

Pearson Edexcel Level 3 GCE

Practice Paper 4

Time: 1 hour 30 minutes

Paper Reference **9FM0/4D**

Further Mathematics

Advanced

Paper 4D: Decision Mathematics 2

You must have:
calculator

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use black ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- Fill in the boxes at the top of this page with your name, centre number and candidate number.
- Answer all questions and ensure that your answers to parts of questions are clearly labelled.
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- The total mark for this part of the examination is 76. There are 7 questions.
- The marks for each question are shown in brackets
 - use this as a guide as to how much time to spend on each question.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Answer ALL questions.

1. The Clarks buy a new house in March 2018, costing £200 000. They have a deposit of £25 000. At the end of each month, interest of 0.25% is added to the balance and the Clarks' monthly payment of £1200 is deducted from the balance.

(a) Write a recurrence relation showing the balance in pounds, b_n , at the end of the n th month. (3)

By solving the recurrence relation,

(b) determine the year in which the Clarks will pay off their mortgage. (5)

(Total for Question 1 is 8 marks)

2. (a) Explain briefly what is meant by a **zero-sum** game. (1)

A two person zero-sum game is represented by the following pay-off matrix for player A .

| | | | |
|----|---|----|-----|
| | I | II | III |
| I | 5 | 2 | 3 |
| II | 3 | 5 | 4 |

(b) Verify that there is no stable solution to this game. (3)

(c) Find the best strategy for player A and the value of the game to her. (8)

(d) Formulate the game as a linear programming problem for player B . Write the constraints as inequalities and define your variables clearly. (5)

(Total for Question 2 is 17 marks)

3. In a strategy video game, a player must assign five units A, B, C, D and E to five tasks. Each unit must be assigned to at most one task and each task must be done by just one unit.

The table shows the number of points scored when each unit is assigned to each task.

| | Farm | Research | Build | Mine | Explore |
|---------------|-------------|-----------------|--------------|-------------|----------------|
| Unit A | 85 | 95 | 86 | 87 | 97 |
| Unit B | 110 | 111 | 95 | 115 | 100 |
| Unit C | 90 | 95 | 86 | 93 | 105 |
| Unit D | 85 | 87 | 84 | 85 | 87 |
| Unit E | 100 | 100 | 105 | 120 | 95 |

The Hungarian algorithm is to be used to find the allocation of units to tasks which will maximise the total number of points scored.

- (a) Explain how this table must be modified before the algorithm can be implemented. **(1)**
- (b) Use the Hungarian algorithm to obtain an allocation which maximises the number of points scored and state the number of points. **(8)**

(Total for Question 3 is 9 marks)

4. The manager of a car hire firm has to arrange to move cars from three garages *A*, *B* and *C* to three airports *D*, *E* and *F* so that customers can collect them. The table below shows the transportation cost of moving one car from each garage to each airport. It also shows the number of cars available in each garage and the number of cars required at each airport. The total number of cars available is equal to the total number required.

| | Airport <i>D</i> | Airport <i>E</i> | Airport <i>F</i> | Cars available |
|-----------------|------------------|------------------|------------------|----------------|
| Garage <i>A</i> | £20 | £40 | £10 | 6 |
| Garage <i>B</i> | £20 | £30 | £40 | 5 |
| Garage <i>C</i> | £10 | £20 | £30 | 8 |
| Cars required | 6 | 9 | 4 | |

- (a) Use the North-West corner rule to obtain a possible pattern of distribution and find its cost. (3)
- (b) Calculate shadow costs for this pattern and hence obtain improvement indices for each route. (4)
- (c) Use the stepping-stone method to obtain an optimal solution and state its cost. (7)

(Total for Question 4 is 14 marks)

5.

