UNIT I

LINEAR DATA STRUCTURES-LIST

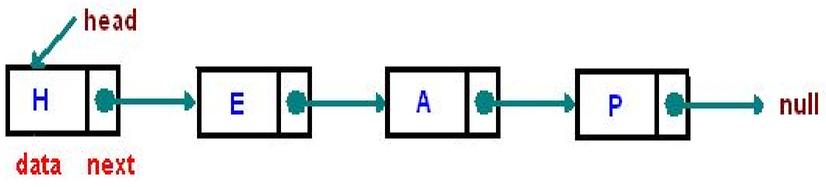
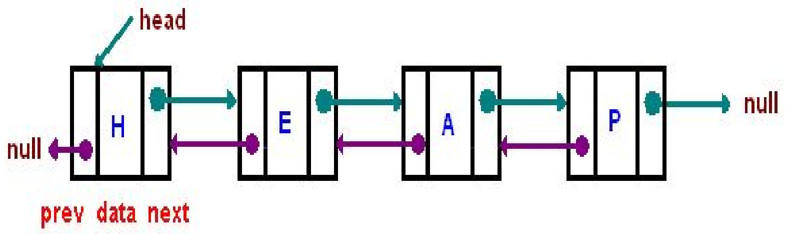
Abstract Data Type (ADT) - List ADT- Arrays based Implementation-linked list implementation-singly linked lists-circularly linked lists-doubly linked list-Application of list-polynomial manipulation-all operations (insertion, deletion, merge, traversal).

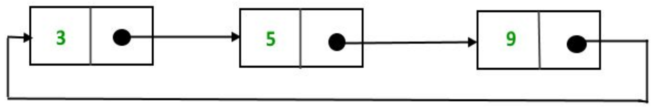
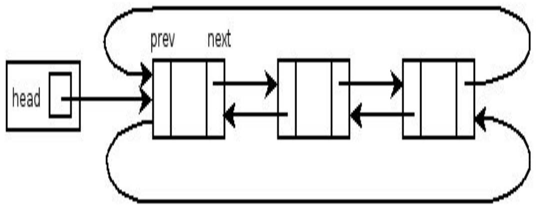
S. No.	Question	Course Outcome	Blooms Taxanomy Level
1	**What is a data structure?** ● A data structure is a method for organizing and storing data which would allow efficient data retrieval and usage. ● A data structure is a way of organizing data that considers not only the items stored, but also their relationships to each other.	C203.1	BTL1
2	**Why do we need data structures?** ● Data structures allow us to achieve an important goal: component reuse. ● Once data structure has been implemented, it can be used again and again in various applications.	C203.1	BTL 1
3	**List some common data structures.** ● Stacks ● Queues ● Lists ● Trees ● Graphs ● Tables	C203.1	BTL 1
4	**How data structures are classified?** Data structures are classified into two categories based on how the data items are operated: i. Primitive data structure ii. Non-Primitive data structure	C203.1	BTL 1

	a. Linear data structure b. Non-linear data structure		
5	**Differentiate linear and non-linear data structure.**	C203.1	BTL 2

Linear data structure	**Non-linear data structure**
Data are arranged in linear or sequential manner	Data are not arranged in linear manner
Every items is related to its previous and next item	Every item is attached with many other items
Data items can be traversed in a single run.	Data items cannot be traversed in a single run.
Implementation is easy	Implementation is difficult.
Example: array, stack, queue, linked list	Example: tree, graph

6	**Define ADT (Abstract Data Type)** An abstract data type (ADT) is a set of operations and mathematical abstractions , which can be viewed as how the set of operations is implemented. Objects like lists, sets and graphs, along with their operation, can be viewed as abstract data types, just as integers, real numbers and Booleans.	C203.1	BTL 1
7	**Mention the features of ADT.** a. Modularity i. Divide program into small functions ii. Easy to debug and maintain iii. Easy to modify b. Reuse i. Define some operations only once and reuse them in future c. Easy to change the implementation	C203.1	BTL 2
8	**Define List ADT** A list is a sequence of zero or more elements of a given type. The list is represented as sequence of elements separated by comma. A1, A2, A3…..AN Where N>0 and A is of type element	C203.1	BTL 1
9	**What are the ways of implementing linked list?** The list can be implemented in the following ways: i. Array implementation ii. Linked-list implementation	C203.1	BTL 1

	iii. Cursor implementation		
10	**What are the types of linked lists?** There are three types i. Singly linked list ii. Doubly linked list iii. Circularly linked list	C203.1	BTL 1
11	**How the singly linked lists can be represented?**  Each node has two elements i. Data ii. Next	C203.1	BTL 1
12	**How the doubly linked list can be represented?**  Doubly linked list is a collection of nodes where nodes are connected by forwarded and backward link. Each node has three fields: 1. Address of previous node 2. Data 3. Address of next node.	C203.1	BTL 1
13	**What are benefits of ADT?** a. Code is easier to understand b. Implementation of ADT can be changed without requiring changes to the program that uses the ADT	C203.1	BTL 1
14	**When singly linked list can be represented as circular linked list?** In a singly linked list, all the nodes are connected with forward links to the next nodes in the list. The last node has a next field, NULL. In order to implement the circularly linked	C203.1	BTL 1

	lists from singly linked lists, the last node's next field is connected to the first node. 		
15	**When doubly linked list can be represented as circular linked list?** In a doubly linked list, all nodes are connected with forward and backward links to the next and previous nodes respectively. In order to implement circular linked lists from doubly linked lists, the first node's previous field is connected to the last node and the last node's next field is connected to the first node. 	C203.1	BTL 1
16	**Where cursor implementation can be used?** The cursor implementation of lists is used by many languages such as BASIC and FORTRAN that do not support pointers. The two important features of the cursor implementation of linked are as follows: ● The data are stored in a collection of structures. Each structure contains data and a index to the next structure. ● A new structure can be obtained from the system's global memory by a call to cursorSpace array.	C203.1	BTL 1
17	**List down the applications of List.** a. Representation of polynomial ADT b. Used in radix and bubble sorting c. In a FAT file system, the metadata of a large file is organized as a linked list of FAT entries. d. Simple memory allocators use a free list of unused memory regions, basically a linked list with the list pointer inside the free memory itself.	C203.1	BTL 1
18	**What are the advantages of linked list?** a. Save memory space and easy to maintain b. It is possible to retrieve the element at a particular index c. It is possible to traverse the list in the order of increasing index.	C203.1	BTL 1

	d. It is possible to change the element at a particular index to a different value,without affecting any other elements.		
19	**Mention the demerits of linked list** a. It is not possible to go backwards through the list b. Unable to jump to the beginning of list from the end.	C203.1	BTL 2

