OCR
RECOGNISING ACHIEVEMENT

Thursday 6 June 2013 – Morning

AS GCE MATHEMATICS (MEI)

4771/01 Decision Mathematics 1

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4771/01
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found in the centre of the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

This information is the same on the Printed Answer Book and the Question Paper.

- The number of marks is given in brackets **[ ]** at the end of each question or part question on the Question Paper.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **8** pages. Any blank pages are indicated.

INSTRUCTIONS TO EXAMS OFFICER/INVIGILATOR

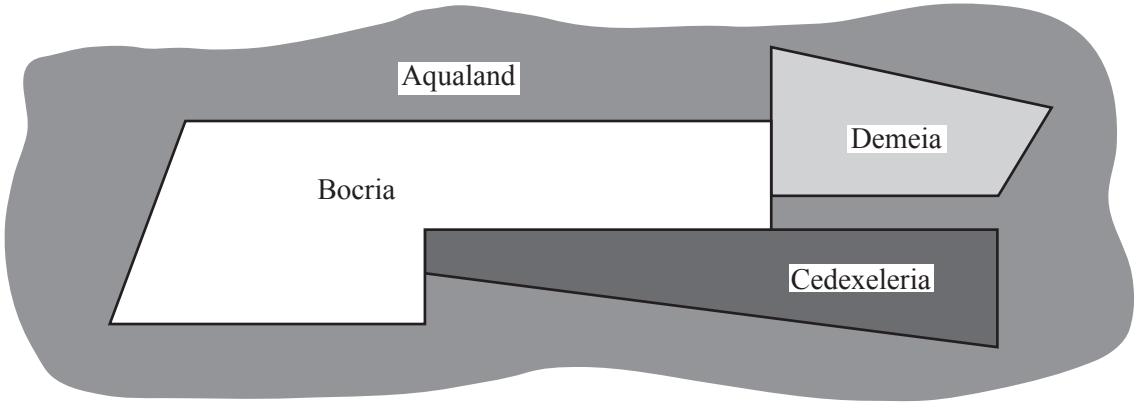
- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

DC (CW/SW) 51937/2

Section A (24 marks)

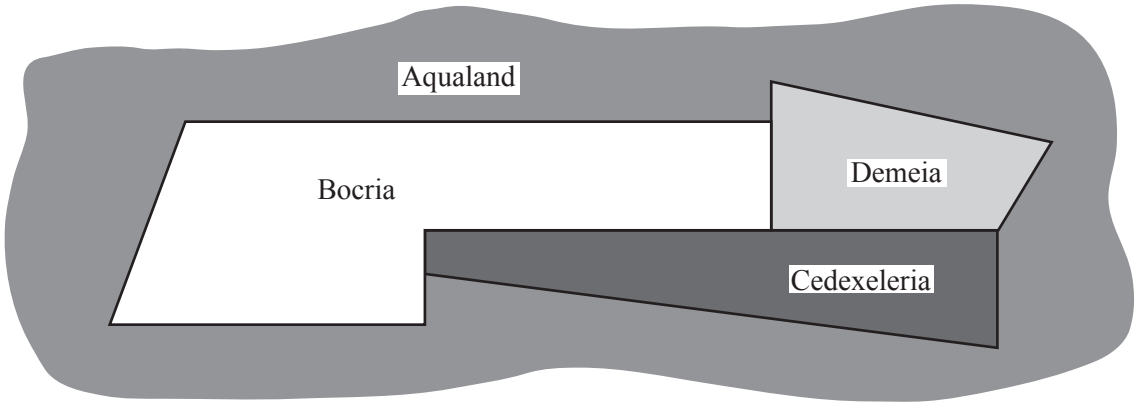
1 The adjacency graph for a map has a vertex for each country. Two vertices are connected by an arc if the corresponding countries share a border.

(i) Draw the adjacency graph for the following map of four countries. The graph is planar and you should draw it with no arcs crossing. **[3]**



(ii) Number the regions of your planar graph, including the outside region. Regarding the graph as a map, draw its adjacency graph. **[2]**

(iii) Repeat parts **(i)** and **(ii)** for the following map. **[3]**



2 The instructions labelled 1 to 7 describe the steps of a sorting algorithm applied to a list of six numbers.

1 Let i equal 1.
2 Repeat lines 3 to 7, stopping when i becomes 6.
3 Let j equal 1.
4 Repeat lines 5 and 6, until j becomes $7 - i$.
5 If the jth number in the list is bigger than the $(j+1)$th, then swap them.
6 Let the new value of j be $j+1$.
7 Let the new value of i be $i+1$.

(i) Apply the sorting algorithm to the list of numbers shown below. Record in the table provided the state of the list after each pass. Record the number of comparisons and the number of swaps that you make in each pass. (The result of the first pass has already been recorded.) **[5]**

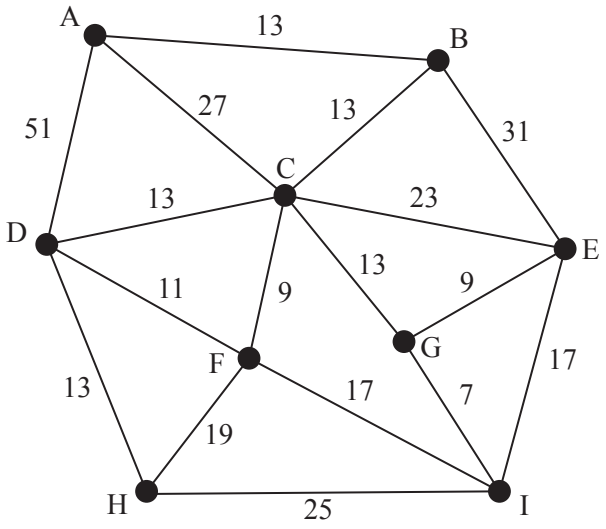
List: 9 11 7 3 13 5

(ii) Suppose now that the list is split into two sublists, {9, 11, 7} and {3, 13, 5}. The sorting algorithm is adapted to apply to three numbers, and is applied to each sublist separately. This gives {7, 9, 11} and {3, 5, 13}.

