Shahjalal University of Science and Technology

Department of Computer Science and Engineering

1st year 2nd Semester Final Examination—Dec' 2019 (2018 Batch)

Course No.—**CSE 137**

Course Title—**Data Structures**

Time—**3 Hours** Total Marks#**100**

(Answer All the Questions)

Group A

1. Answer the following Questions in short (Any **Five**). $2 \times 5 = 10$

   (a) Bubble Sort, Insertion Sort, Selection Sort, Quick Sort, Merge Sort, Heap Sort, Radix Sort—among these sorting algorithms, which of them have online sorting facility? State the proper reason behind your answer.

   (b) Which values makes an AVL Tree *Unbalanced*? Justify your answer showing the formula of BF Calculation.

   (c) Write a function implementing Disjoint Set.

   (d) What is Forest? Between Prim's and Kruskal's algorithm—which one allows forest in it's runtime?

   (e) Draw the flow diagram to represent a Double Alternative. Write the equivalent Pseudo-code also.

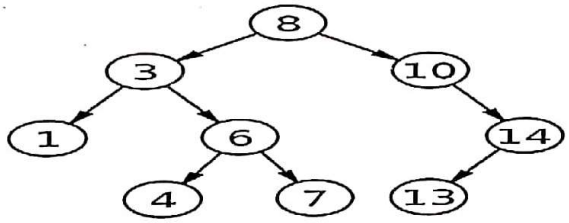
   (f) What is the main property of a BST? What is the main reason behind switching from BST to AVL Tree?

   (g) Draw a null tree. Write the underlying data structures of the following algorithms: BFS, Dijkstra.

   (h) Write the best case, worst case and average case complexity of: Merge Sort, Quick Sort, Insertion Sort and Bubble Sort.

2. Answer the following Questions (Any **Four**). $5 \times 4 = 20$

   (a) **Insert 5** and then **Delete 3** in the following Binary Search Tree (show step by step). 2+3



   (b) How could you be sure that the number of comparison in each level of Merge Sort is less than or equal n? Illustrate and explain.

   (c) You are given the following words: I, SORRY, WE, LOVE, YOU, MORE, THAN, OUR, LIVES, DUDE. You have to sort them in dictionary order, but you could not compare one of them with another. So now, sort them with suitable algorithm showing every steps.

   (d) Write the Pseudo-code for solution of Tower of Hanoi Problem. Illustrate the solution for $n = 4$. 2+3

   (e) Can we implement the Doubly Linked List using arrays? If yes, then do the following operations taking up to 4 arrays of size 10. If no, then do the following operations using pointers. 1+4

   i. INSERT 87 FRONT
   ii. INSERT 65 FRONT
   iii. INSERT 43 BACK
   iv. INSERT 65 BACK
   v. DELETE 43 BACK
   vi. INSERT 51 BACK
   vii. DELETE 65 BACK
   viii. DELETE FIRST ONE

   (f) What is the complexity of a segment tree for build, query and update? Construct a segment tree with the following numbers for finding the minimum number in a range: 25, 41, 63, 34, 17, 51, 89, 57, 64. Which nodes are required for the queries: 2 to 8 and 1 to 5? 1+2+2

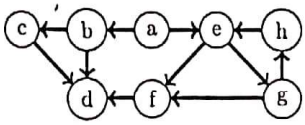
3. Answer the following Questions (Any Two). $10 \times 2 = 20$

(a) Implement REPLACE(T, P, Q) function of String Processing using other four functions named DELETE, INDEX, INSERT and LENGTH. Here, T is the text where the first occurrence of pattern P would be replaced by pattern Q. Construct a pattern matching graph for matching the pattern $P = abababbababa$. Construct the corresponding pattern matching table also. 2+4+4

(b) Observe the following graph. Here, an edge from i to j indicates that the j is dependent on the work i. That means the work i must be done before the work j.

i. Write an algorithm/program to find whether there is a way to do all the works violating at most one dependency. If there is a way, then your algorithm/program must report the violated dependency(if any) and find an order of the tasks. 6

ii. Implement your algorithm/Run your code against the following graph step by step and show the result. 4



(c) Analyze each of the following scenario in case of BFS, Dijkstra and Bellmen-Ford-Moore algorithm. Include complexity, ability and disability of the algorithm in your analysis. A weighted graph have:

i. no negative edge. 2

ii. negative edges, but no negative cycle. 3

iii. have negative cycles. 5

Group B

1. Answer the following Questions in short (Any Five). $2 \times 5 = 10$

(a) Suppose you are given only one stack to traverse a binary tree in post order traversal. How would you keep track in stack whether it is left or right? What is path matrix?