20	**The polynomial equation can be represented with linked list as follows:**
	<table><tr><td>Coefficient</td><td>Exponent</td><td>Next node link</td></tr></table>
	struct polynomial
	{
	int coefficient;int exponent;struct polynomial *next;
	};
		C203.1	BTL 2

21	**What are the operations performed in list?** The following operations can be performed on a list i. Insertion a. Insert at beginning b. Insert at end c. Insert after specific node d. Insert before specific node ii. Deletion a. Delete at beginning b. Delete at end c. Delete after specific node d. Delete before specific node iii. Merging iv. Traversal	C203.1	BTL 1
22	**What are the merits and demerits of array implementation of lists?** Merits ● Fast, random access of elements ● Memory efficient – very less amount of memory is required Demerits ● Insertion and deletion operations are very slow since the elements should be moved. ● Redundant memory space – difficult to estimate the size of array.	C203.1	BTL 1
23	**What is a circular linked list?** A circular linked list is a special type of linked list that supports traversing from the end of the list to the beginning by making the last node point back to the head of the list.	C203.1	BTL 1

24	**What are the advantages in the array implementation of list?** a. Print list operation can be carried out at the linear time b. Find Kth operation takes a constant time	C203.1	BTL 1
25	**What is the need for the header?** Header of the linked list is the first element in the list and it stores the number of elements in the list. It points to the first data element of the list.	C203.1	BTL 1
26	**List three examples that uses linked list?** a. Polynomial ADT b.Radix sort c.Multi lists	C203.1	BTL 1
27	**List out the different ways to implement the list?** 1. Array Based Implementation 2. Linked list Implementation i. Singly linked list ii. Doubly linked list iii. Cursor based linked list	C203.1	BTL 1

28	**Write the routine for insertion operation of singly linked list.**
	Void Insert (ElementType X, List L, Position P)
	{Position TmpCell;
	TmpCell=malloc(sizeof(struct Node));
	if(TmpCell==NULL)
	FatalError("Out of space!!!");
	TmpCell->Element =X; TmpCell->Next=P->Next;
	P->Next=TmpCell;
	}
		C203.1	BTL 5

29	**Advantages of Array over Linked List.** 1. Array has a specific address for each element stored in it and thus we can access any memory directly. 2. As we know the position of the middle element and other elements are easily accessible too, we can easily perform BINARY SEARCH in array.	C203.1	BTL 5
30	**Disadvantages of Array over Linked List.** 1. Total number of elements need to be mentioned or the memory allocation needs to be done at the time of array creation 2. The size of array, once mentioned, cannot be increased in the program. If number of elements entered exceeds the size of the array ARRAY OVERFLOW EXCEPTION occurs.	C203.1	BTL 5

31	**Advantages of Linked List over Array.** 1. Size of the list doesn't need to be mentioned at the beginning of the program. 2. As the linked list doesn't have a size limit, we can go on adding new nodes (elements) and increasing the size of the list to any extent.	C203.1	BTL 5
32	**Disadvantages of Linked List over Array.** 1. Nodes do not have their own address. Only the address of the first node is stored and in order to reach any node, we need to traverse the whole list from beginning to the desired node. 2. As all Nodes don't have their particular address, BINARY SEARCH cannot be performed	C203.1	BTL 5
	PART-B		
1	Explain the various operations of the list ADT with examples	C203.1	BTL 2
2	Write the program for array implementation of lists	C203.1	BTL 5
3	Write a C program for linked list implementation of list.	C203.1	BTL 5
4	Explain the operations of singly linked lists	C203.1	BTL 2
5	Explain the operations of doubly linked lists	C203.1	BTL 2
6	Explain the operations of circularly linked lists	C203.1	BTL 2
7	How polynomial manipulations are performed with lists? Explain the operations	C203.1	BTL 1
8	Explain the steps involved in insertion and deletion into a singly and doubly linked list.	C203.1	BTL2

UNIT II

LINEAR DATA STRUCTURES-STACKS,QUEUES

Stack ADT-Operations-applications-Evaluating arithmetic expressions-conversion of infix to postfix expressions-queue ADT-Operations-circular queue-priority queue-dequeue-applications of queues.

S. No.	Question	Course Outcome	Blooms Taxanomy Level
1	**Define Stack.** A stack is an ordered list in which all insertions and deletions are made at one end, called the top. It is an abstract data type and based on the principle of LIFO (Last In First Out).	C203.2	BTL 1
2	**What are the operations of the stack?** a. CreateStack/ InitStack(Stack) – creates an empty stack b. Push(Item) – pushes an item on the top of the stack c. Pop(Item) – removes the top most element from the stack d. Top(Stack) – returns the first element from the stack e. IsEmpty(Stack) – returns true if the stack is empty	C203.2	BTL 1

3	**Write the routine to push a element into a stack.**
	Push(Element X, Stack S)
	{ if(IsFull(S)
	{ Error("Full Stack"); }
	else
	S→Array[++S→TopOfStack]=X;
	}
		C203.2	BTL 5

