Bihar Engineering University, Patna
End Semester Examination - 2022

Course: B.Tech. | ***Semester: III*** | ***Time: 03 Hours***
Code: 100304 | ***Subject: Data Structure & Algorithms*** | ***Full Marks: 70***

Instructions:-

(i) The marks are indicated in the right-hand margin.
*(ii) There are **NINE** questions in this paper.*
*(iii) Attempt **FIVE** questions in all.*
*(iv) Question No. **1** is compulsory.*

Q.1 Choose the correct answer of the following (Any seven question only): **[2 x 7 = 14]**

(a) In a stack, if a user tries to remove an element from empty stack it is called:
(i) underflow (ii) empty collection
(iii) garbage collection (iv) overflow

(b) Consider the binary max-heap implemented using an array. Which one of the following array represents the heap:
(i) 25, 12, 16, 13, 10, 8, 14 (ii) 25, 12, 16, 13, 10, 8, 14
(iii) 25, 14, 16, 13, 10, 8, 12 (iv) 25, 14, 12, 13, 10, 8, 16

(c) A hash function *h* defined as *h* (key) = key mod 7, with linear probing used to insert keys 44, 45, 79, 55, 91, 18, 63 into a table indexed from 0 to 6. What will be the location of key 18.
(i) 3 (ii) 4
(iii) 5 (iv) 6

(d) If the number of values to be sorted is already partially sorted, then _____ sorting can be efficient.
(i) merge (ii) insertion
(iii) bubble (iv) selection

(e) The time complexity of merge sort is :
(i) $O\ (n)$ (ii) $O\ (logn)$
(iii) $O\ (nlogn)$ (iv) $O\ (n2)$

(f) State *true* or *false*:
A : Binary search is used for searching in a sorted array.
B : The time complexity of binary search is $O\ (logn)$
(i) True, False (ii) False, True
(iii) False, False (iv) True, True

(g) In a circular linked list organization, insertion of a record involves modification of
(i) One pointer (ii) Two pointers
(iii) More than two pointers (iv) No pointer

(h) Level order traversal of a rooted tree can be done by starting from the root and performing
(i) pre-order traversal (ii) in-order traversal
(iii) depth first search (iv) breadth first search

(i) An Abstract Data Type (ADT) is
(i) same as an abstract class (ii) a data type that cannot be instantiated
(iii) a data type for which only the operations defined on it can be used, but none else
(iv) all of the above

(j) How many distinct BSTs can be constructed with 3 district keys?
(i) 4 (ii) 5
(iii) 6 (iv) 9

P.T.O.

Q.2 (a) Explain different asymptotic notations (Big-O, Ω, θ) used for comparing the time complexity of an algorithm with neat figures. **[7]**

(b) The run time of an algorithm is represented by the recurrence relation $T(n) = 2T(n/2) + n\,;\, n \geq 2$ and with boundary condition $T(1) = 0$. What is the time complexity (in terms of θ notation). **[7]**

Q.3 (a) Discuss pre-order, in-order and post-order traversal techniques of binary tree. Write a C function for non-recursive pre-order traversal. **[7]**

(b) The pre-order traversal sequence of a Binary Search Tree (BST) is 30, 20, 10, 15, 25, 23, 39, 35, 42. Write step by step process to derive the BST and find post-order traversal also. **[7]**

Q.4 (a) Consider a circular queue of capacity n-elements implemented with an array. Write C functions for $insertion$ and $deletion$ operations. **[7]**

(b) Convert the given infix expression into postfix using stack : $A + B \,/\, C * (D + E) - F$. For each input symbol clearly mention the *action taken* and *status of the stack* during conversion. **[7]**

Q.5 (a) Write a C function to delete last node from a singly linked list. **[7]**

(b) Create a max-heap by inserting following keys in the given order. Show each insertion step with clear illustration: 25, 35, 18, 9, 46, 70, 48. **[7]**

