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B.Sc. Engg. / HD CSE 4th Semester

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION **SUMMER SEMESTER, 2017-2018**

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) What is an algorithm? How does a software use different algorithms together to achieve a particular high level goal? 2+3

   b) Prove that the expected running time of quicksort using randomized-partition is $O(n\log n)$. 10

   c) The *maximum sub-array* problem and *Longest Increasing Subsequence (LIS)* problem have some similarities and yet they are different. Provide an analysis of the two problems and outline how they are similar and how they are dissimilar. You may draw diagrams if needed. 10

2. a) Although merge sort runs in $\theta(n\log n)$ worst-case time and insertion sort runs in $\theta(n^2)$ worst-case time, the constant factors in insertion sort can make it faster in practice for small problem sizes on many machines. Thus, it makes sense to coarsen the leaves of the recursion by using insertion sort within merge sort when subproblems become sufficiently small. Consider a modification to merge sort in which n/k sublists of length k are sorted using insertion sort and then merged using the standard merging mechanism. 8

      i. Show that insertion sort can sort the n/k sublists, each of length k in $\theta(nk)$ worst-case time.

      ii. Show how to merge the sublists in $\theta(n\log(n/k))$ worst-case time.

   b) Define the optimal substructure of Longest Common Subsequence (LCS) problem. 7

   c) Compute the LCS for the following two strings: 10

      ABABCDA and CDABAB.

3. a) What do you understand by 'optimal substructure'? Why is it a necessary property for a problem to hold if it is to be solved by dynamic programming? 7

   b) How can you find a cycle in a graph by the two set operations **Union**(u,v) and **Find-Set** (x)? 8

   c) Compute the ***prefix function*** (π) for a KMP matcher for the following pattern: 10

      P=abacbcabac

4. a) Prove that Breadth-First Search (BFS) provides the shortest path from the source to all other vertices. 7

   b) The algorithms for finding the Minimum Spanning Tree (MST) in a graph are greedy algorithms. What is the theoretical foundation for MST algorithms to be greedy? 8

   c) Prove that the height of a B-tree is $h \le \log_t\left(\frac{n+1}{2}\right)$ 10

a) Many of the practical algorithms are derived from common-sense. Mention two algorithms that are common sense (do not quote sorting algorithms) and how the algorithms are mapped to common sense. 8

b) Analyze the complexity of Kruskal's MST algorithm. 7

c) Insert the following keys into a B-tree (Assume t=2): 10

G M P X A C D E J K N O R S T U V Y Z

6. a) Activity selection problem can be solved by using a greedy algorithm. What is the greedy choice it makes in every iteration? How can you prove that the greedy activity selection algorithm will provide the optimal set of selected activities? 10

b) A dynamic programming algorithm that matches two time series X and Y has the following cost function: 15

$$c[i,j] = \begin{cases} 0 & \text{if } i=0 / j=0 \\ d[i,j] + min(c[i-1,j], c[i,j-1], c[i-1,j-1]) & \text{otherwise} \end{cases}$$

Where $d[i,j] = |X[i]-Y[j]|$

Calculate the minimum matching cost and find the minimal matching path (warp path) between the two time series as given below:

X=[1,2,3,7,2,4,5] Y=[1,1,6,2,3,3,4,5]

7. a) Show the solution for the following recurrence: 9

$$T(n) = 2T(\sqrt{n}) + \log n$$

b) Analyze the complexity of Build-Max-Heap() algorithm. 10

c) Briefly describe the O, θ and Ω notations. 6

3. a) How do you analyze the correctness of an algorithm? 5

b) Use Floyd Warshall algoritm to calculate the all pair shortest path using the following adjacency matrix for 4 vertics: 10

$$\begin{pmatrix} 0 & 3 & 8 & \infty \\ \infty & 0 & 3 & 1 \\ \infty & 4 & 0 & 2 \\ 2 & \infty & -5 & 0 \end{pmatrix}$$

c) Use graham scan algorithm to find the convex hull of the following points: 10

(1, 3), (1, 2), (-1, -1), (4, 4), (0, 1), (8, 8), (2, 7), (4, 3), (3, 4).