INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING

QUESTION BANK

Department	**COMPUTER SCIENCE AND ENGINEERING**				
Course Title	**DATA STRUCTURES**				
Course Code	ACSD08				
Program	B.Tech				
Semester	III				
Course Type	Core				
Regulation	BT23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	A Harika, Assistant Professor				

COURSE OBJECTIVES:

The students will try to learn:

I	To provide students with skills needed to understand and analyze performance trade-offs of different algorithms / implementations and asymptotic analysis of their running time and memory usage.
II	To provide knowledge of basic abstract data types (ADT) and associated algorithms: stacks, queues, lists, tree, graphs, hashing and sorting, selection and searching.
III	The fundamentals of how to store, retrieve, and process data efficiently.
IV	To provide practice by specifying and implementing these data structures and algorithms in Java.
V	Understand essential for future programming and software engineering courses..

COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Interpret** the complexity of algorithm using the asymptotic notations.	Understand
CO 2	**Select** appropriate searching and sorting technique for a given problem.	Apply

CO 3	**Construct** programs on performing operations on linear and nonlinear data structures for organization of a data	Apply
CO 4	**Make use of** linear data structures and nonlinear data structures solving real time applications.	Apply
CO 5	**Describe** hashing techniques and collision resolution methods for efficiently accessing data with respect to performance.	Understand
CO 6	**Compare** various types of data structures in terms of implementation, operations and performance.	Analyze

QUESTION BANK:

Q.No	QUESTION	Taxonomy	How does this subsume the level	CO's
MODULE I				
INTRODUCTION TO DATA STRUCTURES, SEARCHING AND SORTING				
PART A-PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS				
1	What is the maximum number of "looks" it will take to find the data element with binary search having 22,049 data elements .	Understand	Learner to recall the concept of array and then explain linear search to find the data element in a list.	CO 2
2	Explain the importance of data structures and discuss typical algorithm complexities of different problems? Write the best, average and worst case analysis of linear search and binary search algorithms.	Understand	Learner to recall the concept of constant speed and tangential direction. Then explaining what happens when a body in constant speed changes its direction constantly.	CO 1
3	Suppose an array A with elements indexed 1 to n is to be searched for a value x. Write pseudo code that performs a forward search, returning n + 1 if the value is not found.	Apply	Learner to recall the concept of array and then describe binary search and use necessary formula to perform binary search.	CO 2

4	Searching in a phone book: A phone book is stored in a text file, containing names of people, their city names and phone numbers. Choose an appropriate data structure to search a person's phone number based on his / her first name and city.	Apply	This would require the learner to recall the concept of array and then describe linear search and use necessary formula to perform binary search.	CO 2
5	Consider the following list of integers: [13,9,3,14,5,68,7,80,9,10] and arrange the elements in ascending order using Radix sort.	Apply	Learner to recall the concept of list and then describe radix sort and use necessary sorting technique to arrange the elements in ascending order.	CO 2
6	What is a uniform binary search and write the pseudo code for uniform binary search.	Understand	Learner to recall the concept of uniform binary search and then explain the pseudo code for uniform binary search.	CO 2
7	Given an array A of non-negative integers of size m. Your task is to sort the array in non-decreasing order and print out the original indices of the new sorted array.	Apply	Learner to recall the concept of array and then describe the appropriate sorting technique to use in sorting the numbers in increasing order.	CO 2
8	Consider the following list of integers: [12,9,3,14,5,66,7,80,9,10] and arrange the elements in descending order using insertion sort.	Understand	Learner to recall the concept of list and then describe insertion sort and use necessary sorting technique to arrange the elements in descending order.	CO 2
9	Consider the following list of integers: [1,9,33,47,5,6,7,80,9,10] and write the procedure for finding the element '7' using binary search.	Apply	Learner to recall the concept of list and then explain binary search technique. Use this to find the element from the list.	CO 2
10	Define shell sort and write the pseudo code for shell sort.	Understand	Learner to recall the concept of shell sort and explain shell sort technique.	CO 2

PART-B LONG ANSWER QUESTIONS				
1	What are internal and external sorting techniques? Given an unsorted array arr[0..n-1] of size n, find the minimum length sub-array arr[s..e] such that sorting this sub-array makes the whole array sorted.	Understand	Learner to recall the concept of list and explain the process of sorting a sub-array in an array.	CO 2
2	Define a data structure. Draw and explain the classification of data structures.	Understand	Learner to recall the concept of data structures and explain the classification of data structures.	CO 3
3	The Fibonacci numbers are the numbers in the following integer sequence. 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89..... Write a function that generates the first N Fibonacci numbers.	Apply	Learner to recall the concept of function and describe the technique of generating first N Fibonacci numbers.	CO 2
4	Explain the interpolation search procedure for the following list of elements and assume the key element is 96. 12, 23, 34, 45, 55, 62, 71, 85, 96	Apply	Learner to recall the concept of function and describe the interpolation search technique. Use the technique to perform a search.	CO 2
5	A Pancake Sorting Problem: Given an unsorted array, sort the given array. One can do only the following operation on the array. flip(arr, i): Reverse array from 0 to i Write an efficient program for sorting a given array in O(nLogn) time on the given machine.	Apply	Learner to recall the concept of sorting and describe the Pancake sorting algorithm.	CO 2
6	Define sorting. Write the procedure for bubble sorting using a suitable example.	Understand	Learner to recall the concept of sorting and explain the bubble sort.	CO 2

7	Explain the Binary Search procedure for the following list of elements and assume the key element is 85. 12, 23, 34, 45, 55, 62, 71, 85, 96	Apply	Learner to recall the concept of the list and describe the binary search technique. Use the technique to perform a search.	CO 2
8	Explain the following two comparison sort algorithms with an example and write their time complexities? • Bubble sort • Selection sort	Understand	Learner to recall the concept of sorting and compare the bubble and selection sort.	CO 2
9	Explain the Binary Search procedure for the following list of elements and assume the key element is 49. 12, 23, 34, 45, 55, 62, 71, 85, 96	Apply	Learner to recall the concept of the list and describe the binary search technique. Use the technique to perform a search.	CO 2
10	Sort the given list of elements using insertion sort.14, 33,27,10,35,19,42,44.	Apply	Learner to recall the concept of the list and describe insertion sort. Use the technique to perform insertion sort.	CO 2
11	Write the name of the sorting technique that is used in playing card games. Write a procedure for sorting a given list of numbers using that technique. 14, 25, 36, 74, 85, 6, 53, 62, 41	Apply	Learner to recall the concept of the list and describe insertion sort. Use the technique to perform insertion sort.	CO 2
12	Write the algorithm for bubble sort and explain with an example.	Understand	Learner to recall the concept of sorting and explain the bubble sort.	CO 2
13	Explain the procedure, advantages, and disadvantages of linear and binary search with a suitable example.	Understand	Learner to recall the concept of searching techniques and compare linear and binary search.	CO 2
14	Compare the time complexities of various searching and sorting algorithms.	Understand	Learner to recall the concept of searching and sorting techniques and compare their time complexities.	CO 1