Q.6 (a) Write an algorithm for merge sort and discuss space and time complexity. **[7]**

(b) Define collision in hashing. Explain briefly different methodologies to resolve collision. **[7]**

Q.7 (a) Write algorithm to count leaf nodes in a binary tree. What is the complexity of your algorithm? **[7]**

(b) Compare BFS and DFS traversal techniques for graph. Write an algorithm to perform BFS using queue. **[7]**

Q.8 (a) Differentiate between system defined data types and abstract data types with suitable examples. **[7]**

(b) What is doubly linked list? What are its applications? Explain how a node can be added as last node using appropriate pseudo code **[7]**

Q.9 Write short notes on any two of the following: **[7x2=14]**

(a) AVL Rotations

(b) Open Addressing & Chaining

(c) B-Tree

(d) Priority Queue

Code : 100304

B.Tech 3rd Semester Special Exam., 2022

(New Course)

DATA STRUCTURE AND ALGORITHMS

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Choose the correct answer of any *seven* of the following : 2×7=14

(a) Which data structure is used in redo-undo feature?

(i) Queue

(ii) Stack

(iii) Tree

(iv) Graph

(b) Which among the following data structures is best suited for storing very large numbers (numbers that cannot be stored in long long int)? Following are the operations needed for these large numbers :

(i) Array

(ii) Linked list

(iii) Binary tree

(iv) Hash table

(c) Consider a situation where a client receives packets from a server. There may be differences in speed of the client and the server. Which data structure is best suited for synchronization?

(i) Circular linked list

(ii) Queue

(iii) Stack

(iv) Priority Queue

(d) Which of the following data structures is best suited for efficient implementation of priority queue?

(i) Array

(ii) Linked list

(iii) Heap

(iv) Stack

(e) An Abstract Data Type (ADT) is

(i) same as an abstract class

(ii) a data type that cannot be instantiated

(iii) a data type for which only the operations defined on it can be used, but none else

(iv) All of the above

(f) Let G be a simple undirected graph. Let T_D be a depth first search tree of G. Let T_B be a breadth first search tree of G. Consider the following statements :

(I) No edge of G is a cross-edge with respect to T_D. (A cross-edge in G is between two nodes neither of which is an ancestor of the other in T_D.)

(II) For every edge (u, v) of G, if u is at depth i and v is at depth j in T_B, then $|i - j| = 1$.

Which of the statements given above must necessarily be true?

(i) I only

(ii) II only

(iii) Both I and II

(iv) Neither I nor II

(g) Heap allocation is required for languages that

(i) use dynamic scope rules

(ii) support dynamic data structures

(iii) support recursion

(iv) support recursion and dynamic data structures

(h) If h is chosen from a universal collection of hash functions and is used to hash n keys into a table of size m, where $n \leq m$, the expected number of collisions involving a particular key x is less than

(i) 1 (ii) $1/n$

(iii) $1/m$ (iv) n/m

(i) Consider the following statements :

S1 : A queue can be implemented using two stacks.

S2 : A stack can be implemented using two queues.

Which of the following is correct?

(i) S1 is correct and S2 is not correct

(ii) S1 is not correct and S2 is correct

(iii) Both S1 and S2 are correct

(iv) Both S1 and S2 are incorrect

(j) Given the following prefix expression :

* + 3 + 3 ↑ 3 + 3 3 3

What is the value of the prefix expression?

