UNIVERSITY OF LONDON

GOLDSMITHS COLLEGE

Department of Computing

B. Sc. Examination 2019

IS50003B, IS50003C

Foundations of Problem Solving

Duration: 2 hours 15 minutes

Date and time:

This paper is in two parts: part A and part B. You should answer ALL questions from part A and TWO questions from part B. Part A carries 40 marks, and each question from part B carries 30 marks. The marks for each part of a question are indicated at the end of the part in [.] *brackets.*

There are 100 marks available on this paper.

The use of calculators is allowed. Students are required to note the model of the calculator on the answer sheet.

Electronic calculators must not be programmed prior to the examination. Calculators which display graphics, text or algebraic equations are not allowed.

THIS PAPER MUST NOT BE REMOVED FROM THE EXAMINATION ROOM

Part A

Question 1

In order to write a program for finding the sum of odd numbers from 5 to 78 (consider both 5 and 78 in your program), you have been asked to perform the following tasks:

i. Write the pseudo code of your algorithm to solve the problem. [10]

ii. Draw the flowchart of your algorithm. [10]

Show clearly the variables used in your algorithm as well as the start and the end of your algorithm.

Question 2

The list of numbers shown below is to be sorted in ascending order.

18 17 13 26 10 14 24

(a)

i. Use bubble sort to perform the first pass, giving the state of the list after each exchange. State the number of comparisons and swaps needed to perform the first pass. Clearly indicate number sorted at the end of the first pass.

ii. Continue with the bubble sort by conducting further passes, showing the state of the list after each pass, until the algorithm terminates. State the total number of comparisons, swaps and how many passes are needed before the algorithm terminates. Clearly indicate numbers sorted at the end of each pass.

[10]

(b) Another list of numbers, in descending order, is given below:

710 650 643 455 452 431 245 234 162 134

The numbers in the list represent the lengths, in mm, of some pieces of wood. The wood is sold in one metre lengths.

i. Use the first-fit decreasing bin packing algorithm to determine how these pieces could be cut from the minimum number of one metre lengths. (You should ignore wastage due to cutting.)

ii. Determine whether your solution to part b (i) is optimal. Give a reason for your answer.

[10]

Part B

Question 3 Transportation Problem

The table below shows the cost, in pounds, of transporting one unit stock from each of three supply points, X, Y and Z to three demand points, A, B and C. It also shows the stock held at each supply point and the stock required at each demand point.

	A	B	C	Supply
X	17	8	7	22
Y	16	12	15	17
Z	6	10	9	15
Demand	16	15	23	

(a) This is a **balanced problem**. Explain what this means.

[2]

(b) Use the north west corner method to obtain an initial solution and state the cost of the initial solution.

[6]

(c) Amongst the negative improvement indices, take the smallest to indicate the entering cell and use the stepping stone method to obtain an improved solution. You must make your method clear by stating your shadow costs, improvement indices, routes, entering cell and exiting cell.

[10]

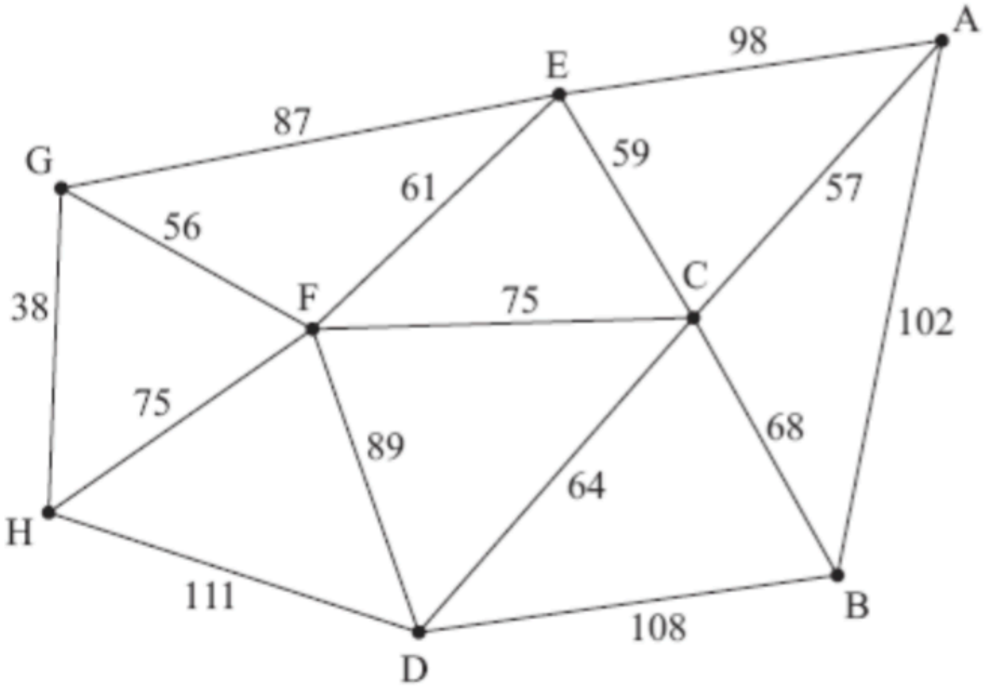
(d) Perform one more iteration of the stepping-stone method to find a further improved solution. You must state clearly your shadow costs, improvement indices, entering cell, exiting cell and clear route.