4	**How the operations performed on linked list implementation of stack?** a. Push and pop operations at the head of the list. b. New nodes should be inserted at the front of the list, so that they become the top of the stack. c. Nodes are removed from the front(top) of the stack.	C203.2	BTL 1
5	**What are the applications of stack?** The following are the applications of stacks • Evaluating arithmetic expressions • Balancing the parenthesis • Towers of Hanoi • Function calls Tree traversal	C203.2	BTL 1
6	**What are the methods to implement stack in C?** The methods to implement stacks are: ● Array based ● Linked list based	C203.2	BTL 1
7	**How the stack is implemented by linked list?** It involves dynamically allocating memory space at run time while performing stack operations. Since it consumes only that much amount of space is required for holding its data elements , it prevents wastage of memory space. struct stack {	C203.2	BTL 1

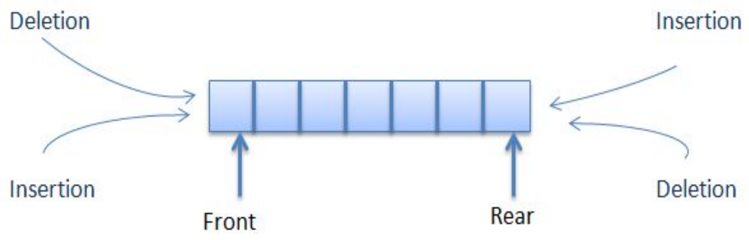
	int element;
	struct stack *next;
	}*top;		

8	**Write the routine to pop a element from a stack.**
	int pop()
	{ if(top==NULL)
	{ printf("\n Stack is empty.\n");getch();exit(1);}
	else
	{int temp;
	temp=top→element; top=top→next; return temp; }}
		C203.2	BTL 5

9	**Define queue.** It is a linear data structure that maintains a list of elements such that insertion happens at rear end and deletion happens at front end. FIFO – First In First Out principle	C203.2	BTL 1
10	**What are the operations of a queue?** The operations of a queue are ● isEmpty() ● isFull() ● insert() ● delete() ● display()	C203.2	BTL 1

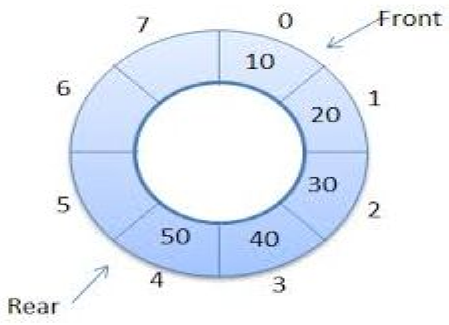
11	**Write the routine to insert a element onto a queue.**
	void insert(int element)
	{
	if(front==-1)
	{
	front = rear = front +1;
	queue[front] = element;
	return;
	}
	if(rear==99)
	{
	printf("Queue is full");
	getch();
	return;
	}
	rear = rear +1;
	queue[rear]=element;
	}
		C203.2	BTL 5

12	**What are the types of queue?** The following are the types of queue: ● Double ended queue ● Circular queue ● Priority queue	C203.2	BTL 1
13	**Define double ended queue** ● It is a special type of queue that allows insertion and deletion of elements at both	C203.2	BTL 1

	Ends. ● It is also termed as DEQUE.  Deletion Insertion Insertion Deletion Front Rear		
14	**What are the methods to implement queue in C?** The methods to implement queues are: ● Array based ● Linked list based	C203.2	BTL 1
15	**How the queue is implemented by linked list?** • It is based on the dynamic memory management techniques which allow allocation and De-allocation of memory space at runtime. **Insert operation** It involves the following subtasks: 1. Reserving memory space of the size of a queue element in memory 2. Storing the added value at the new location 3. Linking the new element with existing queue 4. Updating the *rear* pointer **Delete operation** It involves the following subtasks: 1. Checking whether queue is empty 2. Retrieving the front most element of the queue 3. Updating the front pointer 4. Returning the retrieved value	C203.2	BTL 1

16	**Write the routine to delete a element from a queue**
	int del()
	{int i;
	if(front == NULL) /*checking whether the queue is empty*/
	{return(-9999);}
	else
	{i = front→element;front = front→next;return i;}
	}
		C203.2	BTL 5

17	**What are the applications of queue?** The following are the areas in which queues are applicable a. Simulation b. Batch processing in an operating systems c. Multiprogramming platform systems d. Queuing theory e. Printer server routines f. Scheduling algorithms like disk scheduling , CPU scheduling g. I/O buffer requests	C203.2	BTL 1

18	**Define circular queue** A Circular queue is a queue whose start and end locations are logically connected with each other. That means the start location comes after the end location.  7 0 Front 10 6 1 20 30 5 2 50 40 4 3 Rear	C203.2	BTL 1
19	**What are push and pop operations?** • Push – adding an element to the top of stack • Pop – removing or deleting an element from the top of stack	C203.2	BTL 1

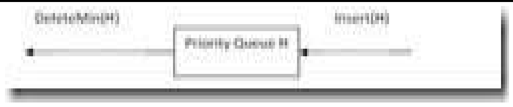
20	**What are enqueue and dequeue operations?**
	• **Enqueue** - adding an element to the queue at the rear end
	If the queue is not full, this function adds an element to the back of the queue, else it prints "**OverFlow**".
	`void enqueue(int queue[], int element, int& rear, int arraySize) {`
	`   if(rear == arraySize)          // Queue is full`
	`         printf("OverFlow\n");`
	`   else{`
	`       queue[rear] = element;    // Add the element to the back`
	`       rear++;`
	`   }`
	`}`
	• **Dequeue** – removing or deleting an element from the queue at the front end
	If the queue is not empty, this function removes the element from the front of the queue, else it prints "**UnderFlow**".
	`void dequeue(int queue[], int& front, int rear) {`
	`   if(front == rear)          // Queue is empty`
	`      printf("UnderFlow\n");`
	`   else {`
	`      queue[front] = 0;       // Delete the front element`
	`      front++;`
	`   }`
	`}`
		C203.2	BTL 1

21	**Distinguish between stack and queue.**	C203.2	BTL4

STACK	QUEUE
Insertion and deletion are made at one end.	Insertion at one end rear and deletion at other end front.

