tmp,*q;
tmp=malloc(sizeof(struct node));
tmp->info=data;
tmp->next=NULL;
 start=tmp;
}

void addatbeg(int data)
{
struct node *tmp;
tmp=malloc(sizeof(struct node));
tmp->info=data;
tmp->next=start;
 start=tmp;
}

void display()
{
```

```
struct node *q;
 if(start==NULL)
 {
printf("list is empty\n");
  }
 q=start;
printf("list is:\n");
 while(q!=NULL)
 {
printf("%d\t",q->info);
  q=q->next;
 }
}
```

(c) Ans. **Draw and explain construction of circular queue.** **4M**

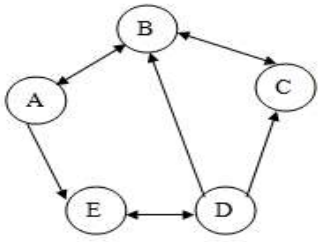
A queue, in which the last node is connected back to the first node to form a cycle, is called as circular queue.



Draw 1M

The above diagram represents a circular queue using array.
It has rear pointer to insert an element and front pointer to delete an element. It works in FIFO manner where first inserted element is deleted first.
Initially front and rear both are initialized to -1 to represent queue empty. First element inserted in circular queue is stored at 0^{th} index position pointed by rear pointer. For the very first element, front pointer is also set to 0^{th} position. Whenever a new element is inserted in a queue rear pointer is incremented by one. If rear is pointing to max-1 and no element is present at 0^{th} position then rear is set to 0^{th} position to continue cycle. Before inserting an element, queue full condition is checked. If rear is set to max-1 position and front is set to 0 then queue is full. Otherwise if rear =front+1 then also queue is full.

Explanation 3M

		If queue is full then new element cannot be added in a queue. For deletion, front pointer position is checked and queue empty condition is checked. If front pointer is pointing to -1 then queue is empty and deletion operation cannot be performed. If queue contains any element then front pointer is incremented by one to remove an element. If front pointer is pointing to max-1 and element is present at 0^{th} position then front pointer is initialize to 0^{th} position to continue cycle. Circular queue has advantage of utilization of space**.** Circular queue is full only when there is no empty position in a queue. Before inserting an element in circular queue front and rear both the pointers are checked. So if it indicates any empty space anywhere in a queue then insertion takes place.	
	(d) Ans.	**Explain indegree and outdegree of a graph with example.** **Indegree of node:** It is number of edges coming towards a specified node i.e. number of edges that have that specified node as the head is known as indegree of a node. **Outdegree of node:** It is number of edged going out from a specified node i.e. number of edges that have that specified node as the tail is known as outdegree of a node In undirected graph each edge is bidirectional so each edge coming towards node is also going out of that node. Due to this indegree and outdegree of a node is same number. In indirected graph, each edge is having direction associated with it, so indegree and outdegree depends on the direction. ***Example:-***  Indegree of node A= 1 Outdegree of node A=2	**4M** ***Each term-explanation 1M*** ***Each example 1M***

		Indegree of node B= 3 Outdegree of node B=2 Indegree of node C= 2 Outdegree of node C=1 Indegree of node D= 1 Outdegree of node D=3 Indegree of node E= 2 Outdegree of node E=1	
3.	**(a)** **Ans.**	**Attempt any THREE of the following:** **Write C program for performing following operations on array: insertion, display.** #include<stdio.h> #include<conio.h> void main() { inta[10],x,i,n,pos; clrscr(); printf("Enter the number of array element\n"); scanf("%d",&n); printf("Enter the array with %d element\n", n); for(i=0;i<n;i++) scanf("%d",&a[i]); printf("Enter the key value and its position\n"); scanf("%d%d" ,&x,&pos); for(i=n; i >= pos; i--) { a[i]=a[i-1]; } a[pos-1]=x; printf("Array element\n "); for(i=0;i<n+1;i++) printf("%d\t",a[i]); getch(); }	**12** **4M** ***Correct program 4M***
	(b) **Ans.**	**Evaluate the following postfix expression:** **5, 6, 2, +, *, 12, 4, /, - Show diagrammatically each step of evolution using stack.**	**4M**

Scanned Symbol	Operand 1	Operand 2	Value	Stack Content
5				5
6				5,6
2				5,6,2
+	6	2	8	5,8
*	5	8	40	40
12				40,12
4				40,12,4
/	12	4	3	40,3
-	40	3	37	37

Result of above postfix expression evaluation- 37

Correct answer 4M

(c) **Sort the following numbers in ascending order using quick sort. Given numbers 50, 2, 6, 22, 3, 39, 49, 25, 18, 5.** **4M**

Ans. Given array

Array elements	50	2	6	22	3	39	49	25	18	5
indexes	0	1	2	3	4	5	6	7	8	9

Set l=0 , h=9 ,pivot= a[h]=5
Initialize index of smaller element, i= l-1 =-1
Traverse elements from j=l to j=h-1

1. j=0 i=-1 since a[j] > pivot do nothing array will remain same

Array elements	50	2	6	22	3	39	49	25	18	5
indexes	0	1	2	3	4	5	6	7	8	9

2. j=1 since a[j]<=pivot, do i++ and swap(a[i], a[j])
i=0

Array elements	**2**	**50**	6	22	3	39	49	25	18	5
indexes	0	1	2	3	4	5	6	7	8	9

Correct solve example 4M

3. j=2 ,i=0 since a[j] > pivot do nothing array will remain same

Array elements	**2**	**50**	6	22	3	39	49	25	18	5
indexes	0	1	2	3	4	5	6	7	8	9

4. j=3 ,i=0 since a[j] > pivot do nothing array will remain same

Array elements	**2**	**50**	6	22	3	39	49	25	18	5
indexes	0	1	2	3	4	5	6	7	8	9

5. j=4, since a[j]<=pivot do, i++ and swap(a[i],a[j])
i=1

Array elements	**2**	**3**	6	22	50	39	49	25	18	5
indexes	0	1	2	3	4	5	6	7	8	9

6. j=5 , i=1 since a[j] > pivot do nothing array will remain same

Array elements	**2**	**3**	6	22	50	39	49	25	18	5
indexes	0	1	2	3	4	5	6	7	8	9

7. j=6, i=1 since a[j] > pivot do nothing array will remain same

Array elements	**2**	**3**	6	22	50	39	49	25	18	5
indexes	0	1	2	3	4	5	6	7	8	9

8. j=7 ,i-1 since a[j] > pivot do nothing array will remain same

Array elements	**2**	**3**	6	22	50	39	49	25	18	5
indexes	0	1	2	3	4	5	6	7	8	9

9. j=8 ,i-1 since a[j] > pivot do nothing array will remain same

Array elements	**2**	**3**	6	22	50	39	49	25	18	5
indexes	0	1	2	3	4	5	6	7	8	9

We come out of loop because j is now equal to high-1.
Finally we place pivot at correct position by swapping a[i+1] and a[h] (or pivot)

a[] = {2,3,**5**,22,50,39,49,25,18,6} // 6 and 5 Swapped

Now, **5**is at its correct place. All elements smaller than 5 are before it and all elements greater than 5 are afterit.

Similarly rest of the passes will be executed and will provide the following output

Output of pass1

Array elements	**2**	**3**	**5**	22	50	39	49	25	18	6
indexes	0	1	2	3	4	5	6	7	8	9

Pass2

A[]={2,3} pivot=3

Array elements	**2**	**3**	**5**
indexes	0	1	2

a[]={22,50,39,49,25,18,6}pivot=6

Array elements	6	50	39	49	25	18	22
indexes	3	4	5	6	7	8	9

a[]={50,39,49,25,18,22}pivot=22

Array elements	18	22	49	25	50	39
indexes	4	5	6	7	8	9

SUMMER – 2019 EXAMINATION
MODEL ANSWER

Subject: Data Structure Using 'C' **Subject Code: 22317**

a[]={18}pivot=18

Array elements	18	22
indexes	4	5

a[]={49,25,50,39},pivot=39

Array elements	25	39	50	49
indexes	6	7	8	9

a[]={25}, pivot=25

Array elements	25	39
indexes	6	7

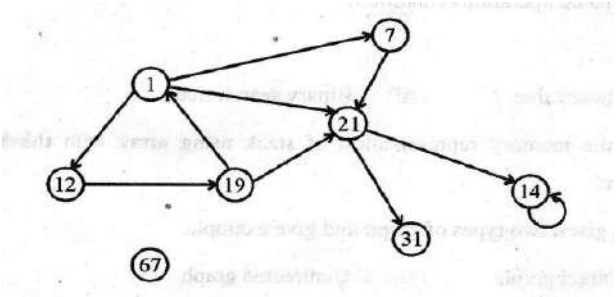
a[]={50,49},pivot=49

Array elements	49	50
indexes	8	9

Final sorted array using quick sort will be

Array elements	**2**	**3**	**5**	**6**	**18**	**22**	**25**	**39**	**49**	**50**
indexes	0	1	2	3	4	5	6	7	8	9

(d) **From the following graph, complete the answers:** **4M**



(i) Indegree of node 21
(ii) Adjacent node of 19

<table>
<tr>
<td></td>
<td>Ans.</td>
<td>
(iii) Path of 31
(iv) Successor of node 67

(i) Indegree of node 21:
node 1, 7, 19

(i1) Adjacent node of 19:
node 1,21

(iii) Path of 3l:
Path1: 1-21-31
Path2: 1-7-21-31
Path3: 1-7-21-31

(iv) Successor of node 67: No Successor of node 67 since it is isolated node or not connected node in node.
</td>
<td>Each correct answer 1M</td>
</tr>
<tr>
<td>4.</td>
<td>(a)

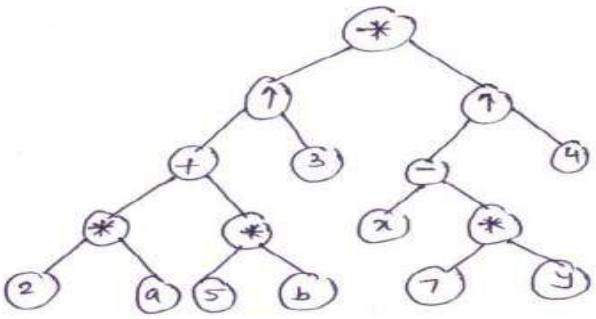
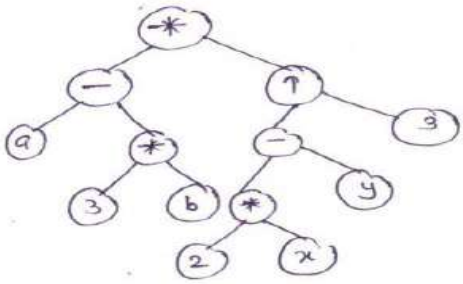
Ans.</td>
<td>
Attempt any THREE of the following:
Differentiate between binary search and sequential search (linear search).

<table>
<tr><th>Sr. No.</th><th>Binary Search</th><th>Sequential search (linear search)</th></tr>
<tr><td>1</td><td>Input data needs to be sorted in Binary Search</td><td>Input data need not to be sorted in Linear Search.</td></tr>
<tr><td>2</td><td>In contrast, binary search compares key value with the middle element of an array and if comparison is unsuccessful then cuts down search to half.</td><td>A linear search scans one item at a time, without jumping to any item.</td></tr>
<tr><td>3</td><td>Binary search implements divide and conquer approach.</td><td>Linear search uses sequential approach.</td></tr>
<tr><td>4</td><td>In binary search the worst case complexity is O(log n) comparisons.</td><td>In linear search, the worst case complexity is O(n), comparisons.</td></tr>
<tr><td>5</td><td>Binary search is efficient for the larger array.</td><td>Linear search is efficient for the smaller array.</td></tr>
</table>
</td>
<td>12
4M

Any four points 1M each</td>
</tr>
</table>

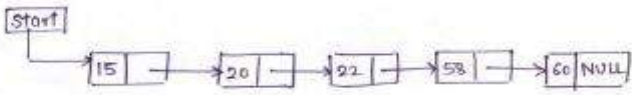
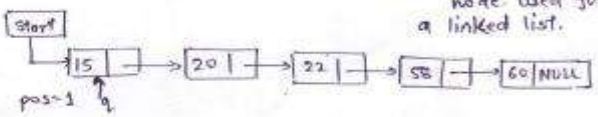
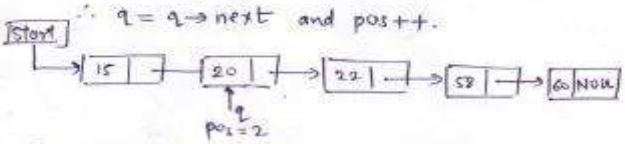
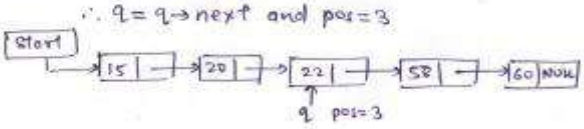
SUMMER – 2019 EXAMINATION
MODEL ANSWER

Subject: Data Structure Using 'C' **Subject Code: 22317**

	(b) **Ans.**	**Draw the tree structure of the following expressions:** **(i) $(2a+5b)^3 * (x - 7y)^4$ (ii) $(a - 3b) * (2x - y)^3$** **(i) $(2a+5b)^3 * (x - 7y)^4$**  **(ii) $(a - 3b) * (2x - y)^3$** 	**4M** ***Each correct tree structure 2M***
	(c) **Ans.**	**Create a singly linked list using data fields 15, 20, 22, 58, 60. Search a node 22 from the SLL and show procedure step-by-step with the help of diagram from start to end.**	**4M**

SUMMER – 2019 EXAMINATION
MODEL ANSWER

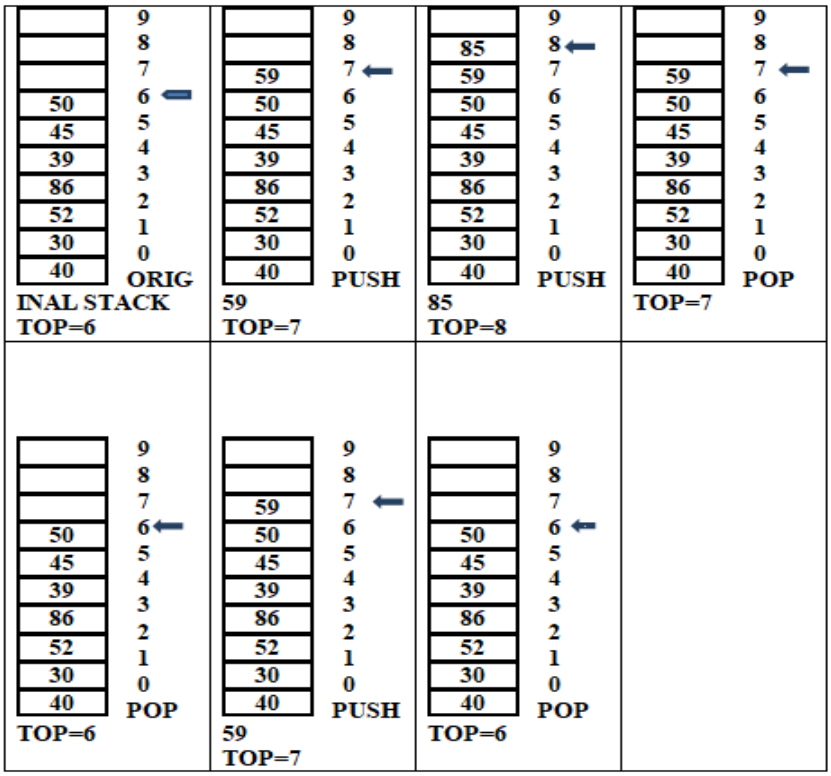
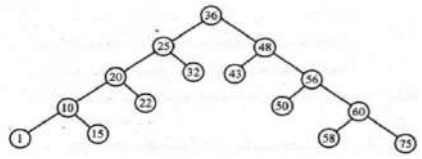
Subject: Data Structure Using 'C' **Subject Code: 22317**

		① With given data fields, singly linked list is created as follows  ② Operation – Search a node 22 from the above SLL a] Initially q = start where q is a pointer of type struct node used for traversing a linked list.  b] q != NULL and pos = 1 q → data ≠ key value i.e 15 ≠ 22 ∴ q = q → next and pos++.  c] q != NULL and pos = 2 q → data ≠ key value i.e 20 ≠ 22 ∴ q = q → next and pos = 3  q != NULL and pos = 3 q → data == key value i.e 22 == 22 ∴ node 22 is located at position 3 search is successful.	***Create linked list 1M*** ***Searching node procedure with diagram 3M***
	(d) **Ans.**	**Evaluate the following prefix expression:** **- * + 4 3 2 5 show diagrammatically each step of evaluation using stack.**	**4M**

		<table><tr><th>Scanned Symbol</th><th>Operand 1</th><th>Operand 2</th><th>Value</th><th>Stack Content</th></tr><tr><td>5</td><td></td><td></td><td></td><td>5</td></tr><tr><td>2</td><td></td><td></td><td></td><td>5,2</td></tr><tr><td>3</td><td></td><td></td><td></td><td>5,2,3</td></tr><tr><td>4</td><td></td><td></td><td></td><td>5,2,3,4</td></tr><tr><td>+</td><td>4</td><td>3</td><td>12</td><td>5,2,12</td></tr><tr><td>*</td><td>12</td><td>2</td><td>24</td><td>5,24</td></tr><tr><td>-</td><td>24</td><td>5</td><td>19</td><td>19</td></tr></table> Result of above prefix expression evaluation - 19	***Each correct step 1M***
	(e) **Ans.**	**Write an algorithm to delete a node from the beginning of a circular linked list.** **Algorithm to delete a node from the beginning of a circular linked list** Consider the function delatbeg() 1. Start 2. Declare struct node *tmp,*q; 3. Set q=last->link; 4. While (q! = last) Do tmp = q; // Identifies beginning node of Circular Linked List last->link=q->link; // Set the address field before deleting identified node free(tmp); // Delete the beginning node End of While 5. last=NULL; // Set last= NULL if only one node is present in the Circular Linked List 6. End of function	**4M** ***Correct algorithm 4M***
5.	**(a)**	**Attempt any TWO of the following:** **Show the effect of PUSH and POP operation on to the stack of size 10. The stack contains 40, 30, 52, 86, 39, 45, 50 with 50 being at top of the stack. Show diagrammatically the effect of:** **(i) PUSH 59 (ii) PUSH 85** **(iii) POP (iv) POP** **(v) PUSH 59 (vi) POP** **Sketch the final structure of stack after performing the above**	**12** **6M**

SUMMER – 2019 EXAMINATION
MODEL ANSWER

Subject: Data Structure Using 'C' **Subject Code: 22317**

	Ans.	**said operations.**  	***Each correct push/pop operation diagrammatically 1M***
	(b)	**Traverse the following tree by the in-order, pre-order and post-order methods:**  	**6M**
	Ans.	INORDER (LVR) 1,10,15,20,22,25,32,36,43,48,50,56,58,60,75 PREORDER (VLR) 36,25,20,10,1,15,22,32,48,43,56,50,60,58,75 POST ORDER (LRV) 1,15,10,22,20,32,25,43,50,58,75,60,56,48,36	***in-order 2M*** ***pre-order2M*** ***post-order2M***

