Paper Reference(s)

6690/01

Edexcel GCE

Decision Mathematics D2

Advanced/Advanced Subsidiary

Wednesday 24 June 2015 – Morning

Time: 1 hour 30 minutes

Materials required for examination
Nil

Items included with question papers
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 or symbolic differentiation/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, initials and signature.
Check that you have the correct question paper.
Answer ALL the questions.
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 6 questions in this question paper. The total mark for this paper is 75.
There are 8 pages in this question paper. The answer book has 20 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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PEARSON

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

1. The tableau below is the initial tableau for a linear programming problem in x, y and z. The objective is to maximise the profit, P.

Basic variable	x	y	z	r	s	t	Value
r	2	–4	1	1	0	0	15
s	4	2	–8	0	1	0	20
t	1	–1	4	0	0	1	8
P	–3	2	7	0	0	0	0

(a) Perform **one** iteration of the Simplex algorithm to obtain a new tableau, T. State the row operations you use.

(5)

(b) Write down the profit equation given by T and state the current values of the slack variables.

(2)

(Total 7 marks)

2. Rani and Greg play a zero-sum game. The pay-off matrix shows the number of points that Rani scores for each combination of strategies.

	Greg plays 1	Greg plays 2	Greg plays 3
Rani plays 1	–3	1	2
Rani plays 2	0	2	1
Rani plays 3	2	4	–5

(a) Explain what the term 'zero-sum game' means.

(1)

(b) State the number of points that Greg scores if he plays his strategy 3 and Rani plays her strategy 3.

(1)

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

(3)

(d) Reduce the game so that Greg has only two possible strategies. Write down the reduced pay-off matrix for Greg.

(3)

(e) Find the best strategy for Greg and the value of the game to him.

(8)

(Total 16 marks)

3.

	A	B	C	D	E	F	G
A	–	x	41	43	38	21	30
B	x	–	27	38	19	29	51
C	41	27	–	24	37	35	40
D	43	38	24	–	44	52	25
E	38	19	37	44	–	20	28
F	21	29	35	52	20	–	49
G	30	51	40	25	28	49	–

The network represented by the table shows the least distances, in km, between seven theatres, A, B, C, D, E, F and G.

Jasmine needs to visit each theatre at least once starting and finishing at A. She wishes to minimise the total distance she travels. The least distance between A and B, is x km, where $21 < x < 27$

(a) Using Prim's algorithm, starting at A, obtain a minimum spanning tree for the network. You should list the arcs in the order in which you consider them.

(2)

(b) Use your answer to (a) to determine an initial upper bound for the length of Jasmine's route.

(1)

(c) Use the nearest neighbour algorithm, starting at A, to find a second upper bound for the length of the route.

(2)

The nearest neighbour algorithm starting at F gives a route of F – E – B – A – G – D – C – F.

(d) State which of these two nearest neighbour routes gives the better upper bound. Give a reason for your answer.

(2)

Starting by deleting A, and all of its arcs, a lower bound of 159 km for the length of the route is found.

(e) Find x, making your method clear.

(3)

(f) Write down the smallest interval that you can be confident contains the optimal length of Jasmine's route. Give your answer as an inequality.

(2)

(Total 12 marks)

4.

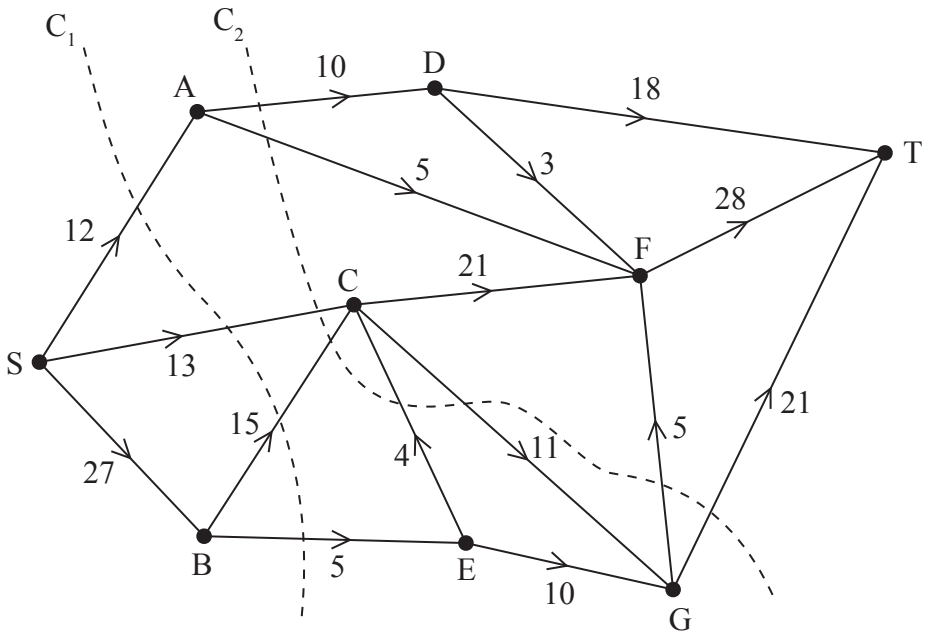


Figure 1

Figure 1 shows a capacitated network. The capacity of each arc is shown on the arc. Two cuts C_1 and C_2 are shown.

