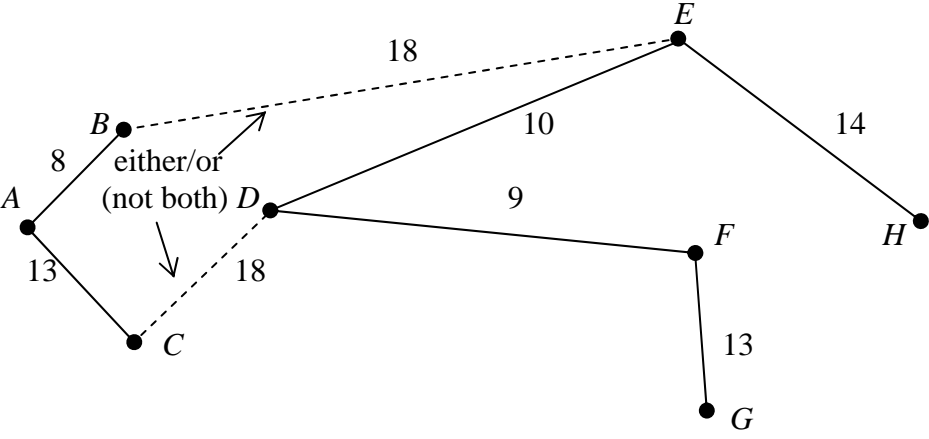


EDEXCEL DECISION MATHEMATICS D2 (6690) – JUNE 2003 PROVISIONAL MARK SCHEME

Question Number	Scheme	Marks												
<p>1. (a)</p>	<table border="1" style="margin-left: 20px;"> <thead> <tr> <th></th> <th>A(I)</th> <th>A(II)</th> </tr> </thead> <tbody> <tr> <td>B(I)</td> <td>3</td> <td>-4</td> </tr> <tr> <td>B(II)</td> <td>-2</td> <td>1</td> </tr> <tr> <td>B(III)</td> <td>-5</td> <td>4</td> </tr> </tbody> </table>		A(I)	A(II)	B(I)	3	-4	B(II)	-2	1	B(III)	-5	4	<p>B2, 1, 0 (2)</p>
	A(I)	A(II)												
B(I)	3	-4												
B(II)	-2	1												
B(III)	-5	4												
<p>(b)</p>	<p>e.g. Let v = value of the game, p = pay-off, $q_i = P(B \text{ plays } i), i = 1, 2, 3$</p> <table border="1" style="margin-left: 20px;"> <thead> <tr> <th></th> <th>A(I)</th> <th>A(II)</th> </tr> </thead> <tbody> <tr> <td>B(I)</td> <td>9</td> <td>2</td> </tr> <tr> <td>B(II)</td> <td>4</td> <td>7</td> </tr> <tr> <td>B(III)</td> <td>1</td> <td>10</td> </tr> </tbody> </table> <p>Matrix becomes</p> <p>maximise $p = v$</p> <p>subject to $v - 9q_1 - 4q_2 - q_3 + r = 0$</p> <p style="padding-left: 40px;">$v - 2q_1 - 7q_2 - 10q_3 + s = 0$</p> <p style="padding-left: 80px;">$q_1 + q_2 + q_3 + t = 0$</p>		A(I)	A(II)	B(I)	9	2	B(II)	4	7	B(III)	1	10	<p>B1</p> <p>M1</p> <p>A2 ft, 1 ft, 0</p> <p>(4)</p> <p>(6 marks)</p>
	A(I)	A(II)												
B(I)	9	2												
B(II)	4	7												
B(III)	1	10												

(ft = follow through mark)

