OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4771

Decision Mathematics 1

QUESTION PAPER

Candidates answer on the printed answer book.

OCR supplied materials:
- Printed answer book 4771
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Monday 24 January 2011
Morning

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. 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.

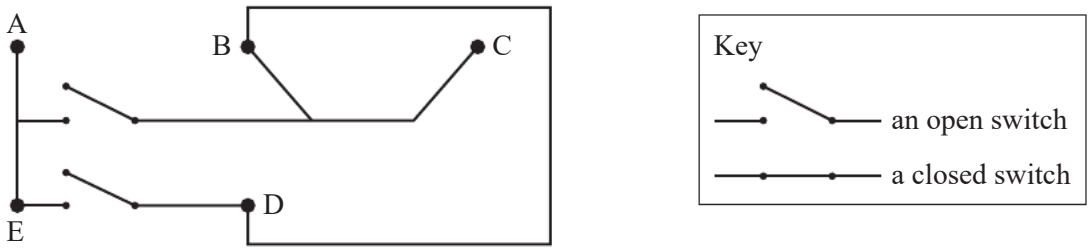
INSTRUCTIONS TO EXAMS OFFICER/INVIGILATOR

- Do not send this question paper for marking; it should be retained in the centre or destroyed.

Answer all questions in the Printed Answer Book provided.

Section A (24 marks)

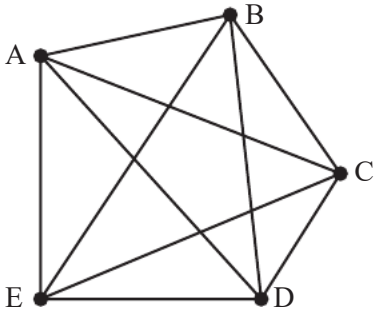
1 The diagram shows an electrical circuit with wires and switches and with five components, labelled A, B, C, D and E.



(i) Draw a graph showing which vertices are connected together, either directly or indirectly, when the two switches remain open. **[2]**

(ii) How many arcs need to be added to your graph when both switches are closed? **[2]**

The graph below shows which components are connected to each other, either directly or indirectly, for a second electrical circuit.



(iii) Find the minimum number of arcs which need to be deleted to create two disconnected sets of vertices, and write down your two separate sets. **[3]**

(iv) Explain why, in the second electrical circuit, it might be possible to split the components into two disconnected sets by cutting fewer wires than the number of arcs which were deleted in part **(iii)**. **[1]**

2 King Elyias has been presented with eight flagons of fine wine. Intelligence reports indicate that at least one of the eight flagons has been poisoned. King Elyias will have the wine tasted by the royal wine tasters to establish which flagons are poisoned.

Samples for testing are made by using wine from one or more flagons. If a royal wine taster tastes a sample of wine which includes wine from a poisoned flagon, the taster will die. The king has to make a very generous payment for each sample tasted.

To minimise payments, the royal mathematicians have devised the following scheme:

Test a sample made by mixing wine from flagons 1, 2, 3 and 4.

If the taster dies, then test a sample made by mixing wine from flagons 5, 6, 7 and 8.

If the taster lives, then there is no poison in flagons 1, 2, 3 or 4. So there **is** poison in at least one of flagons 5, 6, 7 and 8, and there is no need to test a sample made by mixing wine from all four of them.

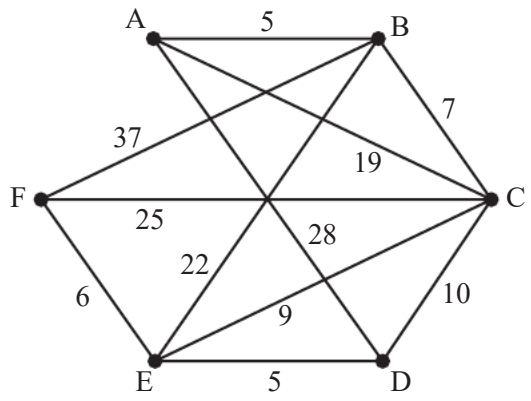
If the sample from flagons 1, 2, 3 and 4 contains poison, then test a fresh sample made by mixing wine from flagons 1 and 2, and proceed similarly, testing a sample from flagons 3 and 4 only if the taster of the sample from flagons 1 and 2 dies.

