Paper Reference(s)

6690

Edexcel GCE

Decision Mathematics D2

Advanced/Advanced Subsidiary

Specimen Paper

Time: 1 hour 30 minutes

Materials required for examination
Nil

Items included with question papers
D1 Answer booklet

Candidates may use any calculator EXCEPT those with the facility for symbolic algebra, differentiation and/or integration. Thus candidates must NOT use calculators such as the Texas Instruments TI 89, TI 92, Casio CFX 9970G, Hewlett Packard HP 48G.

Instructions to Candidates

In the boxes on the answer book, write your centre number, candidate number, your surname, initials and signature.

Information for Candidates

Full marks may be obtained for answers to ALL questions.
This paper has seven questions.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner. Answers without working may gain no credit.

1. A coach company has 20 coaches. At the end of a given week, 8 coaches are at depot *A*, 5 coaches are at depot *B* and 7 coaches are at depot *C*. At the beginning of the next week, 4 of these coaches are required at depot *D*, 10 of them at depot *E* and 6 of them at depot *F*. The table below shows the distances, in miles, between the relevant depots.

	D	*E*	*F*
A	40	70	25
B	20	40	10
C	35	85	15

The company needs to move the coaches between depots at the weekend. The total mileage covered is to be a minimum. Formulate this information as a Linear Programming Problem.

(a) State clearly your decision variables.

(1)

(b) Write down the objective function in terms of your decision variables.

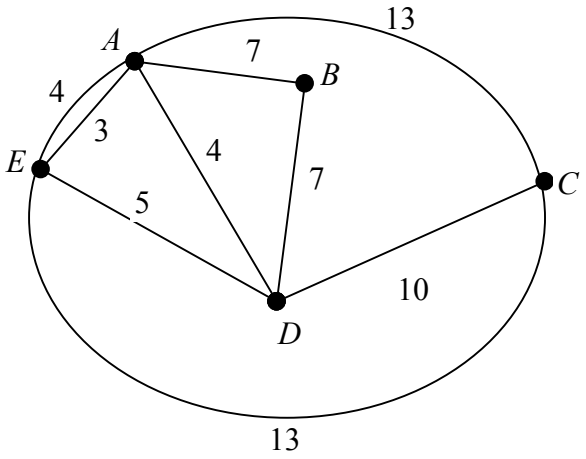
(1)

(*c*) Write down the constraints, explaining what each constraint represents.

(5)

2.

Figure 1



The network in Fig. 1 shows a number of hostels in a national park and the possible paths joining them. The numbers on the edges give the lengths, in km, of the paths.

(a) Draw a complete network showing the shortest distances between the hostels.
(You may do this by inspection. The application of an algorithm is not required.)

(2)

(b) Use the nearest neighbour algorithm on the complete network to obtain an upper bound to the length of a tour in this network which starts at A and visits each hostel exactly once.

(3)

(c) Interpret your result in part (b) in terms of the original network.

(2)

---

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

Given that the game does not have a stable solution, find the best mixed strategy for each player and the value of the game.

		B	
		I	II
A	I	4	–2
	II	–5	6

(10)

4.

Warehouse / Factory	W_1	W_2	W_3	Availabilities
F_1	7	8	6	4
F_2	9	2	4	3
F_3	5	6	3	8
Requirements	2	9	4	

A manufacturer has 3 factories F_1, F_2, F_3 and 3 warehouses W_1, W_2, W_3. The table shows the cost C_{ij}, in appropriate units, of sending one unit of product from factory F_i to warehouse W_j. Also shown in the table are the number of units available at each factory F_i and the number of units required at each warehouse W_j. The total number of units available is equal to the total number of units required.

(*a*) Use the North-West Corner rule to obtain a possible pattern of distribution and find its cost.

(5)

(*b*) Calculate shadow costs R_i and K_j for this pattern and hence obtain improvement indices I_{ij} for each route.

(6)

(*c*) Using your answer to part (*b*), explain why the pattern is optimal.

(1)