	(c) Ans.	**Write an algorithm to count number of nodes in singly linked list.** Let start is pointer variable which always stores address of first node in single linked list. If single linked list is empty then start will point to NULL. q is pointer variable used to store address of nodes in single linked list. Step 1: Start Step 2: [Assign starting address of single linked list to pointer q] q=start Step 3: [Initially set count of nodes in Linked list as zero] count=0 Step 4: [Check if Linked list empty or not] if start==NULL Display "Empty Linked List" go to step 6. Step 5: [Count number of nodes in single linked list] while q!=NULL count++ and q=q->next; Step 6: Display count (total number of nodes in single linked list) Step 7: stop	**6M** ***Correct algorithm 6M***
6.	**(a)**	**Attempt any TWO of the following:** **Sort the following numbers in ascending order using Bubble sort. Given numbers: 29, 35, 3, 8, 11, 15, 56, 12, 1, 4, 85, 5 & write the output after each interaction.**	**12** **6M**
	Ans.	Pass 1 Enter no of elements :12 Enter array elements :29 35 3 8 11 15 56 12 1 4 85 5 Unsorted Data: 29 35 3 8 11 15 56 12 1 4 85 5	

		After pass 1 : 29 35 3 8 11 15 56 12 1 4 85 5 After pass 1 : 29 3 **35** 8 11 15 56 12 1 4 85 5 After pass 1 : 29 3 8 **35** 11 15 56 12 1 4 85 5 After pass 1 : 29 3 8 11 **35** 15 56 12 1 4 85 5 After pass 1 : 29 3 8 11 15 **35** 56 12 1 4 85 5 After pass 1 : 29 3 8 11 15 35 **56** 12 1 4 85 5 After pass 1 : 29 3 8 11 15 35 12 **56** 1 4 85 5 After pass 1 : 29 3 8 11 15 35 12 1 **56** 4 85 5 After pass 1 : 29 3 8 11 15 35 12 1 4 **56** 85 5 After pass 1 : 29 3 8 11 15 35 12 1 4 56 **85** 5 After pass 1 : 29 3 8 11 15 35 12 1 4 56 5 **85** Pass 2 After pass 2 : 3 29 8 11 15 35 12 1 4 56 5 85 After pass 2 : 3 8 **29** 11 15 35 12 1 4 56 5 85 After pass 2 : 3 8 11 **29** 15 35 12 1 4 56 5 85 After pass 2 : 3 8 11 15 **29** 35 12 1 4 56 5 85 After pass 2 : 3 8 11 15 29 **35** 12 1 4 56 5 85 After pass 2 : 3 8 11 15 29 12 **35** 1 4 56 5 85 After pass 2 : 3 8 11 15 29 12 1 **35** 4 56 5 85 After pass 2 : 3 8 11 15 29 12 1 4 **35** 56 5 85 After pass 2 : 3 8 11 15 29 12 1 4 35 **56** 5 85 After pass 2 : 3 8 11 15 29 12 1 4 35 5 **56** 85 Pass 3 After pass 3 : 3 8 11 15 29 12 1 4 35 5 56 85 After pass 3 : 3 8 11 15 29 12 1 4 35 5 56 85 After pass 3 : 3 8 11 15 29 12 1 4 35 5 56 85 After pass 3 : 3 8 11 15 29 12 1 4 35 5 56 85 After pass 3 : 3 8 11 15 12 **29** 1 4 35 5 56 85 After pass 3 : 3 8 11 15 12 1 **29** 4 35 5 56 85 After pass 3 : 3 8 11 15 12 1 4 **29** 35 5 56 85 After pass 3 : 3 8 11 15 12 1 4 29 35 5 56 85 After pass 3 : 3 8 11 15 12 1 4 29 5 **35** 56 85 Pass 4 After pass 4 : 3 8 11 15 12 1 4 29 5 35 56 85 After pass 4 : 3 8 11 15 12 1 4 29 5 35 56 85 After pass 4 : 3 8 11 **15** 12 1 4 29 5 35 56 85 After pass 4 : 3 8 11 12 **15** 1 4 29 5 35 56 85	***Correct passes 6M (For 4 passes 3M shall be awarded)***

		After pass 4 : 3 8 11 12 1 **15** 4 29 5 35 56 85 After pass 4 : 3 8 11 12 1 4 **15** 29 5 35 56 85 After pass 4 : 3 8 11 12 1 4 15 **29** 5 35 56 85 After pass 4 : 3 8 11 12 1 4 15 5 **29** 35 56 85 Pass 5 After pass 5 : 3 8 11 12 1 4 15 5 29 35 56 85 After pass 5 : 3 8 11 12 1 4 15 5 29 35 56 85 After pass 5 : 3 8 11 **12** 1 4 15 5 29 35 56 85 After pass 5 : 3 8 11 1 **12** 4 15 5 29 35 56 85 After pass 5 : 3 8 11 1 4 **12** 15 5 29 35 56 85 After pass 5 : 3 8 11 1 4 12 **15** 5 29 35 56 85 After pass 5 : 3 8 11 1 4 12 5 **15** 29 35 56 85 Pass 6 After pass 6 : 3 8 11 1 4 12 5 15 29 35 56 85 After pass 6 : 3 8 **11** 1 4 12 5 15 29 35 56 85 After pass 6 : 3 8 1 **11** 4 12 5 15 29 35 56 85 After pass 6 : 3 8 1 4 **11** 12 5 15 29 35 56 85 After pass 6 : 3 8 1 4 11 **12** 5 15 29 35 56 85 After pass 6 : 3 8 1 4 11 5 **12** 15 29 35 56 85 Pass 7 After pass 7 : 3 8 1 4 11 5 12 15 29 35 56 85 After pass 7 : 3 1 8 4 11 5 12 15 29 35 56 85 After pass 7 : 3 1 4 8 11 5 12 15 29 35 56 85 After pass 7 : 3 1 4 8 **11** 5 12 15 29 35 56 85 After pass 7 : 3 1 4 8 5 **11** 12 15 29 35 56 85 Pass 8 After pass 12 : **1** 3 4 8 5 11 12 15 29 35 56 85 **Sorted elements are** 1 3 4 8 5 11 12 15 29 35 56 85	
	(b) **Ans.**	**Evaluate the following postfix expression:** **5 7 + 6 2 - ***	**6M**

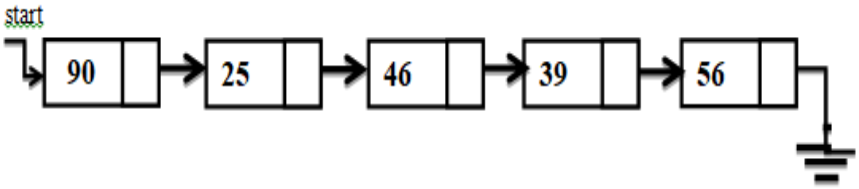
Symbols to be scanned	STACK					Expression Evaluation and Result
	4	3	2	1	0	
5					5	----
7				7	5	----
+					12	7+5=12
6				6	12	----
2			2	6	12	6-2=4
-				4	12	----
*					48	12*4

Correct evaluative 6M

(c) **Create a singly linked list using data fields 90, 25, 46, 39, 56. Search a node 40 from the SLL and show procedure step-by-step with the help of diagram from start to end.** **6M**

Ans. To Search a data field in singly linked list, need to start searching the data field from first node of singly linked list.

ORIGINAL LIST:



List creation 1M

SEARCHING A NODE

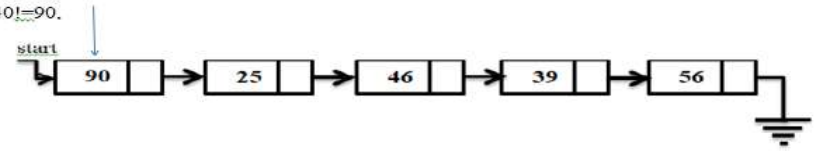
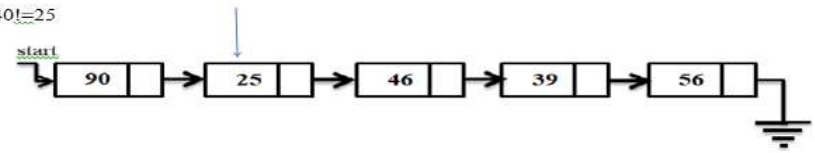
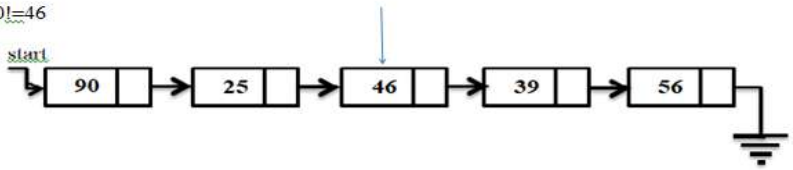
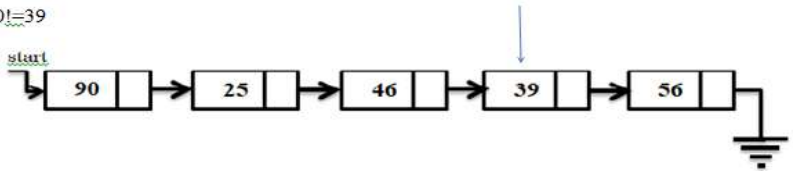
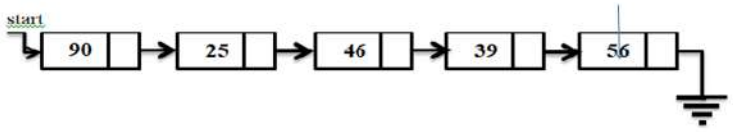
STEP 1:

Compare 40 with 90

40!=90,

SUMMER – 2019 EXAMINATION
MODEL ANSWER

Subject: Data Structure Using 'C' **Subject Code: 22317**

		SEARCHING A NODE **STEP 1:** Compare 40 with 90 40!=90.  **STEP 2:** 40!=25  **STEP 3:** 40!=46  **STEP 4:** 40!=39  **Step 5:** 40!=56  Node not found. Search unsuccessful	***Comparison with each node diagrammatically 1M***

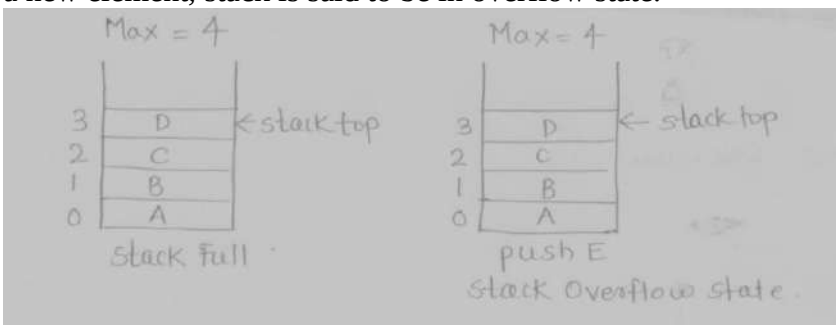
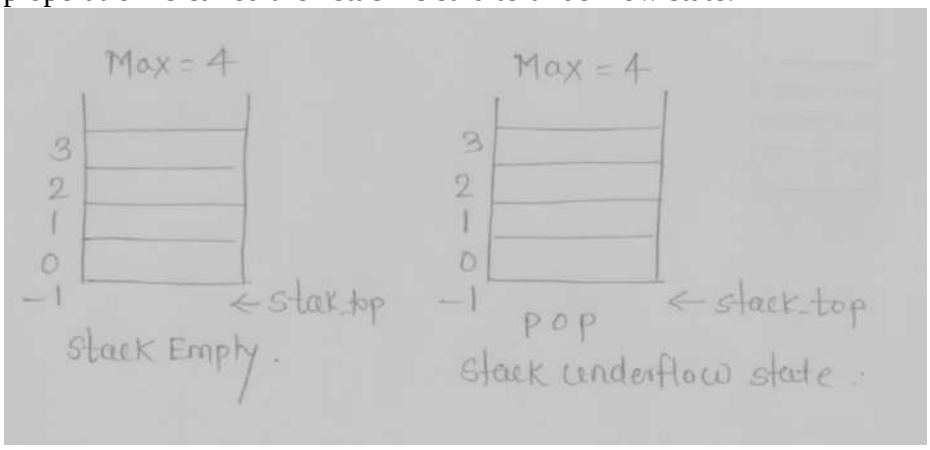
Winter – 19 EXAMINATION

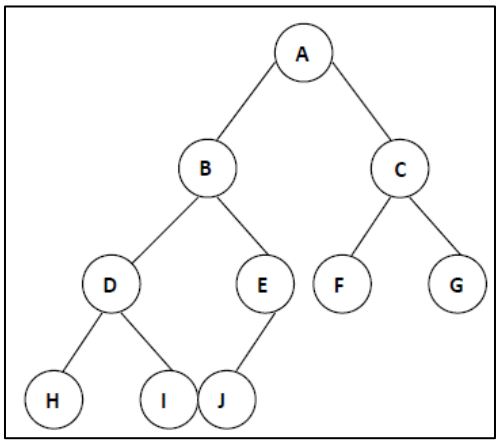
Subject Name: Data Structure Using 'C' **Model Answer** **Subject Code: 22317**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.		**Attempt any Five of the following:**	10M
	a	**Write any four operations that can be performed on data structure.**	2M
	Ans	1. **Data structure operations (Non Primitive)** 2. **Inserting:** Adding a new data in the data structure is referred as insertion. 3. **Deleting:** Removing a data from the data structure is referred as deletion. 4. **Sorting:** Arranging the data in some logical order (ascending or descending, numerically or alphabetically). 5. **Searching:** Finding the location of data within the data structure which satisfy the searching condition. 6. **Traversing:** Accessing each data exactly once in the data structure so that each data item is traversed or visited. 7. **Merging:** Combining the data of two different sorted files into a single sorted file. 8. **Copying:** Copying the contents of one data structure to another. 9. **Concatenation:** Combining the data from two or more data structure. **OR**	2 M for any 4 Operation

		Data structure operations (Primitive) 1. Creation: To create new Data Structure 2. Destroy: To delete Data Structure 3. Selection: To access (select) data from the data structure 4. Updating: To edit or change the data within the data structure.	
	b	**Define the term overflow and underflow with respect to stack.**	**2M**
	Ans	**Stack overflow**: When a stack is full and push operation is performed to insert a new element, stack is said to be in overflow state.  **Stack underflow**: When there is no element in a stack (stack empty) and pop operation is called then stack is said to underflow state.  	1 M for stack overflow and 1M for stack underflow
	c	**Define the following term w.r.t. tree: (i) In-degree (ii) out-degree.**	**2M**
	Ans	**In -degree:** Number of edges coming towards node is in-degree of node. For e.g. : In degree of node B is 1 **Out -degree:** Number of edges going out from node is out -degree of node. For e.g. Out Degree of is node D is 2	1 M for each correct definition

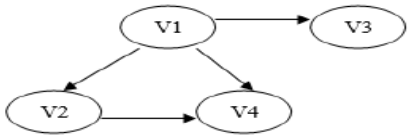
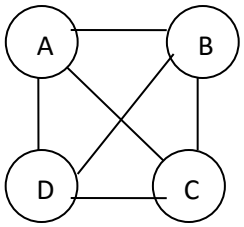
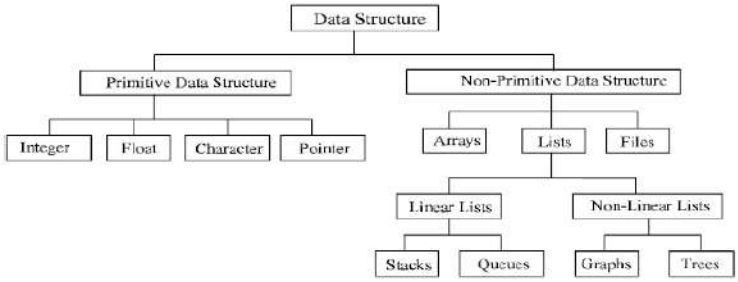


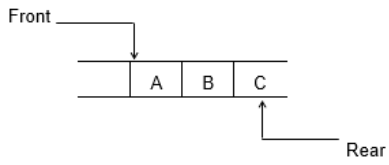
d **Evaluate the following arithmetic expression P written in postfix notation: P : 4, 2, ^, 3, *,3,-,8,4 ,/,+** **2M**

Ans

Sr. No.	Symbol Scanner	STACK
1	4	4
2	2	4, 2
3	^	16
4	3	16, 3
5	*	48
6	3	48,3
7	-	45
8	8	45,8
9	4	45,8,4
10	/	45,2
11	+	47

2 M for correct answer

	e	**Describe directed and undirected graph.**	**2M**
	Ans	**Direct Graph:** A directed graph is defined as the set of ordered pair of vertices and edges where each connected edge has **assigned a direction.**  **Undirected Graph :** An undirected graph G is a graph in which each edge e is not assigned a direction.  	1M for each definition with diagram
	f	**Give classification of data structure.**	**2M**
	Ans	 	2 M for diagram
	g	**Define queue. State any two applications where queue is used.**	**2M**
	Ans	A **Queue** is an ordered collection of items. It has two ends, front and rear. Front end is used to delete element from queue. Rear end is used to insert an element in queue. Queue has two ends; the element entered first in the queue is removed first from the queue. So it is called as FIFO list.	1M for definition, 1M for applications (any two)



APPLICATIONS OF QUEUES

1. Round Robin Technique for processor scheduling is implemented using queues.

2. All types of customer service (like railway ticket reservation) center software's are designed using queues to store customer's information.

3. Printer server routines are designed using queues. A number of users share a printer using printer server (a dedicated computer to which a printer is connected), the printer server then spools all the jobs from all the users, to the server's hard disk in a queue. From here jobs are printed one-by-one according to their number in the queue.

2.		**Attempt any Three of the following:**	**12M**
	a	**Sort the given number in ascending order using Radix sort:** **348, 14, 641, 3851, 74.**	**4M**
	Ans	**Pass 1:**	4 M for correct answer

	0	1	2	3	4	5	6	7	8	9
0348									0348	
0014					0014					
0641		0641								
3851		3851								
0074					0074					

0641,3851,0014,0074,0348

Pass 2:

	0	1	2	3	4	5	6	7	8	9
0641					0641					
3851						3851				
0014		0014								
0074								0074		
0348					0348					

0014,0641,0348,3851,0074

Pass 3:

	0	1	2	3	4	5	6	7	8	9
0014	0014									
0641							0641			
0348				0348						
3851									3851	
0074	0074									

0014,0074,0348,0641,3851

Pass 4:

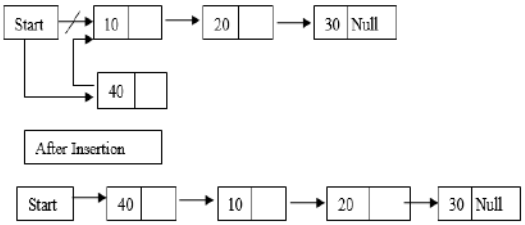
	0	1	2	3	4	5	6	7	8	9
0014	0014									
0074	0074									
0348	0348									
0641	0641									
3851					3851					

Sorted Elements are: 14, 74, 348, 641, 3851

	b	**Write an algorithm to insert a new node at the beginning and end of the singly linked list.**	**4M**
	Ans	**1. Algorithm for inserting a node at the beginning** Insert first(start, item) 1. [check the overflow] if Ptr=NULL then print 'Overflow' exit else Ptr=(node *) malloc (size of (node)) //create new node from memory and assign its address to ptr	2M for Algorithm for inserting a node at the beginning 2M for Algorithm for Inserting A Node at the End

End if

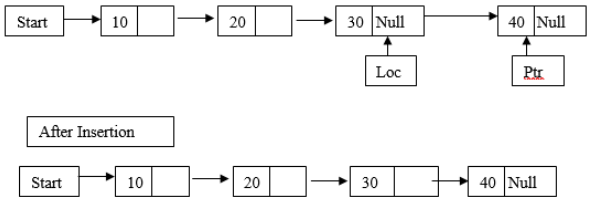
2. set Ptr->num = item
3. set Ptr->next=start
4. set start=Ptr



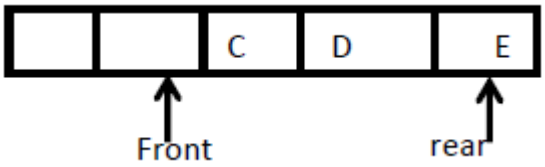
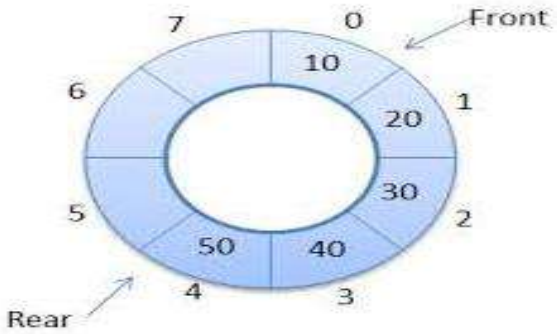
2. Algorithm for Inserting A Node at the End

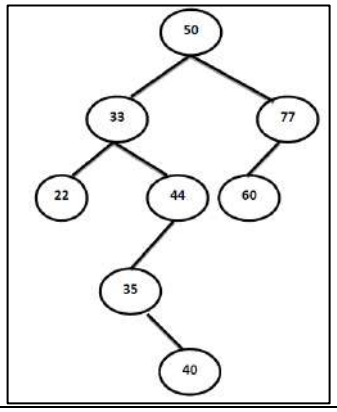
insert last (start, item)

1. [check for overflow]
   If Ptr=NULL, then print 'Overflow'
   exit
   else
   Ptr=(node *) malloc (sizeof (node));
   end if
2. set Ptr->info=item
3. set Ptr->next=NULL
4. if start=NULL and if then set start=P
5. set loc=start
6. repeat step 7 until loc->next != NULL
7. set loc=loc->next
8. set loc->next=P



	c	**Explain the concept of circular Queue along with its need.**	**4M**
	Ans	• Circular queue are the queues implemented in circular form rather than in a straight line. • Circular queues overcome the problem of unutilized space in linear queue implemented as an array. • The main disadvantage of linear queue using array is that when	3 M for explanation and & 1M for need

		elements are deleted from the queue, new elements cannot be added in their place in the queue, i.e. the position cannot be reused. After rear reaches the last position, i.e. MAX-1 in order to reuse the vacant positions, we can bring rear back to the 0th position, if it is empty, and continue incrementing rear in same manner as earlier. • Thus rear will have to be incremented circularly. For deletion, front will also have to be incremented circularly. • Rear can be incremented circularly by the following code. If ((rear == MAX-1) and (front !=0) Rear =0; Else Rear= rear +1; Example: Assuming that the queue contains three elements.  • Now we insert an element F at the beginning by bringing rear to the first position in the queue. this can be represented circularly as shown.  **Need of Circular Queue:** • Circular queues overcome the problem of unutilized space in linear queue implemented as an array. • The element can be stored efficiently in an array so as to wrap around so that the end of queue is followed by front of the queue.	
	d	**Draw a binary search tree for the given number. 50, 33, 44, 22, 77, 35, 60, 40.**	**4M**
	Ans		4 M for correct answer



3. **Attempt any Three of the following:** **12M**

a **Explain time and space complexity with an example.** **4M**

Ans

Time Complexity: Time complexity of program or algorithm is amount of computer time that it needs to run to completion. To measure time complexity of an algorithm we concentrate on developing only frequency count for key statements.