Continue, testing new samples made from wine drawn from half of the flagons corresponding to a poisoned sample, and testing only when necessary.

(i) Record what happens using the mathematicians' scheme when flagon number 7 is poisoned, and no others. **[4]**

(ii) Record what happens using the mathematicians' scheme when two flagons, numbers 3 and 7, are poisoned. **[4]**

3 The network shows distances between vertices where direct connections exist.



(i) Use Dijkstra's algorithm to find the shortest distance and route from A to F. **[6]**

(ii) Explain why your solution to part **(i)** also provides the shortest distances and routes from A to each of the other vertices. **[1]**

(iii) Explain why your solution to part **(i)** also provides the shortest distance and route from B to F. **[1]**

Section B (48 marks)

4 The table shows the tasks involved in preparing breakfast, and their durations.

Task	Description	Duration (mins)
A	Fill kettle and switch on	0.5
B	Boil kettle	1.5
C	Cut bread and put in toaster	0.5
D	Toast bread	2
E	Put eggs in pan of water and light gas	1
F	Boil eggs	5
G	Put tablecloth, cutlery and crockery on table	2.5
H	Make tea and put on table	0.5
I	Collect toast and put on table	0.5
J	Put eggs in cups and put on table	1

(i) Show the immediate predecessors for each of these tasks. **[3]**

(ii) Draw an activity on arc network modelling your precedences. **[3]**

(iii) Perform a forward pass and a backward pass to find the early time and the late time for each event. **[4]**

(iv) Give the critical activities, the project duration, and the total float for each activity. **[3]**

(v) Given that only one person is available to do these tasks, and noting that tasks B, D and F do not require that person's attention, produce a cascade chart showing how breakfast can be prepared in the least possible time. **[3]**

5 Viola and Orsino are arguing about which striker to include in their fantasy football team. Viola prefe Rocinate, who creates lots of goal chances, but is less good at converting them into goals. Orsino prefers Quince, who is not so good at creating goal chances, but who is better at converting them into goals.

The information for Rocinate and Quince is shown in the tables.

	Number of chances created per match								
	Rocinate					Quince			
Number	6	7	8	9		5	6	7	8
Probability	$\frac{1}{20}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{5}$		$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{6}$	$\frac{1}{6}$

Probability of converting a chance into a goal	
Rocinate	Quince
0.1	0.12

(i) Give an efficient rule for using 2-digit random numbers to simulate the number of chances created by Rocinate in a match. **[3]**

(ii) Give a rule for using 2-digit random numbers to simulate the conversion of chances into goals by Rocinate. **[1]**

(iii) Your Printed Answer Book shows the result of simulating the number of goals scored by Rocinate in nine matches. Use the random numbers given to complete the tenth simulation, showing which of your simulated chances are converted into goals. **[3]**

(iv) Give an efficient rule for using 2-digit random numbers to simulate the number of chances created by Quince in a match. **[3]**

(v) Your Printed Answer Book shows the result of simulating the number of goals scored by Quince in nine matches. Use the random numbers given to complete the tenth simulation, showing which of your simulated chances are converted into goals. **[3]**

(vi) Which striker, if any, is favoured by the simulation? Justify your answer. **[2]**

(vii) How could the reliability of the simulation be improved? **[1]**

[Question 6 is printed overleaf.]

6 A manufacturing company holds stocks of two liquid chemicals. The company needs to update its stock levels.

The company has 2000 litres of chemical A and 4000 litres of chemical B currently in stock. Its storage facility allows for no more than a combined total of 12000 litres of the two chemicals.

Chemical A is valued at £5 per litre and chemical B is valued at £6 per litre. The company intends to hold stocks of these two chemicals with a total value of at least £61000.

Let a be the increase in the stock level of A, in thousands of litres (a can be negative).
Let b be the increase in the stock level of B, in thousands of litres (b can be negative).

(i) Explain why $a \geqslant -2$, and produce a similar inequality for b. **[2]**

(ii) Explain why the value constraint can be written as $5a + 6b \leqslant 27$, and produce, in similar form, the storage constraint. **[4]**

(iii) Illustrate all four inequalities graphically. **[5]**

(iv) Find the policy which will give a stock value of exactly £61000, and will use all 12000 litres of available storage space. **[2]**

(v) Interpret your solution in terms of stock levels, and verify that the new stock levels do satisfy both the value constraint and the storage constraint. **[3]**