(b) For which type of binary tree we use sequential representation? Draw all possible skeletons(nodes having no value) of a heap for n = 6.

(c) What is the purpose of Huffman's Algorithm? What is the worst-case space complexity of Binary Search Tree in case of Sequential Representation?

(d) Write the push and pop functions for implementing circular queue.

(e) Sort the following numbers using Merge Sort: 783, 234, -343, 234, 123, 11, 2345.

(f) What is terminal substring? "An articulation bridge produces two articulation points"—Justify.

(g) Illustrate RR rotation.

(h) Define Bracket Notation. Suppose, a sorted array has N elements where duplicate values could exist. We want to find the number of occurrences of the value K in the array. UB and LB is the highest and lowest position of the value K in the array respectively. Write an equation to find the number of occurrences of K.

2. Answer the following Questions (Any Four). $5 \times 4 = 20$

(a) Describe the rotations for deletion from AVL Tree with proper diagram.

(b) "Doubly Linked List could be implemented using one address field instead of two" - Justify giving proper logical support. What is the worst case complexity of Radix Sort and Selection Sort? 3+2

(c) The mirrored structure of some complete binary trees are 2-trees. Write an equation for the number of nodes of those complete binary trees. Is it possible to draw the skeleton of a heap consisting of n elements? 3+2

(d) What is Diameter of a Tree? Write a program to find the diameter of a Tree.

(e) Given an expression Q: 45 * 64 / (6 + 2) - 90 / 15. Now, transform this expression into polish notation and then evaluate the expression in polish notation. 3+2

(f) What is **Free Pool**? Write the steps to find the Lowest Common Ancestor of two node of a binary tree. 1+4

3. Answer the following Questions (Any **Two**). $10 \times 2 = 20$

(a) Write the **query** and **update** functions of Binary Indexed Tree (BIT) with their time complexity. For each of the following indexes, determine, which indexes of BIT have the contribution from these indexes: 21, 35, 32, 48, 12, 96. Let n = 128. 4+6

(b) Suppose, you are given the following three problems.

Problem 1: Given an array of n integers. Query—m queries of 2 types. Query 1—Given a range, find the maximum number in this range. Query 2—Given x and y, update the value of x-th index of the given array with y.

Problem 2: Given an array of n integers. Query—m queries of 2 types. Query 1—Given a range, find the summation of the numbers in this range. Query 2—Given x and y, add the value y with the value of x-th index of the given array.

Problem 3: Given an array of n integers. Query—m queries of 2 types. Query 1—Given a range, find the summation of the numbers in this range. Query 2—Given x, y and z, add the value z with each of the value in the indexes ranges x to y of the given array.

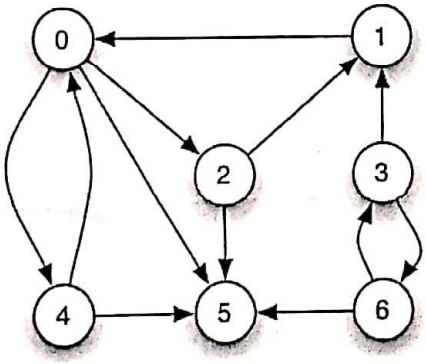
Now, for each of the above problems, answer the following:

i. Find whether the problem could be solved using cumulative approach, segment tree, lazy propagation, Fenwick Tree. State proper reason behind your answer. 4

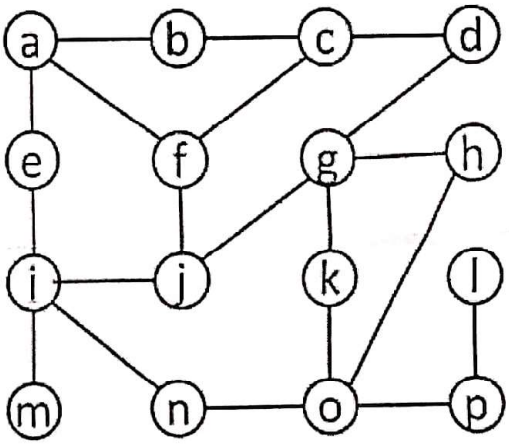
ii. What is the most efficient algorithm to solve this problem in terms of time? why? 3

iii. Show the complexity analysis for preprocessing and answering query. 3

(c) Traverse the following Graph P using **DFS**, where starting node is **2**. You should also traverse the Graph Q through **BFS**, where the starting node is **a**. 5+5



(a) Graph P



(b) Graph Q