

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

SEMESTER FINAL EXAMINATION

DURATION: 1 Hour 30 Minutes

SUMMER SEMESTER, 2019-2020

FULL MARKS: 75

**CSE 4403: Algorithms**

**Programmable calculators are not allowed.**

There are **3 (three)** questions. Answer all **3 (three)** of them.

Figures in the right margin indicate marks.

1. a) Explain with an example in which case paranoid quick sort algorithm will fail. 4 + 4  
 b) Consider that we have a connected graph with a cut  $(S, V - S)$  such that  $u \in S$  and  $v \in (V - S)$ . Assume that the edge  $(u, v)$  has the minimum weight among all the edges crossing the cut. Describe a simple example graph where  $(u, v)$  is not included in the minimum spanning tree. 5  
 c) Assume that we have a minimum spanning tree  $T$  on a connected graph  $G$ . We decrease the weight of an edge  $e \notin T$ . Provide an efficient algorithm for finding the minimum spanning tree of the modified graph and analyze its runtime. 12
  
2. a) After running the Ford-Fulkerson Algorithm on a flow network  $G$ , we have found  $f$  to be the maximum flow. Argue that, if we construct a residual graph for the current network, there will not be any augmenting path. 5  
 b) IUT is going to organize an Intra-University Programming Contest. The contest will have  $n$  ( $1 \leq n \leq 26$ ) problems. To make the problems interesting, the name of the first problem will start with A, the name of the second problem will start with B, and so on. However, the names cannot be selected at random. For each problem  $i$  ( $1 \leq i \leq n$ ), the organizers have come up with a list of acceptable names,  $L_i$ . The names consist of lowercase English letters. You can choose one name for each problem from the list. 20  
 Example: Let's say we have 3 problems. Let the list of acceptable names be:
  1. bravo, charlie
  2. alpha, omega
  3. apricot, capricorn, eagle
 One possible ordering of the problems can be 2, 1, 3 with name alpha, bravo, capricorn. Provide an efficient algorithm to find an ordering of the problems so that the names can be given in the described format.
  
3. a) With brief explanation, determine the complexity class of the following problems: 4 × 4
  - i. Given a chessboard configuration, is  $A$  to  $B$  the next best move?
  - ii. Given a graph, is there a negative cycle or not?
  - iii. Given a program  $P$ , will it halt?
  - iv. Given a set of clauses  $C_1, C_2, \dots, C_k$ , each of length 3, over variables  $X = \{x_1, x_2, \dots, x_n\}$ , is there a satisfying assignment?
 b) Finding all pair shortest path in a graph - is in  $P$  and also in  $NP$ . Justify the statement. 4 + 5