Paper Reference(s)

6690/01

Edexcel GCE

Decision Mathematics D2

Advanced/Advanced Subsidiary

Mock Paper

Time: 1 hour 30 minutes

Materials required for examination	**Items included with question papers**
Nil	D2 Answer Book

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 to Candidates

Write your answers for this paper in the D2 answer book provided.
In the boxes on the answer book, write your centre number, candidate number, your surname, initial(s) and signature.
Check that you have the correct question paper.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.
Do not return the question paper with the answer book.

Information for Candidates

Full marks may be obtained for answers to ALL questions.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 7 questions in this question paper. The total mark for this question paper is 75.
There are 8 pages in this question paper. The answer book has 16 pages. Any blank pages are indicated.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You should show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.

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Turn over

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Write your answers in the D2 answer book for this paper.

1. A company has five machines A, B, C, D and E, which it can assign to four tasks 1, 2, 3 and 4. Each task must be assigned to just one machine and each machine may only be assigned to just one task.

The profit, in £100s, of using each machine to do each task is given in the table below.

	1	2	3	4
A	14	12	11	17
B	14	13	15	16
C	17	16	10	12
D	16	14	13	12
E	13	15	13	15

(a) Explain why it is necessary to add a dummy column to the table.

(2)

(b) Use the Hungarian algorithm to allocate machines to tasks in order to maximise the total profit. You must make your method clear and show the state of the table after each iteration.

(7)

(Total 9 marks)

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2. The following transportation problem is to be solved.

	P	Q	R	Supply
A	7	5	7	12
B	5	6	5	7
C	14	12	9	11
Demand	10	9	11	

A possible north-west corner solution is:

	P	Q	R
A	10	2	
B		7	0
C			11

(a) Use the stepping-stone method once to obtain an improved solution. You must make your shadow costs, improvement indices, entering cell, exiting cell and stepping-stone route clear.

(6)

(b) Demonstrate that your solution is optimal.

(3)

(Total 9 marks)

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

	B plays 1	B plays 2	B plays 3
A plays 1	–2	4	3
A plays 2	4	–1	2

Find the best strategy for player A and the value of the game.

(Total 7 marks)

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4. The table shows the least distances, in km, between six towns A, B, C, D, E and F.

	A	B	C	D	E	F
A	-	98	123	68	96	71
B	98	-	74	129	47	120
C	123	74	-	102	111	63
D	68	129	102	-	85	59
E	96	47	111	85	-	115
F	71	120	63	59	115	-

(a) Starting at A, and making your method clear, find an upper bound for the travelling salesman problem using the nearest neighbour algorithm.

(3)

(b) By deleting A, and all of its arcs, find a lower bound for the travelling salesman problem.

(3)

(c) Write down an inequality about the length of the optimal route.

(2)

(Total 8 marks)

5.

