Pearson Edexcel Level 3 GCE

Practice Paper 2

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. (a) Find the general solution of the recurrence relation $u_{n+2} = u_{n+1} + 2u_n,\ n \geq 1$.

(3)

Given that $u_1 = 1$ and $u_2 = 2$,

(b) find the particular solution of the recurrence relation.

(3)

(Total for Question 1 is 6 marks)

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2. The pay-off matrix for a zero-sum game between A and B is shown below.

	***B* plays 1**	***B* plays 2**	***B* plays 3**
***A* plays 1**	5	3	–1
***A* plays 2**	4	5	2
***A* plays 3**	–4	2	–3
***A* plays 4**	7	–2	4

(b) Verify that the game does not have a stable solution.

(3)

(a) Use dominance arguments to reduce the number of choices available to player A to 3.

(2)

(c) Formulate the game as a linear programming problem for player A. Define the variables and write the constraints as inequalities

(7)

(Total for Question 2 is 12 marks)

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3. Six workers *A*, *B*, *C*, *D*, *E* and *F* are to be assigned to five tasks 1, 2, 3, 4 and 5. Each worker can only be assigned to one task and each task is to be completed by just one worker.

Worker *B* cannot do task 1 and worker *D* cannot do task 5.

The table shows the profit, in £s, earned by each worker on completion of each task.

	1	**2**	**3**	**4**	**5**
A	128	142	153	133	155
B	–	138	147	139	147
C	135	144	144	130	158
D	141	156	154	142	–
E	150	141	141	145	160
F	132	149	149	140	157

Use the Hungarian algorithm to allocate workers to tasks and maximise the total profit. State the value of the profit.

(Total for Question 3 is 9 marks)

4. A steel manufacturer has 3 factories F_1, F_2 and F_3 which can produce 35, 25 and 15 kilotonnes of steel per year, respectively. Three businesses B_1, B_2 and B_3 have annual requirements of 20, 25 and 30 kilotonnes respectively. The table below shows the cost C_{ij} in appropriate units, of transporting one kilotonne of steel from factory F_i to business B_j.

		Business		
		B_1	B_2	B_3
Factory	F_1	10	4	11
	F_2	12	5	8
	F_3	9	6	7

The manufacturer wishes to transport the steel to the businesses at minimum total cost.

(*a*) Write down the transportation pattern obtained by using the North-West corner rule.

(2)

(*b*) Calculate all of the improvement indices I_{ij}, and hence show that this pattern is not optimal.

(5)

(*c*) Use the stepping-stone method to obtain an improved solution.

(3)

(*d*) Show that the transportation pattern obtained in part (*c*) is optimal and find its cost.

(5)

(Total for Question 4 is 15 marks)

5.

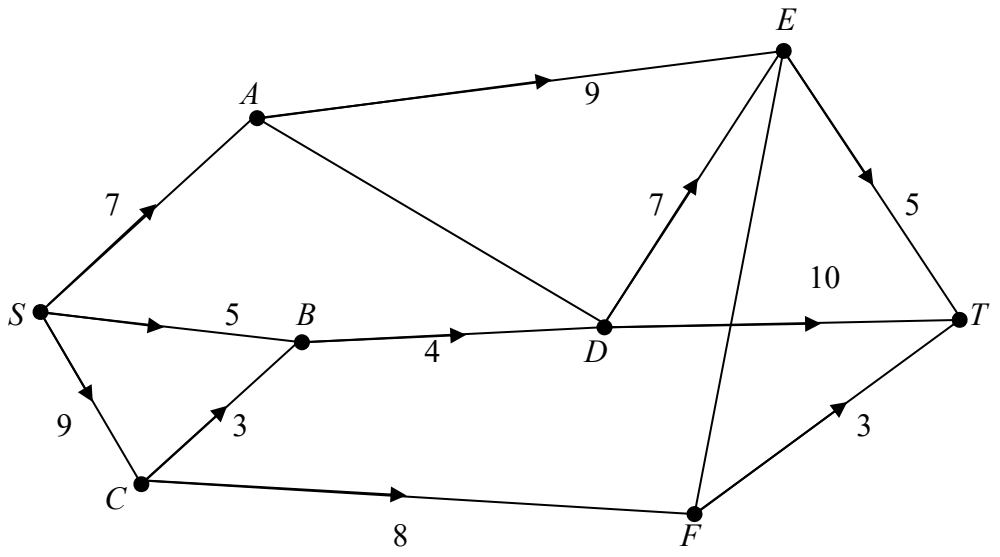

Fig. 3

Figure 3 shows a capacitated, directed network. The number on each arc indicates the capacity of that arc.

(*a*) State the maximum flow along

(i) *SAET,* (ii) *SBDT,* (iii) *SCFT.*

(3)

(*b*) Show these maximum flows.

(1)

(*c*) Taking your answer to part (*b*) as the initial flow pattern, use the labelling procedure to find a maximum flow from *S* to *T*. List each flow augmenting route you find, together with its flow.

(6)

(*d*) Indicate a maximum flow.

(2)

(*e*) Prove that your flow is maximal.

(2)

(Total for Question 5 is 14 marks)

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6. Jack is considering playing a game using a standard pack of 52 playing cards. To play the game, a player places a stake of £1 and takes a card from the pack. If the card is a King, then the player wins £10 and has their stake returned. If the card is a 3, 4 or 5 then a second card is taken from the pack without replacing the first. If this is a King, then the player wins £5 and has their stake returned.

Draw a decision tree and use the EMV to decide whether Jack should play the game.

(Total for Question 6 is 8 marks)

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7. A charity produces mixed packs of posters and flyers to send out to sponsors.

Pack A contains 40 posters and 20 flyers.

Pack B contains 30 posters and 50 flyers.

The charity must send out at least 15 000 flyers.

The charity wants between 40% and 60% of the total packs produced to be Pack As.

Posters cost 15p each and flyers cost 3p each.

The charity wishes to minimise its costs.

Let x represent the number of Pack As produced, and y represent the number of Pack Bs produced.

Formulate this as a linear programming problem, stating the objective and listing the constraints as simplified inequalities with integer coefficients.
You should **not** attempt to solve the problem.

(Total for Question 7 is 6 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, q13
2. p209, q6
3. p70, q7
4. D2 June 2002, q7
5. D1 January 2001, q6
6. p259, q1
7. D1 IAL January 2014, q8