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Mark Scheme (Results)
Summer 2007

GCE

GCE Mathematics

Decision Mathematics D2 (6690)

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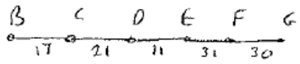
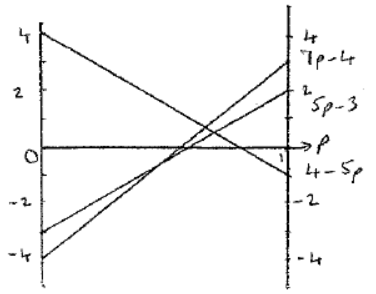
June 2007
6690 Decision Mathematics
Mark Scheme

Question Number	Scheme	Marks
1) (a)	Adds 32 to AB + BA (ACB)	B1
	47 to AE + EA (ACDE)	B1
	32 to CE + EC (CDE)	B1
	53 to DG + GD (DCG)	B1 (4)
(b)	A C B D E F G A	M1 A1
	15 + 17 + 38 + 11 + 31 + 30 + 23 = 165 miles	A1 (3)
(c)	eg BC, CD, DE, EF, FG 	M1
	weight of RSMT = 110 miles	A1
	Lower bound = 110 + 15 + 23	M1
	= 148 miles	A1ft (4)
		11

Question Number	Scheme	Marks
2) (a)	$\begin{array}{c c} & \text{Row min} \\ \begin{bmatrix} 2 & -1 & 3 \\ -3 & 4 & -4 \end{bmatrix} & \begin{array}{l} -1 \leftarrow \\ -4 \end{array} \\ \text{col max} \quad 2 \uparrow \quad 4 \quad 3 & \end{array}$ $2 \neq -1$ $\therefore$ not stable	m1 A1 A1 (3)
(b)	Let Denis play 1 with probability p so he'll play 2 with probability $1-p$ If Hilary plays 1 Denis wins : $2p - 3(1-p) = 5p - 3$ If Hilary plays 2 Denis wins : $-p + 4(1-p) = 4 - 5p$ If Hilary plays 3 Denis wins : $3p - 4(1-p) = 7p - 4$	m1 A2, 1, 0 (3)
		m1 A2, 1, 0 (3)
	$5p - 3 = 4 - 5p$ $10p = 7$ $p = \frac{7}{10}$	m1 A1 ✓ (2)
	Denis should play 1 with probability $\frac{7}{10}$ 2 with probability $\frac{3}{10}$ the value of the game is $\frac{1}{2}$	B1✓, B1 (2) $\boxed{13}$

3) (a)

$$\begin{bmatrix} 66 & 101 & 85 & 36 \\ 66 & 98 & 74 & 38 \\ 63 & 97 & 71 & 34 \\ 67 & 102 & 78 & 35 \end{bmatrix}$$

reducing rows first — then columns

$$\begin{bmatrix} 30 & 65 & 49 & 0 \\ 28 & 60 & 36 & 0 \\ 29 & 63 & 37 & 0 \\ 32 & 67 & 43 & 0 \end{bmatrix} \quad \begin{bmatrix} 2 & 5 & 13 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 3 & 1 & 0 \\ 4 & 7 & 7 & 0 \end{bmatrix}$$

M1 A1 (2)

$$\begin{bmatrix} 1 & 4 & 12 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 2 & 0 & 0 \\ 3 & 6 & 6 & 0 \end{bmatrix}$$

M1 A1√A1√ (3)

$$\begin{bmatrix} 0 & 3 & 11 & 0 \\ 0 & 0 & 0 & 2 \\ 0 & 2 & 0 & 1 \\ 2 & 5 & 5 & 0 \end{bmatrix}$$

M1 A1√A1√

A – cutting
B – stitching
C – filling
D – Dressing

A1 (4)

(b) $66 + 98 + 71 + 35 = 270$ seconds — B1

(c) $20 \times 98 + 66 + 71 + 35 = 2132$ seconds — M1 A1√
$= 35$ minutes 32 seconds — A1 (3)

$\boxed{13}$

4)

(a)

	A	S	D	seats
1			0	94
2			0	65
3			0	80
	18	200	21	

B2,1,0 (2)

(b) total supply > total demand

B1 (1)

(c)

	A	S	D
1	18	76	
2		65	
3		59	21

B1

(d)

$S(1) = 0$ $D(A) = 5$
$S(2) = -0.7$ $D(S) = 4.5$
$S(3) = -0.5$ $D(D) = 0.5$

M1 A1 √

$I_{1D} = 0 - 0 - 0.5 = -0.5$ *
$I_{2A} = 4.2 + 0.7 - 5 = -0.1$
$I_{2D} = 0 + 0.7 - 0.5 = 0.2$
$I_{3A} = 4.6 + 0.5 - 5 = 0.1$

