UNIVERSITY OF LONDON

GOLDSMITHS COLLEGE

B.Sc. Examination 2015

COMPUTER SCIENCE

IS50003B Foundations of Problem Solving

Duration: 2 ¼ hours

Date and time: 14 May 2015 14:30

There are FIVE questions in this paper. You should answer any THREE of them. Each question is marked out of 25. The marks for each part of a question are indicated at the end of the part in [.] brackets.

There are 75 marks available on this paper

THIS PAPER MUST NOT BE REMOVED FROM THE EXAMINATION ROOM

Question 1

a) Starting with a list of all the letters of the alphabet in alphabetical order, demonstrate how a binary search is used to locate the letter P.

b) What is the maximum number of iterations needed to locate any particular letter of the alphabet. What would be one of the letters that would take that long to find? Justify your answer mathematically and by giving the chain of comparisons that would find that element.

[5]

c) What is meant by a divide and conquer strategy? Explain your answer using quicksort as an example

[2]

d) Use quicksort to sort

5 3 7 9 2 1 6

[5]

e) How many comparisons did you have to do?

[2]

f) Show what happens in the first pass through the the list in part (d) using bubblesort.

[4]

g) How many comparisons does that take? How many passes will there be altogether. How many comparisons will each of those take. How many comparisons will the whole sort take?

[4]

Question 2

	S	A	B	C	D	E	F	T
S		14	5	12				
A	14		8		11		18	
B	5	8		-	22			
C	12				13	25		
D		11	22	13		8	5	
E				25	8			8
F		18			5			12
T								

The table above shows almost all of the weights on the arcs of an undirected network.

a) Complete the table by filling in the last row.

[2]

b) Draw the network.

[3]

c) Apply Dijkstra's algorithm to find the least weight route from S to T.

[6]

d) Give your route and its total weight.

[4]

e) Describe a problem for which this would be a useful model

[1]

f) What is a minimal spanning tree? Describe a problem for which it would be useful to know a minimal spanning tree for a graph.

[3]

g) Use Prim's algorithm to find a minimal spanning tree for the network above.

[6].

Question 3

a) Given that k is a constant, first convert the inequalities of the following linear programming problem into equations and then display them in a Simplex tableau.

[6]

Maximise $\quad P = 6x + 5y + 3z$

subject to
$$x + 2y + kz \leq 8$$
$$2x + 10y + z \leq 17$$
$$x \geq 0, y \geq 0, z \geq 0$$

b)

(i) Use the Simplex method to perform **one** iteration of your tableau for part **(a)**, starting by identifying the pivot column and the pivot.

[8]

(ii) Given that the maximum value of P has not been achieved after this first iteration, find the range of possible values of k

[2]

c) In the case where $k = -1$, perform one further iteration and interpret your final tableau.

[9]

Question 4

A farmer has five fields. He intends to grow a different crop in each of four fields and to leave one of the fields unused. The farmer tests the soil in each field and calculates a score for growing each of the four crops. The scores are given in the table below.

	Field A	Field B	Field C	Field D	Field E
Crop 1	16	12	8	18	14
Crop 2	20	15	8	16	12
Crop 3	9	10	12	17	12
Crop 4	18	11	17	15	19

The farmer's aim is to maximise the total score for the four crops.

a) (i) Modify the table of values by first subtracting each value in the table above from 20 and then adding an extra row of equal values.

[3]

(ii) Explain why the Hungarian algorithm can now be applied to the new table of values to maximise the total score for the four crops.

[4]

b) (i) Construct a new table by reducing **rows** first.

[5]

(ii) Show that the zeros in the table from part **(b)(i)** can be covered by one horizontal and three vertical lines, and use the Hungarian algorithm to decide how the four crops should be allocated to the fields.

