



**ADVANCED SUBSIDIARY GCE UNIT  
MATHEMATICS (MEI)**

Decision Mathematics 1

**MONDAY 18 JUNE 2007**

**4771/01**

Morning  
Time: 1 hour 30 minutes

Additional materials:  
Printed Answer Book  
MEI Examination Formulae and Tables (MF2)

**INSTRUCTIONS TO CANDIDATES**

- Write your name, centre number and candidate number in the spaces provided on the printed answer book.
- Answer **all** the questions.
- 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**

- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 72.

**ADVICE TO CANDIDATES**

- Read each question carefully and make sure you know what you have to do before starting your answer.
- 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.

This document consists of **6** printed pages and **2** blank pages.

**Answer all the questions in the printed answer book provided.**

**Section A (24 marks)**

- 1** Bus routes connect towns A and B and towns A and C.

Train lines connect towns B and D, towns C and D, and towns A and C.

John represents this information in a graph with four nodes, one for each town, in which an arc is drawn for each connection, giving five arcs in all.

**(i)** Draw John's graph. [2]

**(ii)** Is John's graph simple? Justify your answer. [2]

Jamil represents the information in a graph with five nodes. He uses one node for each of towns A, B and D. Because in town C the bus station and train station are some distance apart, he uses a node labelled C(bus) and a node labelled C(train). Again there are 5 arcs, each representing a connection.

**(iii)** Draw Jamil's graph. [2]

**(iv)** Is Jamil's graph a tree? Justify your answer. [2]

- 2** Two hikers each have a 25 litre rucksack to pack. The items to be packed have volumes of 14, 6, 11, 9 and 6 litres.

**(i)** Apply the first fit algorithm to the items in the order given and comment on the outcome. [3]

**(ii)** Write the five items in descending order of volume. Apply the first fit decreasing algorithm to find a packing for the rucksacks. [3]

**(iii)** The hikers argue that the first fit decreasing algorithm does not produce a fair allocation of volumes to rucksacks. Produce a packing which gives a fairer allocation of volumes between the two rucksacks. Explain why the hikers might **not** want to use this packing. [2]

- 3** Use a graphical approach to solve the following LP. [8]

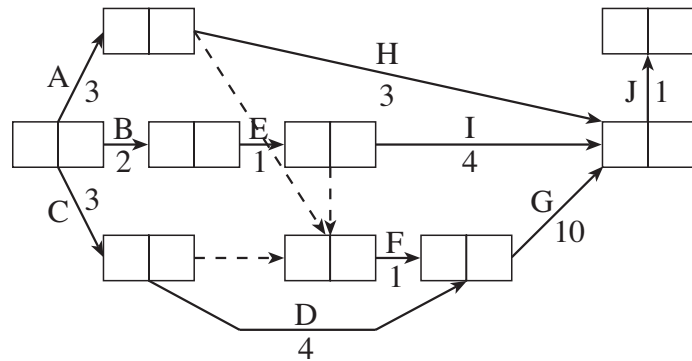
$$\begin{array}{ll}
 \text{Maximise} & 2x + 3y \\
 \text{subject to} & x + 5y \leq 14 \\
 & x + 2y \leq 8 \\
 & 3x + y \leq 21 \\
 & x \geq 0 \\
 & y \geq 0
 \end{array}$$

3

**Section B** (48 marks)

- 4 Colin is setting off for a day's sailing. The table and the activity network show the major activities that are involved, their durations and their precedences.

|   |                               |
|---|-------------------------------|
| A | Rig foresail                  |
| B | Lower sprayhood               |
| C | Start engine                  |
| D | Pump out bilges               |
| E | Rig mainsail                  |
| F | Cast off mooring ropes        |
| G | Motor out of harbour          |
| H | Raise foresail                |
| I | Raise mainsail                |
| J | Stop engine and start sailing |



- (i) Complete the table in your answer book showing the immediate predecessors for each activity. [3]

- (ii) Find the early time and the late time for each event. Give the project duration and list the critical activities. [6]

When he sails on his own Colin can only do one thing at a time with the exception of activity G, motoring out of the harbour.

- (iii) Use the activity network to determine which activities Colin can perform whilst motoring out of the harbour. [1]
- (iv) Find the minimum time to complete the activities when Colin sails on his own, and give a schedule for him to achieve this. [2]
- (v) Find the minimum time to complete the activities when Colin sails with one other crew member, and give a schedule for them to achieve this. [4]

## 4

- 5 The table shows the weights on the arcs of a network.

|   | A  | B  | C | D | E  | F | G  |
|---|----|----|---|---|----|---|----|
| A | –  | 11 | – | – | 10 | 3 | 5  |
| B | 11 | –  | 8 | 5 | –  | – | 14 |
| C | –  | 8  | – | 2 | –  | 7 | –  |
| D | –  | 5  | 2 | – | 6  | – | –  |
| E | 10 | –  | – | 6 | –  | 6 | –  |
| F | 3  | –  | 7 | – | 6  | – | –  |
| G | 5  | 14 | – | – | –  | – | –  |

- (i) Draw the network. [3]

- (ii) Apply Dijkstra's algorithm to find the least weight route from G to D. (Do this on the network you drew for part (i).)

Give your route and its total weight. [6]

- (iii) Find by inspection the route from G to D such that the minimum of the weights for arcs on the route is as large as possible. Give your route and its minimum arc weight. Give an application in which this might be needed. [3]

- (iv) Consider how Dijkstra's algorithm could be modified to solve the problem in part (iii). Explain how to update working values. Explain how to select the next vertex to be permanently labelled. [4]

## 5

- 6 In winter in Metland the weather each day can be classified as dry, wet or snowy. The table shows the probabilities for the next day's weather given the current day's weather.

|                       |       | next day's weather |                |                |
|-----------------------|-------|--------------------|----------------|----------------|
|                       |       | dry                | wet            | snowy          |
| current day's weather | dry   | $\frac{4}{10}$     | $\frac{3}{10}$ | $\frac{3}{10}$ |
|                       | wet   | $\frac{2}{10}$     | $\frac{5}{10}$ | $\frac{3}{10}$ |
|                       | snowy | $\frac{2}{7}$      | $\frac{2}{7}$  | $\frac{3}{7}$  |

You are to use two-digit random numbers to simulate the winter weather in Metland.

- (i) Give an efficient rule for using two-digit random numbers to simulate tomorrow's weather if today is

(A) dry, [2]

(B) wet, [2]

(C) snowy. [3]

- (ii) Today is a dry winter's day in Metland. Use the following two-digit random numbers to simulate the next 7 days' weather in Metland. [4]

23 85 98 99 56 47 82 14 03 12

- (iii) Use your simulation from part (ii) to estimate the proportion of dry days in a Metland winter. [1]

- (iv) Explain how you could use simulation to produce an improved estimate of the proportion of dry days in a Metland winter. [2]

- (v) Give two criticisms of this model of weather. [2]

**6**

**BLANK PAGE**

7

**BLANK PAGE**

---

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (OCR) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

OCR is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.