DATA STRUCTURE AND ALGORITHM

Questions Bank

PCC-CSBS301

CSBS (3rd SEMESTER)

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Questions on Array

Questions for BLOOMS TAXONOMY Level: REMEMBER

1. What is data structure? What are the types of data structure? What are the need & applications of data structure?
2. Differentiate data structure, algorithm and program with a suitable example.
3. What are the types of data structure? What are the need and applications of data structure? What do you mean by Dynamic Data structure?
4. What is Abstract Data type? Explain Abstract Data type (ADT) with examples. 5.Can

a primitive data type be considered as an ADT?

6. List out some of the areas in which data structures are used?
7. What are the major data structures used in the following areas: RDBMS, Network data model and Hierarchical data model?
8. De ne an algorithm. What are the properties of an algorithm?
9. Which properties of an algorithm distinguish from program?
10. What is the Brute Force algorithm?
11. What values are automatically assigned to those array elements which are not explicitly ini- tialized?
12. What are the limitations of arrays? How can you overcome the limitations of arrays? In spite of this limitation why it is important?
13. Explain an efficient way of storing two symmetric matrices of the same order in memory.
14. How data can be organized in memory? What is static and dynamic memory allocation? Explain with example.
15. What is a sparse matrix? How is it represented in memory? What are the types of sparse matrices?
16. What are different characteristics of an algorithm? Explain brie y.
17. What is subscripted variable? Differentiate Primitive Data Structure and Primitive Data- Type.
18. What does the following function do for a given Linked List with first node as head?

```
1  voidfun1(structnode* head){
2        if(head == NULL)
3           return;
4        fun1(head->next);
```

```
5       printf("%d", head->data);
6 }
```

a) Prints all nodes of linked lists
b) Prints all nodes of linked list in reverse order
c) Prints alternate nodes of Linked List
d) Prints alternate nodes in reverse order

19. What is the output of following function for start pointing to rst node of following linked list? **1−>2−>3−>4−>5−>6**

```
1  Void fun(structNode* start){
2       if(start == NULL)return;
3       printf("%d", start->data);
4
5       if(start->next != NULL ) fun(start->next->next);
6       printf("%d", start->data);
7 }
```

a) 1 4 6 6 4 1 b) 1 3 5 1 3 5 c) 1 2 3 5 d) 1 3 5 5 3 1

Questions for BLOOMS TAXONOMY Level: Understand

1. Write an algorithm to find the smallest element in the array.

2. What is the addressing formula for an element $A[i][j]$ in row major order, if i and j are bounded by the lower and upper limits as $l_1 \leq i \leq u_1$ and $l_2 \leq j \leq u_2$? [Assume that the base address is L and w be the number of words allocated to each element]

3. Write an algorithm to multiply two two-dimensional array of size $m \times n$.

4. Given an array $A[10]$. Initially the array contains six elements. Write a C function to insert a new element at the third position in the array.

5. Given an array $A[10]$. Initially the array contains six elements. Write a C function to delete an element at the third position in the array.

6. Given an array $B[10]$. Initially the array contains 8 elements. Write a C function to delete an element from the array. If the element not exists in the array then it will show an appropriate message.

Questions for BLOOMS TAXONOMY Level: Apply

1. Let A be a two-dimensional array declared as follows: A : array [1... 10] [1... 15] of integer; Assuming that each integer takes one memory location. The array is stored in row-major order and the rst element of the array is stored at location 100, what is the address of the element A[i][j]?

2. Let the size of the elements stored in an 8×3 matrix be **4** bytes each. If the base address of the matrix is **3500**, then nd the address of $A[5, 2]$ for both row major and column major cases in C language.

3. Suppose a 2-dimentional array de ned as $A[4...7, -1...3]$ requires 2 bytes of storage space for each element. If the array is stored in row major form, then calculate the address of element at location $A[6, 2]$. Given that the base address is 100. Solve the same problem using column major form.

4. In a compact single dimensional array representation for lower triangular matrices (i.e. all the elements above the diagonal are zero) of size $n \times n$, non-zero elements (i.e. elements of the lower triangle of each row are stored one after another, starting from the rst row, then what will be the index of the $(i, j)^{th}$ element of the lower triangular matrix in this new representation.

5. A program P reads in 500 integers in the range [0...100] representing the scores of 500 students. It then prints the frequency of each score above 50. What would be the best way for P to store the frequencies?

Questions for BLOOMS TAXONOMY Level: Analyze

1. Carly wants to store the details of students studying in 1st year and later on wishes to retrieve the information about the students who score the highest marks in each subject. Specify the scenario where the data can be organized as a single 2-D array or as multiple 1-D arrays.

2. Dave is working on a Campus Management Software but is unable to identify the maximum number of students per course. He decided to implement the same using arrays but discovered that there is memory wastage due to over-provisioning. Which method of memory storage should be used by Dave and how it can be implemented using C/C++?

3. An array, A contains n unique integers from the range x to y (x and y inclusive where n=y- x). That is there is one member that is not in A. Design an faster algorithm for finding the number.

Questions on Stack and Queue

Questions for BLOOMS TAXONOMY Level: REMEMBER

1. What is stack? Why it is called LIFO? What is top of the stack? 2.What

   are the conditions for stack under ow & stack over ow?

3. Why stack is called ADT?

4. What are the applications of stacks?

5. Differentiate between an array and a stack.

6. Parenthesis are never needed in prefix or postfix expressions. Why?

7. Write an algorithm to reverse a queue using a stack.

8. What is queue? Why queue is called FIFO?

9. Why queue is called ADT?

10. What are the applications of priority queue?

11. How can we implement priority queue?

12. What is the limitation of linear queue? How is it solved using circular queue?

13. What is the conditions for checking a circular queue using array is empty or not?

14. What is the conditions for checking a circular queue using array is full or not?

15. Write the differences between stack and queue.

16. Write the operations of priority queue.

17. In which data structure insertion and deletion of elements can take place from either end? Explain.

18. Differentiate between push() and pop() functions.

19. Why are parentheses not required in postfix/prefix expressions?

20. Explain how stacks are used in a non-recursive program?

21. What do you understand by a multiple stack? How is it useful?

22. Explain the terms in x expression, pre x expression, and post x expression.

Questions for BLOOMS TAXONOMY Level: Understand

1. Assume that a queue is available for pushing and popping elements. Given an input sequence a, b, c, (c be the first element), give the output sequence of elements if the rightmost element given above is the fi st to be popped from the queue.
2. Write an algorithm to insert an element into a stack.
3. Write an algorithm to delete an item from a stack.
4. Write the insert and delete functions for the queue.
5. Write short notes on Priority Queue.
6. Write an algorithm to convert a decimal number to binary using a stack.
7. Write an algorithm to print all the prime factors of a number in non-increasing order using a stack. For example the prime divisors of 450 are 5, 5, 3, 3, 2
8. Write the insert function for the queue.
9. Write the delete functions for the queue.
10. Write Q-insert algorithm for circular queue.
11. Write an algorithm to convert an in x expression to its post x form using stack.
12. Write an algorithm to evaluate the post x expression using stack.