EDEXCEL DECISION MATHEMATICS D2 (6690) – JUNE 2003 PROVISIONAL MARK SCHEME

Question Number	Scheme	Marks
2. (a)	In the <i>practical</i> TSP each vertex must be visited <i>at least once</i>	B1
	In the <i>classical</i> TSP each vertex must be visited <i>exactly once</i>	B1 (2)
(b)	$AB, DF, DE, (\text{reject } EF), \left\{ \begin{matrix} FG \\ AC \end{matrix} \right\} EH \left\{ \begin{matrix} DC \\ \text{or} \\ BE \end{matrix} \right\}$	M1 A1
		B1 (3)
(c)	Initial upper bound = $2 \times 85 = 170$ km	M1 A1 (2)
(d)	e.g. when CD is part of the tree Use GH (saving 26) and BD (saving 19) giving new upper bound of 125 km Tour $A B D E H G F D C A$ (or e.g. when BE is part of the tree, use CG (saving 40) giving new upper bound of 130 km; Tour $A B E H E D F G C A$)	M1 A1 A1 (3) (10 marks)

EDEXCEL DECISION MATHEMATICS D2 (6690) – JUNE 2003 PROVISIONAL MARK SCHEME

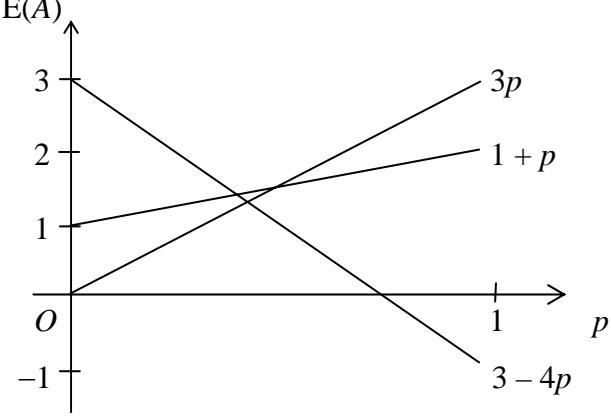
Question Number	Scheme	Marks																																																																											
3. (a)(i)	<p>Either rows then columns giving</p> <table style="display: inline-table; margin-right: 20px;"> <tr><td></td><td>I</td><td>II</td><td>III</td><td>IV</td></tr> <tr><td>C</td><td>0</td><td>22</td><td>16</td><td>4</td></tr> <tr><td>J</td><td>1</td><td>20</td><td>24</td><td>0</td></tr> <tr><td>N</td><td>1</td><td>18</td><td>18</td><td>0</td></tr> <tr><td>S</td><td>1</td><td>23</td><td>26</td><td>0</td></tr> </table> <p style="display: inline-block; vertical-align: middle; margin: 0 10px;">then</p> <table style="display: inline-table;"> <tr><td></td><td>I</td><td>II</td><td>III</td><td>IV</td></tr> <tr><td>C</td><td>0</td><td>4</td><td>0</td><td>4</td></tr> <tr><td>J</td><td>1</td><td>2</td><td>8</td><td>0</td></tr> <tr><td>N</td><td>1</td><td>0</td><td>2</td><td>0</td></tr> <tr><td>S</td><td>1</td><td>5</td><td>10</td><td>0</td></tr> </table> <p>3 lines only needed \Rightarrow least element 1 so</p> <table style="display: inline-table; margin-left: 20px;"> <tr><td></td><td>I</td><td>II</td><td>III</td><td>IV</td></tr> <tr><td>C</td><td>0</td><td>4</td><td>0</td><td>5</td></tr> <tr><td>J</td><td>0</td><td>1</td><td>7</td><td>0</td></tr> <tr><td>N</td><td>1</td><td>0</td><td>2</td><td>1</td></tr> <tr><td>S</td><td>0</td><td>4</td><td>9</td><td>0</td></tr> </table>		I	II	III	IV	C	0	22	16	4	J	1	20	24	0	N	1	18	18	0	S	1	23	26	0		I	II	III	IV	C	0	4	0	4	J	1	2	8	0	N	1	0	2	0	S	1	5	10	0		I	II	III	IV	C	0	4	0	5	J	0	1	7	0	N	1	0	2	1	S	0	4	9	0	M1, A1, A1 (3) M1, A1, A1 (3)
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(a)(ii)	<p>C – III, J – I or IV, N – II, S – IV or I</p> <p>83 minutes \therefore 11.23 a.m.</p>	M1 A1 M1 A1 (4)																																																																											

(continued page 4)