(i) 2178

(ii) 2199

(iii) 2205

(iv) 2232

2. Answer the following :

(a) Define data structures. Differentiate between linear and non-linear data structures. What are the applications of data structures in computer science? What are the factors that influence the choice of a particular data structure? 6

(b) Define the following terms : 2×4=8

(i) Self-referential data structure

(ii) External sorting

(iii) Binary tree

(iv) Complete binary tree

3. Answer the following :

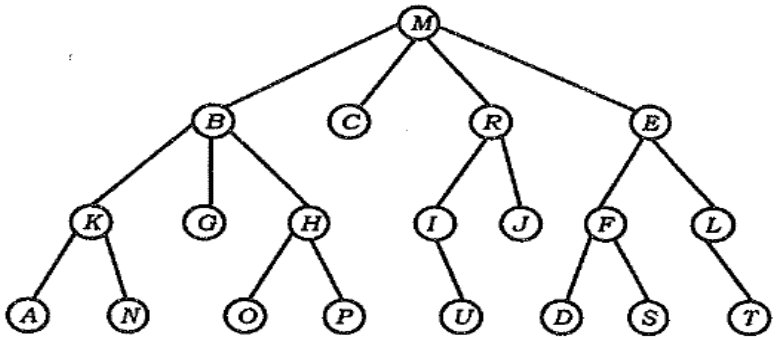
(a) Differentiate between singly and doubly linked list. 3

(b) Write an algorithm to insert an element at k-th position in a doubly linked list. 5

(c) Write a program in C to identify whether the given linked list is having a cycle in it or not. 6

4. Answer the following :

(a) Convert the general tree T_1 into binary tree T_2. Write its preorder, inorder and postorder traversals. 6



(b) What is a threaded binary tree? Represent the binary tree T_2, constructed in **Q 4** (*i*) as a right-in threaded binary tree. 4

(c) Describe binary search tree in detail. 4

5. Answer the following :

(a) Describe stack and its operations. 4

(b) How to efficiently store two stacks in same storage? Discuss the insertion and deletion functions. 5

(c) Discuss the algorithm to convert the infix expression into postfix expression using a stack. 5

6. Answer the following :

(a) Describe queue and its operations. 3

(b) Describe circular queue and its operations. 3

(c) Describe doubly ended queue and its operations. 4

(d) Describe priority queue and its operations. 4

7. What are multi-way search trees? State the properties of a B tree of order *m*. Explain how insertion in B tree is different from insertion in B+ tree. Generate a B tree and a B+ tree of order 3 for the given data : 14

50, 85, 12, 10, 6, 60, 70, 80, 37, 100, 120, 65, 150, 62, 30, 17, 15, 28, 75, 78.

8. With respect to a graph data structure, explain the following with the help of an example each :

   (a) Adjacency matrix 3

   (b) Adjacency list 3

   (c) Depth first search algorithm 4

   (d) Breadth first search algorithm 4

9. Discuss the following sorting algorithms with the help of an example each : 4+4+6

   (a) Bubble sort

   (b) Insertion sort

   (c) Quick sort

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Bihar Engineering University, Patna

B.Tech 3rd Semester Examination, 2024

Course: B.Tech ***Time: 03 Hours***
Code:100304 ***Subject: Data Structure & Algorithms*** ***Full Marks: 70***

Instructions:-

(i) The marks are indicated in the right-hand margin.
*(ii) There are **NINE** questions in this paper.*
*(iii) Attempt **FIVE** questions in all.*
*(iv) Question No. **1** is compulsory.*

Q.1 Choose the correct option / answer from the following (Any seven question only):- **[2 x 7 = 14]**

(a) Which of the following is not a linear data structure?
(i) Stack (iii) Queue
(ii) Array (iv) Tree

(b) Which asymptotic notation gives the best case complexity?
(i) Big Theta (iii) Big O
(ii) Big Omega (iv) Little o

(c) In stack, which operation is not allowed directly?
(i) Push (iii) Pop
(ii) Peek (iv) Deletion from bottom

(d) Which data structure is used in recursive function calls?
(i) Queue (iii) Stack
(ii) Linked List (iv) Array

(e) Which queue allows insertion and deletion at both ends?
(i) Circular queue (iii) Simple queue
(ii) Deque (iv) Priority queue

(f) Which of the following expression is in postfix form?
(i) A + B (iii) A + B * C
(ii) A B C * + (iv) (A + B) * C