15	Write an algorithm to search for an employee ID in an array(Hint: use linear search)	Understand	Learner to recall the concept of searching techniques and explain linear search.	CO 2
16	Explain bubble sort by sorting the following list of elements: 5 ,1, 4, 2, 8.	Apply	Learner to recall the concept of sorting and describe bubble sort. Use bubble sort to sort the given elements.	CO 2
17	What is the idea behind Selection sort and sort the following list of elements using that idea. array A = [7 , 5 , 4 , 2] needs to be sorted in ascending order.	Apply	Learner to recall the concept of sorting and describe selection sort. Use selection sort to sort the given elements.	CO 2
18	Sort the given list of elements using selection sort.14, 33,27,10,35,19,42,44.	Apply	Learner to recall the concept of sorting and describe selection sort. Use selection sort to sort the given elements.	CO 2
19	Define selection sort and write pseudo code for selection sort	Understand	Learner to recall the concept of sorting and explain selection sort.	CO 2
20	Explain insertion sort with an example and compare the time complexity of insertion sort with other sorting algorithms.	Understand	Learner to recall the concept of sorting and explain insertion sort.	CO 2
PART-C SHORT ANSWER QUESTIONS				
1	Define Data Structure. Draw the diagram showing the classification of data structures.	Remember	—	CO 3
2	Define Recursion. Give examples of linear and non-linear recursion.	Understand	Learner to recall the concept of recursion and explain types of recursions.	CO 3

3	Consider a situation where the swap operation is very costly. State the name of the sorting algorithm which should be preferred among the following sorting algorithms • Bubble sort • Insertion sort • Selection sort • Merge sort • Quicksort	Understand	Learner to recall the concept of sorting and explain the procedure of selection sort.	CO 2
4	Define an algorithm. Write the properties of algorithm.	Remember	—	CO 3
5	List the area of applications of Data Structures.	Remember	—	CO 3
6	You have to sort 1 GB of data with only 100 MB of available main memory. Which sorting technique will be most appropriate among the following sorting algorithms • Insertion sort • Selection sort • Merge sort • Quick Sort	Understand	Learner to recall the concept of sorting and explain the procedure of merge sort.	CO 2
7	Which data structure is used to perform recursion?	Remember	—	CO 3
8	What are the practical algorithm design issues?	Remember	—	CO 3
9	Write the disadvantage of linear search compared to other searching techniques.	Remember	—	CO 3
10	Given a list arr = 2, 5, 7, 55, 72, key = 72, write the procedure for finding the element 72 using linear search.	Remember	—	CO 3
11	Explain the time and space complexity of an algorithm.	Remember	—	CO 1
12	Write any two applications of binary search.	Remember	—	CO 2

13	State the name of the sorting algorithm will take the least time when all elements of the input array are identical by considering typical implementations of sorting algorithms.	Understand	Learner to recall the concept of sorting algorithms and explain the different types of sorting techniques.	CO 2
14	State the name of the sorting algorithm that is least dependent on the initial ordering of the input.	Understand	Learner to recall the concept of sorting algorithms and explain the different types of sorting techniques.	CO 2
15	Define a linked list and write any two advantages of linked lists.	Remember	—	CO 3
16	Define Big-Oh, Big-Omega, and Theta notations.	Understand	Learner to recall the need for asymptotic notations in representing time complexities and explain different types of asymptotic notations.	CO 1
17	Consider a list arr = 1, 2, 4, 3. Bubble sort is used to sort the elements of a list. Find out the number of iterations that will be required to sort the list.	Understand	Learner to recall the concept of the list and explain the bubble sort technique.	CO 2
18	Write the best, average, and worst case time complexities of selection sort.	Remember	—	CO 1
19	Write the worst-case time complexity of bubble sort when the input array is already sorted.	Understand	Learner to recall the concept of the list and explain the bubble sort technique.	CO 1
20	Write the best, average, and worst case time complexities of insertion sort.	Remember	—	CO 2
21	How do you show an algorithm is stable?	Understand	Learner to recall the concept of algorithm and their properties.	CO 2
22	What is an in-place algorithm?	Remember	—	CO 2
23	What is the divide and conquer technique?	Remember	—	CO 2

24	Define data abstraction.	Remember	—	CO 2
25	What are the factors of algorithm complexity?	Understand	Learner to recall the concept of algorithm and their properties.	CO 2
MODULE II				
LINEAR DATA STRUCTURES				
PART-A PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS				
1	The following postfix expression with single digit operands is evaluated using stack. 8 2 3 ^ / 2 3 * + 5 / * - Note that ^ is exponential operator. Find the top two elements of the stack after the first * is evaluated?	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
2	Transform the following expression to postfix expression using stacks. (A+B)*(C- (D-E)+F)-G	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
3	Convert the following expression A + (B * C) – ((D * E + F) / G) into postfix form.	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
4	To implement a queue using PUSH, POP and REVERSE operation, show how to implement ENQUEUE and DEQUEUE operations using a sequence of given operations?	Apply	Learner to recall the concept of queue and explain basic operations of stack. Use the stack concepts to implement the operations of queue.	CO 3
5	The following postfix expression containing single digit operands and arithmetic operators + and * is evaluated using a stack. 5 2 * 3 4 + 5 2 * * + Show the content of the stack after evaluating the above expression.	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
6	Evaluate the following postfix operation using a stack. 8 2 3 ^ / 2 3 * + 5 1 * - Where ^ is the exponentiation operator.	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3

