Final Assessment Test – April 2018

Course: CSE2003 - Data Structures and Algorithms
Class NBR(s): 2388 / 2389 / 2391 / 2392 / 2393 /2394 /2395/ 2396 / 2397 / 2398 / 4319 / 5728 / 5925
Slot: G1
Max. Marks: 100

Time: Three Hours

Answer any TEN Questions
(10 X 10 = 100 Marks)

1. a) Solve the following recurrence relation using iteration method: $T(0) = 0$, $T(1) = 1$, $T(n) = 1 + T(n-2)$ for all $n > 1$. [7]

   b) Give the asymptotic bounds for the equation $f(n) = 2n^3 - 6n + 30$ and represent in terms of θ notation. [3]

2. a) Convert the following infix notation into its corresponding postfix form: A+B*C-D/F*E. [7]

   b) If the values of all variables (A to F) in the expression in part a) are equal to T, then what could be the value of T if the expression evaluates to 16. [3]

3. a) Write a procedure (no code required) to delete a node from a binary search tree (discuss all the three possible cases) with suitable examples and neat figures. [7]

   b) What is the worst case time-complexity scenario for search operation in binary search tree for an input sequence of size n. Will the reverse order of the input sequence be the best case time-complexity scenario for search operation in binary search tree? Justify your claim. [3]

4. In a singly linked list, write a pseudocode with suitable figures , for the following:
   a) deletion at the beginning [5]
   b) insertion at the end [5]

5. Assuming the table size as the smallest prime number greater than the input size, hash the following keys: [62, 56, 45, 14, 78, 44, 36, 29, 39]. To handle collision, use (i) linear probing and (ii) quadratic probing. Which of the two methods has less number of total probes? [10]

6. a) Sort the following data using (MAX) heapsort: [20, 12, 35, 15, 10, 80, 30] and illustrate with appropriate figures for each iteration. [7]

   b) What is the running time complexity of the procedures *BUILDHEAP, MAX_HEAPIFY and HEAPSORT*? [3]

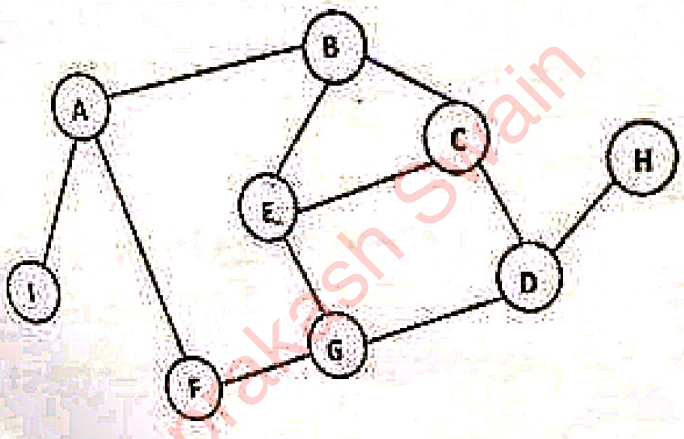
7. a) Sort the characters (using dictionary ordering relation: A<B<C...<Z) in the word **E X A M P L E** using quick sort (Show all iterations). [7]

   b) What is the worst-case, best case and average case time complexity of quick-sort? [3]

8. a) Construct a Binary Search Tree for the following order of input (step by step construction is expected) [7]
   [40, 29, 12, 34, 78, 54, 90, 57, 77, 44, 23, 11, 8, 19]

   b) Traverse the above BST through Inorder, Postorder and Preorder. [3]

9. a) Perform the Depth First Search on the following graph starting from vertex A. Identify backward and cross edges (if any). [6]



b) Perform the Breadth First Search on the above graph starting from vertex G. [4]