(g) Which of the following has both forward and backward traversal?
(i) Singly Linked List (iii) Doubly Linked List
(ii) Circular Queue (iv) Simple Queue

(h) Which of the following trees is height-balanced?
(i) Binary Tree (iii) B -Tree
(ii) AVL Tree (iv) Threaded Tree

(i) What is the time complexity for insertion at the beginning of a singly linked list?
(i) O(1) (iii) O(log n)
(ii) O(n) (iv) O(n log n)

(j) Which of the following uses divide and conquer strategy?
(i) Insertion Sort (iii) Bubble Sort
(ii) Merge Sort (iv) Linear Search

Q.2 (a) Assume the declaration of multi-dimensional arrays A and B to be, A (-2:2, 2:22) and B (1:8, -5:5, -10:5) [7]

(i) Find the length of each dimension and number of elements in A and B.

(ii) Find the address of element B (2, 2, 3), assuming Base address of B =400 and there are W=4 words per memory location.

(b) What is Sparse matrix? Explain how a Sparse matrix can be implemented by using the linked list? [7]

Q.3 (a) Write an algorithm for Insertion Sort. Use Insertion sort algorithm, sort the following elements: [7]

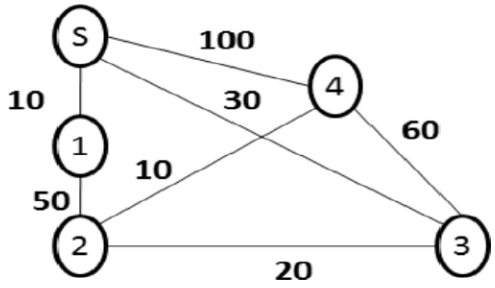
2, 8, 7, 1, 3, 5, 6, 4.

(b) What is circular linked list? Write an algorithm to delete a node from begin in single linked list. [7]

Q.4 (a) Consider the following infix expression and convert it into postfix using stack [7]

A + (B * C – (D/E-F) * G) * H

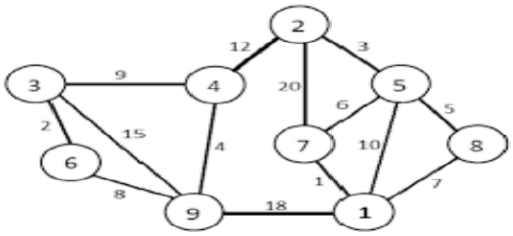
(b) Find the shortest path from S to all remaining vertices of graph using Dijikstra Algorithm [7]



Q.5 (a) Define Hashing. Explain the mid-square and digit folding method hash function with the help of an example. [7]

(b) Use Heap sort algorithm to sort the following sequence {8, 5, 45, 24, 36, 11, 43, and 21}. [7]

Q.6 (a) Discuss spanning tree. Write down the Kruskal algorithm to obtain a minimum cost spanning tree. Use Kruskal algorithm to find the minimum cost spanning tree in the following graph: [7]



(b) What do you mean by priority queue? Explain the types to maintain the priority queue in memory? [7]

Q.7 (a) Explain B-tree. Write down the properties of it. Consider following sequence of inputs: [7]

10,20,35,40,50,60,75,80,95

Assume that the order of the B-tree is 3.

(b) Draw a binary tree with following traversals: [7]

Preorder: A B C D E F G H I J K L

Postorder: C F E G D B K J L I H A

Q.8 (a) Do the following operations for constructing a BST **[7]**
(i) 45, 37, 98, 76, 13, 39,105, 80, 5 insert element as per their occurrence.
(ii) Delete 39 and 45 respectively
Now Traverse the final BST in Inorder, Preorder and Postorder.

