ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION **SUMMER SEMESTER, 2015-2016**

DURATION: 3 Hours **FULL MARKS: 150**

CSE 4403: Algorithms

Programmable calculators are not allowed. Do not write anything on the question paper.

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

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1. a) In a quick-sort algorithm, partition of the problem into two sub-problems depends on the selection of the ***pivot*** element. In the best case scenario, the array is divided into two equal halves. In worst case, the first or the last element is selected as the ***pivot*** and the problem reduces into a problem with one array element less. In both cases merging takes some effort, which is the size of the two sub arrays to be merged. Write the recurrence equation of quick-sort algorithm for its best case and worst case. 6

   b) Write the algorithm to draw a right-angled triangle (as shown in Figure 1) filled with * and analyze its complexity by calculating the cost of each line. 10

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Figure 1: Right-angled triangle

   c) Write a short note on asymptotic growth functoins. 3×3

2. a) How many elements can there be in a complete binary tree with i levels or with a height h ($h = i - 1$)? 5

   b) Heapify algorithm has an asymptotic complexity of $T(n) \leq T(2n/3) + \Theta(1)$. Solve the recurrence. 8

   c) Prove that the expected height of a randomly build binary search tree on n distinct keys is $O(lgn)$. 12

3. a) Build a max heap for the following array: 12
   A={27, 17, 3, 16, 13, 10, 1, 5, 7, 12}

   b) What is a hast function? How is a conflict in hashing resolved? 4+4

   c) What is a red black tree? Define its characteristics. 5

4. a) Activity selection problem applies greedy approach in its optimal solution. However, if there were no greedy heuristics available, what would be your solution approach? 7

   b) Given the following two signals A = {1, 1, 2, 2, 3} and B = {1, 1, 5, 2, 2, 2, 4} find out the warp path (best matching path) and dtw distance between them. 10

   c) Briefly describe longest common subsequence (LCS) problem and explain how dynamic algorithm is used to solve the problem. 8

5. a) Minimum spanning tree algorithms are greedy as they choose smallest edge in each step. Write the theory for the the optimality of the greedy choice, and prove the theory. 8

   b) Define the characteristics of dynamic algorithms and name three problems that can be solved by dynamic algorithms. 5

c) Use graham scan algorithm to find the convex hull of the following points starting form P_0 12
given in Figure 2.

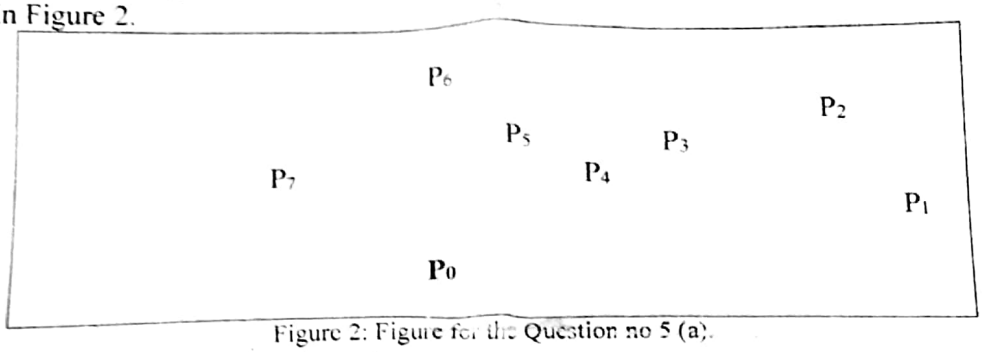

Figure 2: Figure for the Question no 5 (a).

6. a) Prove the optimality of Huffman coding. 8

b) Pictorially describe how node z will be deleted from the binary search sub-tree given below 7
in Figure 3.

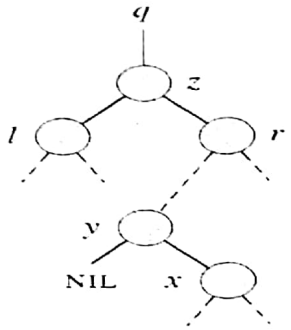

Figure 3: Binary search sub-tree

c) Generate the optimal prefix code for the following character set (from a to g) with their 10
frequencies:
a (10) b (35) c (40) d (2) e (15) f (12) g (4)

7. a) Suppose, you want to buy a flat in Dhaka, from where the travelling cost to different 8
important locations will be lowest overall (i.e. total cost). Now if you want to apply minimum spanning tree, which of the two approaches will be helpful for you?

If you have already bought the flat and then want to calculate the minimum total travelling cost, will your solution work? If not, propose an alternative solution.

b) Given the following adjacency matrix (Figure 4) for a **un-directed** graph with vertices V={a 12
to i}, draw the graph and find the MST with source vertex ***a***.

	A	b	c	d	e	f	g	h	i
a	0	4	∞	∞	∞	∞	∞	8	∞
b		0	8	∞	∞	∞	∞	11	∞
c			0	7	∞	4	∞	∞	2
d				0	9	14	∞	∞	∞
e					0	10	∞	∞	∞
f						0	2	∞	∞
g							0	1	6
h								0	7
i									0

Figure 4: Adjacency Matrix

c) Breifly describe depth first search. 5

8. a) "In a hast table in which collisions are resolved by chaining, an unsuccessful search takes 10
average case time $\Theta(1+\alpha)$, under the assumption of simple uniform hashing" – Prove the theorem.

b) Use robin- karp algorithm to match the pattern $P=aab$ with the text $T=acaabc$ 15