The element inserted last would be removed first. So LIFO structure.	The element inserted first would be removed first. So FIFO structure.
Full stack condition: If(top==Maxsize) Physically and Logically full stack	Full stack condition: If(rear = = Maxsize) Logically full. Physically may or may not be full.

22	**Convert the infix (a+b)*(c+d)/f into postfix & prefix expression** Postfix : a b + c d + * f / Prefix : / * + a b + c d f	C203.2	BTL5
23	**Write postfix from of the expression –A+B-C+D?** A-B+C-D+	C203.2	BTL5
24	**How do you test for an empty queue?** To test for an empty queue, we have to check whether READ=HEAD where REAR is a pointer pointing to the last node in a queue and HEAD is a pointer that pointer to the dummy header. In the case of array implementation of queue, the condition to be checked for an empty queue is READ<FRONT.	C203.2	BTL1
25	**What are the postfix and prefix forms of the expression?** A+B*(C-D)/(P-R) Postfix form: ABCD-*PR-/+ Prefix form: +A/*B-CD-PR	C203.2	BTL1
26	**Explain the usage of stack in recursive algorithm implementation?** In recursive algorithms, stack data structures is used to store the return address when a recursive call is encountered and also to store the values of all the parameters essential to the current state of the procedure.	C203.2	BTL5
27	**Define priority queue with diagram and give the operations.** Priority queue is a data structure that allows at least the following two operations. 1. Insert-inserts an element at the end of the list called the rear. 2. DeleteMin-Finds, returns and removes the minimum element in the priority Queue.	C203.2	BTL1

	 Operations: Insert, DeleteMin		
28	**Give the applications of priority queues.** There are three applications of priority queues 1. External sorting. 2. Greedy algorithm implementation. 3. Discrete even simulation. 4. Operating systems.	C203.2	BTL3

29	**How do you test for an empty stack?**
	To check if the stack is empty, we only need to check whether top and bottom are the same number.
	`bool stack_empty(stack S) //@requires is_stack(S);`
	`{ return S->top == S->bottom; }`
		C203.2	BTL1

30	**What are the features of stacks?** • Dynamic data structures • Do not have a fixed size • Do not consume a fixed amount of memory • Size of stack changes with each push() and pop() operation. Each push() and pop() operation increases and decreases the size of the stack by 1, respectively.	C203.2	BTL1

31	**Write a routine for IsEmpty condition of queue.**
	If a queue is empty, this function returns 'true', else it returns 'false'.
	`bool isEmpty(int front, int rear) {`
	`return (front == rear);`
	`}`
		C203.2	BTL5

PART-B			
1	Explain Stack ADT and its operations	C203.2	BTL5
2	Explain array based implementation of stacks	C203.2	BTL5
3	Explain linked list implementation of stacks	C203.2	BTL5
4	Explain the applications of Stacks	C203.2	BTL5
5	Explain how to evaluate arithmetic expressions using stacks	C203.2	BTL5
6	Explain queue ADT	C203.2	BTL2
7	Explain array based implementation of queues	C203.2	BTL2
8	Explain linked list implementation of queues	C203.2	BTL2

9	Explain the applications of queues	C203.2	BTL5
10	Explain circular queue and its implementation	C203.2	BTL2
11	Explain double ended queue and its operations	C203.2	BTL2
12	Explain priority queue and its operations	C203.2	BTL5

UNIT III

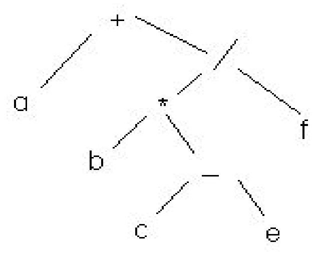
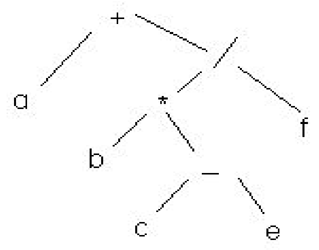
NON LINEAR DATA STRUCTURES- TREES

Tree ADT-tree traversals-Binary Tree ADT-expression Trees-applications of Trees-Binary search tree ADT-Threaded binary Tree-AVL Tree-B-Tree-B+Tree-Heap-Applications of Heap.

S. No.	Question	Course Outcome	Blooms Taxanomy Level
1	**Define non-linear data structure** Data structure which is capable of expressing more complex relationship than that of physical adjacency is called non-linear data structure.	C203.3	BTL1
2	**Define tree?** A tree is a data structure, which represents hierarchical relationship between individual data items.	C203.3	BTL1
3	**Define leaf?** In a directed tree any node which has out degree o is called a terminal node or a leaf.	C203.3	BTL1
4	**Explain the representations of priority queue.** Using Heap structure, Using Linked List	C203.3	BTL2
5	**List out the steps involved in deleting a node from a binary search tree.** 1. t has no right hand child node t->r == z 2. t has a right hand child but its right hand child node has no left sub tree t->r->l == z 3.t has a right hand child node and the right hand child node has a left hand child node t->r->l != z	C203.3	BTL1
6	**Convert the infix expression (A-B/C)*(D/E-F) into a postfix.** Postfix: ABC/-DE/F-*	C203.3	BTL2
7	**What are the steps to convert a general tree into binary tree?** * use the root of the general tree as the root of the binary tree	C203.3	BTL1