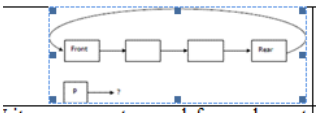
7	Convert the following expression from infix to postfix notation. ((A + B) * C – (D – E) ^(F + G))	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
8	Assume that the operators +, -, × are left associative and îs right associative. The order of precedence (from highest to lowest) is ; x, +, -. The postfix expression corresponding to the infix expression a + b × c – d ê f̂ is	Apply	Learner to recall the concept of stack and explain applications of stack.	CO 3
9	Evaluate the postfix expression 1 2 + 3 * 6 + 2 3 + /	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
10	Evaluate the postfix expression 6 2 3 + - 3 8 2 / + * 2 + 3 +	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
PART-B LONG ANSWER QUESTIONS				
1	Discuss the various operations performed on stack with examples.	Understand	Learner to recall the concept of stack and explain the basic operations of stack.	CO 3
2	Write down the algorithm to convert an infix expression to postfix form.	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
3	Describe the operations of a stack using stacks using arrays.	Understand	Learner to recall the concept of stack and explain the basic operations of stack using arrays.	CO 3
4	Write an algorithm for postfix expression evaluation.	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
5	Write the functional difference between stacks and queues.	Understand	Learner to recall the concept of queue and explain difference between stack and queue.	CO 3
6	Compare between linear queue and circular queue? Write down algorithms for insert and delete operations in a circular queue?	Understand	Learner to recall the concept of queue and explain different types of queue.	CO 3

7	Define a double ended queue (DEQUE). Explain input restricted and output restricted DEQUE.	Understand	Learner to recall the concept of deque and explain types of Deque.	CO 3
8	Explain the concept of a linear queue. Write algorithms for performing insert, delete operations using arrays.	Understand	Learner to recall the concept of linear queue and explain the basic operations of queue using arrays.	CO 3
9	Write the procedure for Circular Queue full and empty conditions.	Understand	Learner to recall the concept of circular queue and explain circular queue full and empty conditions.	CO 3
10	Write the equivalent prefix and postfix expression for the given infix expression: (a * b) / 2 – (c / d – e)	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
11	Convert following infix expression into postfix form: (A+B) * (C-D/E)* G+H	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
12	Evaluate the following postfix notation of expression (Show status of stack after execution of each operations): 5 20 15 - * 25 2 * +	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
13	Convert the following infix expression to postfix expression using a stack using the usual precedence rule: x + y * z + (p * q + r) * s	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
14	Find the result of evaluating the postfix expression 5, 4, 3, +, *, 4, 9, 3, /,+,*	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
15	Convert following infix expression into postfix form: A + (B*C-D/E*G) + H	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
16	Implement an algorithm to DEQUEUE delete from front operation	Understand	Learner to recall the concept of deque and explain basic operations of Deque.	CO 3

17	Implement an algorithm to DEQUEUE delete from rear operation	Understand	Learner to recall the concept of deque and explain basic operations of Deque.	CO 3
18	Implement an algorithm to DEQUEUE insert at front operation	Understand	Learner to recall the concept of deque and explain basic operations of Deque.	CO 3
19	Implement an algorithm to DEQUEUE insert at rear operation	Understand	Learner to recall the concept of deque and explain basic operations of Deque.	CO 3
20	Write the conditions for Queue full and empty conditions.	Understand	Learner to recall the concept of queue and explain basic operations of queue.	CO 3
PART-C SHORT ANSWER QUESTIONS				
1	Define stack. Is it possible to implement a stack using a queue data structure?	Understand	Learner to recall the concept of stack and explain basic operations of stack.	CO 3
2	Define queue. Is it possible to implement a queue using a stack data structure?	Understand	Learner to recall the concept of queue and explain basic operations of queue.	CO 3
3	List out the applications of stack.	Understand	Learner to recall the concept of stack and explain applications of stack.	CO 3
4	List out the applications of queue.	Understand	Learner to recall the concept of queue and explain applications of queue.	CO 3
5	List out various types of queues used in real-time applications.	Remember	—	CO 4
6	List the various operations performed on stacks.	Understand	Learner to recall the concept of the stack and explain basic operations of stack.	CO 3
7	List the various operations performed on linear queues.	Remember	—	CO 3
8	List the various operations performed on double-ended queues.	Understand	Learner to recall the concept of the deque and explain basic operations of deque.	CO 3

9	State the name of the data structure, in which deletion can be done from one end and insertion can take place only at the other end.	Understand	Learner to recall the concept of the queue and explain basic operations of the queue.	CO 3
10	Identify the data structure, in which elements can be inserted or deleted at/from both ends, but not in the middle.	Understand	Learner to recall the concept of the queue and explain basic operations of the queue.	CO 3
11	List out the applications of the double-ended queue.	Remember	—	CO 3
12	Write the conditions for linear queue full and empty.	Remember	—	CO 3
13	State the advantages and disadvantages of the linear queue.	Understand	Learner to recall the concept of the queue and explain disadvantages of queue.	CO 3
14	Write the conditions for stack overflow situation.	Understand	Learner to recall the concept of stack and explain the conditions for stack overflow.	CO 3
15	Write the conditions for stack underflow situation.	Understand	Learner to recall the concept of stack and explain the conditions for stack underflow.	CO 3
16	List the representation three types of expressions.	Remember	—	CO 3
17	Consider the following operation performed on a stack of size 5. Push(1); Pop(); Push(2); Push(3); Pop(); Push(4); Pop(); Pop(); Push(5); After the completion of all operations, find the number of elements present in stack.	Understand	Learner to recall the concept of stack and explain the basic operations for the stack.	CO 3