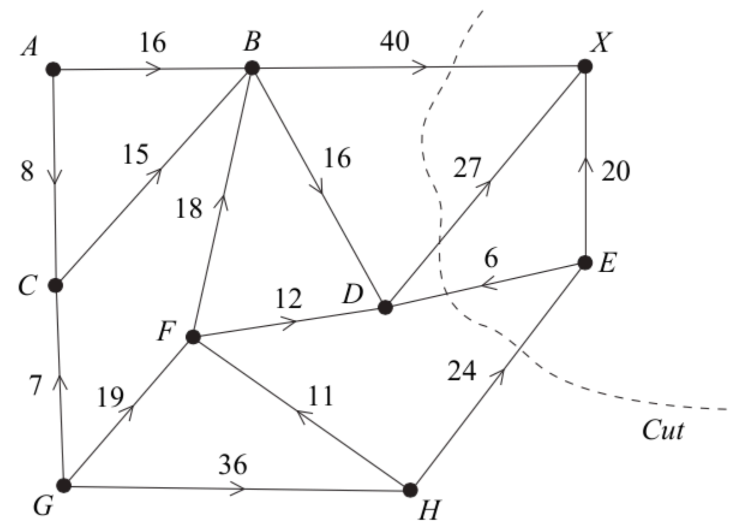
[10]

(iii) Hence find the maximum possible total score for the four crops.

[3]

Question 5

The network shows the evacuation routes along corridors in a company, from two meeting rooms to the exit, in case of a fire alarm sounding.



The two meeting rooms are at A and G and the exit is at X.

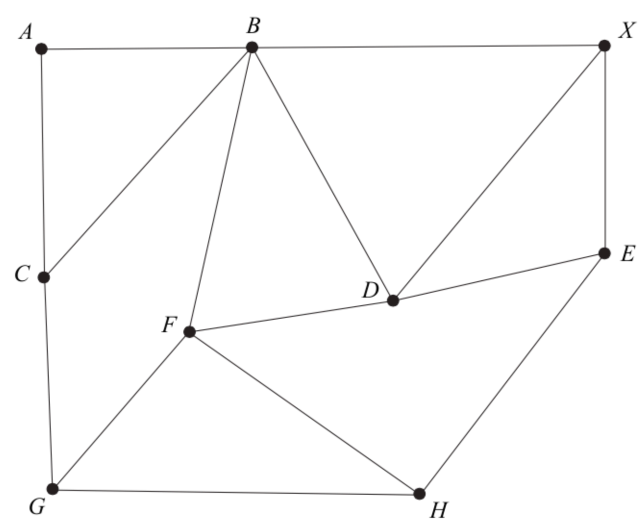
The number on each edge represents the maximum number of people that can travel along a particular corridor in one minute.

a) Find the value of the cut shown on the diagram.

[3]

b) Find the maximum flow along each of the routes ABDX, GFBX and GHEX and enter their values in the table on the figure below.

[4]



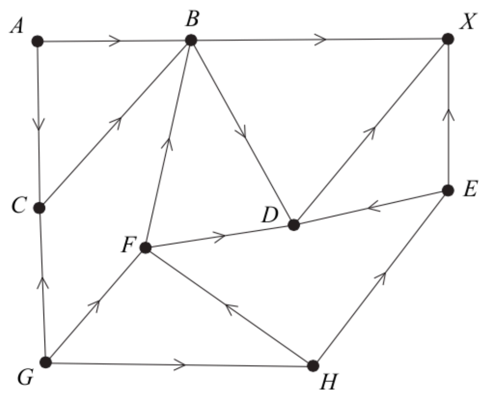
Route	Flow
ABDX	
GFBX	
GHEX	

c) (i) Taking your answers to part **(b)** as the initial flow, use the labelling procedure on the Figure above to find the maximum flow through the network. You should indicate any flow augmenting routes in the table and modify the potential increases and decreases of the flow on the network.

[10]

(ii) State the value of the maximum flow, and, on the Figure below, illustrate a possible flow along each edge corresponding to this maximum flow.

[4]



Maximum flow is .... **people per minute.**

d) During one particular fire drill, there is an obstruction allowing no more than 45 people per minute to pass through vertex B. State the maximum number of people that can move through the network per minute during this fire drill.

[4]