---

5. *This question should be answered on the sheet provided.*

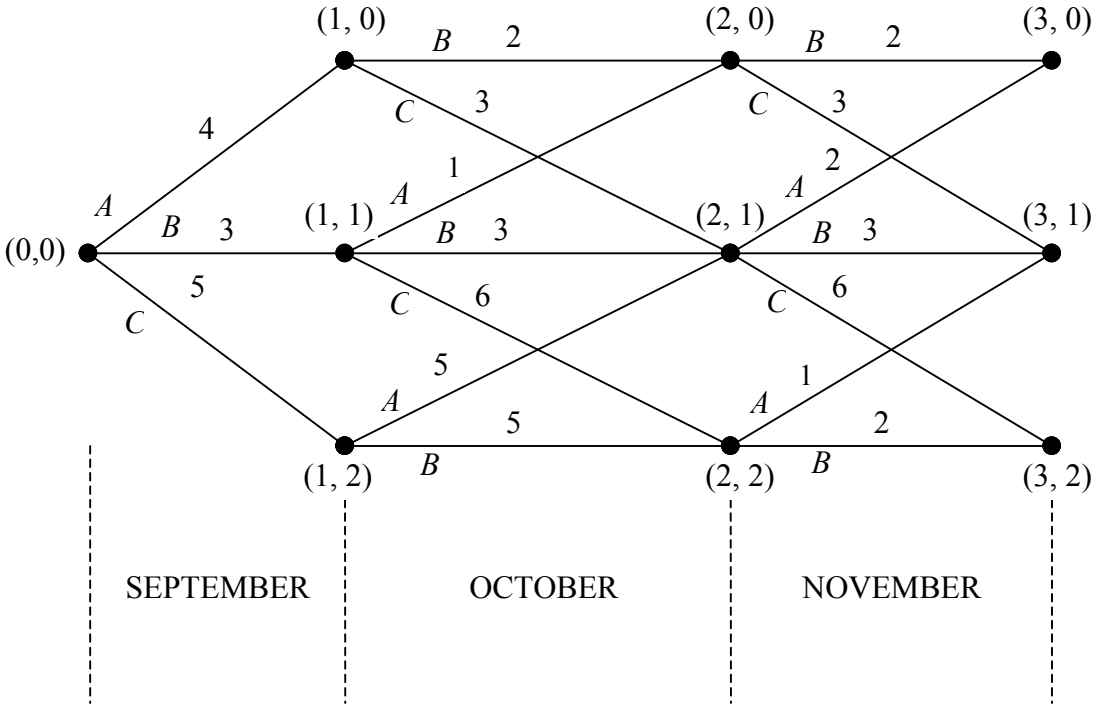
At the beginning of each month an advertising manager must choose one of 3 adverts:

A: use the previous advert;

B: use the current advert;

C: run a new advert.

The possible choices are shown in the network below together with (stage, state) variables at the vertices and the expected profits, in thousands of pounds, on the arcs.



The manager wants to maximise her profits for the 3 month period.

(*a*) Complete the table on the answer sheet.

(9)

(*b*) Hence obtain the sequence of decisions she should make to obtain the maximum profit. State the maximum profit.

(3)

---

6. A large room in a hotel is to be prepared for a wedding reception. The tasks that need to be carried out are:

I clean the room,

II arrange the tables and chairs,

III set the places,

IV arrange the decorations.

The tasks need to be completed consecutively and the room must be prepared in the *least possible time*. The tasks are to be assigned to four teams of workers *A*, *B*, *C* and *D*. Each team must carry out only one task. The table below shows the times, in minutes, that each team takes to carry out each task.

	A	*B*	*C*	*D*
I	17	24	19	18
II	12	23	16	15
III	16	24	21	18
IV	12	24	18	14

(*a*) Use the Hungarian algorithm to determine which team should be assigned to each task. You must make your method clear and show

(i) the state of the table after each stage in the algorithm,

(ii) the final allocation.

(11)

(*b*) Obtain the minimum total time taken for the room to be prepared.

(2)

---

7. *This question should be answered on the sheet provided*

.

	A	*B*	*C*	*D*	*E*	*F*	*G*
A	-	103	89	42	54	143	153
B	103	-	60	98	56	99	59
C	89	60	-	65	38	58	77
D	42	98	65	-	45	111	139
E	54	56	38	45	-	95	100
F	143	99	58	111	95	-	75
G	153	59	77	139	100	75	-

A computer supplier has outlets in seven cities *A*, *B*, *C*, *D*, *E*, *F* and *G*. The table shows the distances, in km, between the seven cities. Joan lives in city *A* and has to visit each city to advise on displays. She wishes to plan a route, starting and finishing at *A,* visiting each city once and covering a minimum distance.

(*a*) Use Prim's algorithm to obtain a minimum spanning tree for the network and draw this tree. Start with *A* and state the order in which the vertices are added to your tree.

(5)

Given that the network representing this problem is complete and satisfies the triangle inequality,

(b) determine an initial upper bound for the length of the route travelled by Joan.

(2)

(c) Starting from your initial upper bound for the length of the route and using an appropriate method, find an upper bound which is less than 430 km.

(3)

(*d*) By deleting city *A*, determine a lower bound for the length of Joan's route.

(4)

END

Sheet for use in answering question 5

6690 Decision Mathematics D2 Specimen Paper

Centre No.	Candidate No.	Surname & Initials (Block Letters)
Hand this sheet in for marking		

Stage	State	Action	Cost	Value
2	0	*B* *C*		
	1	*A* *B* *C*		
	2	*A* *B*		
1	0	*B* *C*		
	1	*A* *B* *C*		
	2	*A* *B*		
0	0	*A* *B* *C*		

……

……

……

……

……

Sheet for use in answering question 7

6690 Decision Mathematics D2 Specimen Paper

Centre No.	Candidate No.	Surname & Initials (Block Letters)
hand this sheet in for marking		

(*a*)

	A	*B*	*C*	*D*	*E*	*F*	*G*
A	-	103	89	42	54	143	153
B	103	-	60	98	56	99	59
C	89	60	-	65	38	58	77
D	42	98	65	-	45	111	139
E	54	56	38	45	-	95	100
F	143	99	58	111	95	-	75
G	153	59	77	139	100	75	-

Minimum spanning tree.

(*b*) Initial upper bound.

(*c*) Improved upper bound.

(*d*) Lower bound.