18	If the elements “A”, “B”, “C” and “D” are placed in a stack and are deleted one at a time, write the order of removal.	Understand	Learner to recall the concept of the stack and explain the basic operations for the stack.	CO 3
19	State the data structure that is required to check whether an expression contains balanced parenthesis or not.	Remember	—	CO 8
20	Write the prefix form of an infix expression p + q – r * t	Remember	—	CO 3
21	What is the difference between queue and deque?	Understand	Learner to recall the concepts queue and double-ended queue.	CO 3
22	What are the limitations of a queue?	Understand	Learner to recall the concept of queues	CO 3
23	Differentiate between stack and queue.	Understand	Learner to recall the concept of stack and queue.	CO 3
24	What is a peek in the stack?	Understand	Learner to recall the concept stacks.	CO 3
25	What is the difference between an array and a stack?	Understand	Learner to recall the concepts of arrays and stacks.	CO 3
MODULE III				
LINKED LISTS				
PART A-PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS				
1	Write a program to print the middlemost node of a linked list.	Apply	Learner to recall the concept of linked list and describe operations of linked list. Use the operation to find the middle node of a linked list.	CO 3
2	Write a program to count the number of occurrences of an element in the linked list without using recursion	Apply	Learner to recall the concept of a linked list and describe operations of a single linked list. Use the search operation to find an element in the linked list.	CO 3
3	Write a program to find the intersection and union of two linked lists.	Understand	Learner to recall the concept of linked lists and explain the intersection and union operations of on linked lists.	CO 3

4	Write a program to swap nodes in a linked list without swapping data.	Understand	Learner to recall the concept of a linked list and explain the process of swapping nodes in a linked list.	CO 3
5	Write a program to search for an element in the linked list without using recursion	Apply	Learner to recall the concept of a linked list and describe operations of a single linked list. Use the search operation to find an element in the linked list.	CO 3
6	A circularly linked list is used to represent a Queue. A single variable p is used to access the Queue. Find the node to which p should point such that both the operations enQueue and deQueue can be performed in constant time? 	Understand	Learner to recall the concept of circular linked list and explain the basic operations.	CO 3
7	Define a node in a linked list? Explain the difference between creation of single linked list node and double linked list node?	Understand	Learner to recall the concept of linked list and explain operations on single and double linked list.	CO 3
8	Write a program to split a circular linked list into two halves.	Apply	Learner to recall the concept of linked list and describe operations of circular linked list. Use the operation to split a linked list into two halves.	CO 3
9	Write a program to display node values in reverse order for a double-linked list.	Understand	Learner to recall the concept of linked list and explain the reverse order for a DLL.	CO 3
10	Write a program to modify the linked list such that all even numbers appear before all the odd numbers in the modified linked list.	Understand	Learner to recall the concept of linked list and explain the sorting operation on linked list.	CO 3

PART-B LONG ANSWER QUESTIONS				
1	Write a program to implement the following operations of a single linked list: • Creating a list: • List traversal	Understand	Learner to recall the concept of linked list and explain operations on single linked list.	CO 3
2	A node can be inserted at various places in a linked list. Write algorithms for inserting a new node in a single linked list at:: • At the front of the linked list: • After a given node: • At the end of the linked list	Understand	Learner to recall the concept of linked list and explain operations on single linked list.	CO 3
3	Write a program to count the number of nodes present in a single linked list?	Apply	Learner to recall the concept of linked list and describe operations on single linked list. Use the operations of single linked list to count the number of nodes.	CO 3
4	Write a program to search for an element present in a single linked list?	Apply	Learner to recall the concept of linked list and describe operations on single linked list. Use the operations of single linked list to search for an element in a linked list.	CO 3
5	Write a program to delete a node from the middle position of the single linked list?	Apply	Learner to recall the concept of linked list and describe operations on single linked list. Use the operations of single linked list to perform deletion operation.	CO 3
6	Write a program to reverse a single linked list of length n?	Apply	Learner to recall the concept of linked list and describe operations on single linked list. Use the operations of single linked list to reverse a linked list.	CO 3

7	Write a program to delete the last item from a singly linked list.	Apply	Learner to recall the concept of single linked lists.	CO 3
8	Write a program to access a specific item in a singly linked list using an index value.	Apply	Learner to recall the concept of single-linked lists.	CO 3
9	Write a program to merge two sorted linked lists into a third linked list using recursion.	Apply	Learner to recall the concept of linked list and describe operations of single linked list. Use the merge operation to combine two sorted linked lists.	CO 3
10	Write a program to traverse through a single linked list.	Apply	Learner to recall the concept of single-linked lists.	CO 3
11	Implement a stack using a linked list with the of a program.	Apply	Learner to recall the concept of linked lists and stacks.	CO 3
12	Implement a queue using a linked list with the of a program.	Apply	Learner to recall the concept of linked lists and queues.	CO 3
13	Write a function to delete a given node in a double-linked list.	Apply	Learner to recall the concept of linked list and describe operations of double linked list. Use the operation to delete a node from the linked list.	CO 3
14	Write a program to count the number of items of a given doubly linked list.	Apply	Learner to recall the concept of double-linked lists.	CO 3
15	Write a program to delete a specific item from a given doubly linked list.	Apply	Learner to recall the concept of double-linked lists.	CO 3
16	Write a program to search for a specific item in a given doubly linked list and return true if the item is found otherwise return false.	Apply	Learner to recall the concept of double-linked lists.	CO 3
17	Write a program to create a doubly linked list and print nodes from the current position to the first node.	Apply	Learner to recall the concept of double-linked lists.	CO 3

18	Write a program to implement the following operations of a double-linked list: Creating a list Inserting a node at the beginning	Apply	Learner to recall the concept of a linked list and describe operations on single linked list. Use the operations of a double linked list to perform various operations.	CO 3
19	Write a program to implement the following operations of a circular single linked list: Creating a list Deleting a node at the end	Apply	Learner to recall the concept of linked list and describe operations on circular single linked list. Use the operations of the double-linked list to perform various operations.	CO 3
20	Write a Python program to print a given doubly linked list in reverse order.	Apply	Learner to recall the concept of double-linked lists.	CO 3
PART-C SHORT ANSWER QUESTIONS				
1	Write the advantages and disadvantages of linked lists.	Remember	—	CO 3
2	List out types of linked lists and its applications.	Remember	—	CO 3
3	Write the advantages of double-linked list over the single-linked list.	Understand	Learner to recall the concept of a linked list and explain the advantages of double linked list over single linked list.	CO 3
4	Write the applications of single and double-linked lists.	Remember	—	CO 3
5	Find the time complexity to count the number of elements in a linked list.	Remember	—	CO 3
6	Write the asymptotic time complexity to insert an element at the second position in the linked list.	Remember	—	CO 3
7	Write an example of a non-contiguous data structure.	Understand	Learner to recall the concept of data structures and explain various types of data structures.	CO 3

