Benha University
Faculty of Engineering (at Shoubra)
Electrical Engineering Department
M.Sc. (Computer Systems Engineering**)**

Final Exam
Subject: Advanced Algorithms - CES 608
Date: Sat 18/05/2019
Duration: 3 hours

Attempt the following questions.

№ of Questions: 6 in 1 page(s)
Total Mark: 60

Question 1: **(10** marks**)**

a) Identify (i) what *Euclid's algorithm* does for a pair of integers in which the first is smaller than the second and (ii) how often this can happen during the algorithm's execution. **(02** marks**)**

b) Sort the following functions according to their order of growth from the lowest to the highest. **(04** marks**)**

$$n^3, n^{\log 5}, 2^n, n \log n, 3^{\log n}, n!, n^n, \log n^8, \log^3 n$$

c) Solve the following recurrence. **(04** marks**)**

$$M(n) = 2M(n\text{-}1) + 1,\ M(1) = 1$$

Question 2: **(10** marks**)**

a) Construct an example of the assignment problem whose optimal solution does not include the smallest element of its cost matrix. **(02** marks**)**

b) Design and analyze a brute-force algorithm for finding a substring in a given text that matches a specified pattern. **(04** marks**)**

c) Design and analyze a brute-force algorithm for computing the value of a given polynomial $p(x)$ at a given point x_0 and determine its worst-case efficiency class. **(04** marks**)**

$$p(x) = a_n x^n + a_{n-1} x^{n-1} + \ldots + a_1 x + a_0$$

Question 3: **(10** marks**)**

a) Justify whether it is possible to implement *insertion sort* for sorting *linked lists* **efficiently**. **(03** marks**)**

b) Design and analyze an efficient algorithm for the *exponentiation problem* (finding a^n). **(03** marks**)**

c) Design and analyze an efficient algorithm for selecting the smallest k elements in a given array of size n. **(04** marks**)**

Question 4: **(10** marks**)**

a) Apply *mergesort* to the following array of characters. **(02** marks**)**

[E, X, A, M, P, L, E, S]

b) Design and analyze an efficient algorithm for estimating the height of a given binary tree. **(03** marks**)**

c) Given a set P of $n > 1$ points in the Cartesian plane, design and analyze an efficient algorithm for finding the closest pair of points the given set. **(05** marks**)**

Question 5: **(10** marks**)**

a) Compare between *Binary Trees*, *AVL Trees*, *Red-Black Trees*, *2-3 Trees*, and *B-Trees*. **(02** marks**)**

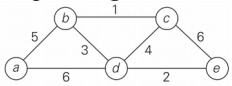
b) Design and analyze an efficient algorithm for checking element uniqueness in a given array. **(04** marks**)**

c) Design and analyze an efficient algorithm for computing the *least common multiple* (LCM) of two given integers m and n. **(04** marks**)**

Question 6: **(10** marks**)**

a) Design and analyze a *dynamic programming algorithm* for the knapsack problem given n items of known weights $w_1, \ldots, w_n$ and values $v_1, \ldots, v_n$ and a knapsack of capacity W. **(05** marks**)**

b) Apply *Kruskal's algorithm* to find a *minimum spanning tree* of the shown graph. **(02** marks**)**



c) Design and analyze a *greedy algorithm* for the change-making problem given an amount n and coin denominations $d_1 > d_2 > \ldots > d_m$. **(03** marks**)**

Good Harvest
Dr. Islam ElShaarawy