OCR
Oxford Cambridge and RSA

Wednesday 6 June 2018 – Morning

A2 GCE MATHEMATICS (MEI)

4772/01 Decision Mathematics 2

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4772/01
- 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 inside 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 barcodes.
- You are permitted to use a scientific or 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.

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1 Sarah is considering planting vegetables to be harvested in three months' time. Seeds and other material will cost her £25. If the weather gives good growing conditions her vegetables will be worth £95. If not, her vegetables will be worth £75.
Alternatively, she can plant flowers, which will cost her £20. If the weather gives good growing conditions her flowers will be worth £85 in three months' time. If not they will be worth £75.
The long-range weather forecast gives a probability of 0.6 of good growing conditions, and a probability of 0.4 of growing conditions which are not good.

(i) Draw a decision tree for Sarah. **[3]**

(ii) Give the best course of action and its EMV. **[6]**

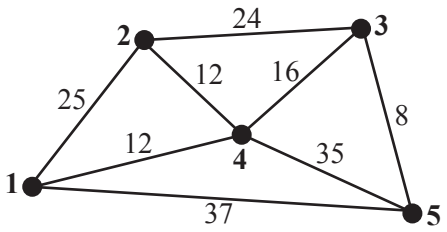
Sarah is a member of a horticultural society. The society offers an 'advice on growing' service for members, based on an analysis of the soil and other growing conditions. From past experience the society estimates that paying for and following its advice leads to a 20% increase in amounts grown for both vegetables and flowers under good growing conditions, and a 10% increase in amounts grown if growing conditions are not good.

(iii) Find the value of the society's advice. **[4]**

Sarah decides to split her planting equally between vegetables and flowers.

(iv) What is the value of the society's advice when she splits her planting equally between vegetables and flowers? **[3]**

2 The five nodes in the network below represent electricity supply poles in a rural village. The arcs represent paths connecting the positions of those poles. The weights on the arcs are distances in metres.



The electricity supply company will need to:

1. know the shortest routes between poles
2. have an efficient (short) route to inspect each pole, starting and ending at pole **1**
3. know how to connect the poles with cables so that the length of cable is as short as possible
4. know the shortest distance to traverse all the paths so that they can be maintained efficiently.

(i) Completed distance and route matrices are shown at the end of the third and fifth iterations of Floyd's algorithm, along with incomplete fourth iteration matrices. Complete the matrices for the fourth iteration. **[5]**

	1	**2**	**3**	**4**	**5**
1	50	25	49	12	37
2	25	48	24	12	32
3	49	24	48	16	8
4	12	12	16	24	24
5	37	32	8	24	16

	1	**2**	**3**	**4**	**5**
1	2	2	2	4	5
2	1	3	3	4	3
3	2	2	2	4	5
4	1	2	3	1	3
5	1	3	3	3	3

	1	**2**	**3**	**4**	**5**
1				12	
2				12	
3				16	
4	12	12	16	24	24
5				24	

	1	**2**	**3**	**4**	**5**
1				4	
2				4	
3				4	
4	1	2	3	1	3
5				3	

	1	**2**	**3**	**4**	**5**
1	24	24	28	12	36
2	24	24	24	12	32
3	28	24	16	16	8
4	12	12	16	24	24
5	36	32	8	24	16

	1	**2**	**3**	**4**	**5**
1	4	4	4	4	4
2	4	4	3	4	3
3	4	2	5	4	5
4	1	2	3	1	3
5	3	3	3	3	3

(ii) Use the final matrices to find the shortest route and shortest distance from **1** to **5**, showing how you used the matrices. **[2]**

(iii) By temporarily deleting pole **4** and its arcs, find a lower bound for the minimum distance Hamilton cycle in the complete network of shortest distances.
(You may find by inspection the minimum connector which you need.) **[3]**

(iv) Use the nearest neighbour algorithm, starting at **1**, to find a Hamilton cycle in the complete network of shortest distances. Give the length of your cycle and the corresponding route through the original network. **[2]**

(v) Find the shortest distance to traverse every path in the network, given that the total length of the paths is 169 metres. **[2]**

(vi) Which of the electricity supply company's needs has not yet been addressed, and what is the answer to it? **[2]**

3 An animal food retailer plans to place a bulk order for $100\,m^3$ of foods from his wholesaler. There are three types of food which he will mix to sell on to his customers, subject to constraints described below.

Food A costs £250 per m^3, contains 15% fibre, 3.5% fat, and 10% protein.

Food B costs £300 per m^3, contains 12% fibre, 4% fat, and 15% protein.

