



Cairo University
Faculty of Computers and Information
Postgraduate Final Exam (Pre M.Sc.)

Department : Computer Science
Lecturer : Sherif Khattab
Course : Advanced mathematics and algorithms
Course Code : CS612 **Marks** : 60
Date: 4/1/2015 **Time** : 2 hours



Answer as much as you can. Max. grade is 60.

Q1. [Marks: 16] Answer the following questions.

- a. [3 pts] Write Kruskal's algorithm for computing the minimum spanning tree of an undirected graph and state its running time.
- c. [3 pts] Describe the Travelling Salesman Problem and state why it is difficult to solve efficiently.
- g. [2 pts] Define and prove the cut property.
- h. [6 pts] Describe with examples three strategies for tackling NP-Complete problems.
- i. [2 pts] You are given an undirected graph and asked to compute all-pairs shortest paths on it. Describe a methodology to select the best algorithm to solve this problem.

Q2. [Marks: 20]

- a. [5 pts] Give an algorithm to solve the **fractional knapsack problem**.
- b. [5 pts] Prove its correctness and state its running time.
- c. [5 pts] Give an **efficient** algorithm to solve the **non-fractional** knapsack problem.
- d. [5 pts] Is your algorithm correct? Why?

Q3. [Marks: 10]

- a. [3 pts] Define the minimum vertex cover problem.
- b. [7 pts] Give an algorithm to solve the problem faster than the brute-force approach.

Q4. [Marks: 25]

- a. [10 pts] Describe an optimal implementation of the union-find data type.
- b. [7 pts] State and prove its time complexity.
- c. [5 pts] Would the running time of Kruskal's minimum spanning tree algorithm decrease by using the optimized union-find data structure? Why?
- d. [3 pts] Give an example of an algorithm that its running time benefits from using a suitable data structure. Name the algorithm and the data structure and state the running time before and after using the data structure.

| Examiners | Name | Signature |
|------------|----------------|-----------|
| Examiner 1 | Sherif Khattab | |
| Examiner 2 | | |

Best Wishes