UNIVERSITY OF WESTMINSTER
FACULTY OF SCIENCE & TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE

Module Title:	**ALGORITHMS: THEORY, DESIGN AND IMPLEMENTATION**
Module Code:	**5SENG001W - 5SENG002C (Sri Lanka)**
Module Leader:	Dr Epaminondas Kapetanios
Date:	**08 MAY 2018**
Start:	**10:00**
Time Allowed:	**1:30 Hour**

INSTRUCTIONS FOR CANDIDATES

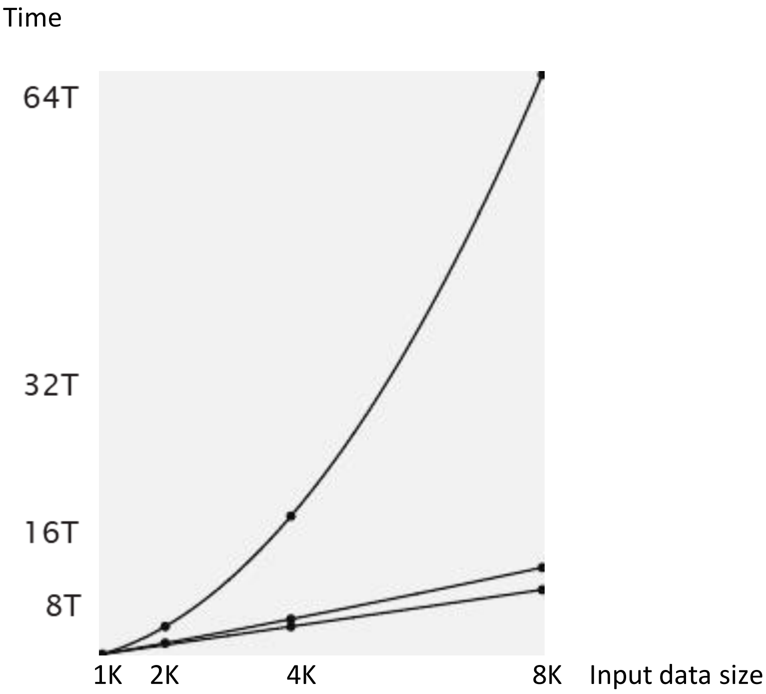
You are advised (but not required) to spend the first ten minutes of the examination reading the questions and planning how you will answer those you have selected.

- You need to answer all questions.
- Calculators are allowed.

THIS PAPER SHOULD NOT BE TAKEN OUT OF THE EXAMINATION ROOM

DO NOT TURN OVER THIS PAGE
UNTIL THE INVIGILATOR INSTRUCTS YOU TO DO SO

PROBLEM 1 [11 Marks]: Define the most commonly used orders of growth classification for measuring the performance of algorithms. Please use two columns stating the big-O notation and the corresponding name, respectively. Subsequently, assign to each of the three plotted graphs (functions) the order of growth classification you think it is appropriate and justify your answer.



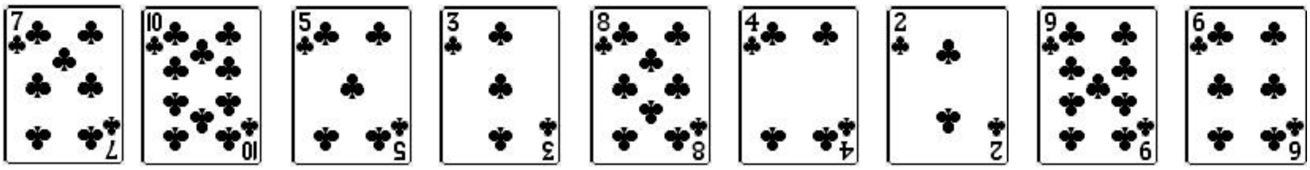
PROBLEM 2 [10 Marks]: Let us assume a programme is looking up a specific entry in a sorted list of size *n*. Suppose this program were implemented on Computer A, a state-of-the-art machine, using a linear search algorithm, and on Computer B, a much slower machine, using a binary search algorithm. Benchmark testing on the two computers running their respective programmes looks something like the following:

***n* (list size)**	**Computer A run-time (in nanoseconds)**	**Computer B run-time (in nanoseconds)**
16	8	100,000
63	32	150,000
250	125	200,000
1,000	500	250,000

Based on these metrics, explain the following:

a) What is the performance of the algorithm running on computer A;
b) What is the performance of the algorithm running on computer B;
c) Which of the two algorithmic implementations is more efficient.