Questions for BLOOMS TAXONOMY Level: Apply

1. Assume that the operators +, -, * are left associative and ^ is right associative. The or- der of precedence (from highest to lowest) is ^, *, +, -.What will be the post x expression corresponding to the in x expression a+b *c-d ^ e ^f ?
2. Pick out the equivalent post x expression for this in x expression:
   X=((A+B)*C-(D-E)^(F+G))
3. Convert the following in x expressions to their post x equivalents:
   (a) A B + C (b) A * B + C / D
   (c) (A B) + C * D / E C
   (d) (A * B) + (C / D) (D + E)

(e) ((A B) + D / ((E + F) * G)) (f)
(A 2 * (B + C) / D * E) + F
(g) 14 / 7 * 3 4 + 9 / 2

4. Convert the following in x expressions to their post x equivalents:
(a) A B + C (b) A * B + C / D
(c) (A B) + C * D / E C
(d) (A * B) + (C / D) (D + E)
(e) ((A B) + D / ((E + F) * G)) (f)
(A 2 * (B + C) / D * E) + F
(g) 14 / 7 * 3 4 + 9 / 2

5. Find the in x equivalents of the following post x equivalents (a) A B + C * D
(b) ABC * + D

6. Give the in x expression of the following pre x expressions.
(a) * + A B C D
(b) + a * B C D

7. Convert the expression given below into its corresponding post x expression and then evaluate it. Also write a program to evaluate a post x expression.
10 + ((7 5) + 10)/2

8. Write a function that accepts two stacks. Copy the contents of rst stack in the second stack. Note that the order of elements must be preserved. (Hint: use a temporary stack)

9. Draw the stack structure in each case when the following operations are performed on an empty stack.
(a) Add A, B, C, D, E, F
(b) Delete two letters
(c) Add G (d) Add H
(e) Delete four letters (f) Add I

10. A single array ***A*[1..*MAXSIZE*]** is used to implement two stacks. The two stacks grow from opposite ends of the array. Variables top1 and ***top*2(*topl* < *top*2)** point to the location of the topmost element in each of the stacks. What is the condition for "stack full", if the space is to be used efficiently.

11. Consider the following stack of characters, where STACK is allocated N=8 memory cells: STACK: A, C, D, F, K, _, _, _. Describe the stack as the following operations take place: (a) POP(STACK, ITEM) (b) POP(STACK, ITEM) (c) PUSH(STACK,L) (d) PUSH(STACK,P) (e) POP(STACK, ITEM) (f) PUSH(STACK,R) (g) PUSH(STACK,S) (h) POP(STACK, ITEM).

12. Consider the following queue of characters, where queue Q is a circular array which is allocated 5 memory cells: Front = 2, Rear = 3, Q: _, P, Q, _, _. Describe the following operations on queue: - (a) R is added to the queue. (b) Two letters are from the queue. (c) S, T, U are added to queue.

13. Write logic for reverse the order of elements on a stack S i) Using two additional stacks. ii) Using one additional queue.

14. Suppose that you have a stack and push to the stack the integers 1,2,...n in that sequence. In between these push operations you also invoke some pop operations in such a way that pop request is never set to an empty stack. Immediately before each pop operation you also print the top of the stack. After all of the integers 1, 2 ...n are pushed, the elements remaining in the stack are printed and popped resulting in an eventually empty stack. If n=5 it means 1, 2,3,4,5 then what is the printed sequence?

15. Convert A+B*C/(D+E).

16. Evaluate: a) **5 6 2+ * 1 2 4 / −** using stack.

b)The following postfix expression with single digit operands is evaluated using stack

8 2 3 ^ / 2 3 * + 5 1 * -

(Note that ^ is the exponentiation operator.)

17. Convert ((X+Y)-(W+Z)*K/L)*M into prefix.

18. A single array A[1…MAXSIZE] is used to implement two stacks. These two stacks grow from opposite ends of the array. Variables top 1 and top 2 (top 1 < top 2) point to the location of topmost element in each of the stacks. If the space is to be used efficiently what is the condition for stack full?

Questions for BLOOMS TAXONOMY Level: Analyze

1. Analyze this code and evaluate the uses of this code?

```
1     voidinsert (Q, x) {
2           push (S1, x);
3         }
4     voiddelete(Q)
5      {
6         if(stack-empty (S2))then
7         if(stack-empty (S1))then
8          {
9           print ("Qisempty");
10          return;
11        }
12        else
13          while(! (stack-empty (S1))) then
14           {
15             x = pop (S1);
16             push (S2, x);
17           }
18           x = pop (S2);
```

19 }

2. Let n insert and m ($\leq n$) delete operations be performed in an arbitrary order on an empty queue Q. let x and y be the number of push and pop operations performed respectively in the process. Which one of the following is true for all m and n?
   (A) $n+m \leq x < 2n$ and $2m \leq y \leq n+m$
   (B) $n+m \leq x < 2n$ and $2m \leq y \leq 2n$
   (C) $2m \leq x < 2n$ and $2m \leq y \leq n+m$
   (D) $2m \leq x < 2n$ and $2m \leq y \leq 2n$

3. Can you implement a stack using queue, justify your answer.

4. Can you implement a queue using stack, justify your answer.

Questions on Recursion

Questions for BLOOMS TAXONOMY Level: REMEMBER

1. What is recursion? Explain with an example.
2. What is recursion tree?
3. Write down the recursive de nition for generation of the Fibonacci sequence.
4. What is tail recursion.
5. Write short notes on Tail Recursion and Tower of Hanoi Problem.
6. Calculate the time complexity of Tower of Hanoi problem.
7. Draw the recursion tree for number of disks equals to 3.
8. Differentiate between an iterative function and a recursive function. Which one will you prefer to use and in what circumstances?