	* determine the first child of the root. This is the leftmost node in the general tree at the next level * insert this node. The child reference of the parent node refers to this node * continue finding the first child of each parent node and insert it below the parent node with the child reference of the parent to this node. * when no more first children exist in the path just used, move back to the parent of the last node entered and repeat the above process. In other words, determine the first sibling of the last node entered. * complete the tree for all nodes. In order to locate where the node fits you must search for the first child at that level and then follow the sibling references to a nil where the next sibling can be inserted. The children of any sibling node can be inserted by locating the parent and then inserting the first child. Then the above process is repeated.		
8	**What is meant by directed tree?** ed tree is an acyclic diagraph which has one node called its root with in degree o while all other nodes have in degree I.	C203.3	BTL1
9	**What is a ordered tree?** In a directed tree if the ordering of the nodes at each level is prescribed then such a tree is called ordered tree.	C203.3	BTL1
10	**What are the applications of binary tree?** 1. Binary tree is used in data processing. 2. File index schemes 3. Hierarchical database management system	C203.3	BTL1
11	**What is meant by traversing?** Traversing a tree means processing it in such a way, that each node is visited only once.	C203.3	BTL1
12	**What are the different types of traversing?** The different types of traversing are a. Pre-order traversal-yields prefix form of expression. b. In-order traversal-yields infix form of expression. c. Post-order traversal-yields postfix form of expression.	C203.3	BTL1
13	**What are the two methods of binary tree implementation?** Two methods to implement a binary tree are a. Linear representation. b. Linked representation	C203.3	BTL1
14	**What is a balance factor in AVL trees?** Balance factor of a node is defined to be the difference between the height of the node's left subtree and the height of the node's right subtree.	C203.3	BTL1

15	**What is meant by pivot node?** The node to be inserted travel down the appropriate branch track along the way of the deepest level node on the branch that has a balance factor of +1 or -1 is called pivot node.	C203.3	BTL1
16	**What is the length of the path in a tree?** The length of the path is the number of edges on the path. In a tree there is exactly one path form the root to each node.	C203.3	BTL1
17	**Define expression trees?** eaves of an expression tree are operands such as constants or variable names and the other nodes contain operators.	C203.3	BTL1
18	**What is a threaded binary tree?** A threaded binary tree may be defined as follows: "A binary tree is *threaded* by making all right child pointers that would normally be null point to the inorder successor of the node, and all left child pointers that would normally be null point to the inorder predecessor of the node	C203.3	BTL1
19	**What is meant by binary search tree?** Binary Search tree is a binary tree in which each internal node *x* stores an element such that the element stored in the left sub tree of *x* are less than or equal to *x* and elements stored in the right sub tree of *x* are greater than or equal to *x*.	C203.3	BTL2
20	**Write the advantages of threaded binary tree.** The difference between a binary tree and the threaded binary tree is that in the binary trees the nodes are null if there is no child associated with it and so there is no way to traverse back. But in a threaded binary tree we have threads associated with the nodes i.e they either are linked to the predecessor or successor in the in order traversal of the nodes. This helps us to traverse further or backward in the in order traversal fashion. There can be two types of threaded binary tree :- 1) Single Threaded: - i.e. nodes are threaded either towards its in order predecessor or successor. 2) Double threaded: - i.e. nodes are threaded towards both the in order predecessor and successor.	C203.3	BTL5
21	**What is the various representation of a binary tree?** Tree Representation Array representation Linked list representation	C203.3	BTL1
22	**List the application of tree.** (i) Electrical Circuit ii) Folder structure a. Binary tree is used in data processing. b. File index schemes c. Hierarchical database management system	C203.3	BTL1
23	**Define binary tree and give the binary tree node structure.**	C203.3	BTL1

			
24	**What are the different ways of representing a Binary Tree?** ● Linear Representation using Arrays. ● Linked Representation using Pointers.	C203.3	BTL1
25	**Give the pre & postfix form of the expression (a + ((b*(c-e))/f).** 	C203.3	BTL2
26	**Define a heap. How can it be used to represent a priority queue?** A priority queue is a different kind of queue, in which the next element to be removed is defined by (possibly) some other criterion. The most common way to implement a priority queue is to use a different kind of binary tree, called a heap. A heap avoids the long paths that can arise with binary search trees.	C203.3	BTL1
27	**What is binary heap?** It is a complete binary tree of height h has between $2^{h \text{ and }} 2^{h+1}$ -1 node. The value of the root node is higher than their child nodes	C203.3	BTL1
28	**Define Strictly binary tree?** If every nonleaf node in a binary tree has nonempty left and right subtrees ,the tree is termed as a strictly binary tree.	C203.3	BTL1
29	**Define complete binary tree?** A complete binary tree of depth d is the strictly binary tree all of whose are at level d.	C203.3	BTL1
30	**What is an almost complete binary tree?** A binary tree of depth d is an almost complete binary tree if : _ Each leaf in the tree is either at level d or at level d-1 _ For any node nd in the tree with a right descendant at level d,all the left descendants of nd that are leaves are at level d.	C203.3	BTL1
31	**Define AVL Tree.** A AVL tree is a binary search tree except that for every node in the tree,the height of the left and right subtrees can differ by atmost 1.	C203.3	BTL1

PART-B			
1	Define Tree. Explain the tree traversals with algorithms and examples.	C203.3	BTL5
2	Construct an expression tree for the expression (a + b * c) +((d * e + 1) * g). Give the outputs when you apply preorder, inorder and postorder traversals.	C203.3	BTL5
3	Explain binary search tree ADT in detail.	C203.3	BTL5
4	Explain AVL tree ADT in detail.	C203.3	BTL5
5	Explain b tree and B+ tree ADT in detail.	C203.3	BTL5
6	Explain Heap tree ADT in detail.	C203.3	BTL5
7	Explain threaded binary tree ADT in detail.	C203.3	BTL2

UNIT IV

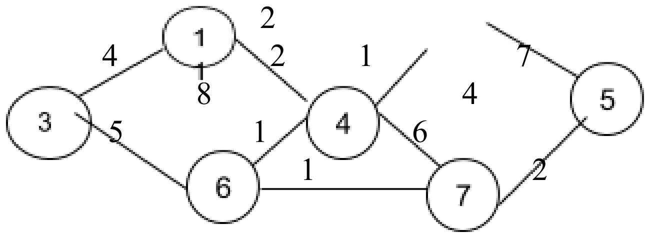
NON LINEAR DATA STRUCTURES- GRAPHS

Definition-Representation of graph-types of graph-Breadth-first traversal-Depth-first-Traversal-Topological sort-Bi-connectivity-Cut vertex-Eulercircuits-Applications of graphs.