10. a) Apply Master's theorem to the following functions and derive its time-complexity in terms of asymptotic notation. [6]

i. $T(n) = 3T(n/2) + n^2$

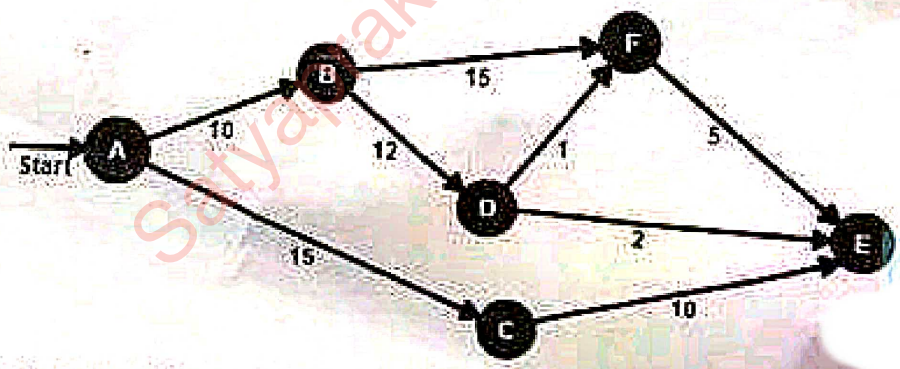
ii. $T(n) = 4T(n/2) + n^2$

iii. $T(n) = \sqrt{2}\,T(n/2) + \log n$

b) Assuming we have the following denominations in Indian currency {1, 2, 5, 10, 20, 50, 100, 500} valued coins/notes, what is the minimum number of coins and/or notes needed to make a change for Rs. 2088? Discuss in detail using greedy strategy. [4]

11. For the sequences ABCBDAB and BDCABA, identify the longest common subsequence using dynamic programming technique. Write down the recursive formula used for solving the same. [10]

12. Find the shortest distance from vertex A to vertex E and vertex F using Dijkstra's algorithm. Draw the shortest path in each case. [10]



13. a) Show that Subset sum problem is NP-Complete by reducing it to 3-SAT-CNF problem. [7]

b) Define NP-hard. Is every NP-hard problem also a NP-complete problem? Justify. [3]

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Final Assessment Test– Jan/Feb 2023

VIT Vellore Institute of Technology

Course: MCSE501L - Data Structures and Algorithms

Class NBR(s):6911 Slot: A1+TA1

Time: Three Hours Max. Marks: 100

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS TREATED AS EXAM MALPRACTICE

Answer ALL Questions

(10 X 10 = 100 Marks)

1. Write a code to find sum of the following series. Find its running time complexity in big O notation and calculate the actual running time.

(1^2-3^4+5^6)/(2^3*4^5) + ... + ((n+1)^2-(n+3)^4+(n+5)^6) / ((n+2)^3*(n+4)^5))

2. a) Suppose a stack implementation supports, in addition to PUSH and POP, an operation REVERSE, which reverses the order of the elements on the stack. [5]

To implement a queue using the above stack implementation, show how to implement ENQUEUE using a single operation and DEQUEUE using a sequence of 3 operations.

b) The following postfix expression, containing single digit operands and arithmetic operators + and *, is evaluated using a stack. 5 2 * 3 4 + 5 2 * * + [5]

Show the contents of the stack

(i) After evaluating 5 2 * 3 4 +

(ii) After evaluating 5 2 * 3 4 + 5 2

(iii) At the end of evaluation

3. a) Write a code segment to perform merging of two presorted arrays. [5]

b) Explain cocktail sort algorithm with a suitable example. [5]

4. Write an algorithm to perform exponential search. Apply exponential search algorithm to search 45 and 76 from the following data: 2, 11, 23, 25, 31, 37, 39, 41, 44, 45, 52, 57, 59, 63, 68, 71, 76, 81.

5. Construct a B+ tree of order 3 from the following data: 43, 32, 12, 78, 51, 87, 92, 17, 22, 8, 19, 39, 77, 66, 40, 50 and then delete 40, 50, 51, 78 and 77.

6. Insert the following data into an initially empty red black tree using bottom up approach: 55, 22, 89, 12, 5, 23, 90, 66, 33, 47, 19, 27, 95, 15, 40 and then delete 22, 90, 33, and 55. Write the steps used in insertion and deletion.