Questions for BLOOMS TAXONOMY Level: Understand

1. Write the recursive function to find the factorial of a number. 2. Write the recursive function to find n^{th} Fibonacci number. 3. Explain the execution order of factorial (5) using stack.
4. Write the recursive function for the problem of Tower of Hanoi problem.
5. Assuming Fib (n) as a recursive function draw a recursive tree for Fib (6).
6. Write the function for tail recursion to find the factorial of a number.
7. Write the function for tail recursion to find n^{th} Fibonacci number.

Questions on Searching

Questions for BLOOMS TAXONOMY Level: REMEMBERING

1. What is the di erence between Linear & Binary Search? What is the prerequisite for binary search?
2. What do you mean by complexity? What is time complexity and what is space complexity?
3. Explain the meaning of worst case analysis and best case analysis with an example.
4. What is the di erence between Linear & Binary Search?
5. What are the advantages of binary search over linear search?
6. What is the precondition of performing binary search in an array? Write the Binary search algorithm.

Questions for BLOOMS TAXONOMY Level: Understanding

1. "Binary search technique can't be implemented using linked list" .Justify
2. "Binary search technique can't be implemented using linked list"_Justify. Derive the worst case time complexity of Binary search.

Questions on Sorting

Questions for BLOOMS TAXONOMY Level: REMEMBERING

1. De ne sorting. What is the importance of sorting?
2. What are the di erent types of sorting techniques? Which sorting technique has the least worst case?
3. Compare heap sort and quick sort.
4. Sort the elements 77, 49, 25, 12, 9, 33, 56, 81 using various sorting techniques (insertion sort, selection sort, bubble sort, merge sort, quick sort, count sort, radix sort).
5. Sort the following sequence of numbers in descending order using heap sort: 42, 34, 75, 23, 21, 18, 90, 67, 78.
6. Identify the sorting algorithm applied to a given rearrangement of a data set after two passes.

Questions for BLOOMS TAXONOMY Level: Understanding

1. Explain the difference between bubble sort and quick sort. Which one is more efficient?
2. Compare heap sort and quick sort.
3. Quick sort shows quadratic behavior in certain situations. Justify.
4. If the following sequence of numbers is to be sorted using quick sort, then show the iterations of the sorting process: 42, 34, 75, 23, 21, 18, 90, 67, 78.
5. In which situation insertion sort running time complexity O(n)? Explain with an example. Then the same situation for quick sort, what happens, explain.
6. Why merge sort is called a divide and conquer method?

Questions for BLOOMS TAXONOMY Level: Applying

1. Sort the following sequence of numbers using merge sort: 66, 77, 11, 88, 99, 22, 33, 44, 55.
2. Write a recursive function to perform selection sort.
3. Write a C function for selection sort and also calculate the time complexity for selection sort.
4. Write the algorithm to sort an array of integers using the Insertion Sort method. Explain the time complexity of this sorting algorithm. Explain with a suitable example the principle operation of Quick sort.
5. Write short notes on Radix Sort.

6. What is a heap? De ne max and min heap. Explain with an example how to construct a heap (show both types).

7. Define Big- O, Ω, Θ notation. Prove that $O(f(x)) + O(g(x)) = O(\max(f(x), g(x)))$.

Questions for BLOOMS TAXONOMY Level: Analyzing

1. Compare the running time complexity of di erent sorting algorithms. 2. Discuss the

advantages of insertion sort.

3. Which sorting algorithm is easily adaptable to singly linked lists? Justify.

4. You have an array of n elements. Suppose you implement quick sort by always choosing the central element of the array as the pivot. Then what is the tightest upper bound for the worst-case performance?

Questions for BLOOMS TAXONOMY Level:Evaluating

1. Bubble sort and selection sort have worst-case time complexity O(n^2), but selection sort is faster than bubble sort. Why?

2. Let P be a Quick Sort Program to sort numbers in ascending order using the rst element as the pivot. Let t1 and t2 be the number of comparisons made by P for the inputs 1, 2, 3, 4, 5 and 4, 1, 5, 3, 2 respectively. Which one of the following holds? (A) $t1 = 5$ (B) $t1 < t2$ (C) $t1 > t2$ (D) $t1 = t2$

Questions on Linked List

Questions for BLOOMS TAXONOMY Level: REMEMBER

1. Make a comparison between a linked list and a linear array. Which one will you prefer to use and when?

2. Why is a doubly linked list more useful than a singly linked list?

3. Give the advantages and uses of a circular linked list.

4. Specify the use of a header node in a header linked list.
5. Polynomials can be represented either by an array or by linked list. Compare & contrast these two types of representations. Represent the following polynomials by a linked data structure (show only the diagram)

$$-5x^5 + 4x^4 - 25x^3 + 10.$$

6. Explain the difference between a circular linked list and a singly linked list.

7. What is linked stack & what is linked queue? Explain insertion & deletion operations on linked stack & linked queue.
8. Use the linked list of the above question to insert the record of a new student in the list.

9. Delete the record of a student with a speci ed roll number from the list maintained in Question 7.

10. Given a linked list that contains English alphabet. The characters may be in upper case or in lower case. Create two linked lists- one which stores upper case characters and the other that stores lower case characters.

11. Create a linked list which stores names of the employees. Then sort these names and re-display the contents of the linked list.

12. Is linked list can be considered as a linear data structure? Explain.

13. If you are using C language to implement the heterogeneous linked list, what pointer type will you use?

14. What is self-referential structure? Explain with an example.

15. Write a function to remove the rst node from the list and insert it at end, without changing the info part of any node.

16. Which of the following statements are true in the case of doubly linked list?
    i) Every node is connected to other node
    ii) We can traverse in both the directions, explain with example.