S. No.	Question	Course Outcome	Blooms Taxanomy Level
1	**Define Graph?** A graph G consist of a nonempty set V which is a set of nodes of the graph, a set E which is the set of edges of the graph, and a mapping from the set for edge E to a set of pairs of elements of V. It can also be represented as G= (V, E).	C203.4	BTL1
2	**Explain the topological sort.** It is an Ordering of vertices in a directed acyclic graph such that if there is a path from vi to vj, then vj appears after vi in the ordering.	C203.4	BTL1
3	**Define NP** NP is the class of decision problems for which a given proposed solution for a given input can be checked quickly to see if it is really a solution.	C203.4	BTL1
4	**Define biconnected graph.** A connected undirected graph is biconnected if there are no vertices whose removal disconnects the rest of the graph.	C203.4	BTL1
5	**Define shortest path problem?** For a given graph G=(V, E), with weights assigned to the edges of G, we have to find the shortest path (path length is	C203.4	BTL1

	defined as sum of the weights of the edges) from any given source vertex to all the remaining vertices of G.		
6	**Mention any two decision problems which are NP-Complete.** NP is the class of decision problems for which a given proposed solution for a given input can be checked quickly to see if it is really a solution	C203.4	BTL2
7	**Define adjacent nodes?** Any two nodes which are connected by an edge in a graph are called adjacent nodes. For E is associated with a pair of nodes∈example, if and edge x (u,v) where u, v V, then we say that the edge x connects the nodes u and v. ∈	C203.4	BTL1
8	**What is a directed graph?** A graph in which every edge is directed is called a directed graph.	C203.4	BTL1
9	**What is a undirected graph?** A graph in which every edge is undirected is called a directed graph.	C203.4	BTL1
10	**What is a loop?** An edge of a graph which connects to itself is called a loop or sling.	C203.4	BTL1
11	**What is a simple graph?** A simple graph is a graph, which has not more than one edge between a pair of nodes than such a graph is called a simple graph.	C203.4	BTL1
12	**What is a weighted graph?** A graph in which weights are assigned to every edge is called a weighted graph.	C203.4	BTL1
13	**Define out degree of a graph?** In a directed graph, for any node v, the number of edges which have v as their initial node is called the out degree of the node v.	C203.4	BTL1
14	**Define indegree of a graph?** In a directed graph, for any node v, the number of edges which have v as their terminal node is called the indegree of the node v.	C203.4	BTL1
15	**Define path in a graph?** The path in a graph is the route taken to reach terminal node from a starting node.	C203.4	BTL1
16	**What is a simple path?** A path in a diagram in which the edges are distinct is called a simple path. It is also called as edge simple.	C203.4	BTL1
17	**What is a cycle or a circuit?** A path which originates and ends in the same node is called a cycle or circuit.	C203.4	BTL1
18	**What is an acyclic graph?** A simple diagram which does not have any cycles is called an acyclic graph.	C203.4	BTL1
19	**What is meant by strongly connected in a graph?** An undirected graph is connected, if there is a path from every vertex to every other vertex. A directed graph with this property is called strongly connected.	C203.4	BTL1

20	**When is a graph said to be weakly connected?** When a directed graph is not strongly connected but the underlying graph is connected, then the graph is said to be weakly connected.	C203.4	BTL1
21	**Name the different ways of representing a graph?** a. Adjacency matrix b. Adjacency list	C203.4	BTL1
22	**What is an undirected acyclic graph?** When every edge in an acyclic graph is undirected, it is called an undirected acyclic graph. It is also called as undirected forest.	C203.4	BTL1
23	**What are the two traversal strategies used in traversing a graph?** a. Breadth first search b. Depth first search	C203.4	BTL1
24	**What is a minimum spanning tree?** A minimum spanning tree of an undirected graph G is a tree formed from graph edges that connects all the vertices of G at the lowest total cost.	C203.4	BTL1
25	**Define topological sort?** A topological sort is an ordering of vertices in a directed acyclic graph, such that if there is a path from v_i to v_j appears after v_i in the ordering.	C203.4	BTL1
26	**What is the use of Kruskal's algorithm and who discovered it?** Kruskal's algorithm is one of the greedy techniques to solve the minimum spanning tree problem. It was discovered by Joseph Kruskal when he was a second-year graduate student.	C203.4	BTL1
27	**What is the use of Dijksra's algorithm?** Dijkstra's algorithm is used to solve the single-source shortest-paths problem: for a given vertex called the source in a weighted connected graph, find the shortest path to all its other vertices. The single-source shortest-paths problem asks for a family of paths, each leading from the source to a different vertex in the graph, though some paths may have edges in common.	C203.4	BTL1
28	**Prove that the maximum number of edges that a graph with n Vertices is n*(n-1)/2.** Choose a vertex and draw edges from this vertex to the remaining n-1 vertices. Then, from these n-1 vertices, choose a vertex and draw edges to the rest of the n-2 Vertices. Continue this process till it ends with a single Vertex. Hence, the total number of edges added in graph is $(n-1)+(n-2)+(n-3)+\ldots+1 = n*(n-1)/2$.	C203.4	BTL5
29	**Define minimum cost spanning tree?** A spanning tree of a connected graph G, is a tree consisting of edges and all the vertices of G. In minimum spanning tree T, for a given graph G, the total weights of the edges of the spanning tree must be minimum compared to all other spanning trees generated from G. -Prim's and Kruskal is the algorithm for finding Minimum Cost Spanning Tree.	C203.4	BTL1

