OCR
Oxford Cambridge and RSA

Wednesday 8 June 2016 – 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 bar codes.
- 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.

1 Martin is considering paying for a vaccination against a disease. If he catches the disease he would not be able to work and would lose £900 in income because he would have to stay at home recovering. The vaccination costs £20. The vaccination would reduce his risk of catching the disease during the year from 0.02 to 0.001.

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

(ii) Evaluate the EMV of Martin's loss at each node of your tree, and give the action that Martin should take to minimise the EMV of his loss. **[4]**

Martin can answer a medical questionnaire which will give an estimate of his susceptibility to the disease. If he is found to be susceptible, then his chance of catching the disease is 0.05. Vaccination will reduce that to 0.0025. If he is found not to be susceptible, then his chance of catching the disease is 0.01 and vaccination will reduce it to 0.0005. Historically, 25% of people are found to be susceptible.

(iii) What is the EMV of this questionnaire? **[6]**

Martin decides not to answer the questionnaire. He also decides that there is more than just his EMV to be considered in deciding whether or not to have the vaccination. The vaccination itself is likely to have side effects, but catching the disease would be very unpleasant. Martin estimates that he would find the effects of the disease 1000 times more unpleasant than the effects of the vaccination.

(iv) Analyse which course of action would minimise the unpleasantness for Martin. **[3]**

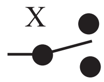
2 **(a)** Emelia: 'I won't go out for a walk if it's not dry or not warm.'
Gemma: 'It's warm. Let's go!'

Will what Gemma has said convince Emelia, and if not, why not? **[2]**

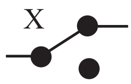
(b) If it is daytime and the car headlights are on, then it is raining.
If the dashboard lights are dimmed then the car headlights are on.
It is daytime.
It is not raining.

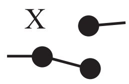
(i) What can you deduce? **[2]**

(ii) Prove your deduction. **[6]**

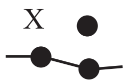
(c) In this part of the question the switch X is represented by 

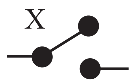
The switch can be wired into a circuit so that current flows when

the switch is up 

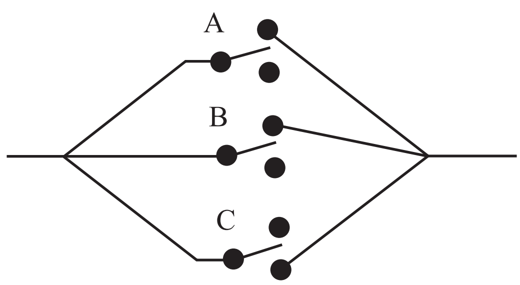
but does not flow when it is down 

Or the switch can be wired so that current flows when

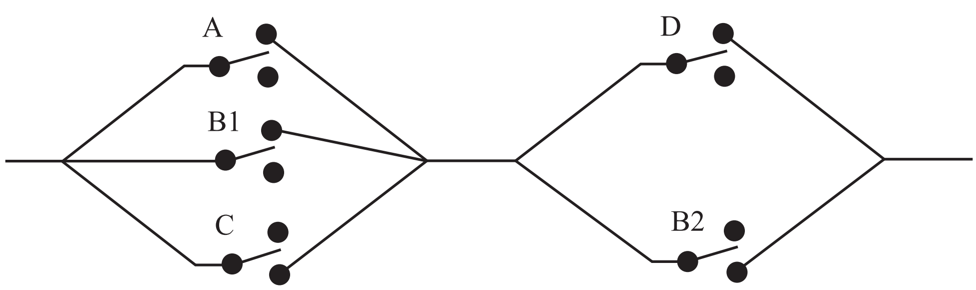
the switch is down 

but does not flow when it is up 

(i) Explain how the following circuit models $(A \wedge B) \Rightarrow C$. **[4]**



In the following circuit B1 and B2 represent 'ganged' switches. This means that the two switches are either both up or both down.



(ii) Given that A is down, C is up and current is flowing, what can you deduce? **[2]**

3 Neil is refurbishing a listed building. There are two types of paint that he can use for the inside walls. One costs £1.45 per m^2 and the other costs £0.95 per m^2. He must paint the lower half of each wall in the more expensive paint. He has $350\,m^2$ of wall to paint. He has a budget of £400 for wall paint.
The more expensive paint is easier to use, and so Neil wants to use as much of it as possible.

Initially, the following LP is constructed to help Neil with his purchasing of paint.

Let x be the number of m^2 of wall painted with the expensive paint.

Let y be the number of m^2 of wall painted with the less expensive paint.

Maximise $\quad P = x + y$
subject to $\quad 1.45x + 0.95y \leqslant 400$
$y - x \leqslant 0$
$x \geqslant 0$
$y \geqslant 0$

(i) Explain the purpose of the inequality $y - x \leqslant 0$. **[1]**

(ii) The formulation does not include the inequality $x + y \geqslant 350$. State what this constraint models and why it has been omitted from the formulation. **[2]**

(iii) Use the simplex algorithm to solve the LP. Pivot first on the "1" in the y column. Interpret your solution. **[7]**

The solution shows that Neil needs to buy more paint. He negotiates an increase in his budget to £450.

(iv) Find the solution to the LP given by changing $1.45x + 0.95y \leqslant 400$ to $1.45x + 0.95y \leqslant 450$, and interpret your solution. **[2]**

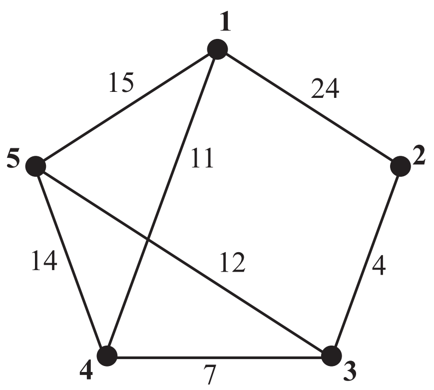
Neil realises that although he now has a solution, that solution is not the best for his requirements.

(v) Explain why the revised solution is not optimal for Neil. **[1]**

In order to move to an optimal solution Neil needs to change the objective of the LP and add another constraint to it.

(vi) Write down the new LP and the initial tableau for using two-stage simplex to solve it. Give a brief description of how to use two-stage simplex to solve it. **[7]**

4



(a) Solve the route inspection problem in the network above, showing the methodology you used to ensure that your solution is optimal. Show your route. **[4]**

(b) Floyd's algorithm is applied to the same network to find the complete network of shortest distances. After three iterations the distance and route matrices are as follows.

	1	**2**	**3**	**4**	**5**
1	48	24	28	11	15
2	24	8	4	11	16
3	28	4	8	7	12
4	11	11	7	14	14
5	15	16	12	14	24

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

(i) Perform the fourth iteration of the algorithm, and show that there is no change to either matrix in the final iteration. **[4]**

(ii) Show how to use the matrices to give the shortest distance and the shortest route from vertex **1** to vertex **2**. **[3]**

(iii) Draw the complete network of shortest distances. **[2]**

(iv) Starting at vertex **1**, apply the nearest neighbour algorithm to the complete network of shortest distances to find a Hamilton cycle. Give the length of your cycle and interpret it in the original network. **[3]**

(v) By temporarily deleting vertex **1** and its connecting arcs from the complete network of shortest distances, find a lower bound for the solution to the Travelling Salesperson's Problem in that network. Say what this implies in the original network. **[4]**

END OF QUESTION PAPER

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