17. What does the following function do for a given Linked List with first node as head?

```
1  voidfun1(structnode* head){
2     if(head == NULL)
3        return;
4     fun1(head->next);
5     printf("%d", head->data);
6  }
```

18. Can we perform insertion sort in linked lists? Explain.

19. The following function reverse () is supposed to reverse a singly linked list. There is one line missing at the end of the function.

```
1  /*Linklistnode*/
2  structnode{
3        intdata;
4        structnode* next;
5  };
6
7  /*head_refisadoublepointerwhichpointstohead(orstart)
       pointeroflinkedlist*/
8  staticvoidreverse(structnode** head_ref)
9  {
10       structnode* prev = NULL;
11       structnode* current = *head_ref;
12       structnode* next;
13       while(current != NULL)
14       {
15            next =current->next;
16            current->next = prev;
17            prev = current;
18            current = next;
19       }
20       /*ADDASTATEMENTHERE*/
21 }
```

What should be added in place of /*ADD A STATEMENT HERE*/ , so that the function correctly reverses a linked list ?

20. Consider the function f de ned below.

```
1 struct item
2 {
3     intdata;
4     structitem * next;
```

```
 5 };
 6
 7 intf(structitem *p)
 8 {
 9     return(
10                 (p == NULL) ||
11                 (p->next == NULL) ||
12                 (( P->data <= p->next->data) && f(p->next))
13               );
14 }
```

For a given linked list p, when the function f returns 1 ?

21. Is it possible to find a loop in a Linked list? Give reason to your answer.

22. How would you sort the elements in a single linked list?

23. Suppose a given linked-list has some odd numbers and even numbers. Write an algorithm to find them and position of them.

24. Which operations are more effective in linked list than arrays? And why?
    i) Insertion
    ii) Deletion
    iii) Traversal

25. Can we do a Binary search on a linked list? Give reason to your answer.

26. If you implement stack or queue using linked list, then what is the full conditions?

27. Application of single and double linked list.

28. Who is responsible to dynamically allocate the memory for creation of a node in a single linked list?

29. Write the recursive definition of Tower of Hanoi. Then find the running time in terms of recurrence relation.

30. Explain head and tail recursion with an example.

32. Draw the recursive tree of Tower of Hanoi.

33. The following recursive function in C is a solution to the Towers of Hanoi problem.

```
 1 voidmove (intn,charA,charB,charC)
 2 {
 3     if(..... )
 4     {
 5         move(.....);
```

```
6         printf("Movedisk%dfrompole%ctopole%c\n",n, A,C);
7         move (.....);
8     }
9 }
```

Fill in the dotted parts of the solution.

34. "The designer of an algorithm needs to balance between space complexity and time complexity"- Comment on the validity of the statement in the context of recursive algorithms.

35. Di erentiate between Array and Linked List. Why are they known as Non-Primitive and Linear data structure?

36. Write short notes on Garbage collection technique.

Questions for BLOOMS TAXONOMY Level: Understand

1. How to read a singly linked list in backward?
2. Write a C/C++ function for insertion of a data item after a speci ed data item into a linear linked list.
3. Write a C/C++ function to print of a linear linked list in reverse order and also count the number of nodes of a linear linked list.
4. Write a C/C++ code for insertion of a data item after a speci ed data item into a doubly linked list.
5. Each node in a singly linked list contains a key value and link to the next node. Write an algorithm to delete any node from the list, assuming the key value of the node to be deleted is known. Your algorithm must validate the given key value for its purpose.
6. Write a function to delete a node from a doubly linked list.
7. Write a function to insert a node at the end of the singly linked list.
8. Write a function to delete last node of the singly linked list.
9. Write a function to insert a node at the beginning of the circular linked list.
10. Write a function to insert data in a sorted linked list.

Questions for BLOOMS TAXONOMY Level: Apply

1. The following C function takes a singly linked list of integers as a parameter and rearranges the elements of the list. The function is called with the list containing the integers 1,2,3,4,5,6,7 in the given order. What will be the contents of the list after the function completes execution?

```
1  structnode{
2        intvalue;
3        structnode *next;
4  };
5  voidrearrange(structnode *list){
6        structnode *p,*q;
7        inttemp;
8        if(!list||!list->next)
9           return;
10       p=list;
11       q=list->next;
12       while(q){
13          temp=p->value;
14          p->value=q->value;
15          q->value=temp;
16          p=q->next;
17          q=p?p->next:0;
18       }
19 }
```

2. Supposed the linked list in the memory consisting of numerical values. Write a function for each of the following:
   i) To nd the maximum (MAX) of the values in the list.
   ii) To nd the average (MEAN) of the values in the list.
   iii) To nd the product (PROD) of the values in the list.

3. How to detect a cycle in a linked list?

4. Given a singly linked list A, nd the middle element of the linked list.

Questions for BLOOMS TAXONOMY Level: Analyze

1. Why Circular linked list is important in case of Josephus Problem?

2. Explain insertion and deletion operations on linked stack and linked queue. Write an algorithm to add two polynomials using dynamic memory allocation. Polynomials can be represented either by an array or by linked list. Compare and contrast these two types of representations. Represent the

following polynomials by a linked data structure (show only the diagram)

3. De ne a linked list with a loop as a linked list in which the tail element points to one of the list's element and not to NULL. Assume that you are given a linked list L, and two pointers P1, P2 to the head. Write an algorithm that decides whether the list has a loop without modifying the original list. The algorithm should run in time O (n)., where n is the number of elements in the list.

4. In the worst case, the number of comparisons needed to search a singly linked list of length n for a given element is which of the following ?Then explain. (A) log 2 n
   (B) n/2
   (C) log 2 n 1
   (D) n

5. How does a stack implemented using a linked list di er from a stack implemented using an array?

Questions on Tree

Questions for BLOOMS TAXONOMY Level: REMEMBER

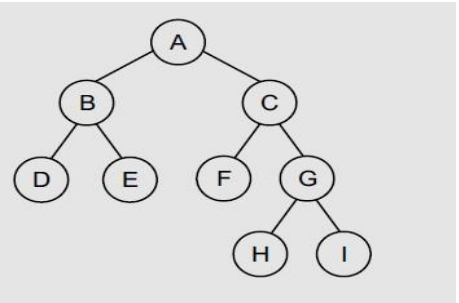
1. Explain the concept of a tree. Discuss its applications.