EDEXCEL DECISION MATHEMATICS D2 (6690) – JUNE 2003 PROVISIONAL MARK SCHEME

Question Number	Scheme	Marks																									
3. (b)	<p>Subtracting all entries from some $n \geq 36$ (stated)</p> <p>e.g. subtractions from 36</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>I</th> <th>II</th> <th>III</th> <th>IV</th> </tr> </thead> <tbody> <tr> <td><i>C</i></td> <td>24</td> <td>2</td> <td>8</td> <td>20</td> </tr> <tr> <td><i>J</i></td> <td>23</td> <td>4</td> <td>0</td> <td>24</td> </tr> <tr> <td><i>N</i></td> <td>21</td> <td>4</td> <td>4</td> <td>22</td> </tr> <tr> <td><i>S</i></td> <td>25</td> <td>3</td> <td>0</td> <td>26</td> </tr> </tbody> </table>		I	II	III	IV	<i>C</i>	24	2	8	20	<i>J</i>	23	4	0	24	<i>N</i>	21	4	4	22	<i>S</i>	25	3	0	26	<p>M1</p> <p>A2, 1, 0 (3)</p> <p>(13 marks)</p>
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<i>C</i>	24	2	8	20																							
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<i>N</i>	21	4	4	22																							
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EDEXCEL DECISION MATHEMATICS D2 (6690) – JUNE 2003 PROVISIONAL MARK SCHEME

Question Number	Scheme	Marks
<p>4.</p> <p>(a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p>	<p>Player A: row minimums are $-1, 0, -3$ so maximin choice is play II</p>	M1 A1
	<p>Player B: column maximums are $2, 3, 3$ so minimax choice is play I</p>	M1 A1 (4)
	<p>Since A's maximin (0) \neq B's minimax (2) there is no stable solution</p>	B1 (1)
	<p>For player A row II dominates row III, so A will <i>now</i> play III</p>	B2, 1, 0 (2)
	<p>Let A play I with probability p and II with probability $(1 - p)$</p>	
	<p>If B plays I, A's expected winnings are $2p + (1 - p) = 1 + p$</p>	
	<p>If B plays II, A's expected winnings are $-p + 3(1 - p) = 3 - 4p$</p>	M1, A2, 1, 0
	<p>If B plays III, A's expected winnings are $3p$</p>	(3)
	<p>E(A)</p> 	M1
	<p>$3 - 4p = 3p \Rightarrow p = \frac{3}{7}$</p>	A1
	<p>A should play I with probability $\frac{3}{7}$</p>	
	<p>A should play II with probability $\frac{4}{7}$</p>	A1
	<p>and never play III</p>	
	<p>The value of the game is $\frac{9}{7}$ to A</p>	A1 (4)
	(14 marks)	

(ft = follow through mark)