2M for Time Complexity and
2M for space complexity

Example:

```
#include<stdio.h>
void main ()
{
int i, n, sum, x;
sum=0;
printf("\n Enter no of data to be added");
scanf("% d", &n);
for(i=0 ; i<n; i++)
```

Statement	Frequency	Computational Time
sum=0	1	t_1
printf("\n Enter no of data to be added")	1	t_2
scanf("% d", &n)	1	t_3
for(i=0 ; i<n; i++)	n+1	$(n+1)t_4$
scanf("%d" , &x)	n	nt_5
sum=sum+x	n	nt_6
printf("\n Sum = %d ", sum)	1	t_7

Total computational time= t1+t2+t3+(n+1)t4 +nt6+nt5+t7
T= n(t4+t5+t6)+ (t1+t2+t3+t4+t7)
For large n , T can be approximated to
T= n(t4+t5+t6)= kn where k= t4+t5+t6
Thus T = kn or

Space Complexity: Total amount of computer memory required by an algorithm to complete its execution is called as space complexity of that algorithm. When a program is under execution it uses the computer memory for THREE reasons. They are as follows...

- Instruction Space: It is the amount of memory used to store compiled version of instructions.
- Environmental Stack: It is the amount of memory used to store information of partially executed functions at the time of function call.
- Data Space: It is the amount of memory used to store all the variables and constants.

If the amount of space required by an algorithm is increased with the increase of input value, then that space complexity is said to be Linear Space Complexity.

Example:

```
int sum(int A[ ], int n)
{
  int sum = 0, i;
  for(i = 0; i < n; i++)
    sum = sum + A[i];
  return sum;}
```

In the above piece of code it requires

'n*2' bytes of memory to store array variable 'a[ ]'
2 bytes of memory for integer parameter 'n'
4 bytes of memory for local integer variables 'sum' and 'i' (2 bytes each)
2 bytes of memory for return value.

That means, totally it requires '2n+8' bytes of memory to complete its execution. Here, the total amount of memory required depends on the value of 'n'. As 'n' value increases the space required also increases proportionately. This type of space complexity is said to be **Linear Space Complexity.**

OR

Time complexity:- Time complexity of a program/algorithm is the amount of computer time that it needs to run to completion. While calculating time complexity, we develop frequency count for all key statements which are important and basic instructions of an algorithm.

Example: Consider three algorithms given below:-

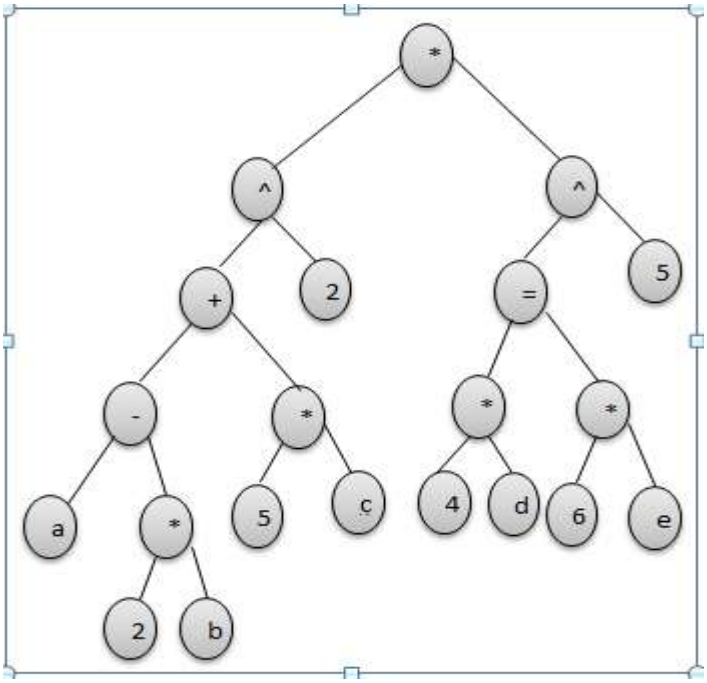
		Algorithm A: - a=a+1 Algorithm B: - for x = 1 to n step 1 a=a+1 Loop Algorithm C:- for x=1 to n step 1 for y=1 to n step 1 a=a+1 Loop Frequency count for algorithm A is 1 as a=a+1 statement will execute only once. Frequency count for algorithm B is n as a=a+1 is key statement executes n time as the loop runs n times. Frequency count for algorithm C is n as a=a+1 is key statement executes n2 time as the inner loop runs n times, each time the outer loop runs and the outer loop also runs for n times. **Space complexity**:- Space complexity of a program/algorithm is the amount of memory that it needs to run to completion. The space needed by the program is the sum of the following components:- **Fixed space requirements**: - It includes space for instructions, for simple variables, fixed size structured variables and constants. **Variable time requirements**: - It consists of space needed by structured variables whose size depends on particular instance of variables. Example: - additional space required when function uses recursion.	
	b	**Convert the following infix expression to postfix expression using stack and show the details of stack in each step.((A+B)*D)^(E-F)**	**4M**
	Ans	**infix expression:** **(((A+B)*D)^(E-F))**	Correct answer-4M

Current Symbol	Operator Stack	Postfix array
(	(	Empty
(	((	Empty
(	(((	Empty
A	(((	A
+	(((+	A
B	(((+	AB
)	((	AB+
*	((*	AB+
D	((*	AB+D
)	(	AB+D*
^	(^	AB+D*
(	(^(	AB+D*
E	(^(	AB+D*E
-	(^(-	AB+D*E
F	(^(-	AB+D*EF
)	(^	AB+D*EF-
)	EMPTY STACK	AB+D*EF-^

Postfix expression: AB+D*EF-^

	c	**Implement a 'C' program to search a particular data from the given array using Linear Search.**	**4M**
	Ans	**Program:-**	

		# include<stdio.h> #include <conio.h> void main () { int a[10], n, key,i,c=0; clrscr( ); printf (“Enter number of array elements\n”); scanf (“%d”, &n); printf (“Enter array elements\n”); for (i=0; i< n; i++) scanf (“%d”, &a[i]); prinntf (“Enter key value\n”); scanf (“%d”, &key); for(i=0;i<n-1;i++) { if (key == a[i]) { c=1; printf (“%d is found at location %d\n”, key, i+1); break; } } if (c==0) printf (“%d not present in the list\n”,key); getch(); }	2M for logic And 2 M for syntax
	d	**Draw an expression tree for the following expression: (a-2b+5e) ^{2} * (4d=6e) ^{5}.**	**4M**
	Ans		Correct Expression tree-4M



4.		**Attempt any Three of the following:**	**12M**
	a	**Find the position of element 21 using binary search method in array 'A' given below: A={11,5,21,3,29,17,2,45}**	**4M**
	Ans	**Given Array** **11 | 5 | 21 | 3 | 29 | 17 | 2 | 45** **Sorted Array for input:** **2 | 3 | 5 | 11 | 17 | 21 | 29 | 45** **Key element to be searched=21** **Step1** **0 | 1 | 2 | 3 | 4 | 5 | 6 | 7** **2 | 3 | 5 | 11 | 17 | 21 | 29 | 45** **l=0 and u=n-1 =7** **mid=(l+u)/2 = 7/2 = 3** **a[mid]=11 not equal to 21** **and**	Each correct step -2M each

21 > 11 l=mid+1 = 4 and u = 7

Step 2:

4	**5**	**6**	**7**
17	**21**	**29**	**45**

l=4 and u =7

mid= 11/2 = 5

a[mid]=21 equal to key element 21

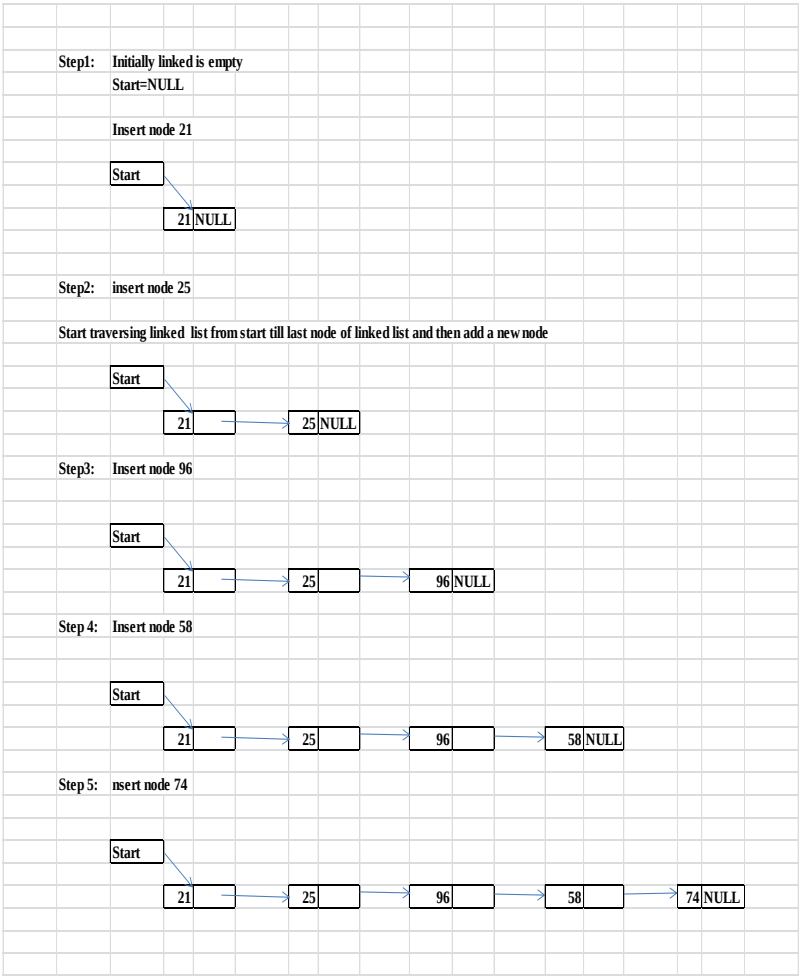
therefore key element 21 is fount un array at position 6

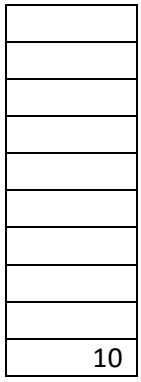
b **Difference between tree and graph(Any 4 points)** **4M**

Ans

Any correct 4 points- 4M

Tree	Graph
Tree is special form of graph i.e. minimally connected graph and having only one path between any two vertices.	In graph there can be more than one path i.e. graph can have uni-directional or bi-directional paths (edges) between nodes
Tree is a special case of graph having no loops, no circuits and no self-loops.	Graph can have loops, circuits as well as can have self-loops.
Tree traversal is a kind of special case of traversal of graph. Tree is traversed in Pre-Order, In-Order and Post-Order	Graph is traversed by DFS: Depth First Search and in BFS : Breadth First Search algorithm
Different types of trees are: Binary Tree, Binary Search Tree, AVL tree, Heaps.	There are mainly two types of Graphs: Directed and Undirected graphs.

			Tree applications: sorting and searching like Tree Traversal & Binary Search.	Graph applications : Coloring of maps, in OR (PERT & CPM), algorithms, Graph coloring, job scheduling, etc.	
			Tree always has n-1 edges.	In Graph, no. of edges depends on the graph.	
			Tree is a hierarchical model.	Graph is a network model.	
	C	**Construct a singly linked list using data fields 21 25 96 58 74 and show procedure step-by-step with the help of diagram start to end.**			**4M**
	Ans				correct construction - 3M and explaination- 1M
	d	**Show the effect of PUSH and POP operation on the stack of size 10.** **PUSH(10)** **PUSH(20)**			**4M**

		POP **PUSH(30)**	
	Ans	**Initial Stack empty**  **Step 1:** PUSH(0) top=top+1 stack[0]=10  **Step 2:** PUSH(0) top=top+1 stack[1]=20  **Step 3:** POP	**Each correct step-1M**

top=top-1 20 is deleted

	stack[9]
	stack[8]
	stack[7]
	stack[6]
	stack[5]
	stack[4]
	stack[3]
	stack[2]
	stack[1]
10	stack[0] top=0

Step 4:

PUSH(0)

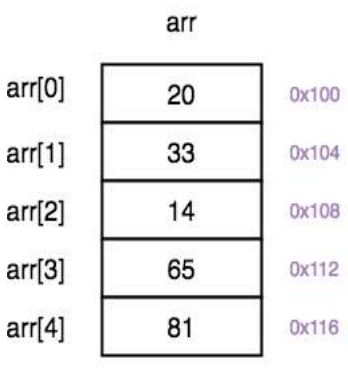
top=top+1 stack[1]=30

	stack[9]
	stack[8]
	stack[7]
	stack[6]
	stack[5]
	stack[4]
	stack[3]
	stack[2]
30	stack[1] top=1
10	stack[0]

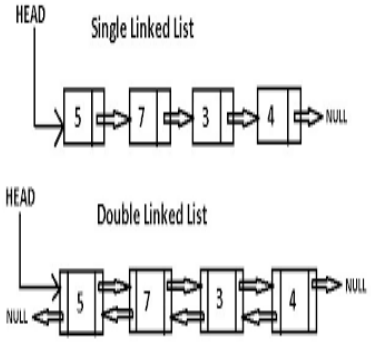
	e	**Compare Linked List and Array (any 4 points).**	**4M**
	Ans		1M for each valid difference

Linked List	Array
Array is a collection of elements of similar data type.	Linked List is an ordered collection of elements of same type, which are connected to each other using pointers.
Array supports Random Access, which means elements can be accessed directly using their index, like arr[0] for 1st element, arr[6] for 7th element etc.	Linked List supports Sequential Access, which means to access any element/node in a linked list; we have to sequentially traverse the complete linked list, up to that element.

		•	Hence, accessing elements in an array is fast with a constant time complexity of O (1).	To access nth element of a linked list, time complexity is O (n).		
			In array, Insertion and Deletion operation takes more time, as the memory locations are consecutive and fixed.	In case of linked list, a new element is stored at the first free and available memory location, with only a single overhead step of storing the address of memory location in the previous node of linked list. Insertion and Deletion operations are fast in linked list.		
		•	Memory is allocated as soon as the array is declared, at compile time. It's also known as Static Memory Allocation.	Memory is allocated at runtime, as and when a new node is added. It's also known as Dynamic Memory Allocation.		
		•	In array, each element is independent and can be accessed using it's index value	In case of a linked list, each node/element points to the next, previous, or maybe both nodes.		
		•	Array can single dimensional, two dimensional or multidime nsional	Linked list can be Linear (Singly), Doubly or Circular li nked list.		
		•	Size of the array must be specified at time of array declaration.	Size of a Linked list is variable. It grows at runtime, as more nodes are added to it.		
		•	Array gets memory allocated in the Stack section	Whereas, linked list gets memory allocated in Heap section.		