2. What are the two ways of representing binary trees in the memory? Which one do you prefer and why?

3. Write short notes on:
   (a) Complete binary trees
   (b) Extended binary trees
   (c) Expression trees

4. Suppose the numbers 7, 5, 1, 8, 3, 6, 0, 9, 4, 2 are inserted in that order into an initially empty binary search tree. The binary search tree uses the usual ordering on natural numbers. What is the in-order traversal sequence of the resultant tree?

5. Consider the tree given below. Now, do the following:
   (a) Name the leaf nodes
   (b) Name the non-leaf nodes
   (c) Name the ancestors of E
   (d) Name the descendants of A
   (e) Name the siblings of C
   (f) Find the height of the tree
   (g) Find the height of sub-tree rooted at E
   (h) Find the level of node E
   (i) Find the in-order, pre-order, post-order, and level order traversal



6. Explain the concept of binary search trees.

7. Explain the operations on binary search trees.

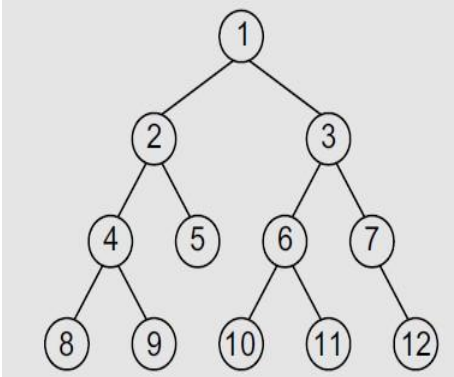
7. Write a short note on threaded binary trees.

8. Why are threaded binary trees called e cient binary trees? Give the merits of using a threaded binary tree.

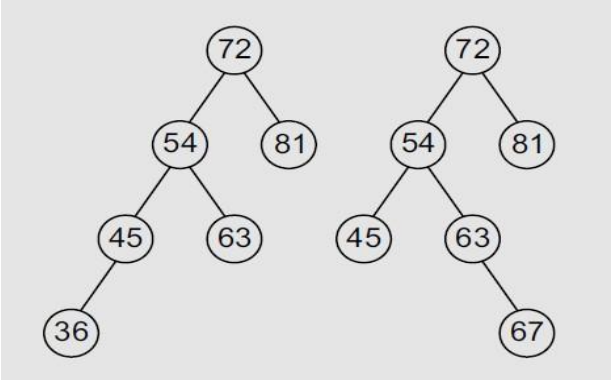
9. Discuss the advantages of an AVL tree.

10. List the merits and demerits of a splay tree.

11. Provide the memory representation of the binary tree given below: a) Find the result of one- way in-order, one-way pre-order, and two-way in-order threading of the tree. b) In each case, draw the tree and also give its memory representation.



12. Balance the AVL trees given below:



13. Create an AVL tree using the following sequence of data: 16, 27, 9, 11, 36, 54, 81, 63, 72.

14. Draw all possible binary search trees of 7, 9, and 11.

15. What is the maximum number of levels that a binary search tree with 100 nodes can have?

16. What is the maximum height of a tree with 32 nodes?

17. What is the maximum number of nodes that can be found in a binary tree at levels 3, 4, and 12?

18. Draw all possible non-similar binary trees having three nodes.

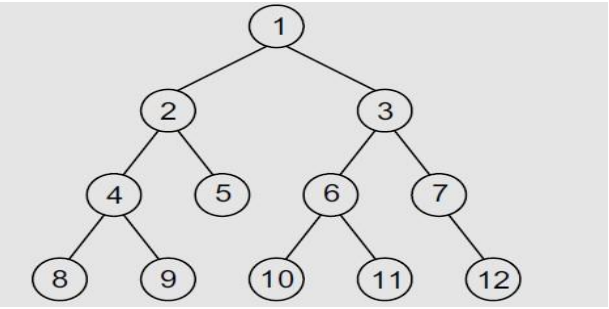
19. Draw the binary tree having the following memory representation:

ROOT 3

AVAIL 15

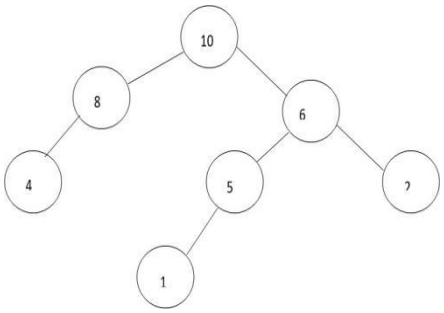
	LEFT	DATA	RIGHT
1	–1	8	–1
2	–1	10	–1
3	5	1	8
4			
5	9	2	14
6			
7			
8	20	3	11
9	1	4	12
10			
11	–1	7	18
12	–1	9	–1
13			
14	–1	5	–1
15			
16	–1	11	–1
17			
18	–1	12	–1
19			
20	2	6	16

20. Draw the memory representation of the binary tree given below.



21. What is complete binary tree and what is full binary tree?

23. Check the following is a max-heap or not? Explain.



24. Which one of the following array represents a binary max-heap?

a) {25,12,16,13,10,8,14}
b) {25,14,13,16,10,8,12}
c) {25,14,16,13,10,8,12}
d) {25,14,12,13,10,8,16}

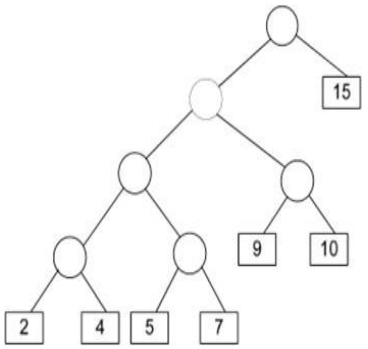
25. What is the content of the array after two delete operations on the correct answer to the previous question?

a) {14,13,12,10,8}
b) {14,12,13,8,10}
c) {14,13,8,12,10}
d) {14,13,12,8,10}

26. Write some applications of tree.

27. The height of a binary tree is the maximum number of edges in any root to leaf path. What is the maximum number of nodes in a binary tree of height h?