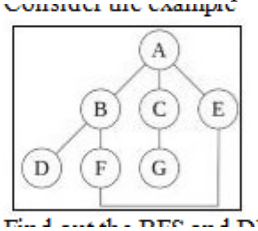
8	Consider a single linked list, list out any two operations that can be implemented in O(1) time.	Remember	—	CO 3

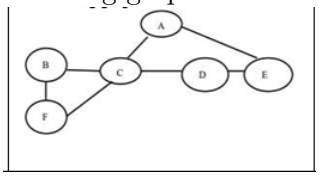
9	def fun1(head):
	if(head == None):
	return
	fun1(head.next)
	print(head.data, end = " ")
	
	What does the following function do for a given Linked List?
		Understand	Learner to recall the concept of linked list and explain the use of the given function.	CO 3

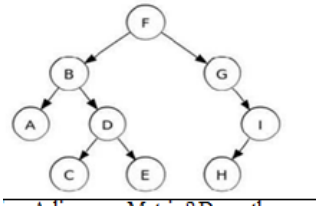
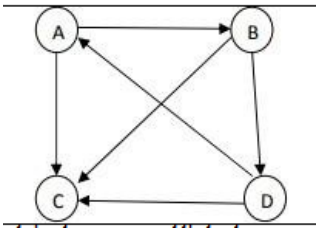
10	def fun1(head):
	if(head == None):
	return
	fun1(head.next)
	print(head.data, end = " ")
	
	What does the following function do for a given Linked List?
		Understand	Learner to recall the concept of linked list and explain the use of the given function.	CO 3

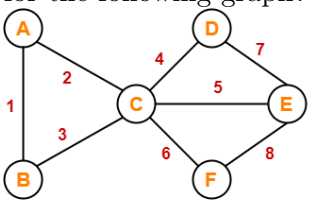
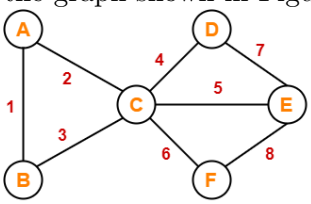
11	Identify the operation that is difficult to perform in a circular single linked list.	Understand	Learner to recall the concept of linked list and explain the operations of circular linked list.	CO 3
12	Define a circular single linked list.	Understand	Learner to recall the concept of linked list and explain circular linked list.	CO 3
13	Identify the variant of linked list in which none of the nodes contains a NULL pointer.	Remember	—	CO 3
14	In a circular linked list, how many pointers require modification if a node is inserted?	Understand	Learner to recall the concept of linked list and explain the operations of circular linked list.	CO 3
15	Identify the searching technique for which linked lists are not suitable data structures.	Remember	—	CO3

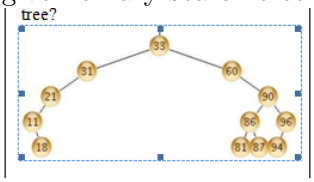
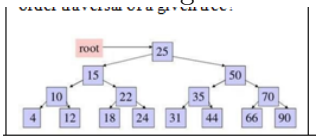
16	In the worst case, find the number of comparisons needed to search a singly linked list of length n for a given element.	Remember	—	CO 6
17	State the name of the data structure in which data elements is logically adjacent to each other.	Understand	Learner to recall the concept of data structures and explain various types of data structures.	CO 6
18	Write the disadvantages of the double-linked list over single-linked list.	Remember	—	CO 6
19	Write the time complexity of enqueue() and equeued() operations of a linked list implementation of a linear queue.	Remember	—	CO 1
20	Write any two operations that is performed more efficiently by a doubly linked list than a singly linked list.	Understand	Learner to recall the concept of a linked list and explain the advantages of double linked list over single linked list.	CO 3
MODULE IV				
NON LINEAR DATA STRUCTURES				
PART A- PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS				
1	Let G be a graph with n vertices and m edges. Find the tightest upper bound on the running time on depth first search of graph G. Assume that graph is represented using adjacency matrix.	Understand	Learner to recall the concept of graphs and explain the graph traversal techniques.	CO 4
2	Let G be a undirected graph with n vertices and 25 edges such that each vertex has degree at least 3. Find the maximum possible value of n?	Understand	Learner to recall the concept of graphs and explain the graph traversal techniques.	CO 3

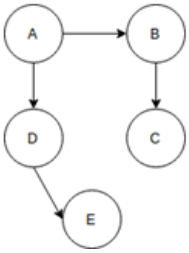
3	In a binary tree, for every node the difference between the number of nodes in the left and right sub trees is at most two. If the height of the tree is h ¿ 0, then find the minimum number of nodes in the tree?	Understand	Learner to recall the concept of binary trees and explain its properties.	CO 3
4	Write a program to find the number of occurrences of a number in a tree of numbers?	Understand	Learner to recall the concept of binary trees and explain frequency of a number in a tree.	CO 3
5	Write breadth first search (BFS) traversal algorithm, based on a queue, to traverse a directed graph of n vertices and m edges?	Understand	Learner to recall the concept of graphs and explain the graph traversal techniques.	CO 3
6	Consider the example  Find out the BFS and DFS	Understand	Learner to recall the concept of graphs and explain the graph traversal techniques.	CO 3
7	Draw a directed graph with five vertices and seven edges. Exactly one of the edges should be a loop, and do not have any multiple edges.	Understand	Learner to recall the concept of graphs and explain the graph traversal techniques.	CO 4
8	Given A Binary Tree. Write an efficient algorithm to delete entire binary tree.	Understand	Learner to recall the concept of trees and explain the algorithm how to delete a binary tree.	CO 3
9	Given A Binary Tree. Write an efficient algorithm to print a left view of a binary tree.	Understand	Learner to recall the concept of trees and explain the algorithm how to delete a binary tree.	CO 3
10	Given binary tree write a recursive solution to traverse the tree using post order traversal.	Understand	Learner to recall the concept of trees and explain post order tree traversal.	CO 3