EDEXCEL DECISION MATHEMATICS D2 (6690) – JUNE 2003 PROVISIONAL MARK SCHEME

Question Number	Scheme		Marks																																																
5. (a)	<table border="1" style="display: inline-table; vertical-align: middle;"> <tr><td></td><td><i>D</i></td><td><i>E</i></td><td><i>F</i></td></tr> <tr><td><i>A</i></td><td>6</td><td></td><td></td></tr> <tr><td><i>B</i></td><td>0</td><td>5</td><td></td></tr> <tr><td><i>C</i></td><td></td><td>4</td><td>4</td></tr> </table>		<i>D</i>	<i>E</i>	<i>F</i>	<i>A</i>	6			<i>B</i>	0	5		<i>C</i>		4	4	<i>or</i>	<table border="1" style="display: inline-table; vertical-align: middle;"> <tr><td></td><td><i>D</i></td><td><i>E</i></td><td><i>F</i></td></tr> <tr><td><i>A</i></td><td>6</td><td>0</td><td></td></tr> <tr><td><i>B</i></td><td></td><td>5</td><td></td></tr> <tr><td><i>C</i></td><td></td><td>4</td><td>4</td></tr> </table>		<i>D</i>	<i>E</i>	<i>F</i>	<i>A</i>	6	0		<i>B</i>		5		<i>C</i>		4	4	M1 A1 A1 (3)															
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(b)	$S_A = 0, S_B = 0, S_C = -10$ $D_D = 20, D_E = 30, D_F = 40$ $I_{AE} = 40 - 30 = 10$ $I_{AF} = 10 - 40 = -30$ $I_{BF} = 40 - 40 = 0$ $I_{CD} = 10 - 10 = 0$ Choose <i>AF</i> as entering route $AF(+) \rightarrow CF(-) \rightarrow CE(+) \rightarrow BE(-)$ $\rightarrow BD(+) \rightarrow AD(-)$ Exiting route <i>CF</i> $\theta = 4$ <table border="1" style="display: inline-table; vertical-align: middle;"> <tr><td></td><td><i>D</i></td><td><i>E</i></td><td><i>F</i></td></tr> <tr><td><i>A</i></td><td>2</td><td></td><td>4</td></tr> <tr><td><i>B</i></td><td>4</td><td>1</td><td></td></tr> <tr><td><i>C</i></td><td></td><td>8</td><td></td></tr> </table> $S_A = 0, S_B = 0, S_C = -10$ $D_D = 20, D_E = 30, D_F = 40$ $I_{AE} = 10, I_{BF} = 30,$ $I_{CD} = 0, I_{CF} = 30$		<i>D</i>	<i>E</i>	<i>F</i>	<i>A</i>	2		4	<i>B</i>	4	1		<i>C</i>		8		$S_A = 0, S_B = -10, S_C = -20$ $D_D = 20, D_E = 40, D_F = 50$ $I_{AF} = 10 - 50 = -40$ $I_{BD} = 20 - 10 = 10$ $I_{BF} = 40 - 40 = 0$ $I_{CD} = 10 - 0 = 10$ $AF(+) \rightarrow CF(-) \rightarrow CE(+) \rightarrow AE(-)$ Exiting route <i>AE</i> $\theta = 0$ <table border="1" style="display: inline-table; vertical-align: middle;"> <tr><td></td><td><i>D</i></td><td><i>E</i></td><td><i>F</i></td></tr> <tr><td><i>A</i></td><td>6</td><td></td><td>0</td></tr> <tr><td><i>B</i></td><td></td><td>5</td><td></td></tr> <tr><td><i>C</i></td><td></td><td>4</td><td>4</td></tr> </table> $S_A = 0, S_B = 10, S_C = 20$ $D_D = 20, D_E = 0, D_F = 10$ $I_{AE} = 40, I_{BD} = -10,$ $I_{BF} = 20, I_{CD} = -30$ $CD(+) \rightarrow AD(-) \rightarrow AF(+) \rightarrow CF(-)$ $\theta = 4$ <table border="1" style="display: inline-table; vertical-align: middle;"> <tr><td></td><td><i>D</i></td><td><i>E</i></td><td><i>F</i></td></tr> <tr><td><i>A</i></td><td>2</td><td></td><td>4</td></tr> <tr><td><i>B</i></td><td></td><td>5</td><td></td></tr> <tr><td><i>C</i></td><td>4</td><td>4</td><td></td></tr> </table> $S_A = 0, S_B = 0, S_C = -10$ $D_D = 20, D_E = 30, D_F = 10$ $I_{AE} = 40, I_{BD} = 0, I_{BF} = 30, I_{CF} = 30$		<i>D</i>	<i>E</i>	<i>F</i>	<i>A</i>	6		0	<i>B</i>		5		<i>C</i>		4	4		<i>D</i>	<i>E</i>	<i>F</i>	<i>A</i>	2		4	<i>B</i>		5		<i>C</i>	4	4		cost £470 A1 (3) M1 A1 M1 A1 (4) M1 A1 ft A1 M1 A1 A1 A1 (7)
		<i>D</i>	<i>E</i>	<i>F</i>																																															
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\therefore optimal, cost £350	\therefore optimal, cost £350	(14 marks)																																																	

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Question Number	Scheme					Marks																																																								
6.	(a) Total cost = $2 \times 40 + 350 + 200 = \text{£}630$					M1 A1 (2)																																																								
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	Profit per cycle = 13×1400 Cost of Kim's time = £2000					B1																																																								
	= 18200 Cost of production = £1540					M1																																																								
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(ft = follow through mark)