28. What is the weighted external path length of the binary tree shown in the following graph?



29. What is a non-linear data structure? Define the following: (Each definition carries 1 mark)

Tree	*Node*	*Root*	*Degree of a Tree*	*Degree of a Node*	*Level*	*Directed and Undirected Graph*
Path	*Forest*	*Height*	*Ancestors*	*Descendant*	*Siblings*	*Weighted and Un-weighted Graph*
Terminal Nodes	*Non-Terminal Nodes*	*Internal Path*	*External Path*	*Leaf Node*	*Orchard*	*Sub-graph*
Degree of a Graph	*Cut Vertex*	*Articulation Point*	*Pendant Vertex*	*Clique*	*Complete and Connected Graph*	*Path and Isomorphism*

30. What is BST?

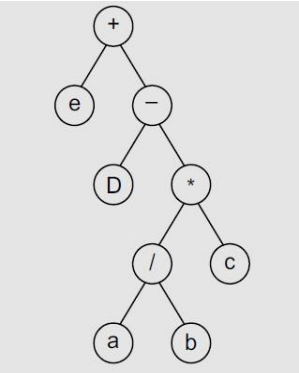
31. Write short notes on the following:
    a) Heap Tree.
    b) B+ Tree.
    c) B* Tree.
    d) BST.
    e) Threaded Binary Tree.

Questions for BLOOMS TAXONOMY Level: Understand

1. For the expression tree given below, do the following:
    (a) Extract the in x expression it represents

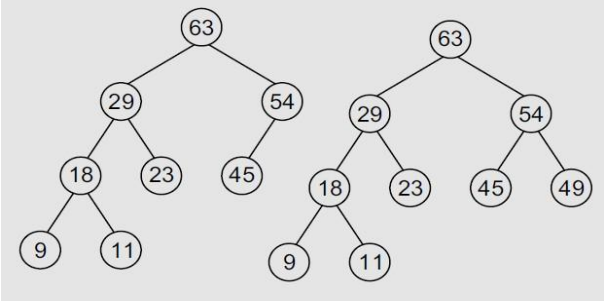
(b) Find the corresponding pre x and post x expressions

(c) Evaluate the in x expression, given a = 30, b = 10, c = 2, d = 30, e = 10



2. Convert the prefix expression / a b * + b c d into in x expression and then draw the corresponding expression tree.

3. Consider the trees given below and state whether they are complete binary tree or full binary tree.



4. List all possible non-similar binary trees having four nodes.

5. construct the expression tree for the following expression tree : $E = (2a + 5b)(x \hat{} 7y)4$.

6. What is an AVL tree? How do AVL trees di er from binary search tree? Clearly mention the di erent rotations used and balance factor of each node.

7. If E and I denote the external and internal path lengths of a binary tree having n internal nodes then prove $E = I + 2n$.

8. For a non-empty binary tree prove $n_0 = n_2 + 1$, where n_0 = No. of terminal nodes and n_2 = No. of nodes of degree **2**.

Questions for BLOOMS TAXONOMY Level: Apply

1. Suppose the numbers 7, 5, 1, 8, 3, 6, 0, 9, 4, 2 are inserted in that order into an initially empty binary search tree. The binary search tree uses the usual ordering on natural numbers. What is the in-order traversal sequence of the resultant tree?

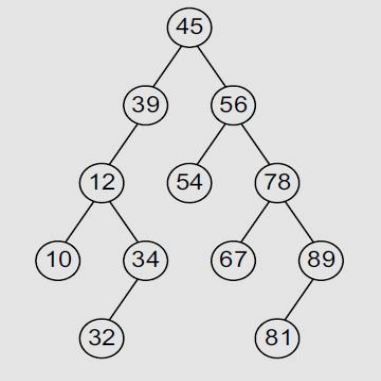
2. What is the maximum possible number of nodes in a binary tree at level 6?

3. The preorder traversal sequence of a binary search tree is
30, 20, 10, 15, 25, 23, 39, 35, 42.
What is the post order traversal sequence of the same tree?

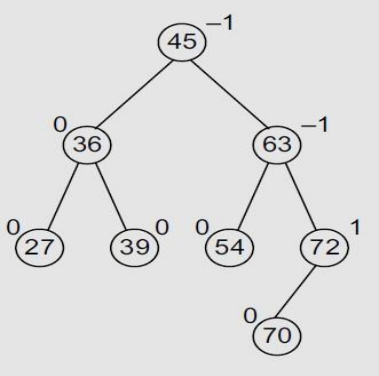
4. Create a binary search tree with the input given below: 98,
2, 48, 12, 56, 32, 4, 67, 23, 87, 23, 55, 46
(a) Insert 21, 39, 45, 54, and 63 into the tree
(b) Delete values 23, 56, 2, and 45 from the tree

5. Consider the binary search tree given below. Now do the following operations:
a) Find the result of in-order, pre-order, and post-order traversals.

b) Show the deletion of the root node
c) Insert 11, 22, 33, 44, 55, 66, and 77 in the tree



6. Consider the AVL tree given below and insert 18, 81, 29, 15, 19, 25, 26, and 1 in it. Delete nodes 39, 63, 15, and 1 from the AVL tree formed after solving the above question.



7. Write a c language function to nd the in-order successor of the root of a binary tree.

8. Write the non-recursive functions for in-order traversal of binary tree. Write the non-recursive functions for pre-order traversal of binary tree.

9. Write the non-recursive functions for post-order traversal of binary tree.

10. Write an algorithm for non-recursive in-order traversal of a threaded binary tree.

11. Write an algorithm to insert a node in a BST.

12. Write an algorithm to delete a node from binary search tree.

13. What is BST? Write an algorithm to left rotate a binary tree.

14. Answer the following questions :

(a) Draw the expression tree of the following in x expression. Convert it into pre x and post x expressions. Expression: $((a+b)+c * (d+e)+f) * (g+h)$.

(b) Consider the algebraic expression $E = (5x + z)(3a - b)2$

i) Draw the expression tree corresponding to E

ii) Find the scope of exponential operator i.e. the sub tree rooted at the exponential operator.

15. Insert the following keys in the order given below to build them into an AVL tree. 8, 12, 9, 11, 7, 6

16. Construct a binary tree from pre and inorder traversal.
Pre-order- A B D I E J C F G K
In-order - D I B E J A F C K G

17. Construct a Binary Tree from Inorder and Postorder traversal.
Post-order- B C A P N T L K G F D
In-order - A B C D F G K L N P T

18. The degree of a node is the number of children it has. Show that in any binary tree, the numbers of leaves are one more than the number of nodes of degree 2.

