Shahjalal University of Science and Technology

Department of Computer Science and Engineering

1^{st} year 2^{nd} Semester Final Examination—Dec' 2018 (2017 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 **Ten**). $1 \times 10 = 10$

   (a) If you build a segment tree with n elements, than what would be the asymptotic complexity of answering a query on an specific range?

   (b) What are common operations that can be performed on a Data Structure?

   (c) What is the main property of maxheap?

   (d) If nodes of a 4-ary tree are numbered top to bottom sequentially, then write an equation to find the parent of of a node numbered k.

   (e) Find two combinations of the first 6 distinct positive integers which would be the worst case if quick sort is implemented.

   (f) What is the main difference between Merge-Sort and Quick-Sort in terms of memory complexity?

   (g) When would you prefer to use DFS instead of BFS?

   (h) In finding Minimum Spanning Tree, if we want to keep an edge in the final edge list, we check whether both of them are already connected some how or not. By which technique we could ensure it?

   (i) Is it possible to calculate BF of a node from it's children's BF in AVL Tree? Give an example to justify your answer.

   (j) What are the acceptable values of BF for a Balanced AVL Tree?

   (k) Is it possible to draw the skeleton of a heap consisting of n elements?

   (l) What is the main property of AVL Tree?

   (m) What is the underlying data structures while implementing Dijkstra's algorithm?

   (n) What is the postfix form of the following prefix *+ab-cd?

   (o) What is the precondition for doing Binary Search? Write it's complexity.

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

   (a) Find a combination of the first 6 distinct positive integers which would be the best case if quick sort is implemented.

   (b) Consider the following scenario:
   You have a 4 by 4 matrix & a 5 by 5, where data are numbered in the following order.

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

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

   - In 4 by 4 matrix, 7^{th} data is in 2^{nd} column, 2^{nd} row. 14^{th} data is in 3^{rd} column, 4^{th} row.
   - In 5 by 5 matrix, 7^{th} data is in 4^{th} column, 2^{nd} row. 14^{th} data is in 4^{th} column, 3^{rd} row.

   Now, you are given an N by N matrix. You have to find a way to calculate row & column number of m-th data from this N by N matrix.

   (c) You are given the following integers: 22, 45, 96, 65, 75, 21, 33, 45, 56, 10. You have to sort them in descending order, but you could not compare one of them with another. So now, sort them with suitable algorithm showing every steps.

(d) What is Disjoint Set? How could we implement it straight forward? How could we optimize it? 1+

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

(f) Show a comparison between Singly linked list and Doubly linked list, What is lazy propagation? Describe the concept of lazy propagation. 2+1+2

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

(a) Consider the following arithmetic infix expression Q. (a) Convert it to the equivalent postfix expression P. (b) Evaluate the expression P.

Q: (15 # 4) ; (3 * 2 - 4) & 100 % (10 + 5 $ 2) / 88

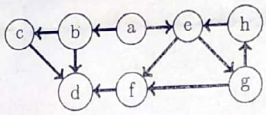
Use the following tables to work with the operators given in Q. In every equation, the operator given in the right side of the equal sign carries its conventional meaning where a and b are two arbitrary operands. In short, every operator used in Q is redefined here. Use the precedence table when needed. The operator with higher precedence should be served first.

Equations	Equations
$a;b = 5a + 3b - 2ab$	$b\$a = b^a$
$a\#b = (a >> b)\&1$	$a - b = a^{b/2}$
$a * b = 2a - 2b + 3ab$	$a\%b = a^2 + \sqrt{b}$
$a/b = a - 100(b+1) + 2$	$a + b = a * 2b$
$a\&b = cos(a - b + 2)$	

Precedence (High to Low)
; * %
/ - +
& $ #

(b) Construct a pattern matching graph for matching the pattern $P = ababba$. Construct the corresponding pattern matching table also.

(c) 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. Choose a suitable algorithm to find every nodes' both direct and indirect dependencies on every other nodes. Implement the algorithm and show it step by step.



(d) Write a Pseudo-code to sort an array of N elements named ARR using Quicksort. Analyze its best, worst and average case complexity.

Group B

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

(a) What are the 6 Rotations could we do in case of deletion in AVL Tree?

(b) 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?

(c) What is the complexity of Warshall's Algorithm?

(d) What is bit matrix?

(e) For which type of binary tree we use sequential representation?

(f) Draw all possible skeletons(nodes having no value) of a heap for n = 6.

(g) A binary tree T has 20 leaves. The number of nodes in T having two children is: ---

(h) What data structures is used in Depth First Search?

(i) What is the complexity of Breadth First Search?

(j) QUEUE: -,B,D,E,-,-. FRONT = 2, REAR = 4. Pop 3 elements and push C. What would be the value of FRONT and REAR then?

(k) Why would not we use circular stack?

(l) What is byte addressable machine?

(m) "An articulation bridge produces two articulation points"—Justify.

(n) What is the Complexity of Radix Sort?

(o) How to find all the permutation of a string?

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

(a) Determine the Binary Tree, where In-order traversal: 4, 2, 5, 1, 6, 7, 3, 8 and Postorder traversal: 4, 5, 2, 6, 7, 8, 3, 1.

(b) Illustrate the LL-Rotation or RR-Rotation with example.

(c) Could a Linked List be implemented using array? If yes, then how? If no, then where is the problem? Explain. How could you maintain the free element in the array? Explain with proper visualization. 2+3

(d) What is **Free Pool**? Could Binary Search be applied on a Singly Linked List? Why? What about Doubly Linked List? Explain. 1+2+2

(e) What is backtrack? Write the steps to find the Lowest Common Ancestor of two node of a binary tree. 1+4

(f) MST, Dijkstra, BFS, DFS—Where could we avoid the use of color/visited array and where it is mandatory to use? Discuss with proper visualization.

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

(a) Suppose, you are given two 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 XOR of the numbers in this range. Query 2—Given x and y, XOR the value of x-th index of the given array with y.
Now, for each problem, answer the following:

i. Find whether the problem could be solved using cumulative sum, 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

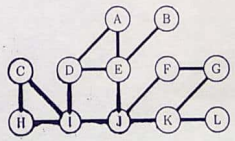
iii. Show the complexity analysis for preprocessing and answering query. 3

(b) Suppose, you are given a complete ternary tree with exactly 16 nodes where nodes are numbered from 1 to 16(numbered levelwise). You have to find a valid order of nodes to visit each node. You can visit any node, anytime, but some nodes could not be visited before visiting it's parent node. These nodes are indicated in the following table by giving value 1.

City#	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Status			1	1	1				1	1	1		1	1	1		

So, use the suitable algorithm to find the answer. Remember, your algorithm must work for any independent starting point.

(c) Find the Articulation point and bridge from the following graph using Depth First Search. Also, indicate the discovery time and low value.



(d) Suppose, you are a programmer in a security company. So, as a security company, usually, they keeps their product names encoded. Below is a sample list of products they provide. Of course all of them are encoded!
The company gave you a long list of their product names in encoded form. Whenever a customer comes and asks for a product, they simply encode the product name and sends it to you. Now, your task is simple. Find an efficient algorithm in terms of both memory and time to serve the queries. Search whether these products are in your list or not: *bacd*, *dcbba* and *abc*. 7+3

i. abcbda	iii. dcbbabd	v. abc	vii. dcbbdaa	ix. ccdbcaa
ii. baccabd	iv. bacd	vi. cdddabd	viii. dabbabd	x. ccdbd