PART-B LONG ANSWER QUESTIONS				
1	Construct a Binary Search Tree for the following data and do in-order, Preorder and Post-order traversal of the tree. 50, 60, 25, 40, 30, 70, 35, 10, 55, 65, 5	Understand	Learner to recall the concept of binary search trees and explain the tree traversals.	CO 3
2	Explain the breadth first search and depth first search tree traversal on the following graph. 	Understand	Learner to recall the concept of graphs and explain the graph traversal techniques.	CO 3
3	Illustrate the output obtained after pre-order, in-order and post-order traversal of the following tree	Understand	Learner to recall the concept of binary search trees and explain the tree traversals.	CO 3
4	Develop a program in Python to implement Depth First Search traversal of a graph using Adjacency Matrix.	Understand	Learner to recall the concept of graphs and explain the graph traversal techniques.	CO 3
5	Construct a binary search tree by inserting following nodes in sequence: 68, 85, 23, 38, 44, 80, 30, 108, 26, 5, 92, 60. Write in-order, pre-order and post-order traversal of the above generated Binary search tree.	Apply	Learner to recall the concept of binary search trees and describe operations of BST. Use tree traversal algorithms.	CO 4

6	Write the in-order, pre-order and post-order traversals for the given binary tree. 	Understand	Learner to recall the concept of binary search trees and explain the tree traversals.	CO 4
7	Define Adjacency Matrix? Draw the Adjacency Matrix of the following graph. Also give adjacency list representation for the same. 	Understand	Learner to recall the concept of adjacency matrix and explain the adjacency list representation.	CO 4
8	Explain the array and linked representation of a binary tree using a suitable example?	Understand	Learner to recall the concept of binary tree and explain the array and linked representation.	CO 3
9	Define a binary tree? Construct a binary tree given the pre-order traversal and in-order traversals as follows: Pre-Order Traversal: G B Q A C K F P D E R H In-Order Traversal: Q B K C F A G P E D H R	Understand	Learner to recall the concept of binary tree and explain the array and linked representation.	CO 4
10	Construct an expression tree for the following expression. A + (B + C* D + E) + F / G. Make a preorder traversal of the resultant tree.	Apply	Learner to recall the concept of expression trees and describe operations of tree construction. Use tree traversal algorithms to construct an expression tree.	CO 4

11	Explain the binary tree traversal algorithms with a suitable example?	Understand	Learner to recall the concept of binary search trees and explain the tree traversals.	CO 3
12	Write the basic tree terminologies and the properties of binary tree?	Understand	Learner to recall the concept of trees and explain the basic tree terminologies.	CO 3
13	Explain the prims and depth kruskals l algorithms for the following graph?  Given Graph	Understand	Learner to recall the concept of minimum spanning tree terminologies.	CO 3
14	Explain the following with example: i. Full binary tree ii. Strictly binary tree iii. Complete binary tree	Understand	Learner to recall the concept of trees and explain the types of trees.	CO 3
15	Write the applications of trees and graphs?	Understand	Learner to recall the concept of trees and graphs and explain the applications of it.	CO 4
16	Discover prims algorithm for the graph shown in Figure  Given Graph	Understand	Learner to recall the concept of graphs and explain the mimimum spanning treel techniques.	CO 3
17	Define a binary search tree and write the properties of a binary search tree? Construct a binary search with the following keys: 8, 3, , 1, 6, 14, 4, 7, 13, 17, 5	Understand	Learner to recall the concept of binary search trees and explain its properties.	CO 3

18	Write the procedure for finding an element 85 in a given binary search tree? 	Understand	Learner to recall the concept of binary search trees and explain search procedure.	CO 3
19	Write a program for breadth first traversal of a graph?	Understand	Learner to recall the concept of graphs and explain the graph traversal techniques.	CO 3
20	Write the in-order, pre-order and post-order traversal of a given tree? 	Understand	Learner to recall the concept of binary search trees and explain the tree traversals.	CO 3
PART-C SHORT ANSWER QUESTIONS				
1	Write the children for node ‘w’ of a complete-binary tree in an array representation?	Remember	—	CO 3
2	Write the advantages of linked list representation of binary trees over arrays?	Remember	—	CO 3
3	Write the different tree traversal algorithms in linked list representation?	Remember	—	CO3
4	State the graph traversal technique which is similar to level order tree traversal?	Remember	—	CO 3
5	Write the recursive algorithm for pre-order traversal?	Understand	Learner to recall the concept of binary trees and explain the traversal operations.	CO 3

6	Write the name of the tree traversal technique which would print the numbers in an ascending order in a binary search tree?	Remember	—	CO 3
7	Define a full binary tree and complete binary tree?	Understand	Learner to recall the concept of binary trees and explain the types of trees.	CO 3
8	Write the time complexity for finding the height of the binary tree?	Understand	Learner to recall the concept of binary trees and explain the operations on trees.	CO 3
9	Write the worst case and average case complexities of a binary search tree?	Understand	Learner to recall the concept of binary search trees and explain the time complexities.	CO 3
10	Write the number of edges present in a complete graph having n vertices?	Understand	Learner to recall the concept of graphs and explain the basics of graphs.	CO 3
11	Write the different ways used to represent a graph in computer?	Remember	—	CO 3
12	Write the DFS traversal of the given graph? 	Understand	Learner to recall the concept of graphs and explain the traversal operations.	CO 4
13	Write the maximum number of edges present in a simple directed graph with 7 vertices if there exists no cycles in the graph?	Understand	Learner to recall the concept of graphs and explain the traversal operations.	CO 3
14	State the difference between pre-order traversal and post-order traversal?	Understand	Learner to recall the concept of binary trees and explain the traversal operations.	CO 3
15	Write the applications of trees?	Remember	—	CO 3

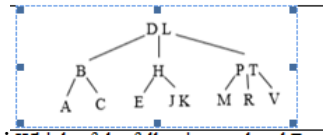
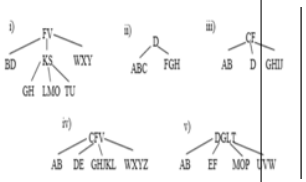
16	Define binary search tree and its operations?	Understand	Learner to recall the concept of binary search trees and explain the basic operations.	CO 3
17	Define strictly binary tree with an example?	Understand	Learner to recall the concept of binary trees and explain the types of trees.	CO 3
18	Write any two applications of priority queue?	Remember	—	CO 4
19	Write the advantages of priority queue?	Remember	—	CO 3
20	Write the time complexity to insert a node based on position in a priority queue?	Understand	Learner to recall the concept of binary trees and explain the types of trees.	CO 1
MODULE V				
BINARY TREES AND HASHING				
PART A-PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	The integers 1-1000 are stored in a binary search tree (BST). Suppose the search algorithm is implemented on the key 363, one of the following sequences is not a possible sequence of nodes that is examined. It is i. 2, 252, 401, 398, 330, 344, 397, 363 ii. 924, 220, 911, 244, 898, 258, 362, 363 iii. 925, 202, 911, 240, 912, 345, 245, 363 iv. 2, 399, 387, 219, 266, 382, 381, 278, 363	Understand	Learner to recall the concept of binary search trees and explain the search algorithm.	CO 4
2	If h is any hashing function and used to hash n keys into a table of size m, where m ¿= n, find the expected number of collisions involving a particular key x?	Understand	Learner to recall the concept of hash table and explain the collision resolution techniques.	CO 5