PROBLEM 3 [15 Marks]: Let us assume that you are asked to sort the cards, which are depicted below, **in ascending order**, by choosing between the *Insertion Sort* and *Selection Sort* algorithms.



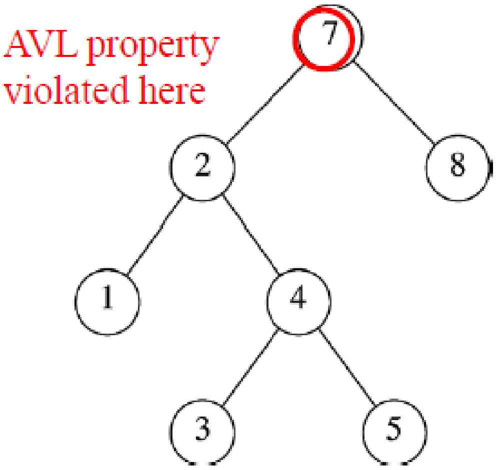
Let us also assume that the list of already sorted cards is the following: [3, 5, 7, 10] with the list of the remaining cards being [8, 4, 2, 9, 6]:

a) Describe the next comparisons and swap(s) of cards to happen **at the next iterative step only**, i.e., picking the next card to be sorted and putting into the list of already sorted cards, according with the
   1. *Insertion Sort* algorithm;
   2. *Selection Sort* algorithm;

b) Name and justify which is the best sorting algorithm for this problem.

PROBLEM 4 [14 Marks]: Let us assume that the Binary Search Tree (BST), which is depicted by the following figure, is being kept balanced by applying the AVL algorithm with balancing factors.

- Describe the AVL algorithm in pseudo-code or plain text (English);
- Apply the AVL algorithm on the depicted BST below and justify why the BST is marked as unbalanced.



PROBLEM 5 [6 Marks]: Let us assume that the following *term-document mappings* hold, where the positions in each document of a particular term is listed by the following the data structure below:

<*term,* number of docs containing *term*;
    doc1: position1, position2 … ;
    doc2: position1, position2 … ;
etc.>

Let us further assume that the term ***be*** is recorded as follows:

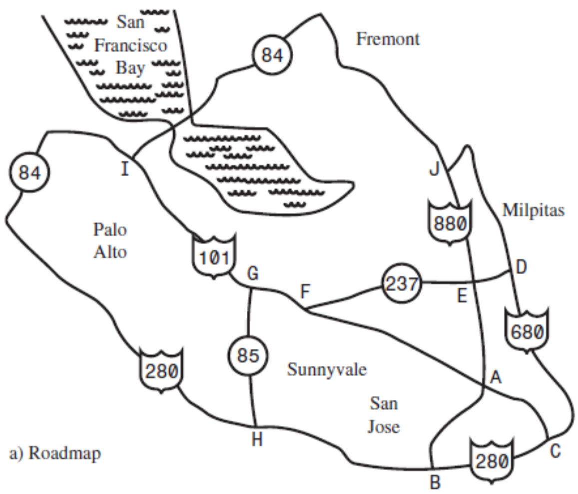
<***be***: 993427;
    1: 7, 18, 33, 72, 86, 231;
    2: 3, 149;
    4: 17, 191, 291, 430, 434;
    5: 363, 367, …>

with 1,2, 4, 5 being the documents. Please provide the following answers:

a) Which documents potentially include the phrase "to be or not to be"?
b) Why do you think these are the only candidate documents to include this phrase?