30	**Define Adjacency in graph.** Two node or vertices are adjacent if they are connected to each other through an edge. In the following example, B is adjacent to A, C is adjacent to B, and so on.	C203.4	BTL1
31	**Define Basic Operations of Graph.** Following are basic primary operations of a Graph • **Add Vertex** − Adds a vertex to the graph. • **Add Edge** − Adds an edge between the two vertices of the graph. • **Display Vertex** − Displays a vertex of the graph.	C203.4	BTL1
32	**What is Levels in graph?** Level of a node represents the generation of a node. If the root node is at level 0, then its next child node is at level 1, its grandchild is at level 2, and so on.	C203.4	BTL1
33	**What is visiting and traversing in graph.** ● Visiting refers to checking the value of a node when control is on the node. ● Traversing means passing through nodes in a specific order.	C203.4	BTL1
PART-B			
1	Explain the various representation of graph with example in detail?	C203.4	BTL2
2	Define topological sort? Explain with an example?	C203.4	BTL5
3	Explain Dijkstra's algorithm with an example?	C203.4	BTL5
4	Explain Prim's algorithm with an example?	C203.4	BTL5
5	Explain Krushal's algorithm with an example?	C203.4	BTL2
6	Write and explain the prim's algorithm and depth first search algorithm.	C203.4	BTL5
7	For the graph given below, construct Prims algorithm  1 2 3 4 5 6 7 2 4 2 1 7 8 4 5 1 6 1 2	C203.4	BTL5
8	Explain the breadth first search algorithm	C203.4	BTL5
9	he algorithm to compute lengths of shortest path	C203.4	BTL5
10	n the depth first search algorithm.	C203.4	BTL2

UNIT V

SEARCHING, SORTING AND HASHING TECHNIQUES

Searching –Linear searching-Binary searching. Sorting-Bubble sort-selection Sort-Insertion Sort-shell sort-Radix Sort. Hashing-Hash functions-Separate chaining-Open Addressing-Rehashing- Extendible hashing.

S. No.	Question	Course Outcome	Blooms Taxanomy Level
1	**Define sorting** Sorting arranges the numerical and alphabetical data present in a list in a specific order or sequence. There are a number of sorting techniques available. The algorithms can be chosen based on the following factors ● Size of the data structure ● Algorithm efficiency Programmer's knowledge of the technique	C203.5	BTL1
2	**Mention the types of sorting** ● Internal sorting ● External sorting	C203.5	BTL2
3	**What do you mean by internal and external sorting?** An internal sort is any data sorting process that takes place entirely within the main memory of a computer. This is possible whenever the data to be sorted is small enough to all be held in the main memory. External sorting is a term for a class of sorting algorithms that can handle massive amounts of data. External sorting is required when the data being sorted do not fit into the main memory of a computing device (usually RAM) and instead they must reside in the slower external memory (usually a hard drive).	C203.5	BTL1
4	**How the insertion sort is done with the array?** It sorts a list of elements by inserting each successive element in the previously sorted Sub list. Consider an array to be sorted A[1],A[2],….A[n] a. Pass 1: A[2] is compared with A[1] and placed them in sorted order. b. Pass 2: A[3] is compared with both A[1] and A[2] and inserted at an appropriate place. This makes A[1], A[2],A[3] as a sorted sub array. c. Pass n-1: A[n] is compared with each element in the sub array	C203.5	BTL1

	A [1], A [2] …A [n-1] and inserted at an appropriate position.		
5	**Define hashing.** Hash function takes an identifier and computes the address of that identifier in the hash table using some function	C203.5	BTL1
6	**What is the need for hashing?** Hashing is used to perform insertions, deletions and find in constant average time.	C203.5	BTL1
7	**Define hash function?** Hash function takes an identifier and computes the address of that identifier in the hash table using some function.	C203.5	BTL1
8	**List out the different types of hashing functions?** The different types of hashing functions are, a. The division method b. The mind square method c. The folding method d. Multiplicative hashing e. Digit analysis	C203.5	BTL1
9	**What are the problems in hashing?** a. Collision b. Overflow	C203.5	BTL1
10	**What are the problems in hashing?** When two keys compute in to the same location or address in the hash table through any of the hashing function then it is termed collision.	C203.5	BTL1
11	**what is insertion sort? How many passes are required for the elements to be sorted ?** one of the simplest sorting algorithms is the insertion sort. Insertion sort consist of N-1 passes . For pass P=1 through N-1 , insertion sort ensures that the elements in positions 0 through P-1 are in sorted order .It makes use of the fact that elements in position 0 through P-1 are already known to be in sorted order .	C203.5	BTL1

12	**Write the function in C for insertion sort ?**
	void insertionsort(elementtype A[ ] , int N)
	{
	int j, p;
	elementtype tmp;
	for(p=1 ; p <N ;p++)
	{
	tmp = a[p] ;
	for (j=p ; j>0 && a [j -1] >tmp ;j--)
	a [j]=a [j-1] ;
	a [j] = tmp ;
	}}
		C203.5	BTL5

13	**Who invented shellsort ? define it ?** Shellsort was invented by Donald Shell . It works by comparing element that are distant . The distance between the comparisons decreases as the algorithm runs until the last phase in which	C203.5	BTL1

	adjacent elements are compared . Hence it is referred as diminishing increment sort.		