19. Show how the following integers can be inserted in an empty binary search tree in the order they are given: 50 , 30,10, 90,100, 40,60,20,110,5

20. Show the steps in creation of a height balanced binary AVL tree using insertion of items in the following order-show the steps required with diagrams.
(March, May , November, August, April, January, December, July, February, june, October, September)

Questions for BLOOMS TAXONOMY Level: Analyze

1. In a binary tree with n nodes, every node has an odd number of descendants. Every node is considered to be its own descendant. What is the number of nodes in the tree that have exactly one child?

2. Consider a node X in a Binary Tree. Given that X has two children, let Y be In order successor of X. Can Y have any left child?

3. Post order traversal of a given binary search tree, T produces the following sequence of keys 10, 9, 23, 22, 27, 25, 15, 50, 95, 60, 40, 29 What will be the result of an in-order traversal of the tree T?

4. Consider the following nested representation of binary trees: (X Y Z) indicates Y and Z are the left and right sub stress, respectively, of node X. Note that Y and Z may be NULL, or further nested. Which of the following represents a valid binary tree?
(a) (1 2 (4 5 6 7))
(b) (1 (2 3 4) 5 6) 7)
(c) (1 (2 3 4)(5 6 7))
(d) (1 (2 3 NULL) (4 5))

5. The following numbers are inserted into an empty binary search tree in the given order: 10, 1, 3, 5, 15, 12, and 16. What is the height of the binary search tree (the height is the maximum distance of a leaf node from the root)?

6. What is the number of leaf nodes in a rooted tree of n nodes, with each node having 0 or 3 children?

7. Why tree is called non-linear data structure?

8. Why heap tree is represented with array?

9. What is the tightest upper bound that represents the time complexity of inserting an object into a binary search tree of n nodes?

10. How does the height of a binary search tree a ect its performance?

11. How many nodes will a complete binary tree with 27 nodes have in the last level? What will be the height of the tree?

12. How is an AVL tree better than a binary search tree?

13. How does a red-black tree perform better than a binary search tree?

14. What are the problems of binary tree? Explain how a height-balanced tree can be formed by inserting the following elements in the given order:
1, 2, 3, 4, 5, 6, 8, 9, 10, 7, 11
Show the root element that can be deleted from the above tree.

Questions for BLOOMS TAXONOMY Level: Evaluate

1. Prove that the maximum number of nodes on level i of a binary tree is $2i$ $(i > 0)$.

2. A 3-ary max heap is like a binary max heap, but instead of 2 children, nodes have 3 children. A 3-ary heap can be represented by an array as follows: The root is stored in the rst location a[0], nodes in the next level, from left to right, is stored from a[1] to a[3].The nodes from the second level of the tree from left to right are stored from a[4] location onward. An item x can be inserted into a 3-ary heap containing n items by placing x in the location a[n] and pushing it up the tree to satisfy the heap property.

   (a) Which one of the following is a valid sequence of elements in an array representing 3 ary max heap?
   i) 1,3,5,6,8,9
   ii) 9,6,3,1,8,5
   iii) 9,3,6,8,5,1
   iv) 9,5,6,8,3,1
   Explain why one option is correct and others fail.

   (b) Suppose the elements 7,2,10 and 4 are inserted in that order, into the valid 3-ary max heap found in the above question. Find the sequence of items in the array representing the resultant heap.

3.A scheme for storing binary trees in an array X is as follows. Indexing of X starts at 1 instead of 0.The root is stored at X [1].For a node stored at X[i], the left child, if any, is stored in X [2i] and the right child, if any, in X[2i+1]. To be able to store any binary tree on n vertices what is the minimum size of X should be.

4.A complete n-ary tree is a tree in which each node has n children or no children. Let I be the number of internal nodes and L be the number of leaves in a complete n-ary tree. If L = 41, and I = 10, what is the value of n?

5.Consider the following C program segment

```
1 structCellNode
2 {
3     structCellNode *leftchild;
4     intelement;
5     structCellNode *rightchild;
6 };
7 intDoSomething(structCellNode*ptr)
8 {
9     intvalue=0;
10    if(ptr!=NULL)
11    {
12       if(ptr->leftchild!=NULL)
13          value=1+DoSomething(ptr->leftchild);
14       if(ptr->rightchild!=NULL)
15          value=max(value,1+DoSomething(ptr->rightchild));
16    }
17    returnvalue;
18 }
```

6.What will be the value returned by the function Do Something when a pointer to the root of a non-empty tree is passed as the argument.

7.Consider the following C program segment where Cell Node represents a node in a binary tree

```
1 structCellNode
2 {
3       structCellNode *leftchild;
4       intelement;
5       structCellNode *rightchild;
6 };
7 intGetValue(structCellNode *ptr)
8 {
9     intvalue=0;
10    if(ptr1=NULL)
```

```
11    {
12      if((ptr->leftchild==NULL)&&(ptr->rightchild==NULL))
13        value=1;
14      else
15        value=value+GetValue(ptr->leftchild)+GetValue(ptr->rightchild);
16    }
17   returnvalue;
18 }
```

8. What will be the value returned by GetValue when a pointer to the root of a binary tree is passed as its argument?

Questions on Graph

Questions for BLOOMS TAXONOMY Level: REMEMBER

1. Which of the following statements is/are TRUE for an undirected graph?
   P: Number of odd degree vertices is even Q:
   Sum of degrees of all vertices is even
   A) P Only
   B) Q Only
   C) Both P and Q
   D) Neither P nor Q

2. What is meant by strongly connected in a graph?

3. What is an acyclic graph? What is cycle or a circuit?

4. When is a graph said to be weakly connected?

4. What is a complete graph? Show that the sum of degree of all the vertices in a graph is always even.
5. What are the difference between graph and tree?

Questions for BLOOMS TAXONOMY Level: Understand

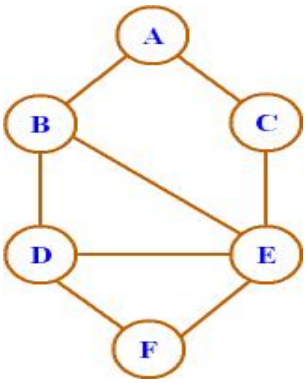
1. Compare BFS and DFS. Discuss the two different ways of representing a graph. 2. Prove

that the number of odd degree vertices in a graph is always even.