PROBLEM 6 [15 Marks]: A road map of Silicon Valley is depicted by the following figure. The map depicts some major highways with their junctions (intersections) as labelled by capital letters of the English alphabet.

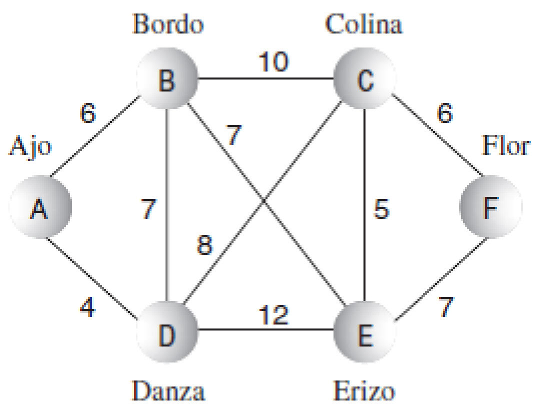
- Draw a graph that reflects this map. You may assume that all highways are two-ways and that all junctions must be captured by the graph;
- Represent the graph as a matrix;
- Based on the matrix, devise an algorithm that gives you the number of possible highways you may take at each junction.



a) Roadmap

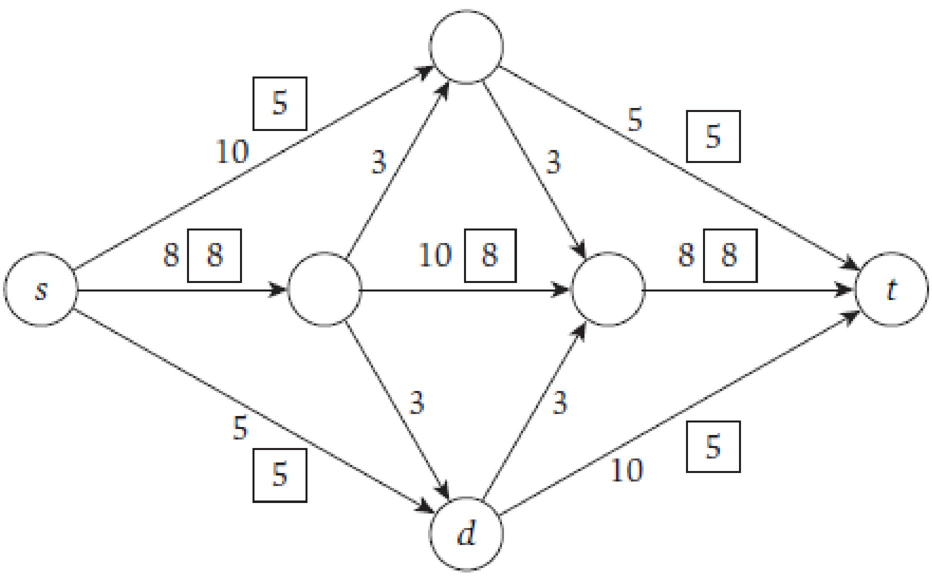
PROBLEM 7: [17 Marks]: Let us assume you are given the following graph representing the potential costs (weights on the edges) associated with laying out a cable TV network among different cities (nodes on the graph).

a) Suggest a network solution for connecting all cities at the minimum cost possible;
b) Justify your approach by briefly explaining the method (algorithmic approach) you followed.



PROBLEM 8: [12 Marks]: The figure below depicts a flow network on which an *s*-*t* flow has been computed. The capacity of each edge appears as a label next to the edge, and the numbers in boxes give the amount of flow sent on each edge. (Edges without boxed numbers—specifically, the four edges of capacity 3—have no flow being sent on them.)

a) What is the value of this flow? Is this a maximum (*s*, *t*) flow in this graph?
b) Find a minimum *s*-*t* cut in the flow network, as pictured in this figure, and also specify what its capacity is.



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