Food C costs £150 per m^3, contains 10% fibre, 2% fat, and 10% protein.

The mixed product must contain at least 13% fibre, at least 3% fat, and at least 13% protein.

The following LP is formulated to help the retailer to decide what order to place.

$$\text{Min } 250a + 300b + 150c$$

$$\text{st } a + b + c = 100$$

$$15a + 12b + 10c \geqslant 1300$$

$$3.5a + 4b + 2c \geqslant 300$$

$$10a + 15b + 10c \geqslant 1300$$

(i) Explain the purpose of each part of this formulation. **[6]**

The initial tableau for an application of the two-phase simplex algorithm is

P	A	B	C	s1	s2	s3	s4	s5	a1	a2	a3	a4	rhs
1	29.5	32	23	0	−1	−1	−1	−1	0	0	0	0	3000
0	−250	−300	−150	0	0	0	0	0	0	0	0	0	0
0	1	1	1	1	0	0	0	0	0	0	0	0	100
0	1	1	1	0	−1	0	0	0	1	0	0	0	100
0	15	12	10	0	0	−1	0	0	0	1	0	0	1300
0	3.5	4	2	0	0	0	−1	0	0	0	1	0	300
0	10	15	10	0	0	0	0	−1	0	0	0	1	1300

The first pivot is to be chosen from the B column. The pivot element is shaded.

(ii) Explain why this is the pivot element. **[1]**

(iii) Perform the first iteration and write down the resulting tableau. **[5]**

(iv) Choose a pivot element for the second iteration. **[1]**

After several more iterations the first entry in the 'rhs' column is reduced to 0. The tableau is then:

P	A	B	C	s1	s2	s3	s4	s5	a1	a2	a3	a4	rhs
1	0	0	0	−1	−1	0	0	0	0	−1	−1	−1	0
0	0	0	0	−270	0	−20	0	−22	0	20	0	22	27600
0	0	0	1	4.2	0	0.2	0	0.12	0	−0.2	0	−0.12	4
0	0	0	0	−1	−1	0	0	0	1	0	0	0	0
0	1	0	0	−1.2	0	−0.2	0	0.08	0	0.2	0	−0.08	36
0	0	1	0	−2	0	0	0	−0.2	0	0	0	0.2	60
0	0	0	0	−3.8	0	−0.3	1	−0.28	0	0.3	−1	0.28	74

(v) Give a full interpretation of this tableau. **[7]**

4 **(a)** Identify which of the following deductions are correct. For those that are not correct, show why they are not.

(i) If it is raining, then you must put up your umbrella. It is raining.
Therefore you must put up your umbrella.

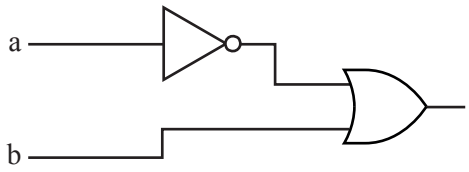
(ii) If it is raining, then you must put up your umbrella. You have put up your umbrella.
Therefore it is raining.

(iii) All cows have three legs. Ermintrude is a cow.
Therefore Ermintrude has three legs.

(iv) All cats purr. This animal purrs.
Therefore this animal is a cat.

(v) If it is very windy we will not ski. It is not very windy.
Therefore we will ski. **[8]**

(b) The diagram shows a combinatorial circuit for $a \Rightarrow b$.



(i) Draw a combinatorial circuit for $\sim b \Rightarrow \sim a$. **[2]**

(ii) Use a truth table to prove that $(a \Rightarrow b) \Leftrightarrow (\sim b \Rightarrow \sim a)$. **[3]**

(iii) Use Boolean algebra to prove that $(a \Rightarrow b) \Leftrightarrow (\sim b \Rightarrow \sim a)$. **[3]**

(c) When there is an electrical storm Keith's garage door mechanism can be damaged. When the garage door mechanism is damaged the residual current circuit breaker (the RCCB) can trip immediately, or when the mechanism is activated.

When the RCCB trips, it turns off all of the electricity supply to the house.

When water penetrates the outside light control, the RCCB can trip when the light is turned on.

Both the garage door mechanism and the outside light control can be switched off independently. The RCCB can be re-set, although it will trip again immediately if there is still a problem with a component connected to the power supply.

Keith returns home after a wet and stormy day to find that the outside light will not turn on and the garage door will not open. He finds that the RCCB has tripped.

What should he do? Describe what actions he should take to determine why the RCCB tripped, and what he will be able to deduce. **[4]**

END OF QUESTION PAPER