Mark Scheme (Final)
Summer 2007

GCE

GCE Mathematics (6690/01)

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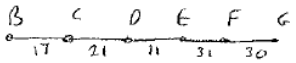
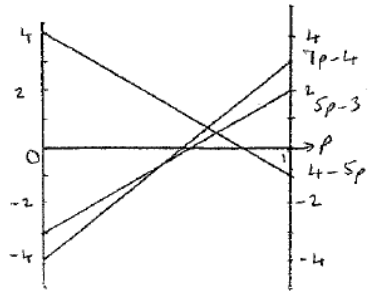
June 2007
6690 Decision Mathematics
Mark Scheme

Question Number	Scheme	Marks
1) (a)	Add 32 to AB + BA (ACB) 47 to AE + EA (ACDE) 32 to CE + EC (CDE) 53 to DG + GD (DCG)	B1 B1 B1 B1 (4)
(b)	A C B D E F G A 15 + 17 + 38 + 11 + 31 + 30 + 23 = 165 miles	m1 A1 A1 (3)
(c)	eg BC, CD, DE, EF, FG  weight of RSMT = 110 miles Lower bound = 110 + 15 + 23 = 148 miles	m1 A1 m1 A1 (4) 11

Question Number	Scheme	Marks
2) (a)	$\begin{bmatrix} 2 & -1 & 3 \\ -3 & 4 & -4 \end{bmatrix}$ Row min: -1 ← , -4 col max: 2 ↑, 4, 3 $2 \neq -1$ $\therefore$ 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)
	 $5p - 3 = 4 - 5p$ $10p = 7$ $p = \frac{7}{10}$	m1 A2,1,0 (3) 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) 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

$$\begin{bmatrix} 30 & 65 & 49 & 0 \\ 28 & 60 & 36 & 0 \\ 29 & 63 & 37 & 0 \\ 32 & 67 & 43 & 0 \end{bmatrix}$$

then columns

$$\begin{bmatrix} 2 & 5 & 13 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 3 & 1 & 0 \\ 4 & 7 & 7 & 0 \end{bmatrix}$$

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

$= 35$ minutes 32 seconds

m1 A1√

A1 (3)

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-θ	θ
2		65	
3		59+θ	21-θ

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.

	A1	A2	A3
R1	-6	3	-5
R2	2	-1	-4
R3	3	-2	1

Add 7

	A1	A2	A3
R1	1	10	2
R2	9	6	3
R3	10	5	8

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 $V - P_1 - 9P_2 - 10P_3 \leq 0$

$V - 10P_1 - 6P_2 - 5P_3 \leq 0$

$V - 2P_1 - 3P_2 - 8P_3 \leq 0$

$P_1 + P_2 + P_3 \leq 1$ accept =

$V, P_1, P_2, P_3 \geq 0$

M1 A1✓ A1✓ A1 (4) [8]

Alt 2

Add 4 to all entries

	R1	R2	R3
A1	10	2	1
A2	1	5	6
A3	9	8	3

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 $10x_1 + 2x_2 + x_3 \leq 1$

$x_1 + 5x_2 + 6x_3 \leq 1$

$9x_1 + 8x_2 + 3x_3 \leq 1$

$x_1, x_2, x_3 \geq 0$ accept $P_i \geq 0$

M1 A1✓ A1✓ A1 (4) [8]

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(a)

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

XA D H L Y (minimax = 86)

(b) X B F — H / I — L Y (minimax = 87) One

B1

m1
A1 A1
(4)

m1
A1√A1√
(3)

m1
A1√

A1√(3)

m1 A1√
(2)

m1 A1
(2)

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