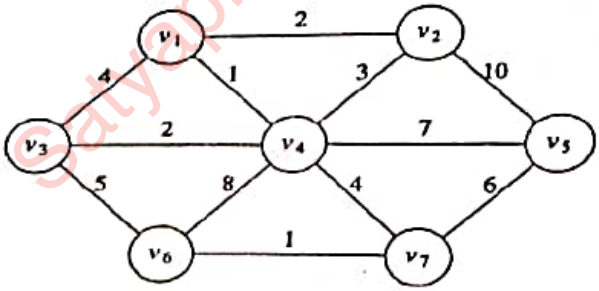
7. a) What is threaded binary tree? Explain construction of threaded binary tree with a suitable example. [5]

b) Insert the following data into an initially empty splay tree: 56, 45, 23, 17, 12, 33, 90, 85, 44 and 10. Splay the tree at node 10. Delete 33. [5]

8. Construct routing table of node A in the network represented by the following cost matrix using Dijkstra's algorithm:

	A	B	C	D	E	F
A	-	5	3	15	-	13
B	-	-	-	6	-	-
C	-	1	-	-	3	-
D	-	-	-	-	2	-
E	-	-	-	3	-	2
F	-	-	-	-	8	-

9. What is Boruvka's algorithm? Simulate it for constructing minimum spanning tree of the following graph.



10. Write an algorithm to perform the operations: insertion and deletion in a min ternary heap and explain it with the following operations. In an initially empty heap, insert letters of word: **"plaincomputer"** and delete the letters: a, p, m, t.

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VIT

Reg. No. : 22BRS1119

Final Assessment Test (FAT) - November/December 2023

Programme	B.Tech.	Semester	FALL SEMESTER 2023 - 24
Course Title	DATA STRUCTURES AND ALGORITHMS	Course Code	BCSE202L
Faculty Name	Prof. Karthikeyan .N	Slot	A1+TA1
Time	3 Hours	Class Nbr	CH2023240100647
		Max. Marks	100

Section A (10 X 10 Marks)
Answer all questions

01. Consider an array containing the integer values $a_1, a_2, \ldots, a_n$. Write an algorithm ***hasUniqueElements*** to return TRUE if the number of occurrences of each value in the array is one; otherwise, return FALSE. The signature of the algorithm is ***bool hasUniqueElements(int n, int a[]).*** [10]

Analyze the time and space complexity of ***hasUniqueElements*** algorithm with a proper explanation.

02. a) Write the recurrence relation for the following algorithm and find its time complexity. **[5 Marks]** [10]

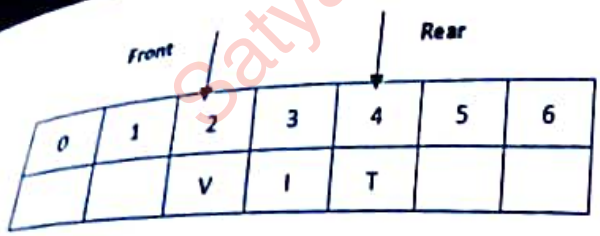
Algorithm : power(x, n)

```
{
if (n==0)
 return 1;
if (n==1)
 return x;
if ((n % 2) == 0)
 return power(x*x, n/2);
else
 return power(x*x, n/2) * x;
}
```

b) You are a software developer working on a compiler project. As part of your task, you need to convert infix expressions to postfix notation using stack. Consider the following infix expression : **(A + B * (C - D)) / E**; convert it into a postfix expression along with the conversion table. **[5 Marks]**

03. Consider the following circular queue that consists of characters of size 7. The front is pointing to index 2, and the rear is pointing to index 4, as shown in the figure given below. Write an algorithm to perform the following operations on a circular queue by considering queue overflow and underflow conditions and show the status of queue, front and rear after performing each operation. [10]

- Elements A, B, X, Y and Z are added to the queue.
- Two characters are removed from the queue.



04. Consider the linked list which consists of 'N' nodes that are connected in bidirectional order. In bidirectional, forward iteration starts at the first node, and the process ends at the last node. In reverse, iteration starts at the last node, and the process ends at the first node. **[Each 5 Marks]**

i) Write an algorithm to interchange the first node and last node in the linked list.

ii) Write an algorithm to connect the next pointer of the last node to the first node in the forward process, and to connect the previous pointer of the first node to the last node in the reverse process after implementing the algorithm(i).