A1 (4)

	A	S	D
1	18	$76-\theta$	θ
2		65	
3		$59+\theta$	$21-\theta$

Entering 1D
Exiting 3D
$\theta = 21$

	A	S	D
1	18	55	21
2		65	
3		80	

M1 A1 √
A1 (3)

(e)

$S(1) = 0$ $D(A) = 4.9$
$S(2) = -0.7$ $D(S) = 4.5$
$S(3) = -0.5$ $D(D) = 0$

M1
A1

$I_{1A} = 5 - 0 - 4.9 = 0.1$
$I_{2D} = 0 + 0.7 - 0 = 0.7$
$I_{3A} = 4.6 + 0.5 - 4.9 = 0.2$
$I_{3D} = 0 + 0.5 - 0 = 0.5$

A1

Optimal since all II's ≥ 0

A1 (4)

cost £902.70

M1 A1 (2)

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5)	**Alt 1**	
	Game from R's point of view.	
	$\begin{array}{c\|ccc} & A1 & A2 & A3 \\ \hline R1 & -6 & 3 & -5 \\ R2 & 2 & -1 & -4 \\ R3 & 3 & -2 & 1 \end{array}$ Add 7 $\begin{array}{c\|ccc} & A1 & A2 & A3 \\ \hline R1 & 1 & 10 & 2 \\ R2 & 9 & 6 & 3 \\ R3 & 10 & 5 & 8 \end{array}$	B1, B1. (2)
	Let R play 1 with probability p_1 2 " " p_2 3 " " p_3 V = value of the game	B1 (1)
	maximise $P = V$	B1 (1)
	Subject to $V - p_1 - 9p_2 - 10p_3 \le 0$	M1 A1√
	$V - 10p_1 - 6p_2 - 5p_3 \le 0$	A1√
	$V - 2p_1 - 3p_2 - 8p_3 \le 0$	
	$p_1 + p_2 + p_3 \le 1$ accept =	A1
	$V, p_1, p_2, p_3 \geq 0$	(4) 8
	Alt 2	
	Add 4 to all entries $\begin{array}{c\|ccc} & R_1 & R_2 & R_3 \\ \hline A1 & 10 & 2 & 1 \\ A2 & 1 & 5 & 6 \\ A3 & 9 & 8 & 3 \end{array}$	B1 (1)
	Let R play 1 with probability p_1 2 p_2 3 p_3 let V = value of game.	B1
	let $x_1 = \frac{p_1}{V}$, $x_2 = \frac{p_2}{V}$ $x_3 = \frac{p_3}{V}$	B1 (2)
	maximise $P = x_1 + x_2 + x_3$	B1 (1)
	Subject to $10x_1 + 2x_2 + x_3 \le 1$	M1 A1√
	$x_1 + 5x_2 + 6x_3 \le 1$	A1√
	$9x_1 + 8x_2 + 3x_3 \le 1$	A1
	$x_1, x_2, x_3 \geq 0$ accept $p_i \geq 0$	(4) 8

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(a)

Stage	State	Action	Destination	Value	Marks
	J	JY	Y	98 *	
1	K	KY	Y	94 *	B1
	L	LY	Y	86 *	
	G	GJ	J	max (79, 98) = 98 *	M1
		GK	K	max (98, 94) = 98 *	
2	H	HK	K	max (95, 94) = 95	A1 A1
		HL	L	max (72, 86) = 86 *	
	I	IL	L	max (56, 86) = 86 *	(4)
	C	CG	G	max (50, 98) = 98 *	
	D	DG	G	max (92, 98) = 98	M1
3		DH	H	max (81, 86) = 86 *	A1√ A1√
	E	EH	H	max (89, 86) = 89 *	(3)
	F	FH	H	max (84, 86) = 86 *	
		FI	I	max (72, 86) = 86 *	
	A	AC	C	max (95, 98) = 98	
		AD	D	max (86, 86) = 86 *	M1
4		AE	E	max (63, 89) = 89	A1√
	B	BE	E	max (88, 89) = 89	
		BF	F	max (87, 86) = 87 *	
5	X	XA	A	max (55, 86) = 86 *	A1√ (3)
		XB	B	max (85, 87) = 87	

X A D H L Y (minimax = 86) M1 A1√ (2)

(b) X B F H/I L Y (minimax = 87) One M1 A1 (2)

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