Array representation

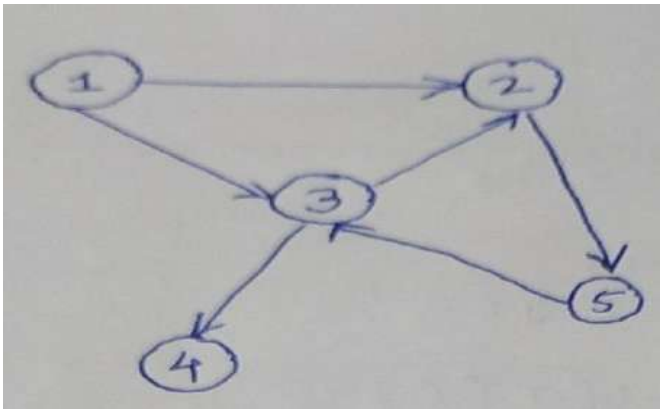


Linked list presentation

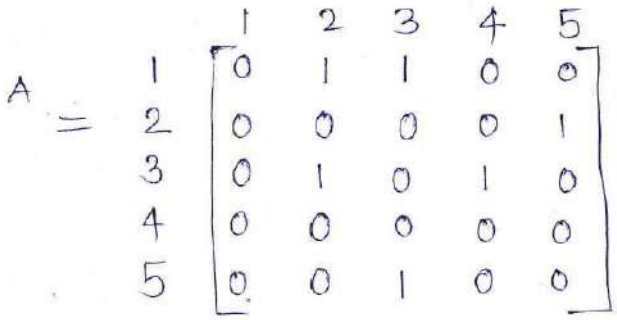
5.		**Attempt any Three of the following:**	**12- M**
	a	**Implement a 'C' program to insert element into the queue and delete the element from the queue.**	**6M**
	Ans	#include<stdio.h> #include<conio.h> #define max 5 void main() { int a[max],front,rear,no,ch,i; clrscr(); front=rear=-1; do { printf("\n 1.INSERT"); printf("\t 2.DELETE"); printf("\t 3.EXIT"); printf("\n\n ENTER YOUR CHOICE:- "); scanf("%d",&ch); switch(ch) { case 1: printf("\n ENTER ITEM TO BE INSERTED :- "); scanf("%d",&no); if(rear==max-1) { printf ("\n QUEUE IS FULL.");	Insert logic-3M, delete logic-3M

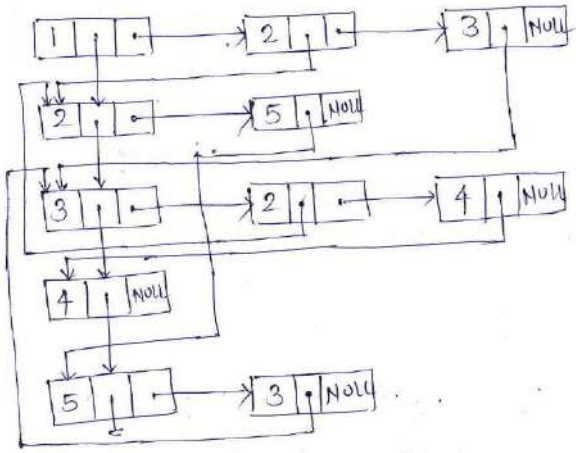
```
break;
}
rear=rear+1;
a[rear]=no;
if(front==-1)
front=0;
break;
case 2:
if(front==-1)
{
printf ("\n QUEUE IS EMPTY.");
break;
}
no=a[front];
printf("\n DELETED ELEMENT IS:- %d",no);
if(front==rear)
front=rear=-1;
else
front=front+1;
break;
case 3:
exit(0);
}
printf("\n\n DO YOU WANT TO CONTINUE:(1 FOR YES/2 FOR NO):-");
scanf("%d",&ch);
}while(ch==1);
getch();
}
```

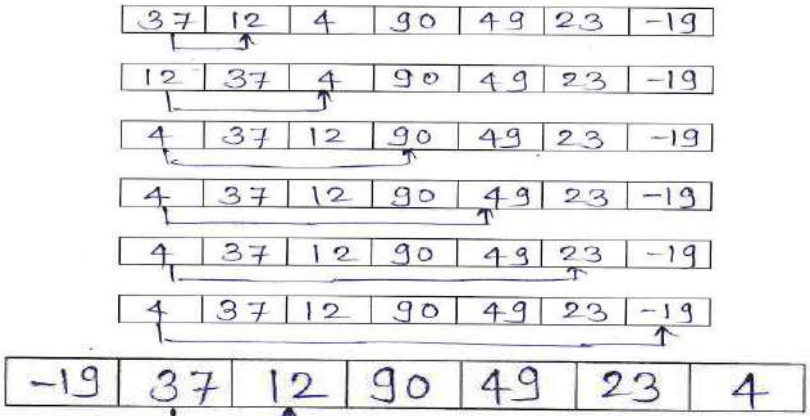
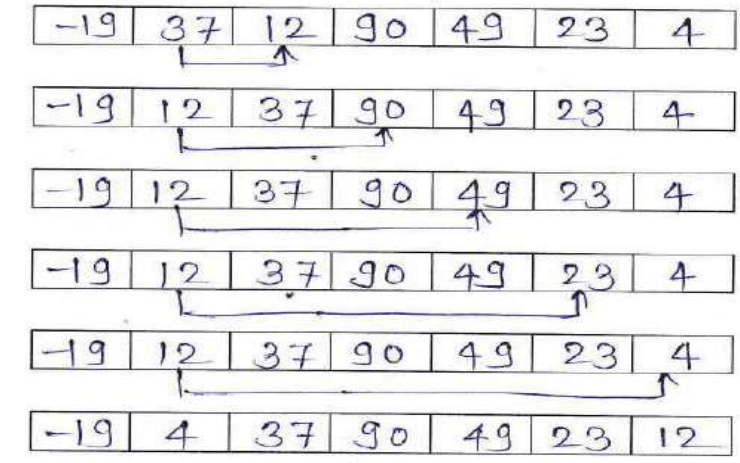
b **Consider the graph given in following figure and answer given questions.** **6M**



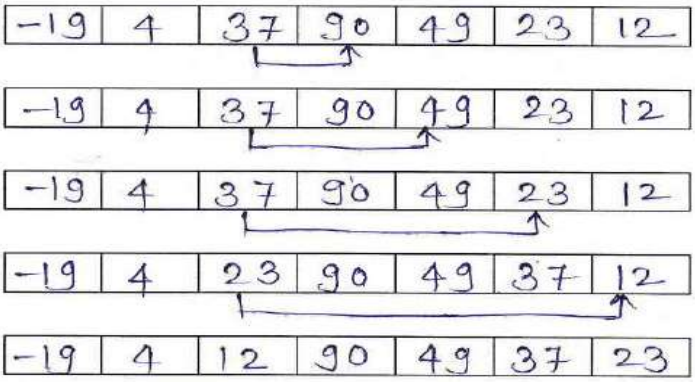
1)All simple path from 1 to 5
2)In-degree of and out-degree of 4
3) Give Adjacency matrix for the given graph.
4) Give Adjacency list representation of the given graph.

	Ans	i) Nodes: **1-2-5** ii) Nodes: **1-3-2-5** 2) **In degree** of node 4- **1**, **Out degree** of node 4 - **0** 3)**Correct adjacency matrix:**  **4) Adjacency list representation** Node | Adjacent nodes 1 | 2,3 2 | 5 3 | 2,4 4 | NIL 5 | 3	Simple path: - Each path ½ M Each degree ½ M Correct adjacency matrix: 2M Adjacency list representation -2M

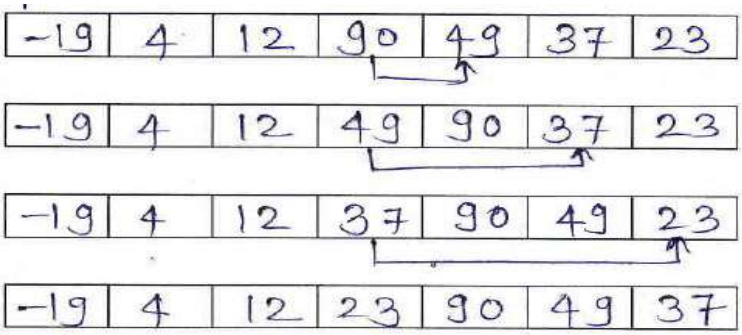
		Representation:  	
	c	**Write an algorithm to search a particular node in the give linked list.**	**6M**
	Ans	**Assumption:** Node contains two fields: info and next pointer start pointer : Header node that stores address of first node step 1: start step 2: Declare variable no, flag and pointer temp step 3: Input search element step 4: Initialize pointer temp with the address from start pointer.(temp=start), flag with 0 step 5: Repeat step 6 till temp != NULL step 6: compare: temp->info = no then set flag=1 and go to step 7 otherwise increment pointer temp and go to step5 step 7: compare: flag=1 then display "Node found" otherwise display "node not found" step 8: stop	Correct steps of algorithm-6M
6.		**Attempt any Three of the following:**	**12M**
	a	**Elaborate the steps for performing selection sort for given elements of array. A={37,12,4,90,49,23,-19}**	**6M**

	Ans	Pass 1  Pass 2  	Correct steps: each pass-1M

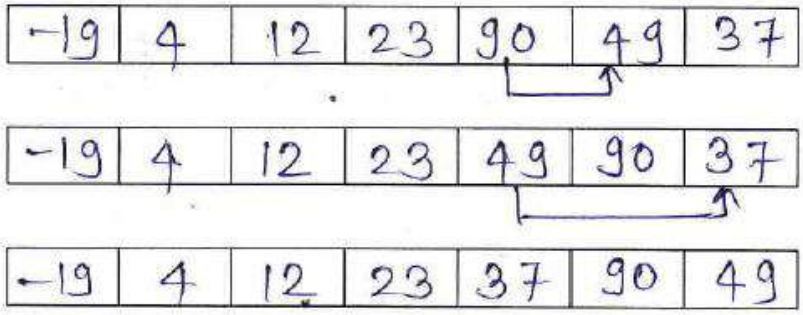
Pass 3



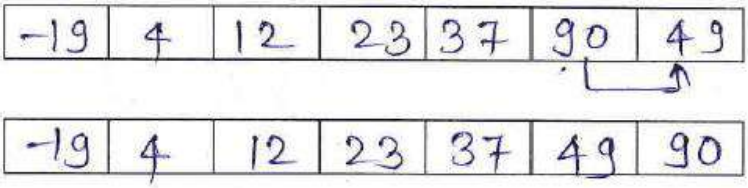
Pass 4

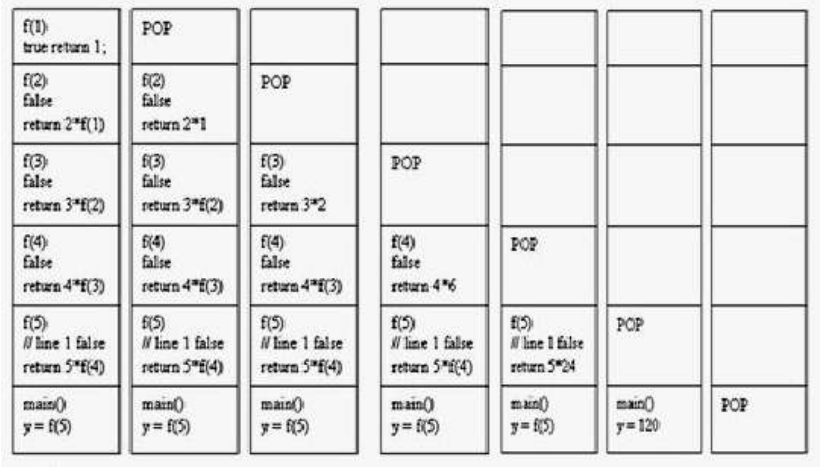


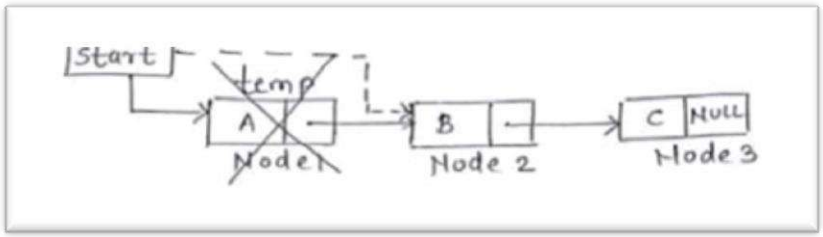
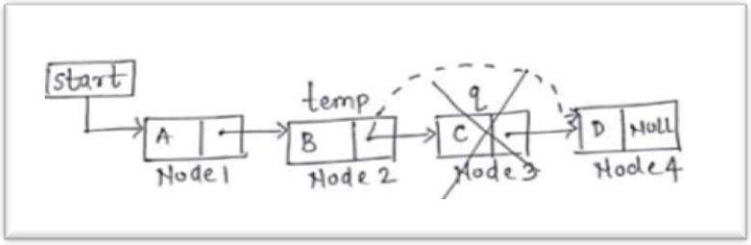
Pass 5

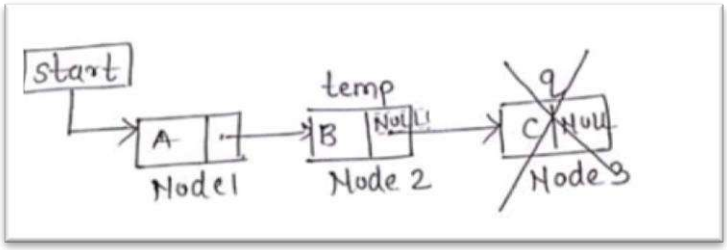


Pass 6



	b	**Explain the concept of recursion using stack.**	**6M**
	Ans	Recursion is a process of calling a function by itself. a recursive function body contains a function call statement that calls itself repetitively. Recursion is an application of stack. When a recursive function calls itself from body, stack is used to store temporary data handled by the function in every iteration. Example: function call from main() : fact(n); // consider n=5 Function definition: int fact(int n) { if(n==1) return 1; else return(n*fact(n-1)); } In the above recursive function a function call fact (n-1) makes a recursive call to fact function. Each time when a function makes a call to itself, it save its current status in stack and then executes next function call. When fact ( ) function is called from main function, it initializes n with 5. Return statement inside function body executes a recursive function call. In this call, first value of n is stored using push ( ) operation in stack (n=5) and a function is called again with value 4(n-1). In each call, value of n is push into the stack and then it is reduce by 1 to send it as argument to recursive call. When a function is called with n=1, recursive process stops. At the end all values from stack are retrieved one by one using pop ( ) operation to perform multiplication to calculate factorial of number.  In the above diagram, first column shows result of push operation after each	Explanation-4M & 2M for Example

		recursive call execution. Next columns shows result of pop operation for calculating factorial.	
	c	**Show with suitable diagrams how to delete a node from singly linked list at the beginning, in between and at the end of the list.**	**6M**
	Ans	In a linear linked list, a node can be deleted from the beginning of list, **from in between positions and from end of the list.** **Delete a node from the beginning:-**  Node to be deleted is node1.Create a temporary node as 'temp'. Set 'temp' node with the address of first node. Store address of node 2 in header pointer 'start' and then delete 'temp' pointer with free function. Deleting temp pointer deletes the first node from the list. **Delete a node from in between position:-**  Node to be deleted is node3.Create a temporary node as 'temp' and 'q'. Set 'temp' node with the address of first node. Traverse the list up to the previous node of node 3 and mark the next node (node3) as 'q'. Store address from node 'q' into address field of 'temp' node. Then delete 'q' pointer with free function. Deleting 'q' pointer deletes the node 3 from the list.	Diagram for beginning-2M, end-2M, inbetween-2M

		Delete a node from the end:-  Node to be deleted is node 3.Create a temporary node as ‘temp’ and ‘q’. Set ‘temp’ node with the address of first node. Traverse the list up to the second last node and mark the last node as ‘q’. Store NULL value in address field of ‘temp’ node and then delete ‘q’ pointer with free function. Deleting q pointer deletes the last node from the list.	

22317

21222

3 Hours / 70 Marks Seat No. | | | | | | | | |

15 minutes extra for each hour

Instructions : (1) All Questions are *compulsory.*

(2) Illustrate your answers with neat sketches wherever necessary.

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

Marks

1. Attempt any FIVE of the following : **10**

(a) Define linear data structure and non-linear data structure.

(b) Enlist operations on stack.

(c) Define : (i) General tree (ii) Binary tree

(d) Draw the diagram of circular queue with front and rear pointers.

(e) Describe given two types of graphs : Directed and Undirected graph.

(f) Define Abstract Data Type.

(g) State any four applications of queue.

2. Attempt any THREE of the following : **12**

(a) Describe the working of Bubble sort method with an example.

(b) Write an algorithm to traverse a linked list.

(c) Explain Queue overflow and underflow conditions with examples.

(d) Explain the following terminologies with respect to graph :

(i) In degree (ii) Out degree

(iii) Successor (iv) Predecessor

3. Attempt any THREE of the following : **12**

(a) Describe time and space complexity with example of each.

(b) Evaluate the following postfix expression :

10, 2, *, 15, 3, /, +, 12, 3, +, +

Show diagrammatically each step of evaluation using stack.

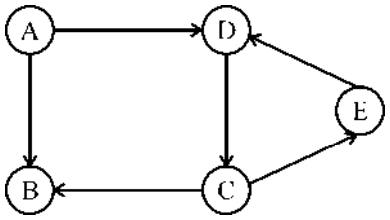
(c) Find the position of element 30 using Binary search method in array

A = {10, 5, 20, 25, 8, 30, 40}

(d) For the following graph :

(i) Give adjacency matrix representation

(ii) Give adjacency list representation



4. Attempt any THREE of the following : **12**

(a) Describe the working of radix sort with example.

(b) Construct a binary search tree for following elements :

22, 27, 14, 31, 40, 43, 44, 10, 20, 35

Show each step of construction of BST.

(c) Write an algorithm to insert a new node at the beginning of a Singly linked list. Give example.

(d) Write a 'C' program to calculate the factorial of number using recursion.

(e) Describe circular linked list with suitable diagram. Also state advantage of circular linked list over linear linked list.

5. Attempt any TWO of the following : **12**

(a) Write a program to implement a stack with push, pop and display operations.

(b) Draw tree for given expression and find pre-order and post-order traversal.

$(2b + 5c)^2 (4d – 6e)^5$

(c) Write an algorithm to search an element in linked list.

6. Attempt any TWO of the following : **12**

(a) Describe the working of Selection Sort Method. Also sort given input list in ascending order using selection sort.

Input list : 50, 24, 5, 12, 30

(b) Convert the following Infix expression to its prefix form using stack. Show the details of stack at each step of conversion.

Expression : P * Q ↑ R – S / T + (U/V)

(c) Create a Singly linked list using data fields 70, 50, 30, 40, 90. Search a node 40 from the singly linked list & show procedure step-by-step with the help of diagram from start to end.

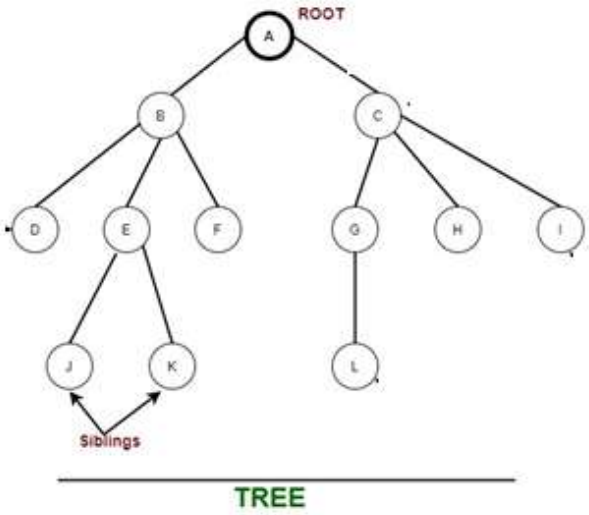
WINTER – 2022 EXAMINATION

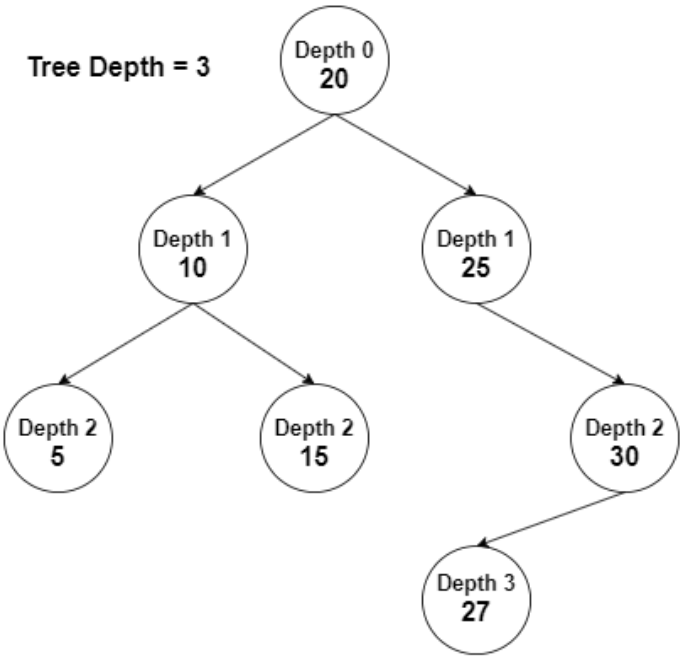
Subject Name: Data Structures Using 'C' **Model Answer** **Subject Code:** 22317

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any FIVE of the following:**	**10 M**
	a)	**Define complexity and classify it.**	**2 M**
	Ans	Complexity of an algorithm is a measure of the amount of time and/or space required by an algorithm for an input of a given size (n). Types of Complexity 1)Time complexity 2)Space complexity	Complexity definition-1 M and type - 1 M
	b)	**State the following terms :** **(i) searching** **(ii) sorting**	**2 M**
	Ans	(i) Searching: The process of finding the desired information from the set of items stored in the form of elements in the computer memory is referred to as 'searching in data structure' (ii) Sorting: Sorting is the processing of arranging the data in ascending and descending order.	Each term carries – 1 M

	c)	**List any four applications of stack.**	**2 M**
	Ans	1)Reversing a list 2)Conversion of infix to prefix expression 3)Conversion of infix to postfix expression 4)Evaluation of prefix expression 5)Evaluation of postfix expression 6)Tower of Hanoi 7)Polish notation	Four applications carries - 2 M
	d)	**List any four types of queue.**	**2 M**
	Ans	1)linear queue 2)circular queue 3)Priority queue 4)Dequeue or double ended queue	Each type ½ M
	e)	**Define Abstract data type.**	**2 M**
	Ans	• ADT is defined as a mathematical model of the data objects that make up a data type as well as functions that operate on these objects. • ADT is the specification of logical and mathematical properties of a data type or structure.	Correct definition 2 M
	f)	**Define the following terms :** **(i) Sibling** **(ii) Depth of tree**	**2 M**
	Ans	**i) Sibling:** **Siblings:** Nodes which belong to the same parent are called as siblings. In other words, nodes with the same parent are sibling nodes.  TREE	Each term carries 1 M with example

		(ii) Depth of tree The **depth** of a node is the number of edges from that node to the tree's root node. As such, the depth of the whole tree would be the depth of its deepest leaf node. The root node has a depth of **0**.  	