How many comparisons and swaps does this need? **[2]**

(iii) How many further swaps would the original algorithm need to sort the revised list {7, 9, 11, 3, 5, 13} into increasing order? **[1]**

3 The network below represents a number of villages together with connecting roads. The numbers on the arcs represent distances (in miles).



(i) Use Dijkstra's algorithm to find the shortest routes from A to each of the other villages.

Give these shortest routes and the corresponding distances. **[6]**

Traffic in the area travels at 30 mph. An accident delays all traffic passing through C by 20 minutes.

(ii) Describe how the network can be adapted and used to find the fastest journey time from A to F. **[2]**

Section B (48 marks)

4 Simon has a list of tasks which he has to complete before leaving his home to go on holiday. The table lists those tasks, their durations, and their immediate predecessors. The durations assume that only one person is working on each activity.

Task		Duration (minutes)	Immediate predecessor(s)
A	pack suitcases	30	–
B	make up beds	10	–
C	clean upstairs	20	A, B
D	wash upstairs floors	10	C
E	bring in outside furniture	15	–
F	close down central heating	5	–
G	disconnect TV system	5	–
H	load car	10	A
I	clean downstairs	25	D, F
J	wash downstairs floors	10	I
K	wash patios	15	E
L	lock up	5	G, H, J, K

(i) Draw an activity on arc network for these activities. **[5]**

(ii) Mark on your diagram the early time and the late time for each event. Give the minimum completion time and the critical activities. **[6]**

(iii) Explain why Simon will require help if the tasks are all to be completed within the minimum time. **[1]**

Simon's friend offers to help. They share the tasks between them so that each task is completed by only one person.

(iv) Produce a cascade chart to show how the tasks can be shared between Simon and his friend, and scheduled, so that the project can be completed in the minimum time. **[4]**

5 Angelo manages a winter sports shop in a ski resort. He needs to decide how many snowboards and how many pairs of skis to purchase for the coming season to maximise his profit from hiring them out.

He has space for at most 250 snowboards and 500 pairs of skis.

Because there are more skiers than snowboarders Angelo will purchase at least 10% more pairs of skis than snowboards.

Both snowboards and skis need servicing, and his servicing facility can cope with no more than 600 units (ie snowboards or pairs of skis).

His expected profit from buying and renting out a snowboard is €40 for the season, and his expected profit from buying and renting out a pair of skis is €50 for the season.

(i) Define appropriate variables, construct inequality constraints, and draw a graph representing the feasible region for Angelo's decision problem. **[10]**

(ii) Give the objective function and find the solution which will give the maximum profit. **[3]**

Angelo considers increasing the cost of snowboard hire so that snowboard profits rise enough to change the optimal solution.

(iii) By how much will snowboard profits have to rise to change the optimal solution? **[1]**

Angelo increases the cost of snowboard hire and creates extra storage space for snowboards.

(iv) What is the greatest number of extra snowboards it is worth Angelo accommodating? **[2]**

[Question 6 is printed overleaf.]

6 The time intervals between customers arriving at the queue for the till in a small supermarket are modelled by the following probability distribution.

Time interval (mins)	1	2	3	4
Probability	0.3	0.5	0.1	0.1

(i) Give a rule for using 1-digit random numbers to simulate inter-arrival times. **[2]**

(ii) Use the nine random digits provided to simulate nine inter-arrival times. Hence, assuming that the first customer arrives at the queue at time 0, give the arrival times of the first ten customers. **[3]**

Customers shop for single items, light loads, medium loads or heavy loads. These require respectively 0.1, 0.25, 1 and 2 minutes on average to process at the till. The proportions in each category are $\frac{1}{7}, \frac{2}{7}, \frac{3}{7}$ and $\frac{1}{7}$ respectively.

(iii) Give an efficient rule for using 2-digit random numbers to simulate till processing times. **[3]**

(iv) Use the 2-digit random numbers provided to simulate the till processing times for the first ten customers. There are more random numbers provided than you will need. **[2]**

60% of customers pay by credit card and 40% pay by cash. A credit card transaction takes 1 minute on average, and a cash transaction takes 0.25 minutes.

(v) Give an efficient rule for using 1-digit random numbers to simulate payment times. **[1]**

(vi) Use the ten random digits provided to simulate the payment times for the first ten customers. **[1]**

(vii) Use your answers to parts **(ii)**, **(iv)** and **(vi)** to find the departure times for the first ten customers. **[2]**

The shop owner is considering installing a second till which does not have credit card facilities. All customers paying cash will use this till.

(viii) Repeat part **(vii)** under this proposed new arrangement. **[2]**

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