14	**write the function in c for shellsort?**
	Void Shellsort(Elementtype A[ ],int N)
	{
	int i , j , increment ;
	elementtype tmp ;
	for(elementtype=N / 2;increment > 0;increment / = 2)
	For(i= increment ; i <N ; i ++)
	{
	tmp=A[ ];
	for(j=I; j>=increment; j - =increment)
	if(tmp< A[ ]=A[j – increment];
	A[j]=A[j – increment];
	Else
	Break;
	A[j]=tmp;
	}}
		C203.5	BTL5

15	**ferentiate between merge sort and quick sort?** **Mergesort** — **quick sort** 1. Divide and conquer strategy — Divide and conquer strategy 2. Partition by position — Partition by value	C203.5	BTL4
16	**Mention some methods for choosing the pivot element in quick sort?** 1. Choosing first element 2. Generate random number 3. Median of three	C203.5	BTL2
17	**What are the three cases that arise during the left to right scan in quick sort?** 1. I and j cross each other 2. I and j do not cross each other 3. I and j points the same position	C203.5	BTL1
18	**What is the need of external sorting?** External sorting is required where the input is too large to fit into memory. So external sorting Is necessary where the program is too large	C203.5	BTL1
19	**What is sorting?** Sorting is the process of arranging the given items in a logical order. Sorting is an example where the analysis can be precisely performed.	C203.5	BTL1
20	**What is mergesort?** The mergesort algorithm is a classic divide conquer strategy. The problem is divided into two arrays and merged into single array	C203.5	BTL1
21	**Compare the various hashing techniques.** Technique — Load Factor Separate chaining - close to 1 Open Addressing - should not exceed 0.5 Rehashing - reasonable load factor	C203.5	BTL2

22	**Define collision in hashing.** When two different keys or identifiers compute into the same location or address in the hash table through any of the hashing functions, then it is termed Collision.	C203.5	BTL1
23	**Define Double Hashing.** Double Hashing is a collision-resolution technique used in open addressing category. In double hashing, we apply a second hash function to x and probe at a distance of hash2 (x), 2hash2 (x)………., and so on.	C203.5	BTL1
24	**What are applications of hashing?** The applications of hashing are, ● Compliers use hash table to keep track of declared variables on source code. ● Hash table is useful for any graph theory problem, where the nodes have real names instead of numbers. ● Hash tables are used in programs that play games. ● Online spelling checkers use hashing.	C203.5	BTL1
25	**What does internal sorting mean?** Internal sorting is a process of sorting the data in the main memory	C203.5	BTL1
26	**What are the various factors to be considered in deciding a sorting algorithm?** Factors to be considered in deciding a sorting algorithm are, 1. Programming time 2. Executing time for program 3. Memory or auxiliary space needed for the programs environment.	C203.5	BTL1
27	**How does the bubble sort get its name?** The bubble sort derives its name from the fact that the smallest data item bubbles up to the top of the sorted array.	C203.5	BTL1
28	**What is the main idea behind the selection sort?** The main idea behind the selection sort is to find the smallest entry among in a(j),a(j+1),……..a(n) and then interchange it with a(j). This process is then repeated for each value of j.	C203.5	BTL1
29	**Is the heap sort always better than the quick sort?** No, the heap sort does not perform better than the quick sort. Only when array is nearly sorted to begin with the heap sort algorithm gains an advantage. In such a case, the quick deteriorates to its worst performance of O (n2).	C203.5	BTL4
30	**Name some of the external sorting methods.** Some of the external sorting methods are, 1. Polyphase sorting 2. Oscillation sorting 3. Merge sorting	C203.5	BTL2
31	**Define radix sort** Radix Sort is a clever and intuitive little sorting algorithm. **Radix sort** is a on comparative integer sorting algorithm that sorts	C203.5	BTL1

	data with integer keys by grouping keys by the individual digits which share the same significant position		
32	**Define searching** Searching refers to determining whether an element is present in a given list of elements or not. If the element is present, the search is considered as successful, otherwise it is considered as an unsuccessful search. The choice of a searching technique is based on the following factors a. Order of elements in the list i.e., random or sorted b. Size of the list	C203.5	BTL1
33	**Mention the types of searching** The types are ● Linear search ● Binary search	C203.5	BTL2
34	**What is meant by linear search?** **Linear search** or **sequential search** is a method for finding a particular value in a list that consists of checking every one of its elements, one at a time and in sequence, until the desired one is found.	C203.5	BTL1
35	**What is binary search?** For binary search, the array should be arranged in ascending or descending order. In each step, the algorithm compares the search key value with the middle element of the array. If the key match, then a matching element has been found and its index, or Position, is returned. Otherwise, if the search key is less than the middle element, then the algorithm repeats its action on the sub-array to the left of the middle element or, if the search key is greater, on the sub-array to the right.	C203.5	BTL1
36	**What are the collision resolution methods?** The following are the collision resolution methods ● Separate chaining ● Open addressing ● Multiple hashing	C203.5	BTL1
37	**Define separate chaining** It is an open hashing technique. A pointer field is added to each record location, when an overflow occurs; this pointer is set to point to overflow blocks making a linked list. In this method, the table can never overflow, since the linked lists are only extended upon the arrival of new keys.	C203.5	BTL1
38	**What is open addressing?** Open addressing is also called closed hashing, which is an alternative to resolve the	C203.5	BTL1

	Collisions with linked lists. In this hashing system, if a collision occurs, alternative cells are tired until an empty cell is found. There are three strategies in open addressing: ● Linear probing ● Quadratic probing ● Double hashing		
39	**What is Rehashing?** If the table is close to full, the search time grows and may become equal to the table size. When the load factor exceeds a certain value (e.g. greater than 0.5) we do Rehashing: Build a second table twice as large as the original and rehash there all the keys of the original table. Rehashing is expensive operation, with running time O(N) However, once done, the new hash table will have good performance.	C203.5	BTL1
40	**What is Extendible Hashing?** Used when the amount of data is too large to fit in main memory and external storage is used. **N** records in total to store, **M** records in one disk block **The problem**: in ordinary hashing several disk blocks may be examined to find an element - a time consuming process. **Extendible hashing**: no more than two blocks are examined.	C203.5	BTL1
PART -B			
1	Explain the sorting algorithms	C203.5	BTL2
2	Explain the searching algorithms	C203.5	BTL5
3	Explain hashing	C203.5	BTL5
4	Explain open addressing	C203.5	BTL5
5	Write a C program to sort the elements using bubble sort, insertion sort and radix sort.	C203.5	BTL5
6	Write a C program to perform searching operations using linear and binary search.	C203.5	BTL5
7	n in detail about separate chaining.	C203.5	BTL2
8	Explain Rehashing in detail.	C203.5	BTL5
9	Explain Extendible hashing in detail.	C203.5	BTL5