Pearson Edexcel Level 3 GCE

Practice Paper 3

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 70. 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. Solve the recurrence relation $a_n = 2a_{n+1} + 15a_{n-2} + 2^n$, with $a_1 = 2$ and $a_2 = 4$.

(Total for Question 1 is 8 marks)

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2. Maria and Nolan play a zero-sum game. The following pay-off matrix for Maria shows the game.

	Nolan plays 1	**Nolan plays 2**	**Nolan plays 3**	**Nolan plays 4**
Maria plays 1	–1	–4	–2	2
Maria plays 2	1	–3	0	3
Maria plays 3	2	–5	–2	4

Nolan says that a zero-sum game must have a value of zero.

(a) State whether or not Nolan is correct, giving a reason for your answer

(1)

(b) Show that there is a stable solution to the game.

(2)

(c) Find the play-safe strategy for each player and the value of the game to Maria.

(3)

(Total for Question 2 is 6 marks)

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3. A theme park has four sites, *A*, *B*, *C* and *D*, on which to put kiosks. Each kiosk will sell a different type of refreshment. The income from each kiosk depends on what it sells and where it is located. The table below shows the expected daily income, in pounds, from each kiosk at each site.

	Hot dogs and beefburgers (H)	**Ice cream (I)**	**Popcorn, candyfloss and drinks (P)**	**Snacks and hot drinks (S)**
Site *A*	267	272	276	261
Site *B*	264	271	278	263
Site *C*	267	273	275	263
Site *D*	261	269	274	257

Reducing rows first, use the Hungarian algorithm to determine a site for each kiosk in order to maximise the total income. State the site for each kiosk and the total expected income. You must make your method clear and show the table after each stage.

(Total for Question 2 is 13 marks)

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4. (a) Explain why a dummy demand point might be needed when solving a transportation problem.

The table shows the cost, in pounds, of transporting one van load of fruit-tree seedlings from each of the three greenhouses *A*, *B* and *C* to three garden centres *S*, *T* and *U*. It also shows the stock held at each greenhouse and the amount required at each garden centre.

	S	***T***	***U***	**Supply**
A	6	10	7	50
B	7	5	8	70
C	6	7	7	50
Demand	100	30	20	

The total cost of the transportation is to be minimised.

(b) Use the north-west corner method to obtain an initial solution.

(2)

(c) Taking the most negative improvement index in each case to indicate the entering square, use the stepping-stone method to obtain an optimal solution. You must state your shadow costs, improvement indices, stepping-stone routes, entering squares and exiting cells.

(4)

(d) State the cost of your optimal solution.

(1)

(e) Formulate this transportation algorithm as a linear programming problem. You must define your decision variables and make the constraints and objective function clear (You do not need to solve the problem).

(5)

(Total for Question 4 is 12 marks)

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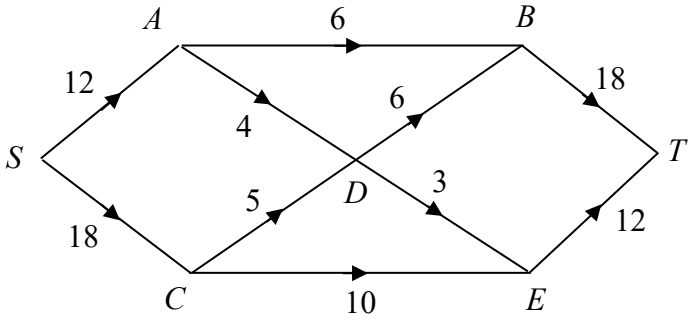
5. The diagram shows a capacitated directed network. The numbers on each arc indicate the capacity of that arc in appropriate units.



(a) Explain why it is not possible to achieve a flow of 30 through the network from S to T.

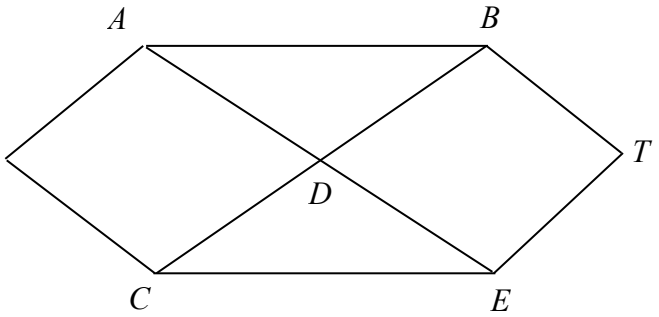
(1)

(b) State the maximum flow along

(i) $SABT$, (ii) $SCET$.

(2)

(c) Show these flows on the copy of the diagram below.



(2)

(d) Taking your answer to part (c) as the initial flow pattern, use the labelling procedure to find a maximum flow from S to T. Show your working and list each flow-augmenting path you use, together with its flow.

(3)

(e) Indicate a maximum flow.

(1)

(f) Prove that your flow is maximal.

(2)

(Total for Question 5 is 11 marks)

6. (a) Explain the purpose of a utility function in decision analysis.

(2)

A company with current assets of £70 000 is committed to the completion of a project. The latest analysis indicates there is a 10% chance of making a loss of £30 000 and a 90% chance of breaking even on the project. The company uses an expected utility to assess the maximum amount, £p, it should pay in insurance to cover the possible loss.

(b) Use $\mathrm{u}(x) = \ln x$, where x represents the total value of the company's assets, to determine the value of p.

(1)

(Total for Question 6 is 8 marks)

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7. A factory can process up to five units of carrots each month.
Each unit can be sold fresh or frozen or canned.
The profits, in £100s, for the number of units sold, are shown in the table.
The total monthly profit is to be maximised.

Number of units	0	1	2	3	4	5
Fresh	0	45	85	120	150	175
Frozen	0	45	70	100	120	130
Canned	0	35	75	125	155	195

Use dynamic programming to determine how many of the five units should be sold fresh, frozen and canned in order to maximise the monthly profit. State the maximum monthly profit.

(Total for Question 7 is 12 marks)

TOTAL FOR DECISION MATHEMATICS 2 IS 70 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. p238, q15
2. p209, q2
3. D2 January 2006, q1
4. p34, q4
5. p145, q24
6. p261, q8
7. D2(R) June 2013, q8