	g)	**Write algorithm for preorder traversal of binary tree.**	**2 M**
	Ans	Step 1 : Start Step 2: Repeat Steps 3 to 5 while TREE != NULL Step 3: Write TREE -> DATA Step 4: PREORDER(TREE -> LEFT) Step 5: PREORDER(TREE -> RIGHT) [END OF LOOP] Step 6: END **Preorder:** The preorder traversal method performs the following operations: Process the root node (N). Traverse the left subtree of N (L). (c) Traverse the right subtree of N (R).	Correct algorithm – 2 M
2.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a)	**Write a program to implement bubble sort.**	**4 M**
	Ans	/* *Bubble sort code* */ #include <stdio.h> int main()	Correct logic - 4 M

```
{
 int array[100], n, c, d, swap;
 printf("Enter number of elements\n");
 scanf("%d", &n);
 printf("Enter %d integers\n", n);
 for (c = 0; c < n; c++)
  scanf("%d", &array[c]);
 for (c = 0 ; c < n - 1; c++)
 {
  for (d = 0 ; d < n - c - 1; d++)
  {
   if (array[d] > array[d+1]) /* For decreasing order use '<' instead of '>' */
   {
    swap       = array[d];
    array[d]   = array[d+1];
    array[d+1] = swap;
   }
  }
 }
 printf("Sorted list in ascending order:\n");
 for (c = 0; c < n; c++)
   printf("%d\n", array[c]);
 return 0;
}
```

	b)	**Convert following expression into postfix form with illustration of all steps using stack: (A +B-C+D*E/F^G)**	**4 M**

Ans

Character scanned	Stack	Postfix expression
(	(	Empty
(	((	Empty
A	((	A
+	((+	A
B	((+	AB
-	((-	AB+
C	((-	AB+C
+	((+	AB+C-
D	((+	AB+C-D
*	((+*	AB+C-D
E	((+*	AB+C-DE
/	((+	AB+C-DE*
F	((+/	AB+C-DE*F
^	((+/^	AB+C-DE*F
G	((+/^	AB+C-DE*FG
)	(	AB+C-DE*FG^/+
)	Empty	AB+C-DE*FG^/+

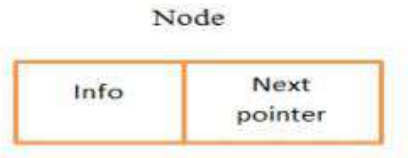
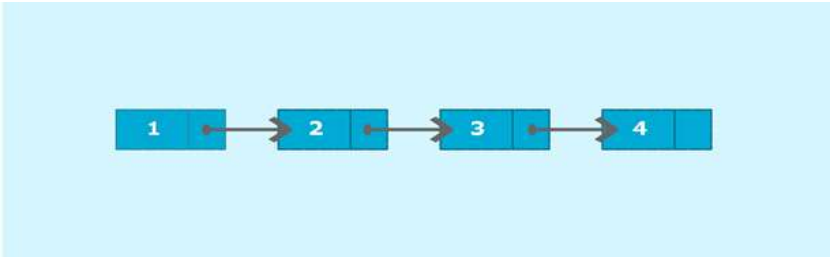
Stepwise carries 4 M

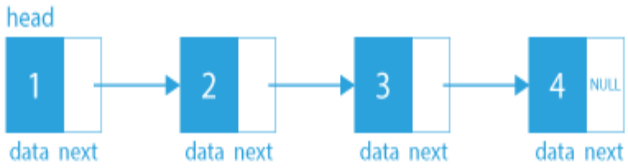
c) Differentiate between Stack and Queue (any four points). **4 M**

Ans

Stacks	**Queues**
Stacks are based on the LIFO principle, i.e., the element inserted at the last, is the first element to come out of the list.	Queues are based on the FIFO principle, i.e., the element inserted at the first, is the first element to come out of the list.
Insertion and deletion in stacks takes place only from one end of the list called the top.	Insertion and deletion in queues takes place from the opposite ends of the list. The insertion takes place at the rear of the list and the deletion takes place from the front of the list.
Insert operation is called push operation.	Insert operation is called enqueue operation.
Delete operation is called pop operation.	Delete operation is called dequeue operation.

Four points carries 4 M

		access the list, called the top, which always points to the last element present in the list.	access the list. The front pointer always points to the first element inserted in the list and is still present, and the rear pointer always points to the last inserted element.
		Stack is used in solving problems works on recursion.	Queue is used in solving problems having sequential processing.
		Stack does not have any types.	Queue is of three types – 1. Circular Queue 2. Priority queue 3. double-ended queue.
	d)	**Explain node structure for single linked list. Also write advantages of singly list over array. (any Two)**	**4 M**
	Ans	• **Node:** Each data element in a linked list is represented as a node. Node contains two parts one is info (data) and other is next pointer (address). Info part stores data and next pointer stores address of next node.  Singly Linked List The singly linked list is a linear data structure in which each element of the list contains a pointer which points to the next element in the list. Each element in the singly linked list is called a node. Each node has two components: data and a pointer next which points to the next node in the list. The first node of the list is called as head, and the last node of the list is called a tail. The last node of the list contains a pointer to the null. Each node in the list can be accessed linearly by traversing through the list from head to tail.  Consider the above example; node 1 is the head of the list and node 4 is the tail of the list. Each node is connected in such a way that node 1 is pointing to node 2 which in turn	Advantages 2 M and structure of singly linked list – 2 M

		pointing to node 3. Node 3 is again pointing to node 4. Node 4 is pointing to null as it is the last node of the list. **Advantages of a Linked List over Array** Arrays allow random access and require less memory per element (do not need space for pointers) while lacking efficiency for insertion/deletion operations and memory allocation. On the contrary, **linked lists are dynamic and have faster insertion/deletion time complexities** 1) **Dynamic Data Structure:** Linked List being a dynamic data structure can shrink and grow at the runtime by deallocating or allocating memory, so there is no need for an initial size in linked list.  Whereas an initial size has to be declared in an array, and the number of elements cannot exceed that size. 2) **No Memory Wastage:** As the size of a linked list can grow or shrink at runtime, so there is no memory wastage. Only the required memory is allocated. In arrays, we have to first initialize it with a size which we may or may not fully use; hence wastage of memory may occur. 3) **Implementation:** Some very helpful data structures like queues and stacks can be easily implemented using a Linked List. 4) **Insertion and Deletion Operation:** In a Linked List, insertion and deletion operations are quite easy, as there is no need to shift every element after insertion or deletion. Only the address present in the pointers needs to be updated. While in an array, we have to shift elements. Suppose we have an array that is sorted, and now we need to insert some element in the array in a sorted way. Let arr[]= [1, 3 , 5, 7, …..], and we have to insert 2. So, all the elements after 1 have to move by one place towards the right.	
3.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a)	**Explain stack overflow and stack underflow with example.**	**4 M**

Ans

Stack Overflow:

Stack overflow caused by an insertion in a stack that is already full.

Before you push an element into the stack, first check whether stack is full or not.

If stack is full then stack overflow, else push element onto the stack.

if (isfull()= =1) then stack overflow , else push( ) element on the stack.

Stack overflow with diagram-2M

Example:

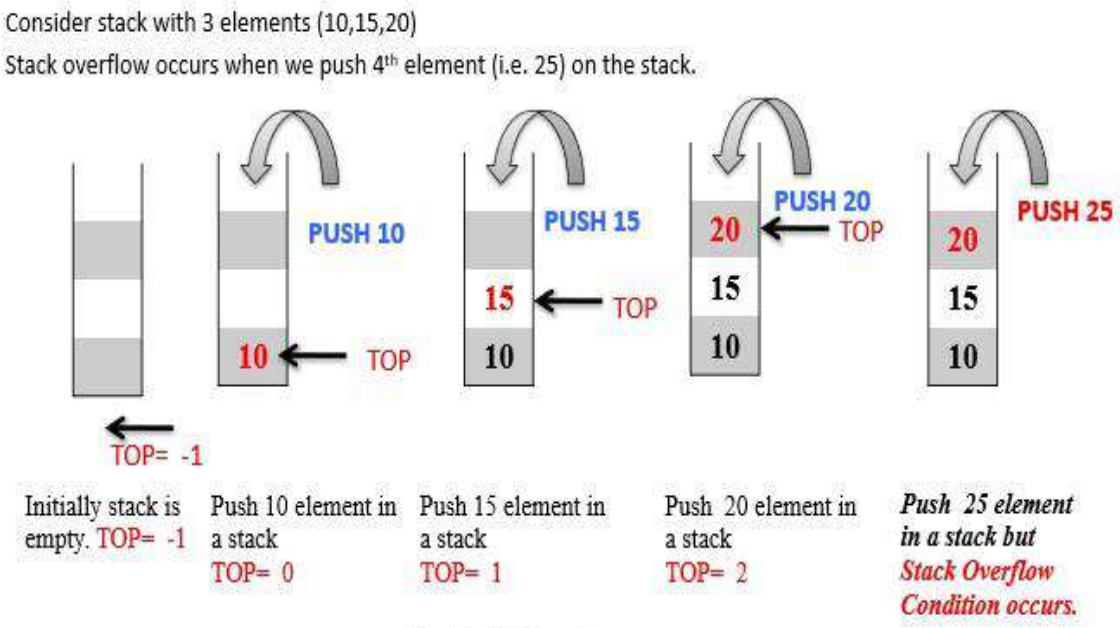


Fig. Stack Overflow

Stack Underflow:

Stack underflow caused by deletion of an element from an empty stack.

if (isempty()= =1) then stack Underflow , else pop( ) element from the stack.

Stack underflow with diagram-2M

Example:

Consider stack with 3 elements (10,15,20)

Stack underflow occurs when we pop an element from the empty stack.

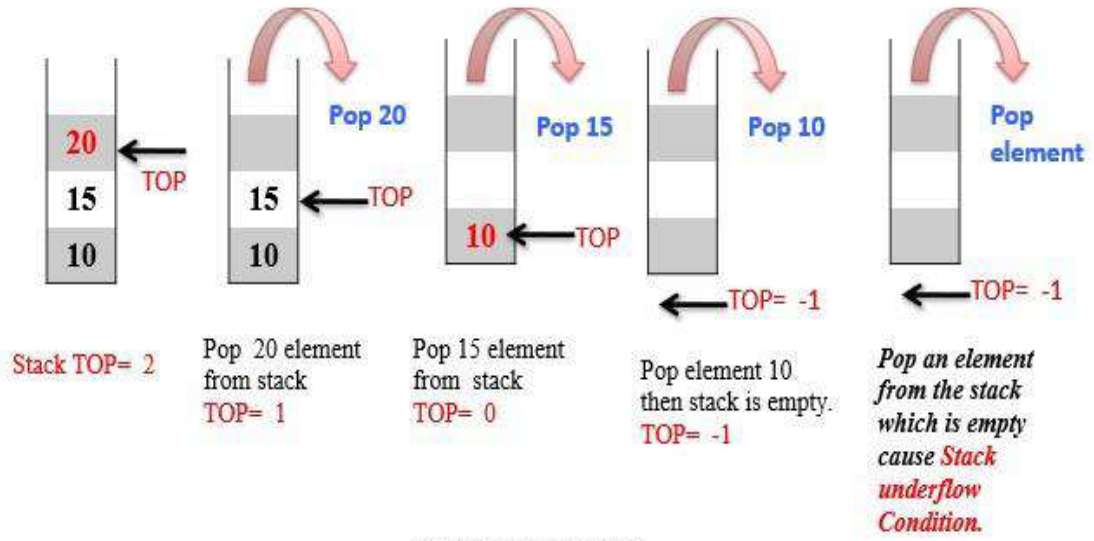
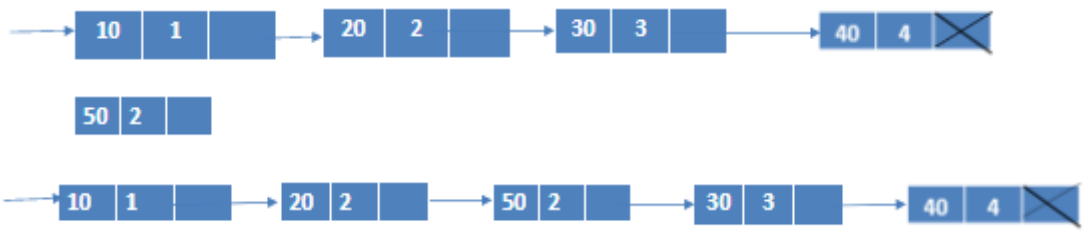


Fig. Stack Underflow

	b)	**With a neat sketch explain working of priority queue.**	**4 M**
	Ans	**Priority Queue:** • A priority queue is a data structure in which each element is assigned a priority. The priority of the element will be used to determine the order in which the elements will be processed. • The general rules of processing the elements of a priority queue are • An element with higher priority is processed before an element with a lower priority. • Two elements with the same priority are processed on a first-come-first-served (FCFS) basis. • A priority queue can be thought of as a modified queue in which when an element has to be removed from the queue, the one with the highest-priority is retrieved first. 	Diagram 2M Explanation 2M

Operation on priority queue

1) Insertion in priority queue
- When a new element has to be inserted in a priority queue, we have to traverse the entire list until we find a node that has a priority lower than that of the new element.
- The new node is inserted before the node with the lower priority. However, if there exists an element that has the same priority as the new element, the new element is inserted after that element.

2) Deletion in priority queue
- It is a very simple process in this case.
- The first node of the list will be deleted, and the data of that node will be processed first.

c) Find location of element 20 by using binary search algorithm in the list given below: — 4 M

10, 20, 30, 40, 50, 60, 70, 80

Ans

Binary Search: — Each correct step-1M

Array A: {10,20,30,40,50,60,70,80} and key element 20

Step 1: Store given sorted elements in an array say A[8].

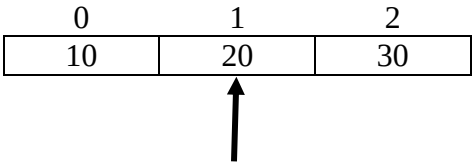
0	1	2	3	4	5	6	7
10	20	30	40	50	60	70	80

Step 2:
- First set Begin and End.
- Begin(i)=0
- End(j)=7
- Mid=(Begin + End)/2=(0+7)/2=3.5=3
- Compare A[Mid]= =key
- Here A[Mid]=A[3]=40 & key=20
- Key< A[Mid] i. e 20<40

0	1	2	3	4	5	6	7
10	20	30	40	50	60	70	80

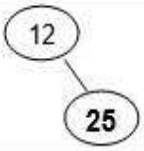
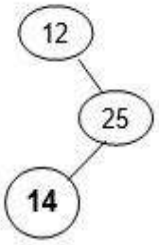
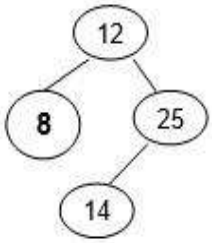
Mid

Step 3:
- key can be found in left side of Mid element.
- Beginning remain same and end will change to Mid-1.

		• Begin(i)=0 • End(j)=Mid-1=3-1=2 • Mid=(Begin + End)/2=(0+2) / 2=2 / 2=1  **Mid** Step 4: • Compare A[Mid]= =key • Here A[Mid]=A[1]=20 & key=20 • Key == A[Mid] i. e 20 = =20 **Thus element is found at A[1] location in an array [10,20,30,40,50,60,70,80]**	
	d)	**Explain Binary Search Tree (BST) with example.**	**4 M**
	Ans	**Binary Search Tree (BST):** **A binary tree which is either empty or in which each node contains a key that satisfies the following condition-** 1. All keys are distinct. 2. For every node 'x' in the tree the value of all the keys in its left sub tree are smaller than the key value in 'X' 3. For every node 'x' in the tree the value of all the keys in its right sub tree are larger than the key value in 'X'. In BST, Nodes are arranged such that all nodes in a left sub tree having less values than the root node & all the nodes in right subtree having values greater than root node. **Characteristics of BST** 1. All the nodes in a left sub tree having less values than root node. 2. All the nodes in a right sub tree having greater values than root node. so faster insertion, deletion & searching can be performed.	Explanation= 2M Example=2M

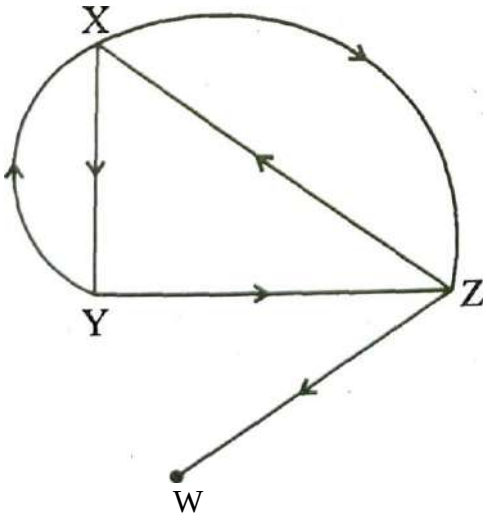
Example:

BST for following Data: 12, 25, 14, 8

Sr. No	Input Element	Operation/Description	Tree
1.	**12**	First element Insert into tree	
2.	**25**	Compare 25 with 12 i.e., 25>12 so goes to right of 12	
3.	**14**	Compare 14 with 12 i.e., 14>12 so goes to right of 12 But there is 25 so compare 25 with 14 i.e.,14<25 so, 14 goes to left of 25	
4.	**8**	Compare 8with 12 i.e., 8<12 so goes to left of 12	

4.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a)	**Differentiate between linear and non-linear data structure. (any four points)**	**4 M**
	Ans		Any 4 valid points: 1 M each

Sr.	Linear data structure	Non- Linear data structure
1	Data elements are arranged in a linear order	Data elements are arranged in a non-linear (hierarchical) order
2	Single level is involved.	Multiple level is involved.
3	Implementation is easy	Implementation is complex
4	Memory is not utilized in an efficient way.	Memory is utilized in an efficient way.
5	Examples are: array, stack, queue, linked list, etc.	Examples are: trees and graphs.
6	Application: software development.	Application: Artificial Intelligence and image processing.

	b)	**Consider the graph given below:**  **(i) Find indegree(x)** **(ii) Find outdegree(z)** **(iii) Find sink node** **(iv) Successor of node y**	**4 M**
	Ans	Indegree (x): 2 Outdegree (z): 2 Sink Node: W Successor of node y: Z	1M each correct answer
	c)	**Describe working of linear search with example.**	**4 M**

Ans **Working of Linear Search:**

In linear search, elements are examined sequentially starting from first element.
It traverse data sequentially to find particular data.
The process of searching end when comparison results in success.
Searching continues sequentially till the record with matching key(i.e. element to be search)is compared with other elements.
Compare key with each element one by one .
Not Suitable for searching when large number of elements are given.
Time consuming.

Working-2M

Example-2M

Example:

Consider the array A={23,16,5,105}
Find key=5 is present or not.