3	Consider a hash table with 9 slots. The hash function is h(k) = k mod 9. The Collisions are resolved by chaining. The following 9 keys are inserted in the order: 5, 28, 19, 15, 20, 33, 12, 17, 10. Find the maximum, minimum and average chain length in the hash table?	Apply	Learner to recall the concept of hash tables and describe concepts of hashing techniques. Use collision resolution techniques.	CO 5
4	A binary search tree contains the numbers 1, 2, 3, 4, 5, 6, 7, 8. When the tree is traversed in pre-order and the values in each node printed out, the sequence of values obtained is 5, 3, 1, 2, 4, 6, 7, 8. Find the post order traversal sequence of the tree?	Apply	Learner to recall the concept of hash tables and describe concepts of hashing techniques. Use collision resolution techniques.	CO 5
5	A hash table contains 10 buckets and uses linear probing to resolve collisions. The key values are integers and hash function used is key % 10. If the values 43, 165, 62, 123, 142 are inserted in the table, then find the location of the key value 142 in the table?	Apply	Learner to recall the concept of hash tables and describe concepts of hashing techniques. Use collision resolution techniques.	CO 5
6	Find the smallest number of keys that will force a B-tree of order 3 to have a height 2?	Apply	Learner to recall the concept of B-tree and describe concepts of B-tree construction. Use search procedure to find the smallest number of keys.	CO 11

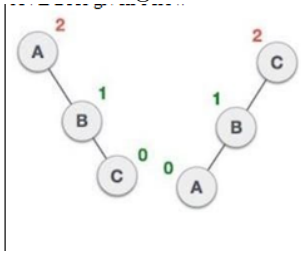
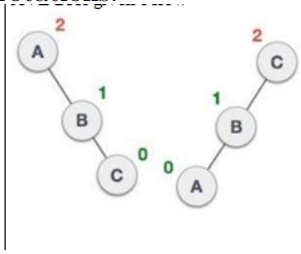
7	Suppose that the computer you will be using has disk blocks holding 4096 bytes, the key is 4 bytes long, each child pointer (which is a disk block id) is 4 bytes, the parent is 4 bytes long and the data record reference (which is a disk block id along with a offset within the block) is 8 bytes. You have an application in which you want to store 1,000,000 items in your B-tree. What value would you select for t? (Show how you derived it.) What is the maximum number of disk pages that will be brought into main memory during a search? Remember that the root is kept in main memory at all times	Apply	Learner to recall the concept of B-tree and describe concepts of B-tree construction. Use search procedure to find the smallest number of keys.	CO 5
8	Show the B-tree that results when inserting R,Y,F,X,A,M,C,D,E,T,H,V,L,W,G (in that order)branching factor of t = 3. You need only draw the trees just before and after each split.	Apply	Learner to recall the concept of B-tree and describe concepts of B-tree construction. Use search procedure to find the smallest number of keys.	CO 5
9	Draw a hash table with open addressing and a size of 9. Use the hash function "k%9". Insert the keys: 5, 29, 20, 0, 27 and 18 into your table (in that order).	Understand	Learner to recall the concept of hash tables and describe concepts of hashing techniques. Use collision resolution techniques.	CO 5

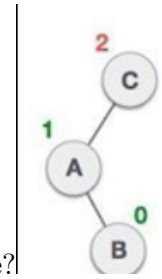
10	A cosmetician wants to represent a list of her clients' records (by their ID). For each client we would like to mark whether he is a man or she is a woman. Suggest a data structure that supports the following operations in O(log n) time in the worst case, where n is the number of persons (men and women) in the data structure when the operation is executed: 1. Insert(k, c) - Insert a new client c with id = k to the data structure, at first mark the client as a woman. 2. Update(k) – Update client with ID = k to be a man. 3. FindDiff(k) – Find the difference between the number of women and the number of men (— #of women - #of men —) among all the clients with ID smaller than k	Understand	Learner to recall the concept of hash tables and describe concepts of hashing techniques. Use collision resolution techniques.	CO 5
PART-B LONG ANSWER QUESTIONS				
1	Define the properties of binary search trees? Write a program to construct a binary search tree with the given keys 8, 3, 10, 1, 6, 14, 4, 7, 13?	Understand	Learner to recall the concept of binary search trees and explain the binary search procedure for a particular element.	CO 4
2	List out the operations of a binary search tree and write the procedure to search for a key 45 in a given binary search tree containing elements 25, 15, 50, 10, 22, 35, 70, 4, 12, 18, 24, 31, 44, 66, 90?	Understand	Learner to recall the concept of binary search trees and explain the binary search procedure for a particular element.	CO 4

3	Write the procedure for inserting an element 60 in a given binary search tree containing elements 25, 15, 50, 10, 22, 35, 70, 4, 12, 18, 24, 31, 44, 66, 90?	Understand	Learner to recall the concept of binary search trees and explain the procedure for inserting a particular element.	CO 4
4	Explain the different possibilities that arise while deleting an element from a given binary search tree containing elements 50, 30, 70, 20, 40, 60, 80? i. Delete 20 ii. Delete 30 iii. Delete 50	Understand	Learner to recall the concept of binary search trees and explain the procedure for deleting a particular element.	CO 4
5	Define an AVL tree and write the steps used to follow while inserting an element 3 into an given AVL tree containing elements 13, 10, 15, 5, 11, 16, 4, 8.	Understand	Learner to recall the concept of AVL trees and explain the types of rotations.	CO 3
6	Draw a hash table with open addressing and a size of 9. Use the hash function (k mod 9). Insert the keys: 5, 29, 20, 0, 27 and 18 into the hash table (in that order).	Understand	Learner to recall the concept of hash table and explain open hashing procedure.	CO 5
7	Define a B-Tree and its properties? Construct a B-tree of minimum degree 3 from the following elements 1, 2, 3, 4, 5, 6, 30, 40, 50, 60, 70, 80, 82, 84, 86.	Understand	Learner to recall the concept of B-tree and explain its properties and construction.	CO 5
8	Write the procedure for insertion and deletion operation in a B tree with the following elements 10, 20, 30, 40, 50, 60, 70, 80, 90.	Understand	Learner to recall the concept of B-tree and explain its properties and construction.	CO 3
9	Explain the collision resolution techniques separate chaining and open addressing with suitable example?	Understand	Learner to recall the concept of hashing and explain collision resolution techniques.	CO 5