(b) Describe an AVL tree. Construct an AVL tree by inserting the following elements in the order of their occurrence {60, 2, 15, 20, 12, 115, 90 and 88}. **[7]**

Q.9 (a) Write merge sort algorithm and its analysis. Use merge sort algorithm to sort 9, 11, 10, 1, 60, 10, 6, 25, 40, and 30. Is it a stable sorting algorithm? Justify. **[7]**

(b) Write short notes on ***any one*** the following: **[7]**
(i) Double-ended Queue (Deque)
(ii) Threaded Binary Tree
(iii) Time Complexity and Big-O Notation
(iv) DFS, BFS

Code : 100304

B.Tech 3rd Semester Exam., 2021
(New Course)

DATA STRUCTURES AND ALGORITHMS

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

(iv) Question No. 1 is compulsory.

1. Choose the correct answer of the following (any *seven*) : 2×7=14

   (a) What is the worst case run-time complexity of binary search algorithm?

   (i) $O(n^2)$

   (ii) $O(n^{\log n})$

   (iii) $O(n^3)$

   (iv) $O(n)$

   (b) push() and pop() functions are found in

   (i) queues

   (ii) list

   (iii) stacks

   (iv) trees

(c) Binary search tree has average case run-time complexity of $O(\log n)$. What could be the worst case?

(i) $O(n)$

(ii) $O(n^2)$

(iii) $O(n^3)$

(iv) None of the above

(d) What will be the running-time of Dijkstra's single-source shortest path algorithm, if the graph $G(V, E)$ is stored in the form of adjacency list and binary heap is used?

(i) $O(|V|^2)$

(ii) $O(|V|\log|V|)$

(iii) $O(|E|+|V|\log|V|)$

(iv) None of the above

(e) Tower of Hanoi is a classic example of

(i) divide and conquer

(ii) recursive approach

(iii) (ii) but not (i)

(iv) Both (i) and (ii)

(f) If locality is a concern, you can use _____ to traverse the graph.

(i) breadth-first search

(ii) depth-first search

(iii) either BFS or DFS

(iv) None of the above

(g) Which data structure is used for balancing of symbols?

(i) Queue

(ii) Stack

(iii) Tree

(iv) Graph

(h) Which data structure is most efficient to find the top 10 largest items out of 1 million items stored in file?

(i) Min heap

(ii) Max heap

(iii) Binary search tree

(iv) AVL tree

(i) A data structure is required for storing a set of integers such that each of the following operations can be done in $(\log n)$ time, where n is the number of elements in the set :

- Deletion of the smallest element

- Insertion of an element if it is not already present in the set

Which of the following can be used?

(i) A heap can be used but not a balanced binary search tree

(ii) A balanced binary search tree can be used but not a heap

(iii) Both balanced binary search tree and heap can be used

(iv) Neither balanced binary search tree nor heap can be used

(j) The most appropriate matching for the following pairs is

X.	Depth-first search	1.	Heap
Y.	Breadth-first search	2.	Queue
Z.	Sorting	3.	Stack

(i) X–1, Y–2, Z–3

(ii) X–3, Y–1, Z–2

(iii) X–3, Y–2, Z–1

(iv) X–2, Y–3, Z–1

2. Answer the following :

(a) Josephus problem : A group of soldiers is surrounded by an overwhelming army. There is no hope of victory without reinforcements. There is only a single horse available for escape. The soldiers agree to a pact to determine which of them is to escape and summon help. They form a circle, and a number n and one of their names are picked from a hat. Beginning with the soldier whose name is picked, they begin to count clockwise around the circle. When the count reaches n, that soldier is removed from the circle, and the count begins again with the next soldier. The eliminated soldier is no longer a part of the circle. The process continues until one soldier remains and takes the horse to summon help. Suppose $n = 3$ and there are five soldiers who form a circle in the order A, B, C, D and E. Let the soldier to start with A, so C is eliminated first, then A gets eliminated second, then E at third, finally B gets eliminated. So D is the one who escapes with the horse. Write a function in C which displays the

names of every soldier in the order of their elimination and finally the name of the soldier left, using circular linked list. New list should not be created. 7

(b) Write a program in C to insert an element after an existing element in a doubly linked list. 7