Index	Element
0	23
1	16
2	5
3	105

← Key=5 Compare A[0]==5 No match

Index	Element
0	23
1	16
2	5
3	105

← Key=5 Compare A[1]==5 No match

Index	Element
0	23
1	16
2	5
3	105

← Key=5 Compare A[2]==5 **Match Found**

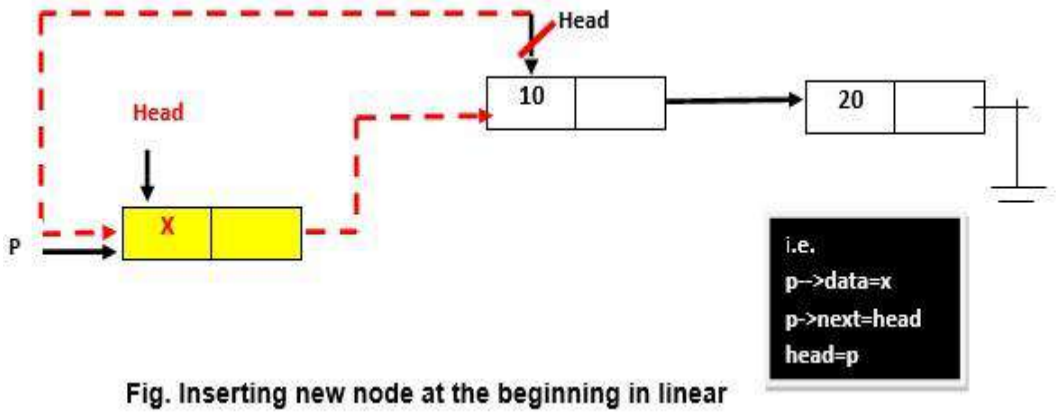
Thus, key element 5 is found at A[2] i.e. in the third location

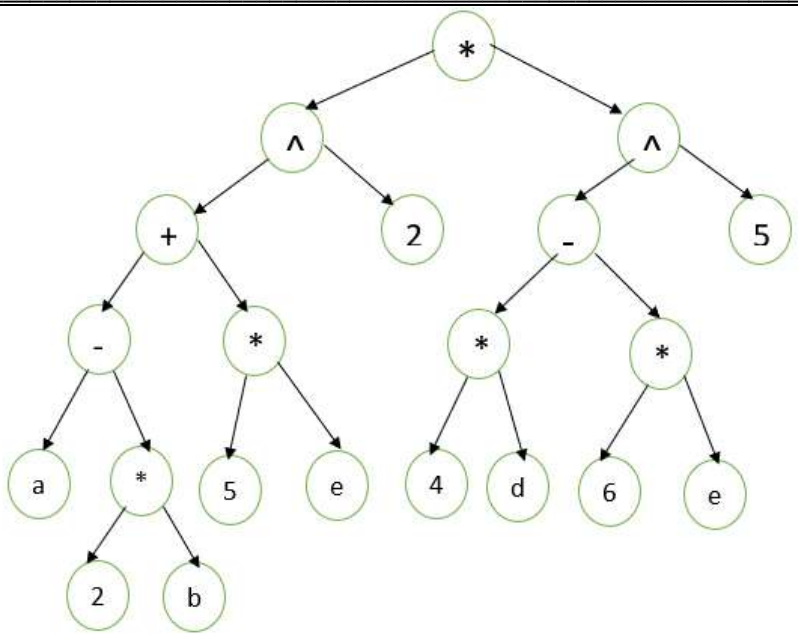
d) **Compare linear list with circular list.** **4 M**

Ans

Sr.	Linear List	Circular List
1	Next field of the last node is set to NULL	Next field of the last node is connected back to head node.
2	Points to first node	Points to last node.
3	Insertion at end has O(n)	Insertion at end has O(1) complexity

Any 4 points: 1 M each

				complexity.	
			4	Ends on Finding the NULL pointer	Searching terminates on coming to first node.
			5	Not suited for implementing data structure.	Can be used for Queue data structure.
	e)	**Write an algorithm to insert a new node at the beginning in linear list.**			**4 M**
	Ans	**Algorithm to insert a new node at the beginning in linear list:** 1. START 2.Obtain free space for new node 3. Assign data to the data field of new node. 4.Set the next field of new node to the beginning of the list. 5.Change the reference pointer(head) of the linked list to point new node. 6.STOP  **Fig. Inserting new node at the beginning in linear**			4 M for insert a new node at the beginning in linear list
5.		**Attempt any <u>TWO</u> of the following:**			**12 M**
	a)	**Draw tree for given expression :** **$(a-2b+5c)^2 * (4d -6e)^5$.**			**6 M**

	Ans		Correct tree structure - 6 M
	b)	**Write a 'C' program for insert and delete operation to be performed on queue.**	**6 M**
	Ans	**Program:** **//Implementation of queue as Data Structure using array;** #include <stdio.h> #define qsize 5 int front; int rear; int queue[qsize]; void insertq(int);// function declaration void deleteq(); void display(); int main() { //initially queue is empty front = rear =-1; int x,choice; do { printf("Queue Operations\n"); printf("1.Insert\n2.Delete\n3.Display\n4.Exit"); printf("Enter your choice 1\2\3\4"); scanf("%d",&choice); switch(choice) { case 1: {	6M for correct program

```
printf("Enter value to be added\n");
scanf("%d",&x);
insertq(x);
break;
}
case 2: {
deleteq();
break;
}
case 3: {
display();
break;
}
case 4: {
printf("Exit\n");
break;
}
default: printf("Enter Valid choice from 1/2/3/4\n");
break;
 }
}while(choice !=4);
return 0;
}
void insertq(int x)
{
//check queue is full?yes or no
if(rear == qsize-1)
printf("Queue is Overflow\n");
else
{
//queue with zero element
if(front ==-1 && rear==-1)
{
front=0;
rear =0;
}
else
{
// queue with one or more element
rear = rear +1;
}
 // add new element at rear end of queue
queue[rear]=x;
```

```
 }
}
void deleteq()
{
 int x;
 //check queue underflow? yes or no
 if (front==-1 && rear==-1)
 {
 printf("queue is underflow\n");
  }
 else
 {
 // identify element to be processed
 x= queue[front];
 //is it the last element
 if(front==rear)
 {
 front=rear=-1;// queue is empty
 }
 else
 {
 front = front+1;
 }
  printf("element %d is deleted\n",x);
 }
}
void display()
{
 int i;
 if(front==-1 && rear ==-1)
 {
 printf("Queue is Empty\n");
 }
 else
 {
 printf("Queue elements are\n");
 for(i=front; i<=rear; i++)
 {
 printf("%d\t",queue[i]);
 }
 }
}
```

	c)	**Write a 'C' program for insertion sort.** **Sort the following array using insertion sort: 30 10 40 50 20 45**	**6 M**
	Ans	**Program to implement insertion sort:** #include <stdio.h> int main() { int a[10],n,i,min,j,key; printf("Enter number of elements\n"); scanf("%d",&n); printf("enter %d elements\n",n); for (i=0;i<n;i++) { scanf("%d",&a[i]); } for(i=1;i<=n-1;i++) { key= a[i]; for (j=i-1 ; j >=0 && a[j] > key ;j--) { a[j+1]= a[j]; } a[j+1]= key ; } printf("Sorted Array\n "); for (i=0;i<n;i++) { printf("%d\t",a[i]); } return 0; } **Example:**	Insertion Program-3 M Example with all iterations -3 M

pass-1	**30**	10	40	50	20	45
	SA	**USA**				

10	**30**	40	50	20	45
SA		**USA**			

pass-2	**10**	**30**	40	50	20	45
	SA		**USA**			

10	**30**	**40**	50	20	45
SA			USA		

pass-3

10	**30**	**40**	50	20	45
SA			**USA**		
10	**30**	**40**	**50**	20	45
SA				**USA**	

pass-4

10	**30**	**40**	**50**	20	45
SA				**USA**	

10	30	40	50	**50**	45
SA				**USA**	

10	30	40	**40**	**50**	45
SA				**USA**	

10	30	**30**	**40**	**50**	45
SA				**USA**	

10	**20**	**30**	**40**	**50**	45
SA					**USA**

pass-5

10	**20**	**30**	**40**	**50**	45
SA					**USA**

10	**20**	**30**	**40**	**50**	**50**
SA				**USA**	

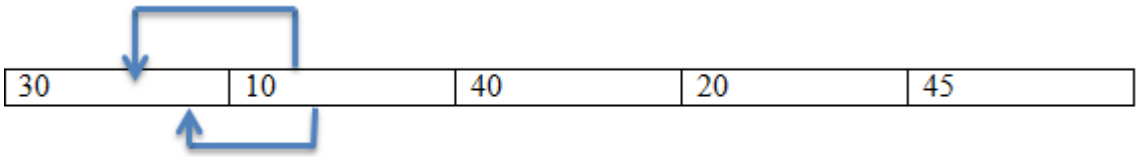
10	**20**	**30**	**40**	**45**	**50**
SA					

OUTPUT:

10	**20**	**30**	**40**	**45**	**50**
SA					

OR

Pass1: 1st element is compared with all previous element (i.e. 0th element)



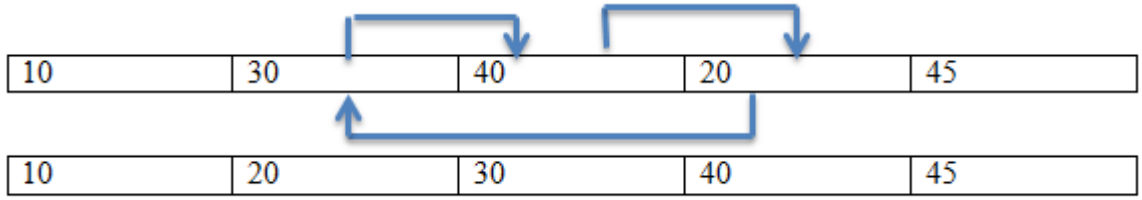
10	30	40	20	45

Since 30>10, move 30 to right and insert (place) 10 to its correct position.

Pass 2: Second element is compared with all previous element (i.e. 0th and 1st)

Since 10<40 and 30<40, 40 is at its correct position.

Pass 3: 3rd element is compared with all previous elements (i.e. 0th, 1st and 2nd)



Since 40>20, move 40 to right and compare 30 with 20 again. Again 30>20 move 30 to right and compare 10 with 20. As 10<20 insert (place) 20 to a[1] position.

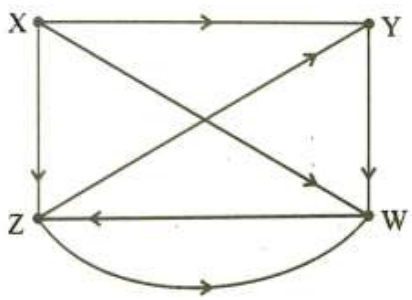
Pass 4: 4th element is compared with all its previous elements(i.e. 0th, 1st , 2nd and 3rd)

10	20	30	40	45

Since 10<45, 20<45, 30<45 and 40<45, 45 is at its correct position.

Sorted array is

10	20	30	40	45

6.		**Attempt any <u>TWO</u> of the following:**	**12 M**
	a)	**Consider the graph G given below:**  **i) Write Adjacency matrix representation.** **ii) Write Adjacency list.**	**6 M**
	Ans	**Adjacency matrix representation.** **W X Y Z** **W** [**0 0 0 1**] **X** [**1 0 1 1**] **Y** [**1 0 0 0**] **Z** [**1 0 1 0**] **Adjacency list.** **Header Node** | **Adjacent Node list** W | Z X | W, Y, Z Y | W Z | W, Y	Correct Adjacency Matrix-3 M Correct Adjacency List-3 M
	b)	**Write a menu driven 'C' program to implement stack using array with the following menu: (i)push (ii)pop (iii)display (iv)exit**	**6 M**
	Ans	**Menu driven program to implement stack operations** #include<stdio.h> #define stacksize 5 int stack[stacksize]; int top; void push(int x); void pop();	Each operation with correct logic code -1 M each Main function and

```
void display();
int main()
{
   //clrscr();
   top=-1;
   int choice,x,i;
      printf("\n\t STACK OPERATIONS USING ARRAY");
   printf("\n\t--------------------------------");
   printf("\n\t 1.PUSH\n\t 2.POP\n\t 3.DISPLAY\n\t 4.EXIT");
   do
   {
      printf("\n Enter the Choice:");
      scanf("%d",&choice);
      switch(choice)
      {
         case 1:
         {
            printf("Enter value to be pushed into stack\n");
            scanf("%d",&x);
            push(x);
            break;
         }
         case 2:
         {
            pop();
            break;
         }
         case 3:
         {
            display();
            break;
         }
         case 4:
         {
            printf("\n\t EXIT POINT ");
            break;
         }
         default:
         {
            printf ("\n\t Please Enter a Valid Choice(1/2/3/4)");
         }
         }
   }
```

stack initialization- 2 M

```
   while(choice!=4);
   return 0;
}
void push(int x)
{
   if(top== stacksize-1)
   {
      printf("\n\tSTACK is over flow");
         }
   else
   {
       top++;
      stack[top]=x;
   }
}
void pop()
{
   int x;
   if(top==-1)
   {
      printf("\n\t Stack is under flow");
   }
   else
   {
      x= stack[top];
      printf("\n\t The popped elements is %d",x);
      top--;
   }
}
void display()
{
   if(top>=0)
   {
      printf("\n The elements in STACK \n");
      for(int i=top; i>=0; i--)
         printf("\n%d",stack[i]);
      printf("\n Press Next Choice");
   }
   else
   {
      printf("\n The STACK is empty");
   }
  }
```

	c)	**Write the 'C' function for:** **(i) searching a node in single linked list.** **(ii) counting number of nodes in single linked list.**	**6 M**
	Ans	**I. searching a node in single linked list.** void search( ) { printf("enter data to be searched\n"); scanf("%d", &data); struct node *ptr; int pos=1; ptr=start; while(ptr!=NULL) { if(ptr->info==x) { printf("element %d is found at position %d\n",x,pos); break; } else { ptr=ptr->next; pos++; } } if(ptr==NULL) printf("element %d not found in list\n",x); } **II. Counting number of nodes in single linked list.** void count() { struct node *ptr; int c=0; ptr=start; while(ptr!=NULL) { ptr=ptr->next; c++; } printf("no of nodes in list are %d\n",c); }	Correct function for searching node – 3 M Correct function for Counting nodes – 3 M

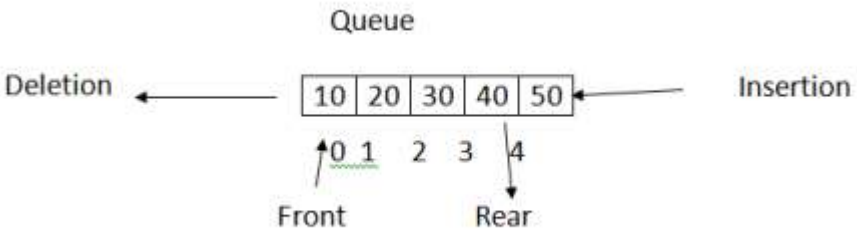
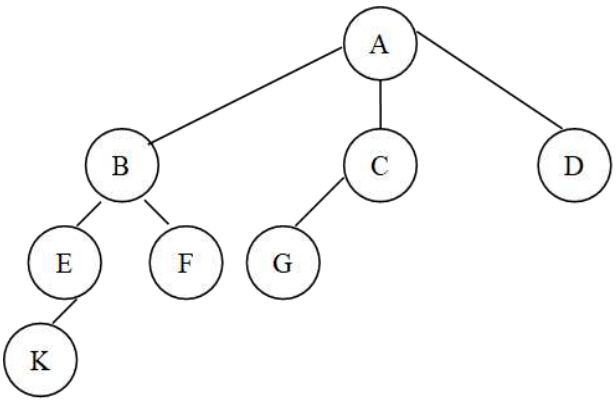
SUMMER – 2023 EXAMINATION
Model Answer – Only for the Use of RAC Assessors

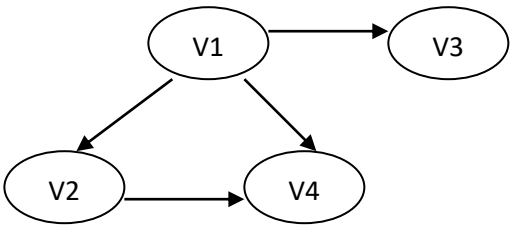
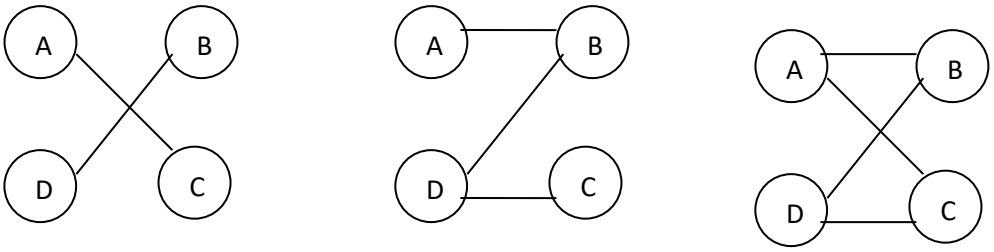
Subject Name: Data Structure Using C **Subject Code:** 22317

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any FIVE of the following:**	**10 M**
	a)	**Write any four operations performed on data structure.**	**2 M**
	Ans	Insert Travese Create Destroy Select Update Copy Merge Search Sort	Each one carries ½ M

	b)	**Draw the diagram of Linear Queue to represent front and rear pointers.**	**2 M**
	Ans		Correct diagram carries - 2 M
	c)	**State the following terms:** **(i) Leaf node of a tree** **(ii) Degree of a tree**	**2 M**
	Ans	**Leaf Node:** Lead node is a terminal node of a tree. It does not have any nodes connected to it. K, F, G, and D are leaf nodes. All other nodes are called non-leaf nodes or internal nodes **Degree of the Tree:** The degree of a tree is the maximum degree of the nodes in the tree. The degree of the shown tree is 3. 	Each definition with example carries – 1 M
	d)	**Write any two operations performed on the stack.**	**2 M**
	Ans	1) Push 2) Pop 3) Stack overflow 4) Stack underflow.	Each operation carries – 1 M
	e)	**What are directed and undirected graphs ?**	**2 M**
	Ans	**Directed Graph:** A directed graph G is also called **digraph** which is same as a multigraph except that each edge e in G is assigned a direction or in other words, each edge in G is identified with an ordered pair (U,V) of nodes in G rather than an unordered pair.	Each type carries – 1 M

		 G=(V,E) V(G)={V1,V2,V3,V4} E(g)={(V1,V2),(V1,V4),(V2,V4), (V1,V3)} **Undirected Graph:** An undirected graph G is a graph in which each edge e is not assigned a direction. 	
	f)	**Explain linear and non-linear data structures.**	**2 M**
	Ans	A linear data structure is one in which the components are stored in a **sequential order and are linked** to the elements before and after them. Array, Stack, Queue, Linked list, and other linear data structures are examples. When the data items or pieces of a data structure are not placed sequentially or linearly, the data structure is called to be non-linear. Because the items are not stored sequentially, they cannot be traversed or retrieved in a single iteration that is the single level is not engaged in non-linear data structures. In **terms of implementation**, a **non-linear data** structure is difficult. When compared to linear data structures, they make better use of system memory. Tree and graph are examples of non-linear data structures. The tree data structure contains a hierarchical relationship. Non-linear data structures are memory efficient because they do not require a memory allocation in advance, as previously stated.	Explanation carries – 1 M
	g)	**Define Searching. What are its types?**	**2 M**
	Ans	Searching is an operation or a technique that helps finds the place of a given element or value in the list. Any search is said to be successful or unsuccessful depending upon whether the element that is being searched is found or not. Some of the standard searching technique that is being followed in the data structure is listed below: • Linear Search or Sequential Search • Binary Search	Correct def: 1m, types- 1m
2.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a)	**Sort the following elements using Radix Sort Method:**	**4 M**

{361, 12, 527, 143, 9, 768, 3481}.