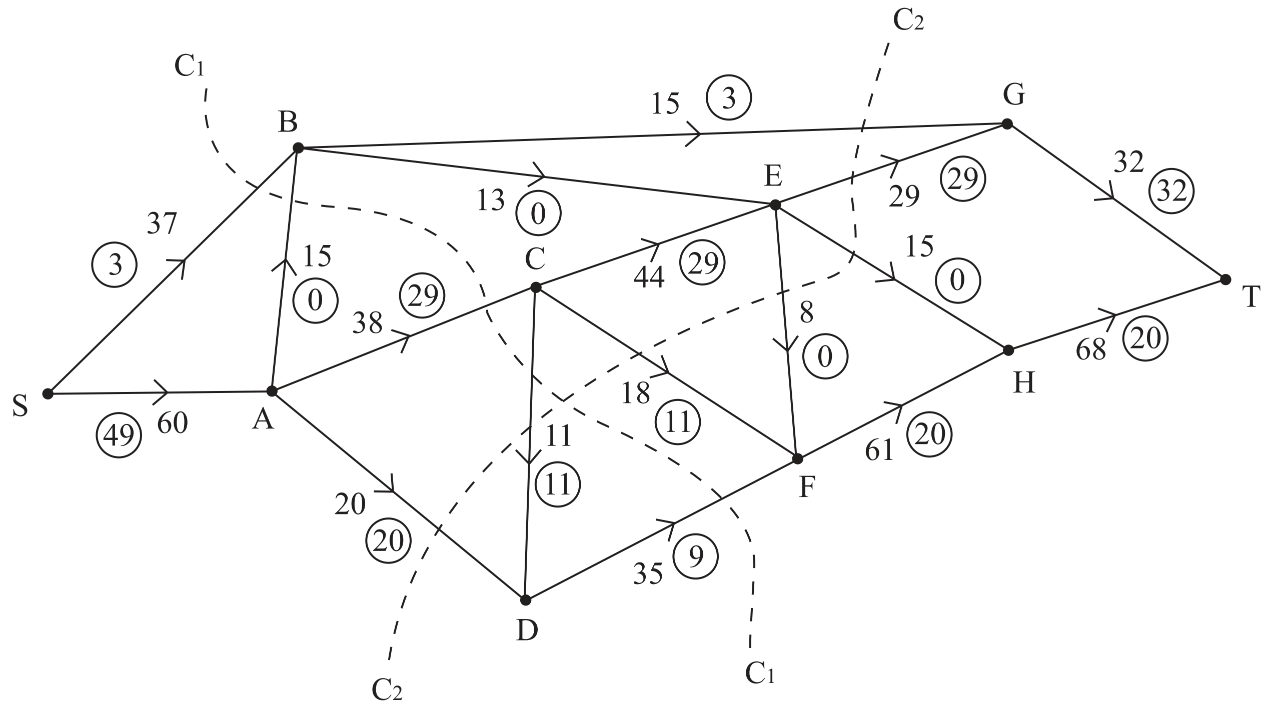

Figure 1

Figure 1 shows a capacitated, directed, network. The capacity of each arc is shown on that arc and the numbers in circles represent an initial flow from S to T.

Two cuts, C_1 and C_2 are shown on Figure 1.

(a) Find the capacity of each of the two cuts and the value of the initial flow. **(3)**

(b) Complete the initialisation of the labelling procedure on Figure 1 in the answer book, by entering values along SB, AB, BE and BG. **(2)**

(c) Hence use the labelling procedure to find a maximum flow of 85 through the network. You must list each flow-augmenting path you use, together with its flow. **(5)**

(d) Show your flow pattern on Figure 2. **(2)**

(e) Prove that your flow is maximal. **(2)**

(Total 14 marks)

6. The tableau below is the initial tableau for a maximising linear programming problem.

Basic variable	x	y	z	r	s	t	Value
r	16	2	4	1	0	0	350
s	18	–2	6	0	1	0	480
t	5	0	5	0	0	1	360
P	–18	–7	–20	0	0	0	0

(a) Write down the four equations represented in the initial tableau.

(4)

(b) Taking the most negative number in the profit row to indicate the pivot column at each stage, perform **<u>two</u>** complete iterations of the Simplex algorithm. State the row operations that you use.

(9)

(c) State whether or not your last tableau is optimal. Give a reason for your answer.

(1)

(Total 14 marks)

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7. D2 make industrial robots. They can make up to four in any one month, but if they make more than three they need to hire additional labour at a cost of £300 per month. They can store up to three robots at a cost of £100 per robot per month. The overhead costs are £500 in any month in which work is done.

The robots are delivered to buyers at the end of each month. There are no robots in stock at the beginning of January and there should be none in stock at the end of May.

The order book for January to May is:

Month	January	February	March	April	May
Number of robots required	3	2	2	5	4

Use dynamic programming to determine the production schedule that minimises the costs, showing your working in the table provided in the answer book. State the minimum cost.

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

END