(a) Find the capacity of each of the two cuts.

(2)

Given that one of these two cuts is a minimum cut,

(b) write down the maximum possible flow through the network.

(1)

Given that the network now has a maximal flow from S to T,

(c) determine the flow along arc SB.

(1)

(d) Explain why arcs GF and GT cannot both be saturated.

(1)

Given that arcs EC, AD and DF are saturated and that there is no flow along arc GF,

(e) determine a maximum flow pattern for this network and draw it on Diagram 1 in the answer book. You do not need to use the labelling procedure to determine the maximum flow.

(2)

(Total 7 marks)

5. The table shows the cost, in pounds, of transporting one unit of stock from each of four supply points, A, B, C and D, to each of three sales points, P, Q and R. It also shows the stock held at each supply point and the amount required at each sales point. A minimum cost solution is required.

	P	Q	R	Supply
A	20	5	13	74
B	7	15	8	58
C	9	14	21	63
D	22	16	10	85
Demand	145	57	78	

The north-west corner method gives the following initial solution.

	P	Q	R	Supply
A	74			74
B	58			58
C	13	50		63
D		7	78	85
Demand	145	57	78	

(a) Taking AQ as the entering cell, use the stepping stone method to find an improved solution. Make your route clear.

(2)

(b) Perform one further iteration of the stepping stone method to obtain an improved solution. You must make your method clear by stating your shadow costs, improvement indices, route, entering cell and exiting cell.

(4)

(c) Determine whether your current solution is optimal. Justify your answer.

(3)

(d) State the cost of the solution you found in (b).

(1)

(e) Formulate this problem as a linear programming problem. You must define your decision variables and make the objective function and constraints clear.

(7)

(Total 17 marks)

6.

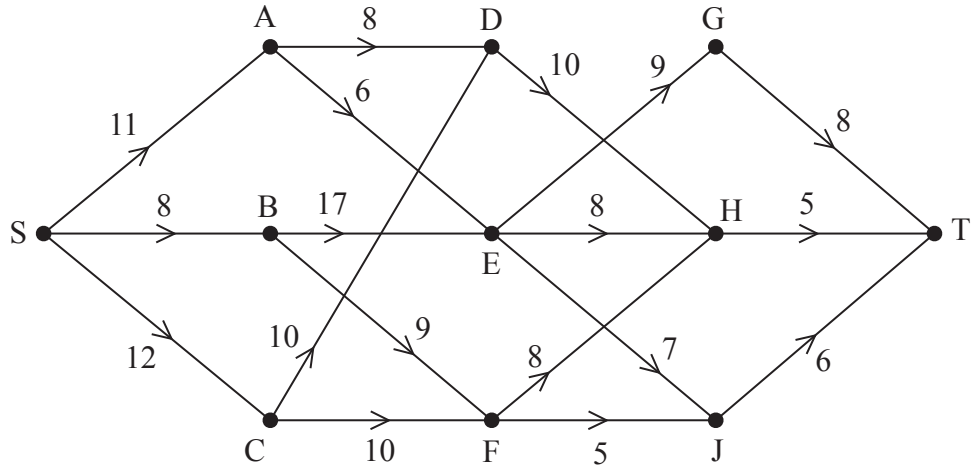


Figure 2

The staged, directed network in Figure 2 represents a series of roads connecting 11 towns, S, A, B, C, D, E, F, G, H, J and T. The number on each arc shows the weight limit, in tonnes, for the corresponding road. Janet needs to drive a truck from S to T, passing through exactly three other towns. She needs to find the maximum weight of the truck that she can use.

(a) Write down the type of dynamic programming problem that Janet needs to solve.

(1)

(b) Use dynamic programming to complete the table in the answer book.

(10)

(c) Hence find the maximum weight of the truck Janet can use.

(1)

(d) Write down the route that Janet should take.

(1)

Janet intends to ask for the weight limit to be increased on one of the three roads leading directly into T. Janet wishes to maximise the weight of her truck.

(e) (i) Determine which of the three roads she should choose and its new minimum weight limit.