05. In a distributed environment, a server receives multiple requests from various systems. Each request is formatted as **(system_id, task size)**, where system_id represents the source system and task size indicates the amount of work required. The server aims to process requests in ascending order of task size, prioritizing those with the least size work first. To achieve this, the server must sort the requests based on their respective task sizes. Given the requests from various systems along with their corresponding task sizes: **[(A, 5), (B, 1), (C, 2), (D, 1), (E, 4), (F, 6), (G, 3), (H, 1), (I, 9), (J, 7), (K, 2)]**, perform the sorting of requests based on task size using divide and conquer algorithm. Choose an algorithm with a worst-case time complexity of **O(n log n).** [1

06. Assume you are given two binary search trees T1 and T2 with n1 and n2 nodes, respectively, and a target value X. Find the number of distinct pairs (v1, v2) such that v1 belongs to T1, v2 belongs to T2, and **v1+v2=X**. Write an algorithm to find the distinct pairs from T1, T2 and explain each step with neat sketch. [10]

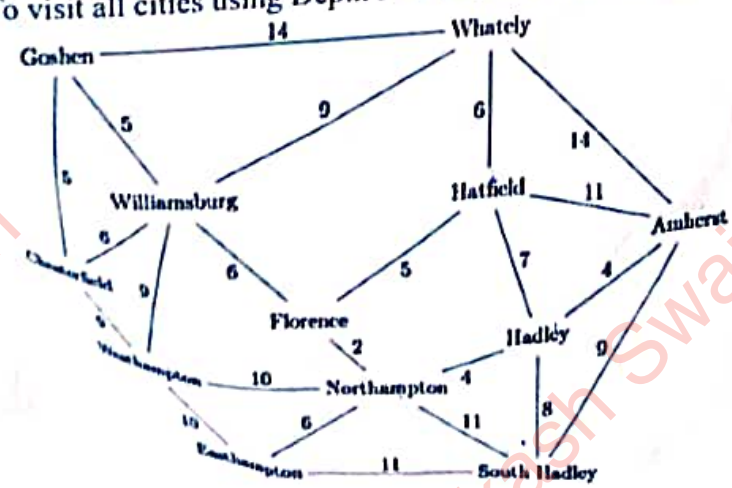
Note: Assume that every BST node has a unique key.

07. The provided graph shows the city of New York. Each city in the network is connected, and the edges indicate the distance between any two cities. Assume that you are a tourist guide, and you need to take the travellers to visit all the cities in New York.**[Each 5 Marks]** [10]

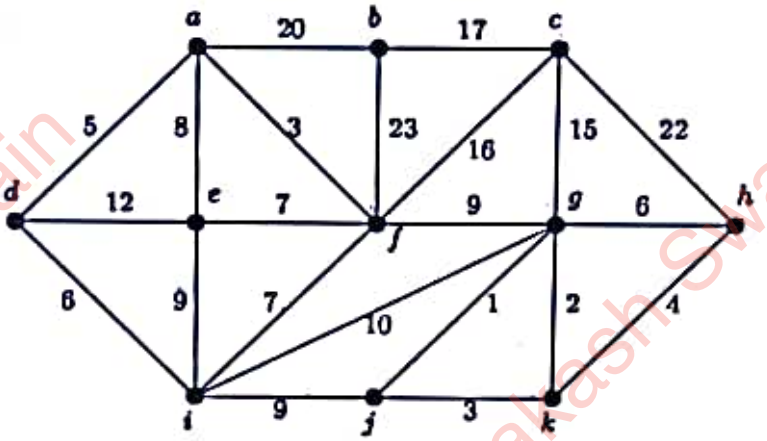
Write down the algorithm for the given conditions.

(i) To visit all cities using Breadth First Search by selecting the **Easthampton city** as starting city.

(ii) To visit all cities using Depth First Search by selecting the **Easthampton city** as starting city.



08. Write prim's algorithm to find the **Minimum Spanning Tree (MST)** for the given graph. Illustrate the step-by-step process, including the selection of the starting vertex and the addition of edges to the MST at each step. Provide the final MST with all its edges and the total cost of the MST. *[10]*



09. Consider a game scenario where you have many keys with the 4-digit number written on it. Your task is to find the correct bucket to place the key using the hashing techniques namely 1. Linear probing 2. Quadratic probing 3. Separate chaining, and a hash-function **h(key) = key mod m** for the following numbered keys {5471, 2523, 6173, 6199, 4344, 7674, 2374, 7486}.
Assume there are nine keys overall, represented by the character **m**. Show the steps for assigning keys to buckets using the above three techniques and illustrate the process of handling collisions. *[10]*