Ans

First Iteration: Sort the numbers according to Unit place

Inputs	Pockets									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0361		0361								
0012			0012							
0527								0527		
0143				0143						
0009										0009
0768									0768	
3481		3481								

Output = {0361,3481,0012,0143,0527,0768,0009}

Second Iteration: Sort the numbers according to 10th place

Inputs	Pockets									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0361							0361			
3481									3481	
0012		0012								
0143					0143					
0527			0527							
0768							0768			
0009	0009									

Output = {0009,0012,0527,0143,0361,0768,3481}

Third Iteration: Sort the numbers according to 100th place

Inputs	Pockets									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0009	0009									

Each iteration carries – 1 M

0012	0012									
0527						0527				
0143		0143								
0361				0361						
0768								0768		
3481					3481					

Output = {0009,0012,0143,0361,3481,0527,0768}

Fourth Iteration: Sort the numbers according to 1000th place

Inputs	**Pockets**									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0009	0009									
0012	0012									
0143	0143									
0361	0361									
3481				3481						
0527	0527									
0768	0768									

Output = {0009,0012,0143,0361,0527,0768,3481}

Sorted Numbers are = 0009,0012,0143,0361,0527,0768,3481

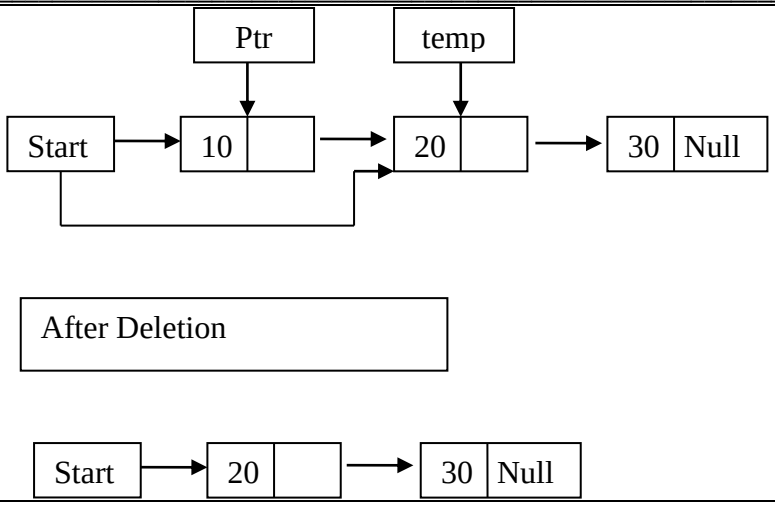
b) Write an algorithm to delete a node at the beginning from a singly Linked List. **4 M**

Ans

Deletefirst(start)

1. [check for Underflow]
   if start=NULL then print 'List is Empty'
   exit
   endif
2. set Ptr=start
3. set start=start->next
4. print 'Element deleted is Ptr->info
5. free(Ptr)

Correct logic carries – 4 M



	c)	**Explain stack overflow and underflow conditions with example.**	**4 M**
	Ans	**Stack Overflow condition**: When stack is completely full (i.e. TOP= MaxSize -1) and we try to insert more element onto stack then this condition is called overflow condition and no further element could be inserted now until any element is deleted. **Stack Overflow:** This is the situation when the stack becomes full, and no more elements can be pushed onto the stack. At this point the stack top is present at the highest location of the stack. Push e D Top=4 C Top=3 B Top=2 A Top=1 Top=0 **Underflow Condition:** When a stack is empty (i.e. TOP= -1) and we try to delete more element from it, then this condition is called underflow condition. **Stack empty or underflow:** This is the situation when the stack contains no element. At this point, the top of stack is present at the bottom of the stack. Pop Top=0	stack overflow and underflow carries 2 M with example
	d)	**Implement a C program to insert an element in an array.**	**4 M**
	Ans	#include<stdio.h> #include<conio.h> void main() {	Any correct suitable program

```
int x,i,max=10,pos,K,n,a[10];
clrscr();
printf("Enter number of element");
scanf("%d",&n);
if(n<max)
{
printf("Enter the element:\n");
for(i=0;i<n;i++)
{
printf("Enter element %d\t",i+1);
scanf("%d",&a[i]);
}
printf("Array");
for(i=0;i<n;i++)
{
printf("\n element no %d is %d",i+1,a[i]);
}
printf("\n Enter the element to be added:");
scanf("%d",&x);
printf("Enter the postion of the element where element to be added");
scanf("%d",&pos);
for(i=n;i>=pos;i--)
{
a[i]=a[i-1];
}
a[pos-1]=x;
printf("Array with element inserted:");
for(i=0;i<n+1;i++)
{
printf("\n Element no %d is %d",i+1,a[i]);
}
}
else
{
printf("Memory not available....\n try again 1=y,2=n");
scanf("%d",&K);
if(K==1)
main();
else
exit();
}
getch();
}

//OUTPUT
/*Enter number of element5
Enter the element:
Enter element 1 23
Enter element 2 32
```

4 M

```
Enter element 3 65
Enter element 4 12
Enter element 5 45
Array
 element no 1 is 23
 element no 2 is 32
 element no 3 is 65
 element no 4 is 12
 element no 5 is 45
 Enter the position of element to be added:89
Enter the postion of the element where element to be added 1
Array with element inserted:
 Element no 1 is 89
 Element no 2 is 23
 Element no 3 is 32
 Element no 4 is 65
 Element no 5 is 12
 Element no 6 is 45
*/
```

3. **Attempt any THREE of the following:** **12 M**

a) **Differentiate between tree and graph with respect to any four parameters.** **4 M**

Ans

Parameter	Tree	Graph
Path	Only one between two vertices	More than one path allowed
Root node	It has exactly one root node	Graph may or may not have root node
Loop	No loop are permitted	Graph can have a loop
No. of edges	N-1	Not defined
complexity	Less complex as compared to graph	More complex as compared to tree
Traversal technique	Preorder, postorder and inorder	Breadth first search and depth first search
Parent child relationship	Parent child relationship exists	No parent child relationship exists
Application	Decision tree, sorting	Finding shortest path, route optimization.

Any 4 correct points – 4 M

b) **Write an algorithm to delete an intermediate node in a singly linked list.** **4 M**

Ans Step 1: IF START = NULL

Correct algorithm – 4 M

Write UNDERFLOW

Go to Step 1 [END OF IF]

Step 2: SET PTR = START

Step 3: SET PREPTR = PTR

Step 4: Repeat Steps 5 and 6 while PREPTR DATA != NUM

Step 5: SET PREPTR = PTR

Step 6: SET PTR = PTR NEXT [END OF LOOP]

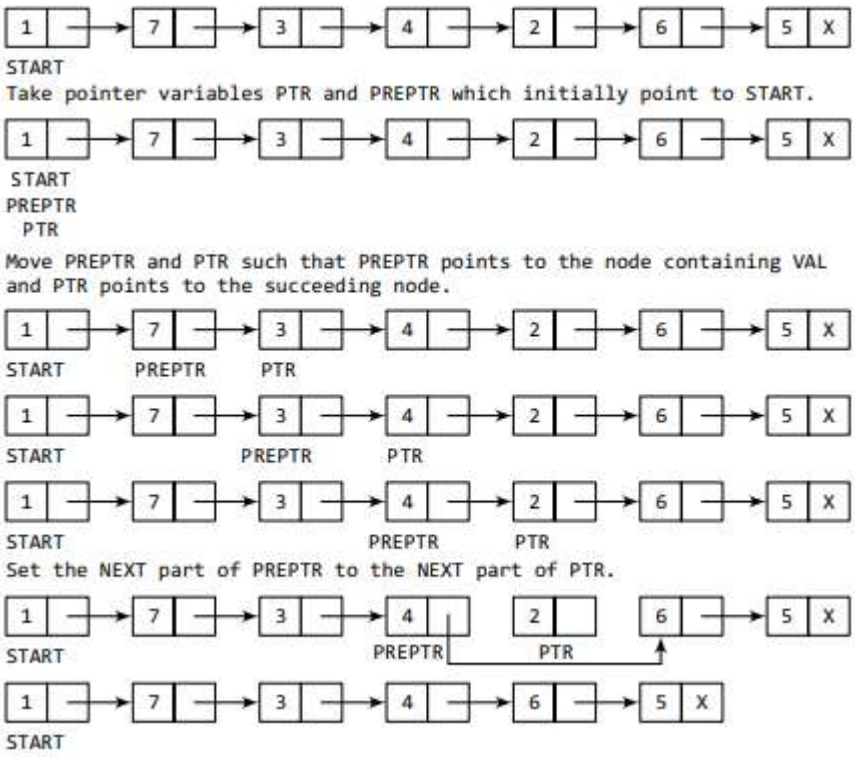
Step 7: SET TEMP = PTR

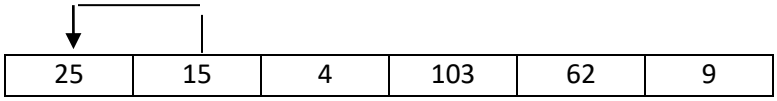
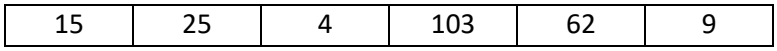
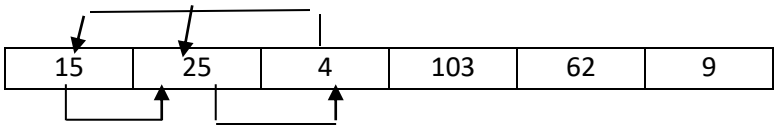
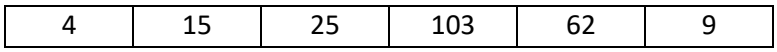
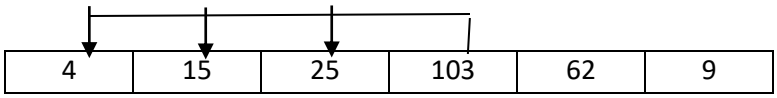
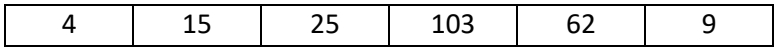
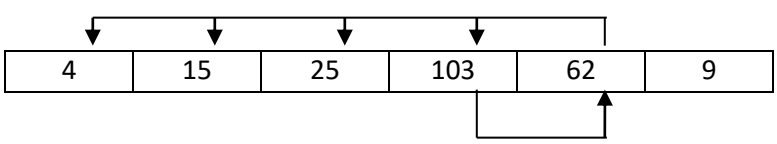
Step 8: SET PREPTR NEXT = PTR NEXT

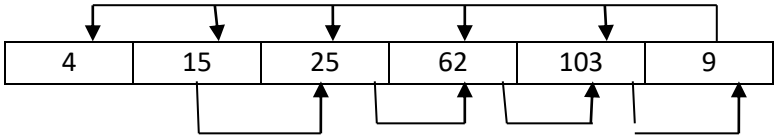
Step 9: FREE TEMP

Step 10 : EXIT

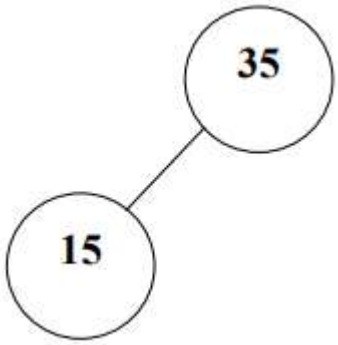
Consider the linked list shown in Fig. Suppose we want to delete the node that succeeds the node which contains data value 4. Then the following changes will be done in the linked list.



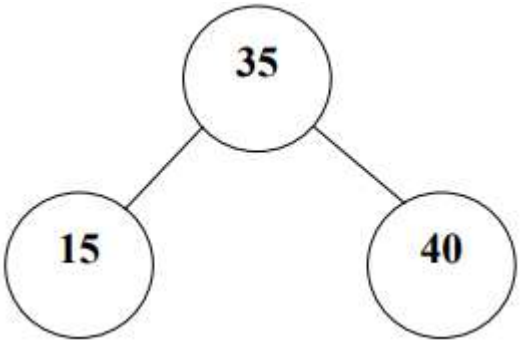
	c)	**Sort the following numbers in ascending order using Insertion sort:** **{25, 15, 4, 103, 62, 9} and write the output after each iteration.**	**4 M**
	Ans	Pass1: 1st element is compared with all previous element (i.e., 0th element)  Since 25>15, move 25 to right and insert (place) 15 to its correct position. Array elements after pass 1  Pass 2: Second element is compared with all previous element (i.e., 0th and 1st)  Since 15>4 and 25>4 move 15 and 25 to right by one position and insert (place) 4 to its correct position. Array element after pass 2  Pass 3: 3rd element is compared with all previous elements (i.e., 0th, 1st and 2nd)  Since 4<103, 15<103 and 25<103, 103 is at its correct position. Array element after pass 3  Pass 4: 4th element is compared with all its previous elements(i.e. 0th, 1st , 2nd and 3rd)  	Any Correct answer – 4 M

		<table><tr><td>4</td><td>15</td><td>25</td><td>103</td><td>62</td><td>9</td></tr></table> Compare 62 with 4, Since 62> 4, Compare 62 with 15, since 62> 15, Compare 62 with 25, since 62> 25. Again compare 62 with 103, since 62<103, move 103 to its right position by 1 element and insert (place) 62 to its right position i. e. a[3]. Array after pass 4 <table><tr><td>4</td><td>15</td><td>25</td><td>62</td><td>103</td><td>9</td></tr></table> Pass 5: 5th element is compared with all its previous elements(i.e. 0th, 1st , 2nd, 3rd and 4th)  Compare 9 with 4, Since 9> 4, compare 9 with 15, since 9< 15, Compare 9 with 25, since 9< 25. Compare 9 with 103, since 9< 103. Shift or move 15, 25, 62 and 103 to its right by 1 position and insert(place) 9 to its correct position i. e. a[1].	
	d)	**Construct the Binary Search Tree using following elements :** **(35, 15, 40, 7, 10, 100, 28, 82, 53, 25, 3}. Show diagrammatically each Step of construction of BST.**	**4 M**
	Ans	Step 1:- Inserting Element 35 	Correct answer – 4 M

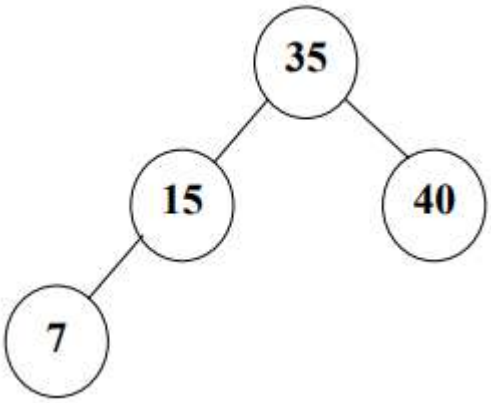
Step 2:- Inserting Element 15



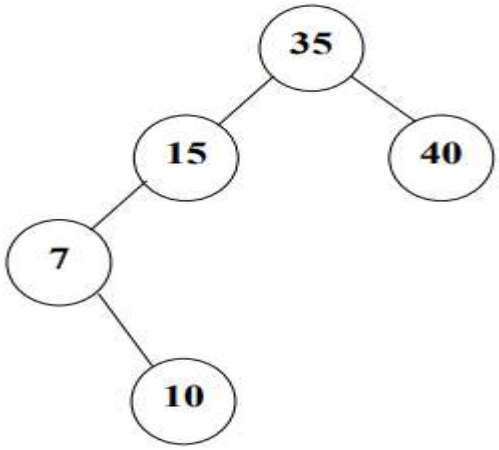
Step 3:- Inserting Element 40



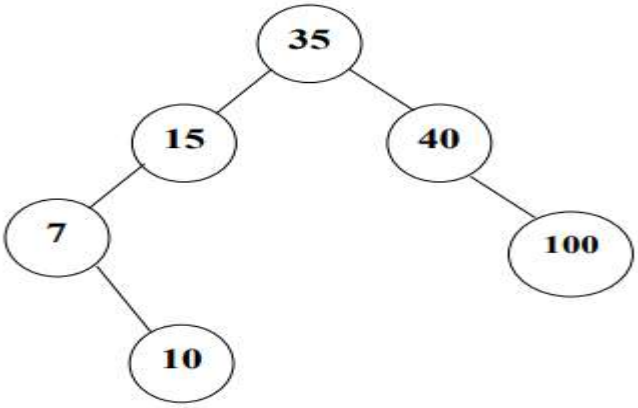
Step 4:- Inserting Element 7



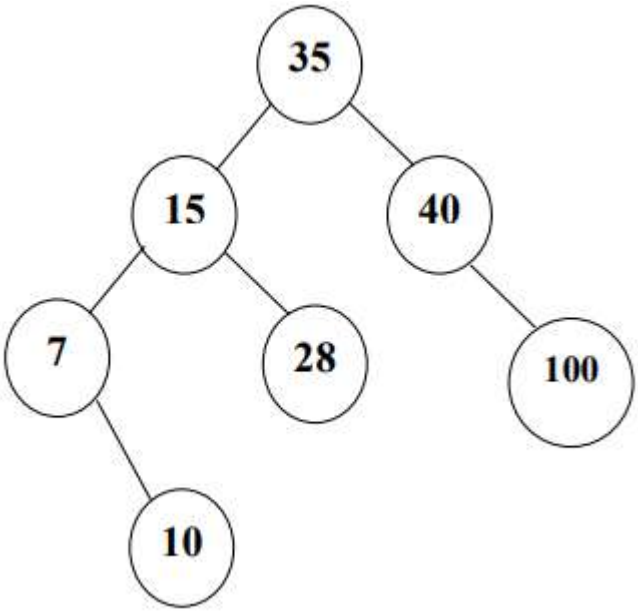
Step 5:- Inserting Element 10



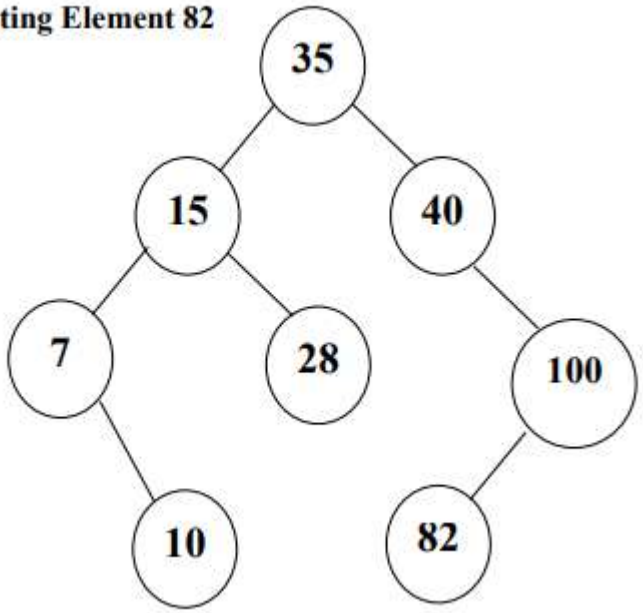
Step 6:- Inserting Element 100



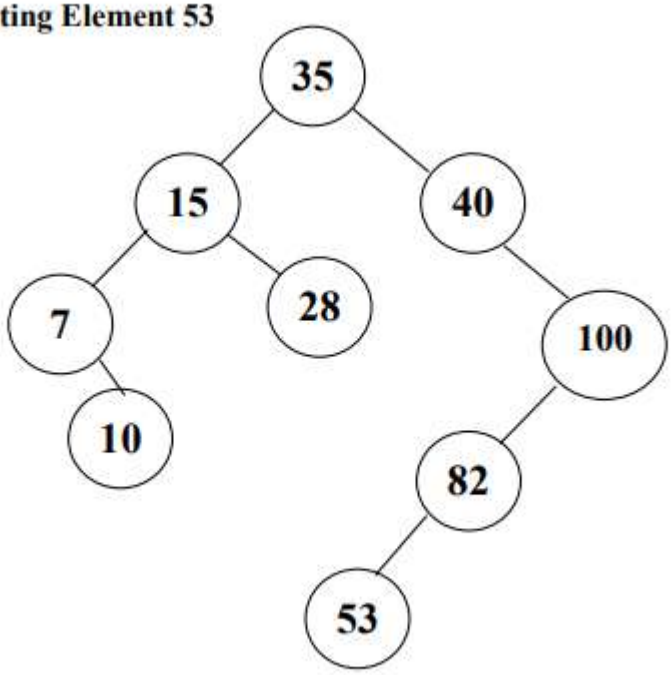
Step 7: - Inserting Element 28



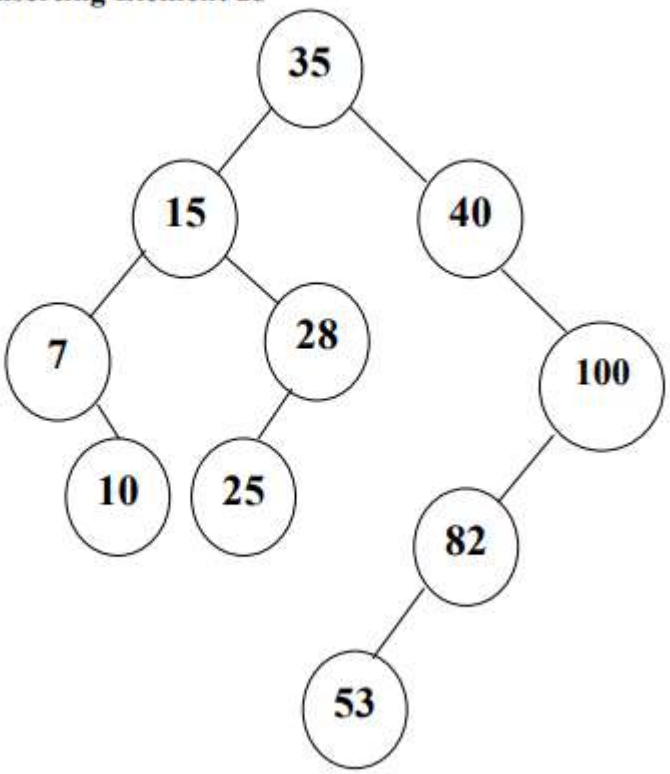
Step 8: - Inserting Element 82



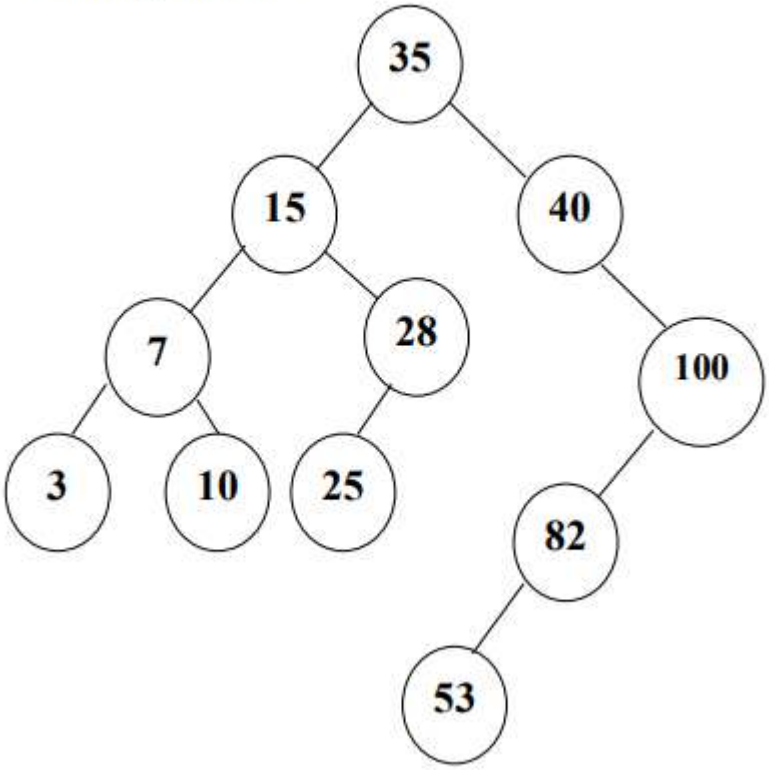
Step 9: - Inserting Element 53



Step 10:- Inserting Element 25

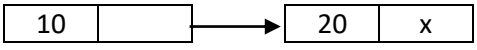


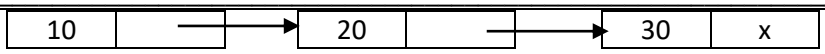
Step 11: - Inserting Element 3



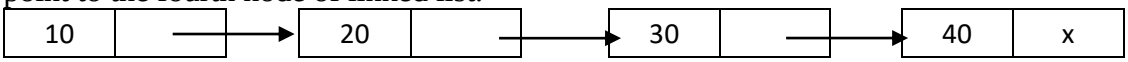
4.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a)	**Differentiate between Binary search and Linear search with respect to any four parameters.**	**4 M**
	Ans		Any 4 correct points – 4 M

Linear Search	**Binary Search**
Search element is compared with each element in list	Search element is compared with mid element only
Simplest method of searching	Comparatively difficult method of searching
Easy to implement	Comparatively difficult to implement
Given list of numbers can be sorted or unsorted order	Given list of numbers must be in sorted order
Linear search only requires equality Comparisons.	Binary search requires an ordering comparison.