(ii) Write down the maximum weight of the truck she would be able to use and the new route she would take.

(3)

(Total 16 marks)

TOTAL FOR PAPER: 75 MARKS

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Answer Book

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Question Number	Leave Blank
1	
2	
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PEARSON

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1.

b.v.	x	y	z	r	s	t	Value
r	2	–4	1	1	0	0	15
s	4	2	–8	0	1	0	20
t	1	–1	4	0	0	1	8
P	–3	2	7	0	0	0	0

(a) *You may not need to use all these tableaux*

b.v.	x	y	z	r	s	t	Value	Row Ops

b.v.	x	y	z	r	s	t	Value	Row Ops

b.v.	x	y	z	r	s	t	Value	Row Ops

Leave blank

Question 1 continued

b.v.	x	y	z	r	s	t	Value	Row Ops

b.v.	x	y	z	r	s	t	Value	Row Ops

Q1

(Total 7 marks)

Leave blank

2.

	Greg plays 1	Greg plays 2	Greg plays 3
Rani plays 1	–3	1	2
Rani plays 2	0	2	1
Rani plays 3	2	4	–5

Leave blank

Question 2 continued

Leave blank

Question 2 continued

Leave blank

Question 2 continued

Q2

(Total 16 marks)

Leave blank

3.

	A	B	C	D	E	F	G
A	–	x	41	43	38	21	30
B	x	–	27	38	19	29	51
C	41	27	–	24	37	35	40
D	43	38	24	–	44	52	25
E	38	19	37	44	–	20	28
F	21	29	35	52	20	–	49
G	30	51	40	25	28	49	–

Leave blank

Question 3 continued

	A	B	C	D	E	F	G
A	–	x	41	43	38	21	30
B	x	–	27	38	19	29	51
C	41	27	–	24	37	35	40
D	43	38	24	–	44	52	25
E	38	19	37	44	–	20	28
F	21	29	35	52	20	–	49
G	30	51	40	25	28	49	–

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Question 3 continued

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Question 3 continued

Q3

(Total 12 marks)

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4.

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Question 4 continued

(e)

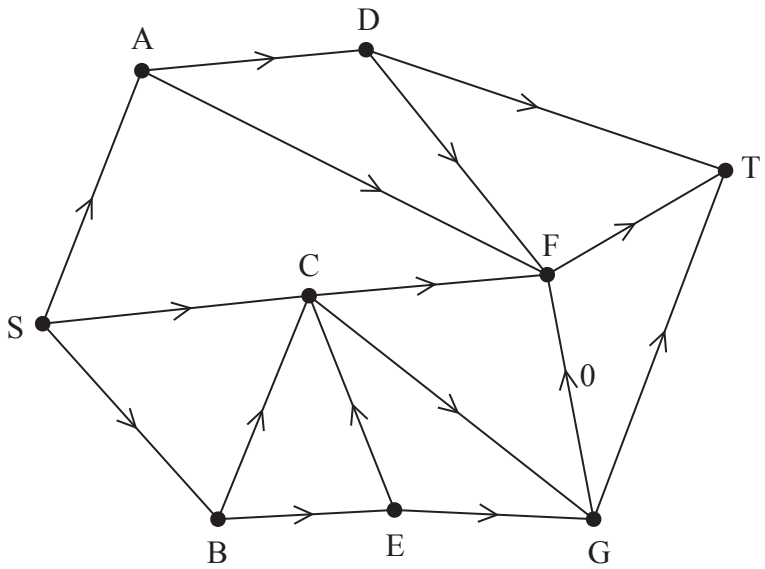


Diagram 1

(Total 7 marks)

Q4

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5.

	P	Q	R	Supply
A	20	5	13	74
B	7	15	8	58
C	9	14	21	63
D	22	16	10	85
Demand	145	57	78	

	P	Q	R
A			
B			
C			
D			

	P	Q	R
A			
B			
C			
D			

	P	Q	R
A			
B			
C			
D			

	P	Q	R
A			
B			
C			
D			

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Question 5 continued

	P	Q	R
A			
B			
C			
D			

	P	Q	R
A			
B			
C			
D			

	P	Q	R
A			
B			
C			
D			

	P	Q	R
A			
B			
C			
D			

	P	Q	R
A			
B			
C			
D			

Leave blank

Question 5 continued

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Question 5 continued

Q5

(Total 17 marks)

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6. (a)

You may not need to use all the rows of this table

Stage	State	Action	Dest.	Value

Leave blank

Question 6 continued

Stage	State	Action	Dest.	Value

(c) Weight:

(d) Route:

(e) (i)

(e) (ii)

Q6

(Total 16 marks)

TOTAL FOR PAPER: 75 MARKS

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