10. (a) Construct the AVL tree using the following keys: **{H, I, J, B, A, E, C, F, D, G, K, L}**. Show all the steps required for constructing a tree with a balance factor. **[6 Marks]** *[10]*
(b) Draw the resultant AVL tree after removing the root node. If the resultant tree is unbalanced, apply suitable rotation to obtain a balanced tree. **[2 Marks]**
(c) Delete node H from the resultant AVL tree from (b) and show the final tree. **[2 Marks]**

Final Assessment Test (FAT) - November/December 2023

Programme	B.Tech.	Semester	FALL SEMESTER 2023 - 24
Course Title	DATA STRUCTURES AND ALGORITHMS	Course Code	BCSE202L
Faculty Name	Prof. Karthikeyan .N	Slot	A2+TA2
		Class Nbr	CH2023240100660
Time	3 Hours	Max. Marks	100

Part A (10 X 10 Marks)
Answer all questions

01. (a) In the year 2004, Sachin played in nine innings against the Australian cricket team. Following his remarkable performance with couple of centuries and half-centuries, he was honoured with the title of "Man of the Series". His individual inning scores for those matches were as follows: 98, 101, 82, 78, 100, 180, 80, 55, and 112. Given a value of 'K', write an algorithm to return the Kth largest score of Sachin's innings by applying the following constraint: Arrange the scores in descending order by selecting the largest score from the unsorted positions and relocating it to the sorted position. (8 marks)
(b) Analyze the best case and the worst-case time complexity of the algorithm. (2 marks) **[10]**

02. Implement a hash table using linear probing. Describe the step-by-step process of inserting and retrieving elements. Insert the following sequence of keys in the hash table {9, 7, 11, 13, 12, 8, 17, 6, 1, 23}, showing how the table evolves during insertion. Assume that the table size is 11, and index starts from 0. Compute the average number of probes for the successful search and unsuccessful search respectively. **[10]**

03. (a) Define Double ended queue (DEQUE). Illustrate the following operations performed on a DEQUE: (6 marks) **[10]**
(i) Insert 10, 25 in order at the left end
(ii) Insert 32, 12 in order at the right end
(iii) Delete at the left end
(iv) Delete at the right end
(v) Insert 50 at left end
(vi) Delete at the left end
(b) Write an algorithm to insert a non-negative integer into a DEQUE based on the following criteria: If sum of the digits (SOD) present in the given input is prime then insert into the left of DEQUE and if SOD is odd then insert the input into the right of DEQUE, and discard otherwise. (4 marks)

04. a) For each of the following pairs of functions f(n) and g(n), give an appropriate positive constant c such that $f(n) \leq c \times g(n)$ for all $n > 1$. Find the minimum possible value of c. (5 Marks) **[10]**
i. $f(n) = n^2 - n + 1$, $g(n) = 2n^3$
ii. $f(n) = n\sqrt{n} + n^2$, $g(n) = n^2$
b) Given a code snippet:

```
1.  read n
2.  i = n, sum = 0
3.  while( i > 0)
4.  {
5.    k = 2;
6.    while(k < i)
7.    {
8.      sum = sum + i * k
9.      k = k * 7
10.   }
11.   i = i - 1
12. }
```

Compute the time complexity of the code in terms of n. Justify your answer. (5 Marks)

05. a) Write an algorithm to convert a given prefix expression in to an expression tree. Trace the algorithm to convert the following prefix expression to expression tree.(5 marks) [10]

+ + a * b c * - * d e f g

b) Write an algorithm to interchange left child node and right child node of every node in an expression tree. (5 marks)

06. [10]

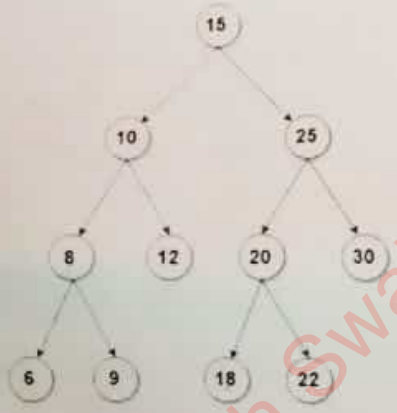


Figure 1: Sample Binary Search Tree

A subtree of a Binary Search Tree (BST) is said to be valid, only if the value of each node is within the range [m, n]. For example, considering the sample BST shown in Figure 1, a subtree with root 8 is valid since 8, 6, and 9 are in the range [5, 20]; whereas a subtree with root 20 is not valid, since 22 is not within the range [5, 20]. Write an algorithm to count the number of valid subtrees in a Binary Search Tree. Apply the algorithm for the following BST and find the total number of subtrees with nodes in the range [5, 20].