Linear search has complexity O(n).	Binary search has complexity O(log n).
Linear search is too slow to be used with large lists due to its o (n) average case performance.	Binary search is considered to be a more efficient method that could be used with large lists.
Linear search only requires sequential Access.	Binary search requires random access to the data.

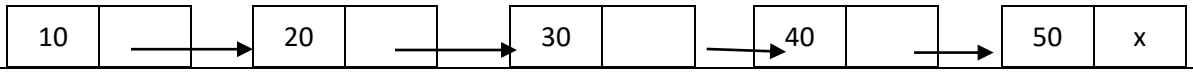
	b)	**Create a singly Linked List using data fields 10, 20, 30, 40, 50 and show procedure step-by-step with the help of diagram from start to end.**	**4 M**
	Ans	Step 1: For creating a singly linked list, first create new node (first node) allocate memory for new node and initialised its data part to 10 and next part to null. Start address will point to the first node of linked list. 10 | X Start Step 2: To add 20 in singly linked list, create new node (second node) allocate memory for new node and initialised its data part to 20 and next part to null. Address of first node will point to the second node of linked list.  Step 3: To add 30 in singly linked list, create new node (third node) allocate memory for new node and initialised its data part to 30 and next part to null. Address of second node will point to the third node of linked list.	Correct answer – 4 M



Step 4: To add 40 in singly linked list, create new node (fourth node) allocate memory for new node and initialised its data part to 40 and next part to null. Address of third node will point to the fourth node of linked list.



Step 5: To add 50 in singly linked list, create new node (fifth node) allocate memory for new node and initialised its data part to 50 and next part to null. Address of fourth node will point to the fifth node of linked list.



c) **Show the effect of PUSH and POP operation on to the stack of size 10. The stack contains 10, 20, 30, 40, 50 and 60, with 60 being at top of the stack. Show diagrammatically the effect of -** **4 M**

(i) PUSH 55

(ii) PUSH 70

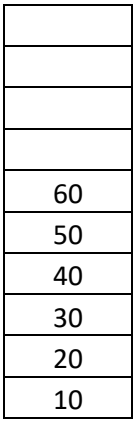
(iii) POP

(iv) POP

Sketch the final structure of stack after performing the above said operations.

Ans

Initial Stack



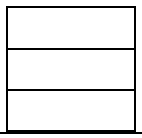
1 M for push 55

1 M for push 70

1 M for pop

1 M for pop

(i) PUSH 55



55	top =6
60	
50	
40	
30	
20	
10	

(ii) PUSH 70

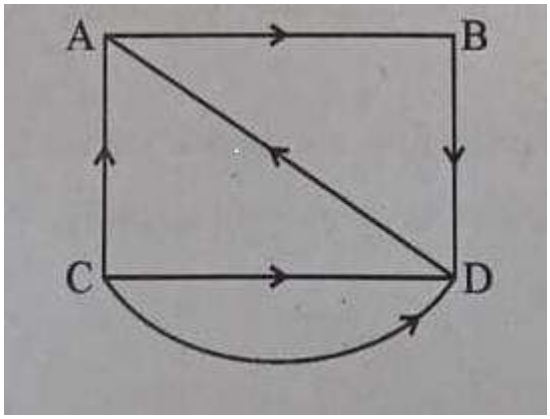
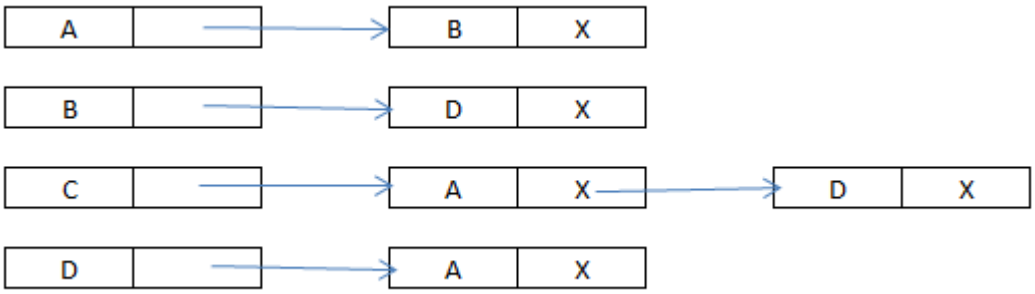
70	top =7
55	
60	
50	
40	
30	
20	
10	

(iii) POP

55	top =6
60	
50	
40	
30	
20	
10	

(iv) POP

60	top =5

		50 40 30 20 10	
	d)	**For the following directed graph:** **(i) Give adjacency matrix representation.** **(ii) Give adjacency list representation.** 	**4 M**
	Ans	Adjacency matrix representation A B C D A 0 1 0 0 B 0 0 0 1 C 1 0 0 1 D 1 0 0 0 Adjacency list representation 	Matrix representation – 2 M, List representation – 2 M

5. **Attempt any TWO of the following:** **12 M**

a) **Convert the infix expression to its postfix expression using stack ((A+B)*D)^(E-F).Show diagrammatically each step of conversion.** **6 M**

Ans

Input Symbol	Stack	Postfix Expression
	#	
(	# (	EMPTY
(	# ((	EMPTY
A	# ((	A
+	# ((+	A
B	# ((+	AB
)	# (	AB+
*	# (*	AB+
D	# (*	AB + D
)	#	AB + D*
^	# ^	AB + D*
(	# ^ (	AB + D*
E	# ^ (	AB + D *E
-	# ^ (-	AB + D *E
F	# ^ (-	AB + D *E F
)	# ^	AB + D *E F -
	Stack empty	AB + D *E F - ^

Correct postfix expression- 6 M

(Note: Correct Steps should be considered and given ½ M)

b) **Show the effect of INSERT and DELETE operation onto the linear queue of size 10. The linear queue sequential contains 10,20,30,40 and 50 where 10 is at front queue. Show diagrammatically the effect of –** **6 M**

INSERT (75)

INSERT (85)

DELETE

INSERT (60)

DELETE

INSERT (90)

Ans

Given Queue

10	**20**	**30**	**40**	**50**					

front rear

Insert (75)

Each correct operation – 1 M

10	20	30	40	50	75				

front rear

Insert (85)

10	20	30	40	50	75	85			

front rear

Delete

	20	30	40	50	75	85			

front rear

10 is deleted

Insert (60)

	20	30	40	50	75	85	60		

front rear

Delete

		30	40	50	75	85	60		

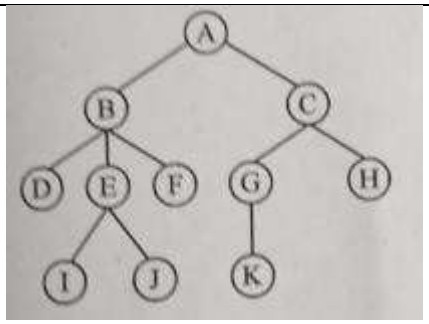
front rear

20 is deleted

Insert (90)

		30	40	50	75	85	60	90	

front rear

	c)		**6 M**

From the given tree, complete the following answers :

(i) Degree of tree : _____
(ii) Degree of node B: _____
(iii)Level of node H: _____
(iv)Indegree of node C: _____
(v) (V) Outdegree of node B : _____
(vi)(vi) Height of the tree : _____

	Ans	(i) Degree of tree: 3 (ii) Degree of node B: 2 (iii)Level of node H: 2	Each correct answer –

		(iv) Indegree of node C: 1 (v) Outdegree of node B: 3 (vi) Height of the tree: 3	1 M
6.		**Attempt any <u>TWO</u> of the following:**	**12 M**
	a)	**Find the position of element 29 using Binary search method in an array given as : { 11,5,21,3,29,17,2,43}**	**6 M**
	Ans	**Given Array :** **0 1 2 3 4 5 6 7** a: 11 5 21 3 29 17 2 43 sorted array **0 1 2 3 4 5 6 7** a: 2 3 5 11 17 21 29 43 Pass-1 **0 1 2 3 4 5 6 7** a: 2 3 5 11 17 21 29 43 L H mid= (L+H)/2 = (0+7)/2 = 7/2=3 **0 1 2 3 4 5 6 7** a: 2 3 5 11 17 21 29 43 L mid H a[mid]=a[3]=11 11 is not equal to 29 Since 29 > 11 L = mid+1 = 4 H = n-1=7 **Pass-2** **4 5 6 7** a: 17 21 29 43 L H mid = 5 **4 5 6 7** a: 17 21 29 43 L mid H	Each correct pass-2M

a[mid]=a[5]=21
21 is not equal to 29
Since 29 > 21
L = mid+1 = 6
H = n-1=7

Pass- 3

	6	**7**
a	29	43
	L	H

mid = 6
a[mid]=a[6]=29
29 is equal to 29

Hence Element 29 Is found at position 7th of array

b) Evaluate the following postfix expression : **6 M**

4 6 24 + *6 3 / -

Show diagrammatically each step of evaluation using stack.

Ans

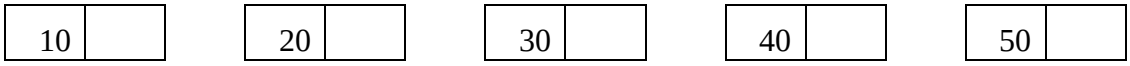
postfix expression	**operand 1**	**operand 2**	**result**
4			4
6			4 6
24			4 6 24
+	6	24	4 30
*	4	30	120
6			120 6
3			120 6 3
/	6	3	120 2
-	120	2	118

Result is 118

Each correct steps- 1 M

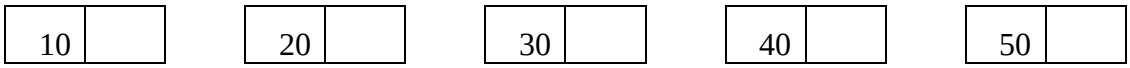
c) Create a singly linked list using data fields 10, 20, 30, 40, 50. Search a node 40 from the singly linked list and show procedure step-by-step with the help of the diagram from start to end. **6 M**

	Ans		For correct answer 6m



Node to be searched = 40

Consider pointer ptr is used for traversal of Singly linked List

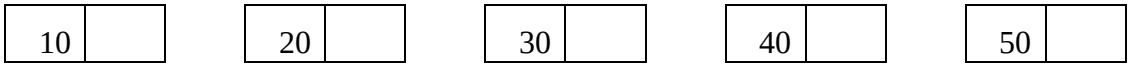


ptr

will check ptr->infor =10

Since 10 is not equal to 40

set ptr = ptr->next

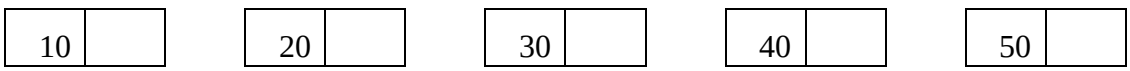


ptr

will check ptr->infor = 20

Since 20 is not equal to 40

set ptr = ptr->next

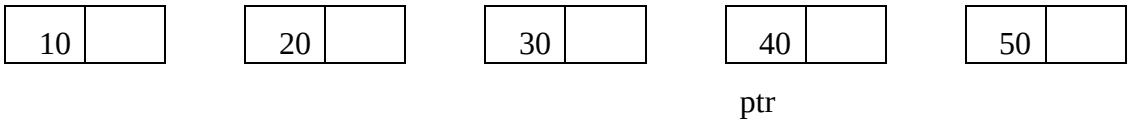


ptr

will check ptr->infor = 30

Since 30 is not equal to 40

set ptr = ptr->next



will check ptr->infor = 40

Since 40 is equal to 40

Hence Node 40 is present in Linked list

22317

23124

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions : (1) All Questions are *compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following : **10**

(a) State any two differences between linear search and binary search.

(b) Define term pointer and null pointer.

(c) Define the terms : linear data structure and non-linear data structure.

(d) List any four applications of queue.

(e) Write any four operations that can be performed on data structure.

(f) Convert the following infix expression to its postfix form using stack :

A + B – C * D/E + F

(g) Describe given two types of graphs : Directed graph and Undirected graph.

2. Attempt any THREE of the following : **12**

(a) Describe working of selection sort method with suitable example.

(b) Write algorithm to delete an intermediate node from a singly linked list.

(c) Differentiate between tree and graph w.r.t. any four parameters.

(d) Convert the given infix expression to postfix expression using stack and the details of stack at each step of conversion.

Expression : A * B ↑ C – D / E + [F / G]

3. Attempt any THREE of the following : **12**

(a) Explain complexity of following algorithms in terms of time and space :

(i) Binary search

(ii) Bubble sort

(b) Draw an expression tree for the following expression :

$(a + 3b – 7c)^3 * (6d – 8e)^7$

(c) Describe working of bubble sort with example.

(d) Show the effect of PUSH and POP operation on the stack of size 10. The stack contains 10, 20, 25, 15, 30 & 40 with 40 being at top of stack. Show diagrammatically the effect of

(i) PUSH (45) (ii) PUSH (50)

(iii) POP (iv) PUSH (55)

4. Attempt any THREE of the following : **12**

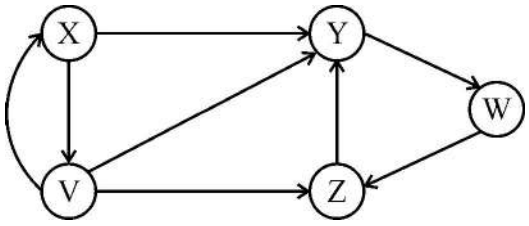
(a) Create singly linked list using data fields 10, 20, 30, 40, 50 and show step-by-step procedure with the help of diagram from start to end.

(b) Describe advantages of circular link list over linear link list with example.

(c) Explain the working of Radix sort method with an example.

(d) Write an algorithm to count no. of nodes in singly linked list.

(e) Consider the graph 'G' in the following figure :



(i) Find all simple path from X & Z.

(ii) Find indegree and outdegree of node Y and Z.

(iii) Find adjacency matrix A for the above graph.

(iv) Give adjacency list representation of above graph.

5. Attempt any TWO of the following : **12**

(a) Define the term tree traversal. Construct the Binary Search Tree (BST) of following :

85, 90, 45, 60, 25, 35, 10, 20, 75, 95 and traverse the above BST in inorder, preorder & postorder.

(b) Explain operation on singly linked list.

(c) Implement a 'C' program to insert element into the queue and delete the element from the queue.

6. Attempt any TWO of the following : **12**

(a) Find out prefix equivalent of the expression :

(i) [(A + B) + C] * D

(ii) A[(B * C) + D]

(b) Sort the following number in ascending order using bubble sort. Given numbers as follows : 475, 15, 513, 6753, 45, 118.

(c) Describe circular linked list with suitable diagram. State advantages of circular linked list over linear linked list.