Figure 1

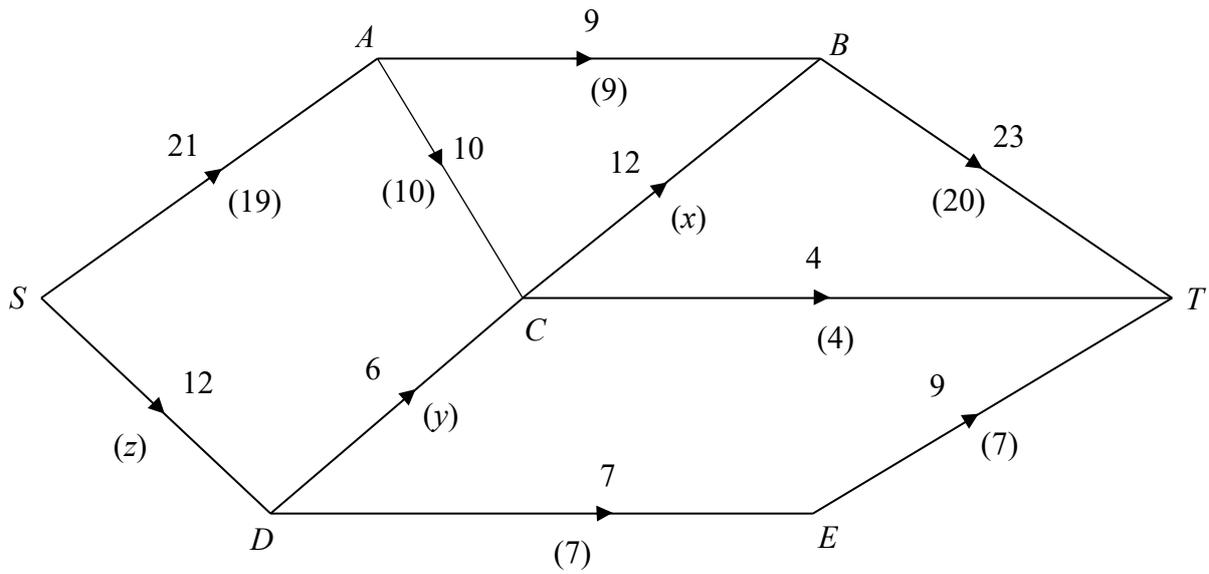


Figure 1 shows a directed, capacitated network where the number on each arc is its capacity. A possible flow is shown from S to T and the value in brackets on each arc is the flow in that arc.

(a) Find the values of x, y and z .

(3)

(b) Find, by inspection, the maximal flow from S to T and verify that it is maximal.

(2)

(Total for Question 5 is 5 marks)

6. The table shows the possible routes, travel times and possible delay times, in minutes, for a car journey from Stone to Nantwich.

| Main route | Usual time | Possible delay | Probability of delay |
|------------|------------|----------------|----------------------|
| A51 | 39 | 10 | 0.1 |
| | | 20 | 0.01 |
| M6 | 35 | 10 | 0.1 |
| | | 30 | 0.01 |
| A500 | 41 | 5 | 0.1 |
| | | 10 | 0.01 |

- (a) Draw a decision tree to model the route decisions and possible outcomes. (8)
- (b) Calculate the minimum expected time and state the corresponding route. (1)
- (c) Give a reason why the minimum expected time might not correspond to the favoured one. (2)

(Total for Question 6 is 11 marks)

7. An engineering firm makes motors. They can make up to five in any one month, but if they make more than four they have to hire additional premises at a cost of £500 per month. They can store up to two motors for £100 per motor per month. The overhead costs are £200 in any month in which work is done.

Motors are delivered to buyers at the end of each month. There are no motors in stock at the beginning of May and there should be none in stock after the September delivery.

The order book for motors is:

| Month | May | June | July | August | September |
|------------------|-----|------|------|--------|-----------|
| Number of motors | 3 | 3 | 7 | 5 | 4 |

Use dynamic programming to determine the production schedule that minimises the costs.

(Total for Question 7 is 12 marks)

TOTAL FOR DECISION MATHEMATICS 2 IS 76 MARKS

Looking for answers or mark schemes? The source of these questions is either the Pearson D2 textbook or past papers which can be found on the Emporium website.

1. p236, q5
2. D2 June 2005, q6
3. p55, q4
4. D2 June 2003, q5
5. D1 November 2004
6. p260, q4
7. D2 January 2006, q2