07. Given a linked list L, write an algorithm split(), that splits the linked list L based on the input value 'K'. L is split into two linked lists L1 and L2. The nodes whose values are less than 'K' are removed and added in to a new stack based linked list S, and the nodes whose values are greater than or equal to 'K', are removed and added in to a new queue based linked list Q. For example, Input: L = { (Head) 2-> 7 -> 6 -> 9 -> 5 -> 3 -> 1 -> 32 -> 4 -> 21 } and the split value = 7; Output: Stack S = { (Top) 4 -> 1 -> 3 -> 5 -> 6 -> 2 }, Queue Q = { (Front) 7 -> 9 -> 32 -> 21 (Rear)}. [10]

08. Write Prim's algorithm to construct a minimum spanning tree for a given undirected connected graph. Apply Prim's algorithm on the graph given in Figure 2. Compute the time complexity of constructing minimum spanning tree by assuming that a min-heap is used for implementation of priority queue. [10]

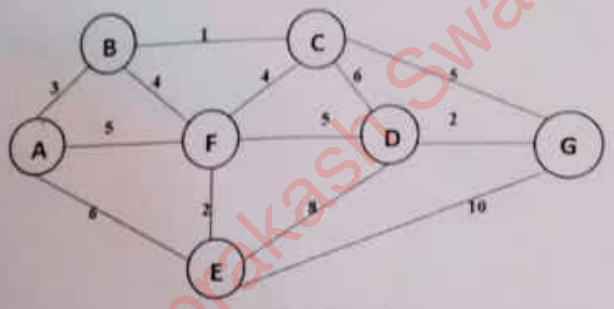


Figure 2: A Graph

09. [10]

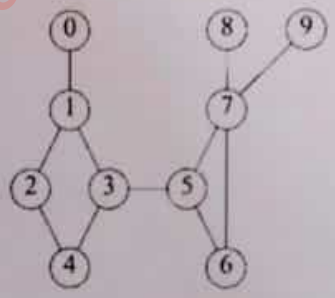


Figure 3: Sample Undirected Connected Graph

An edge (u,v) of a undirected connected graph G, is a bridge, if and only if the deletion from G produces a graph that is no longer connected. Considering the sample graph given in Figure 3, the edges (0,1), (3, 5), (7, 8) and (7, 9) are bridges. Write an algorithm that finds the bridges in a graph. Compute the time complexity of your algorithm.

10 (a) Show the result of inserting 10, 12, 1, 14, 6, 5, 8, 15, 3, 9 , 7, 4, 11, 13 and 2 in order in to an initially empty binary min heap tree. (5 Marks) [10]

(b) Give an algorithm that finds an arbitrary element x in a binary min heap using atmost roughly 3n/4 comparisons. (5 Marks)

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Reg. No. : 22BCE1473

Final Assessment Test (FAT) - November/December 2023

Programme	**B.Tech.**	Semester	**FALL SEMESTER 2023 - 24**
Course Title	**DATA STRUCTURES AND ALGORITHMS**	Course Code	**BCSE202L**
Faculty Name	**Prof. Vijayalakshmi A**	Slot	**D1+TD1**
		Class Nbr	**CH2023240101102**
Time	**3 Hours**	Max. Marks	**100**

Part - A (7 X 10 Marks)
Answer all questions

01. Compute the time complexity of the following recurrence relations. Assume that T(n) is constant for $n \leq 2$. **[10]**
    i. $T(n) = 3T(n/3) + \sqrt{n}$ (5 Marks)
    ii. $T(n) = 2^n T(n/2) + n^n$ (5 Marks)

02. The share market price of a Product X varies over time-interval of one hour. The price in rupees are recorded from 9 AM to 5 PM is given as follows 40, 42, 44, 43, 46, 41, 47, 49. **[10]**
    i. Write an algorithm to sort the given prices in non-decreasing order using divide and conquer approach and discuss the time complexity of the algorithm for average case. [7 Marks]
    ii. Use your algorithm to compute the minimum share price of the product X. [3 Marks]