3. Answer the following :

(a) Insert the following numbers, in the given sequence, in an empty AVL tree :

1, 26, 2, 25, 3 24, 4, 23, 5

Display the tree after every insertion. Also state the minimum number of nodes which are required to construct AVL tree of height 7 (note that the root is at level 0). 8

(b) Sort the following numbers in ascending order using heapsort. Show step-by-step analysis : 6

25, 57, 48, 37, 12, 92, 86, 33

4. Insert the following numbers, in the given sequence, in an empty B tree of order 5 and display the tree at every split :

17, 16, 15, 14, 13, 12, 11, 10, 9,
8, 7, 6, 5, 4, 3, 2, 1

Now delete the following elements from the tree, in the given sequence, and display the tree at every merge. 14

5. Insert the following numbers, in the given sequence, in an empty B+ tree of order 3 and display the tree at every split :

10, 20, 30, 90, 80, 60, 70,
40, 50, 66, 16, 84, 21, 76

Now delete the following elements from the tree, in the given sequence, and display the tree at every merge. 14

6. Answer the following :

(a) Construct the Huffman tree for data given in the table below : 8

Alphabet	*Frequency*
R	5
T	6
Y	2
C	16
S	3
L	60
A	8

(b) Show at every step the contents of the hash table after inserting the keys in the order 23, 11, 4, 17, 84, 22, 33. The hash function is given as

$$h(key) = key \% 11$$

The hash table has a space for 11 keys only. Resolve collision using—

(i) linear probing;

(ii) quadratic probing. 6

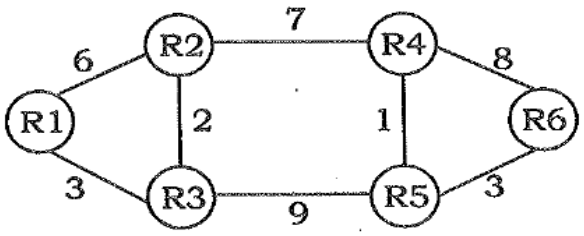
7. Differentiate between the following :

   (a) Abstract Data Type and Data Structure 4

   (b) Stack and Queue 5

   (c) Depth-first search and Breadth-first search 5

8. Explain in detail the Kruskal's and Prim's algorithms for constructing minimum spanning tree. For the weighted undirected graph given below, construct the minimum cost spanning tree for the given graph using Kruskal's algorithm and Prim's algorithm when the starting vertex is R1 : 14



9. Define the following : 2×7=14

   (a) Tree

   (b) Binary tree

   (c) Strict binary tree

   (d) Complete binary tree

   (e) Full binary tree

   (f) Min heap

   (g) Skew tree

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Bihar Engineering University, Patna

B.Tech. 3rd Semester Examination, 2023

Course: B.Tech. ***Time: 03 Hours***

Code: 100304 ***Subject: Data Structure and Algorithms*** ***Full Marks: 70***

Instructions:-

(i) The marks are indicated in the right-hand margin.

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*(iv) Question No. **1** is compulsory.*

Q.1 Choose the correct answer of the following (Any seven question only): **[2 x 7 = 14]**

(a) What is the time complexity of the following code snippet?

```
for(i=0; i<n; i++){
    for(j=0; j<i; j++){
        int sum= i + j;
    }
}
```

(i) O(n) (ii) O(n2) (iii) O(log n) (iv) O(1)

(b) Which type of traversal of binary search tree outputs the value in sorted order?

(i) Pre-order (ii) In-order (iii) Post-order (iv) None of the above

(c) Suppose a circular queue of capacity (n – 1) elements is implemented with an array of n elements. Assume that the insertion and deletion operations are carried out using REAR and FRONT as array index variables, respectively. Initially, REAR = FRONT = 0. The conditions to detect queue full and queue empty are _____.