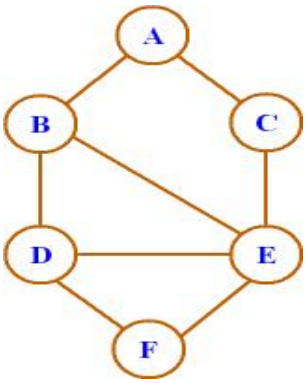
3. Prove that the maximum number of edges possible in a simple graph of n nodes is n(n-1)/2.

Questions for BLOOMS TAXONOMY Level: Apply

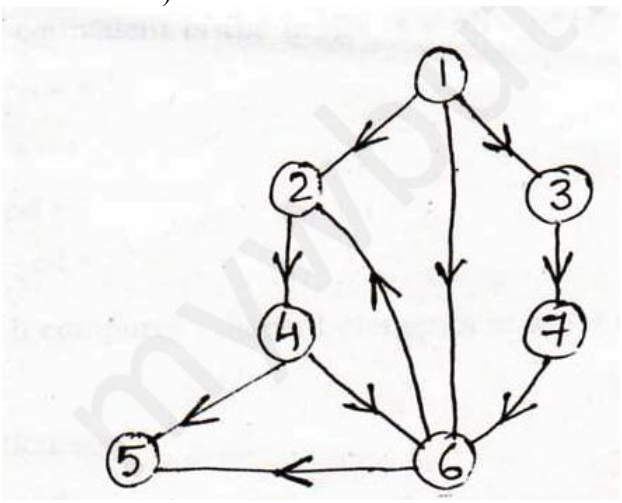
1. Give the adjacency matrix and adjacency list of the following graph:


A
B
C
D
E
F

2. For the following graph Find
   i) BFS traversal
   ii) DFS traversal



3. For the following graph Find
   i) BFS traversal
   ii) DFS traversal



Questions on Hashing

Questions for BLOOMS TAXONOMY Level: REMEMBER

1. Given the following input (4322, 1334, 1471, 9679, 1989, 6171, 6173, and 4199) and the hash function x mod 10, which of the following statements are true?
   i. 9679, 1989, 4199 hash to the same value
   ii. 1471, 6171 has to the same value
   iii. All elements hash to the same value
   iv. Each element hashes to a di erent value

2. What do you mean by hashing? What are the applications where you will prefer hash tables to other data structures?

3. Write down some applications of hashing.

4. Is hashing a search technique? If yes, then compare with binary search.

5. What are different methods of collision resolution in hashing?

6. What are the advantages and disadvantages of hashing with respect to searching? 7. What

do you mean by probing?

8. What is the significance "open" in open addressing technique? 9. Why

complexity of hashing is O(1)

Questions for BLOOMS TAXONOMY Level: Understand

1. De ne hashing. Why hashing is referred to as heuristic search method?

2. What is the primary advantage of hashing over deterministic search algorithms? Why the hash functions need to be simple?

3. What do you mean by collision? How is it handled? Explain with suitable example the collision resolution scheme using linear probing with open addressing. Write an algorithm to insert an element in the hash table using Quadratic probing.

4. Explain linear probing and double hashing with suitable example.

Questions for BLOOMS TAXONOMY Level: Apply

1. Answer the following questions :

(a) A hash table of length 10 uses open addressing with hash function h(k)=k mod 10, and linear probing. After inserting 6 values into an empty hash table, the table is as shown below.

0	
1	
2	42
3	23
4	34
5	52
6	46
7	33
8	
9	

(b) Which one of the following choices gives a possible order in which the key values could have been inserted in the table? Explain.

a) 46, 42, 34, 52, 23, 33
b) 34, 42, 23, 52, 33, 46
c) 46, 34, 42, 23, 52, 33
d) 42, 46, 33, 23, 34, 52

(c) How many different insertion sequences of the key values using the same hash function and linear probing will result in the hash table shown above?

(d) The keys 12, 18, 13, 2, 3, 23, 5 and 15 are inserted into an initially empty hash table of length 10 using open addressing with hash function h(k)=k mod 10 and linear probing. What is the resultant hash table?

Questions on File

Questions for BLOOMS TAXONOMY Level: REMEMBER

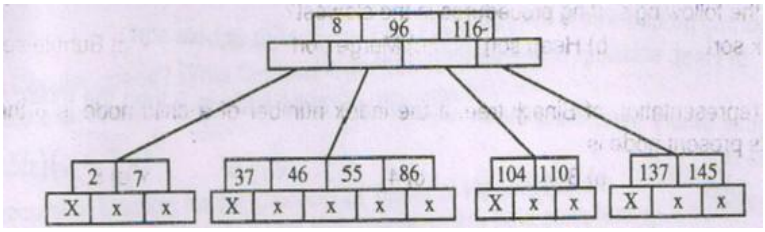
1. What is index?
2. What are the various types of indexing?
3. State the advantages of using indexing over a sequential file.

Questions for BLOOMS TAXONOMY Level: Understand

1. What are the methods available in storing sequential files?
2. Discuss the difference between command file and executable file.
3. Compare sequential versus direct access file structures. Explain multi-index le structure.
4. What is B-Tree? Explain with an example. Write the advantages and disadvantages of B-Tree.
5. What are the applications of such a B-tree in data structures?

Questions for BLOOMS TAXONOMY Level: Apply

1. Show the stages in growth of an order- 4 B-Tree when the following keys are inserted in the order given: **74, 72, 19, 87, 51, 10, 35, 18, 39, 60, 76, 58, 19, 45**
2. Construct the expression tree for the following expression tree : $E = (2a + 5b)(x - 7y)4$.
3. Consider a B-Tree of order 5 as shown below- insert the elements 4, 5, 58, 6 in this order in the B-Tree.



4. Construct a B-tree of order 3 with the following data 50, 40, 60, 30, 70, 20, 80, 10, 90, 9, 99
5. Insert the following keys into a B-Tree of given order mentioned below: a, f, b, k, h, m, e, s, r, c. (Order 3)
   a, g, f, b, k, d, h, m, j, e, s , i, r, x, c, l, n, t, u, p. (Order 5)
6. Show the way how the letters A to P of English alphabet can be entered into a b-Tree of order 4.