03. Construct a deque for the given binary string. Read a binary string as an input and store each bit in the rear end of the deque. Delete two bits from the front end of the deque and append the deleted first bit at the front end and the second bit at the rear end of the deque. Write a pseudocode to check whether the content of deque is the same as the input string after performing the above operations for a maximum of k times, where k is the length of the input string. **[10]**
    Example:
    Input binary string: 11011
    First iteration: 10111
    Second iteration: 11110
    Third iteration: 11101
    Fourth iteration: 11011
    Output: Same as input string

04. Given a binary search tree T and an input value K, write a pseudocode to print all possible paths in a tree T. And also write a pseudocode to find all nodes along the path whose sum is equal to K. For example, given a binary search tree T as shown in Figure 1 and a given number K=22, two paths need to be printed: One path contains nodes 10 and 12, and another path contains nodes 10, 5 and 7. **[10]**

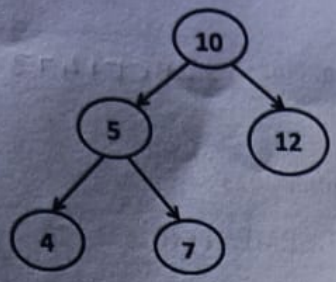

Figure 1 Binary Search Tree

05. An undirected graph G is said to be connected if and only if for every pair of distinct vertices u and v in V(G), there is a path from u to v in G. A connected component in an undirected graph is a group of vertices that are connected to each other through edges but not connected to other vertices outside the group. [1

Given a set of vertices labeled from 0 to n-1 and a list of edges as shown in Figure 2 of graph G, write a pseudocode to find the number of connected components in an undirected graph G.

Example

n=5 and edges = {(0, 1), (1, 2), (3, 4)}

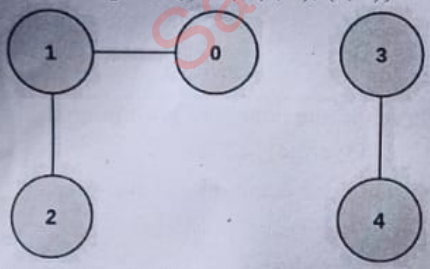

Figure 2. Graph G

Output:

2 connected components.

06. The graph G=(V, E) shown in Figure 3 represents the interconnection of 7 cities, where V represents cities and E represents the distance between cities. Use Dijkstra's algorithm to find the shortest path from city A to City F. List out all the iterations of cost calculation from the source vertex (A) to the destination vertex (F). Write a pseudocode for the same and find its time complexity. [10]

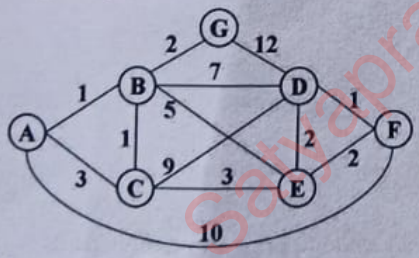

Figure 3 Undirected Graph

07. Construct a hash table of size 7 for the given values { 50, 700, 76, 85, 92, 73, 101} using a hash function h(x) = x mod 7. Show the resultant table after inserting the values in the given order by applying each of the following collision handling techniques. [10]

i. Linear probing [5 Marks]

ii. Quadratic probing [5 Marks]

Part - B (2 X 15 Marks)
Answer all questions

08. Consider the data of a mobile phone manufacturing company that produces a limited number of colors (e.g., white, blue, red, black) and different models of mobile phones (e.g., V1.1, V2.3, V3.1,V2.2). The manufacturer has decided to store the color and model number of the mobile phone in a singly linked list when it is manufactured. Write a pseudo code for the following process: [15]

i. Create a singly linked list to store the mobile data. [5 Marks]
ii. Remove the identical model numbers from a singly linked list. [5 Marks]
iii. Display the list grouped according to the mobile colors. [5 Marks]

09. a. Construct an AVL tree for the following sequence of elements and insert the elements into a tree in the same order 14, 17, 11, 7, 53, 4, 13, 12, 8, 60, 19, 16, 20. Show the necessary operations on each insertion of elements and draw the resultant tree. [7 Marks] [15]
b. Delete the following elements in the same order 8, 7, 11, 14, 17 from an AVL tree. Show the necessary operations on each deletion of elements and draw the resultant tree. [5 Marks]
c. Compute the time complexity of AVL tree operations such as insertion, deletion, and search. [3 Marks]