(i) Full: FRONT == (REAR+1) mod n, Empty: REAR == FRONT

(ii) Full: FRONT == (REAR+1) mod n, Empty: REAR == (FRONT+1) mod n

(iii) Full: REAR == FRONT, Empty: FRONT == (REAR+1) mod n

(iv) Full: REAR == (FRONT+1) mod n, Empty: REAR == FRONT

(d) Which of the following data structures can be used for parentheses matching?

(i) Tree (ii) Queue (iii) Stack (iv) Priority queue

e) What is the worst-case time complexity of inserting n elements into an empty linked list, if the linked list needs to be maintained in sorted order?

(i) $\Theta(n)$ (ii) $\Theta(n\log n)$ (iii) $\Theta(n_2)$ (iv) $\Theta(n_3)$

(f) What will be the postfix expression for the given infix expression: (a+b)*c-d

(i) -*+a b c d (ii) ab+c*d- (iii) ab+cd-* (iv) abc*+d-

(g) What is the outcome of the prefix expression +, -, *, 3, 2, /, 8, 4, 1?

(i) 12 (ii) 11 (iii) 5 (iv) 4

(h) Where will the new element be inserted in the linked list implementation of the queue?

(i) At the middle position of the linked list (ii) At the head position of the linked list

(iii) At the tail position of the linked list (iv) None of the above

(i) Let us consider a list of numbers (34, 16, 2, 93, 80, 77, 51) and a hash table size of 10. What is the order of elements(from index 0 to size-1) in the hash table?

(i) null, null, 77, 16, null, 34, 93, 2, 51, 80 (ii) 80, 51, 2, 93, 34, null, 16, 77, null, null

(iii) 77, 16, 34, 93, 2, 51, 80 (iv) 80, 51, 2, 93, 34, 16, 77

(j) The height of a binary tree is the maximum number of edges in any root to leaf path. The maximum number of nodes in a binary tree of height h is:

(i) 2h-1 (ii) 2h-1-1

(iii) 2_{h+1}-1 (iv) 2h+1

Q.2 (a) Why do we need an asymptotic notation? Explain the different asymptotic notations with definitions and examples. **[7]**

(b) Write the worst-case run time complexity of the following algorithms: linear search, bubble sort, merge sort, and push operation in the stack. **[7]**

Q.3 (a) Write push() and pop() functions of a stack. **[9]**

(b) Evaluate the following postfix expression using STACK. Show all the steps. **[5]**
$8, 2, /, 3, *, 4, -, 6, 2, /, +$

Q.4 (a) Write the algorithm to count the total elements in a singly linked list. **[7]**

(b) How a doubly linked list is better than a singly linked list? Explain deletion operation on a doubly linked list using an example. **[7]**

Q.5 (a) The following values are to be stored in a hash table: **[7]**
25,42,96,101,102,162,197
Describe how the values are hashed by using the division method of hashing with a table size of 7. Use chaining as the method of collision resolution.

(b) Apply the merge sort on the following numbers. **[7]**
10,15,50,17,20,25,30,16,70,6.

Q.6 (a) Differentiate between stack and queue. Explain different types of queues with examples. **[7]**

(b) Write the properties of a binary search tree. Create a binary search tree using the following elements: 45, 15, 79, 90, 10, 55, 12, 20, 50 **[7]**

Q.7 (a) Consider the in-order and pre-order traversal of a binary search tree are (1, 2, 3, 4, 5, 6, 8, 10, 25) and (4, 3, 1, 2, 10, 8, 5, 6, 25) respectively. Construct a unique binary search tree for the given in-order and pre-order traversals. **[7]**

(b) Explain the insertion in the AVL tree using an example. **[7]**

Q.8 Explain the Heap sort algorithm. Create a heap for the following elements and then sort them. **[14]**
13, 102, 405, 136, 15, 105, 390, 432, 28, 444

Q.9 Write the short note on the following: **[3.5x4=14]**

(a) Circular Queue

(b) Depth first search

(c) B tree

(d) Adjacency matrix