[10]

(e) State the cost of the solution you found in part (d).

[2]

Question 4 Travelling Salesman Problem



The network in the diagram above shows the distances, in km, between eight weather data collection points. Starting and finishing at A, Fiona needs to visit each collection point at least once, in a minimum distance.

(a) Using Kruskal's algorithm, obtain a minimum spanning tree for the network, stating clearly the order in which you select the arcs.

[5]

(b) Use your answer to part (a) to determine an initial upper bound for the length of Fiona's route.

[3]

(c) Starting from your initial upper bound use short cuts to find an upper bound which is 616km. State the corresponding route.

[6]

(d) Starting at B, use the nearest neighbour algorithm to find a second upper bound for the length of the route. You must state clearly your routes and their lengths.

[5]

(e) State the best upper bound from your answers to (c) and (d).

[2]

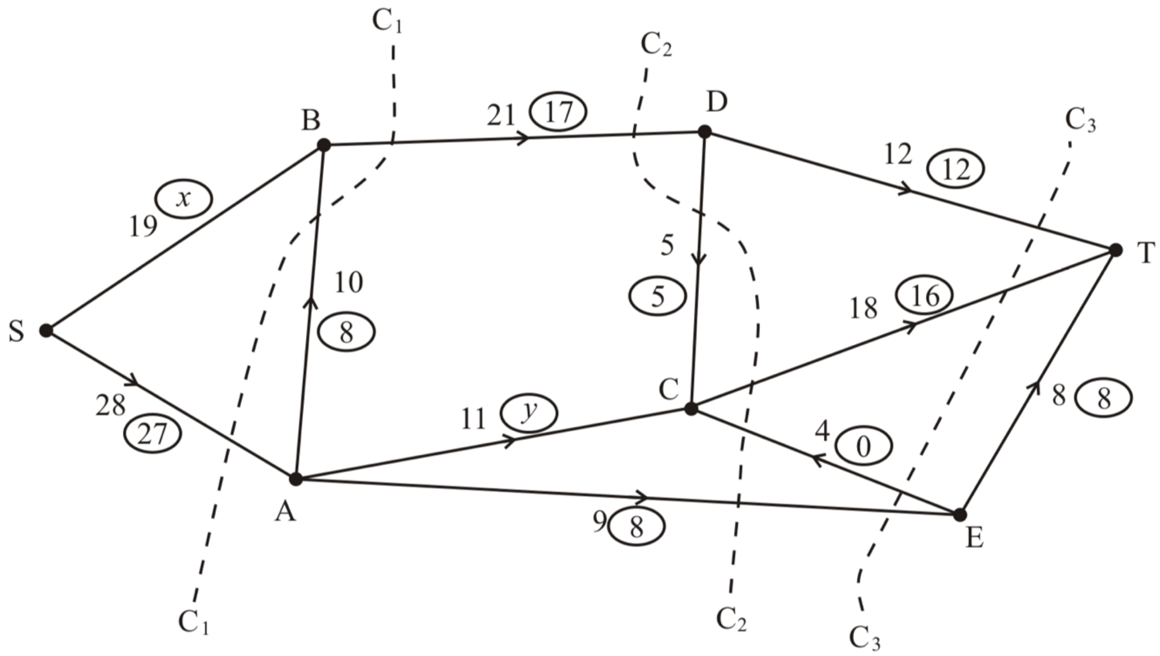
(f) By deleting C and all its arcs, find a lower bound for the length of the route.

[7]

(g) Using your results, write down the smallest interval which you are confident contains the optimal route length.

[2]

Question 5   Network Flow



The diagram above shows a capacitated, directed network. The number on each arc represents the capacity of that arc. The numbers in circles represent a feasible flow.

(a) State the value of the feasible flow, showing clearly how it was obtained. [4]

(b) State the capacities of cuts C_1, C_2 and C_3. You must show your working. [6]

(c) Find the values of x and y. You must clearly show your working. [4]

(d) What does it mean for an arc to be saturated? List all the saturated arcs in the network. [6]

(e) By inspection or otherwise, find a flow-augmenting route to increase the flow by one unit. You must clearly state your route. [3]

(f) Prove that the new flow is now maximal. [7]

END OF EXAMINAMTION