10	Explain the following: i. Hashing ii. Hash table iii. Hash Function	Understand	Learner to recall the concept of hashing and explain hashing concepts.	CO 11
11	Insert the following sequence of elements into an AVL tree, starting with an empty tree: 10, 20, 15, 25, 30, 16, 18, 19 and delete 30 in the AVL tree that you got.	Understand	Learner to recall the concept of AVL trees and explain the various operations of AVL trees.	CO 4
12	Explain the collision resolution technique double hashing and linear probing with suitable example?	Understand	Learner to recall the concept of hash table and explain the collision resolution techniques.	CO 5
13	Show the B-tree the results when deleting A, then deleting V and then deleting P from the following B-tree with a minimum branching factor of t =2 	Understand	Learner to recall the concept of B-tree and explain its properties and construction.	CO 5
14	Which of the following are legal B-trees for when the minimum branching factor t = 3? For those that are not legal, give one or two sentence very clearly explaining what property was  violated.	Understand	Learner to recall the concept of B-tree and explain its properties and construction.	CO 3

15	Create a binary search tree for the following elements (23, 32, 24, 36, 15, 12, 39, 2, 19). Discuss the height of the above binary search tree.	Understand	Learner to recall the concept of binary search trees and explain its properties and construction.	CO 3
16	Explain with examples different cases of deletion of elements in a binary search tree.	Understand	Learner to recall the concept of binary search trees and explain the deletion of elements in a binary search tree.	CO 3
17	Explain how M-way search trees differ from binary search trees with an example.	Understand	Learner to recall the concept of M-way search trees and explain its basic concepts.	CO 3
18	Construct a M-way search tree of order 3 for the following nodes 20,70,110,210,130	Understand	Learner to recall the concept of M-way search trees and explain its basic concepts.	CO 3
19	2. Consider a hash table with keys 54,26,93,17,77,31,44,55,20. The hash function h(k) = k Mod 11. Show the hash table entries after the following operations. Use linear probing as a collision resolution technique: a. Initial allocation b. inserting 67, 98 c. deleting 17 and 31	Understand	Learner to recall the concept of M-way search trees and explain its basic concepts.	CO 3
20	Explain the process of Creation of B-Tree with n Key values. Illustrate how insert and delete operations will be performed in B-Tree with an example.	Understand	Learner to recall the concept of M-way search trees and explain its basic concepts.	CO 3
PART-C SHORT ANSWER QUESTIONS				
1	Define binary search tree?	Understand	Learner to recall the concept of binary search trees and explain the basic concepts.	CO 3

2	Write the worst case and average case complexities of a binary search tree?	Remember	—	CO 2
3	Define an AVL tree and its operations?	Understand	Learner to recall the concept of AVL trees and explain the basic concepts.	CO 3
4	State the maximum height of an AVL tree with p nodes?	Remember	—	CO 11
5	State the data structure which checks the height of the left and the right sub-trees and assures that the difference is not more than 1?	Remember	—	CO 3
6	Write the formula for balance factor in AVL trees?	Remember	—	CO 3
7	List out the types of rotations performed in AVL trees?	Understand	Learner to recall the concept of AVL trees and explain the types of rotations.	CO 3
8	Explain how to perform left and right rotations on the right and left unbalanced AVL trees given below 	Understand	Learner to recall the concept of AVL trees and explain the types of rotations. 	CO 3

9	Explain how to perform left-right rotation on the given unbalanced AVL  tree?	Understand	Learner to recall the concept of AVL trees and explain the types of rotations.	CO 3
10	Construct a binary search tree with the following keys 27, 14, 35, 10, 19, 31, 42, and write the procedure to search for a key 20?	Understand	Learner to recall the concept of binary search trees and explain the search procedure for a particular element.	CO 3
11	The height of a BST is given as h. Consider the height of the tree as the no. of edges in the longest path from the root to the leaf. Find the maximum no. of nodes possible in the tree.	Remember	—	CO 3
12	In a full binary search tree every internal node has exactly two children. If there are 100 leaf nodes in the tree, Find the no of internal nodes present in the tree.	Understand	Learner to recall the concept of binary search trees and explain the search procedure for a particular element.	CO 3
13	If a node having two children is to be deleted from the binary search tree, then it is replaced by its successor.	Remember	—	CO 3
14	State the run time for traversing all the nodes of a binary search tree with n nodes and printing them in order.	Understand	Learner to recall the concept of binary search trees and explain the binary search procedure for a particular element.	CO 3

15	If n elements are sorted in a binary search tree, find the time complexity to search a key in the tree.	Remember	—	CO 3
16	Write the purpose of a hash table.	Understand	Learner to recall the concept of hash table and explain the hashing methods.	CO 5
17	State the techniques required to avoid collision.	Remember	—	CO 5
18	Define a hash function and list out popular hash functions.	Understand	Learner to recall the concept of hash table and explain the popular hashing methods.	CO 5
19	In the simple chaining technique used in hashing, a state which data structure is appropriate?	Remember	—	CO 5
20	Write the applications of hashing.	Understand	Learner to recall the concept of hash table and explain the applications of hashing.	CO 5
21	Illustrate Quadratic probing example.	Understand	Learner to recall the concept of hash table and explain the applications of hashing.	CO 5
22	Distinguish open hashing and closed hashing	Understand	Learner to recall the concept of hash table and types of hashing.	CO 5
23	In a hash table of size 13 which index positions would the two keys 27, 130 map to?	Apply	Learner to recall the concept of hash table and explain the applications of hashing.	CO 5

Course Coordinator **HOD CSE**