

GCE

Mathematics (MEI)

Unit 4773: Decision Mathematics Computation

Advanced GCE

Mark Scheme for June 2014

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All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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	Question				Answer	Marks	Guidance
1	(i)						
			130	50			
			115	50			
			85	50			
			70	50			
			85	50		B1	130 and 115 used correctly
			115	50			
			130	50		B1	$u_n = u_{n-1} - 50 + x$
			115	50		_	
			85	50		B1	$x = 150 - u_{n-2}$
			70	50		D1	1 11 1.1 1
			85	50		B1	dealing with -ve orders
			115	50			
			130	50	Settles to cycle		
			115	50	85		
			85	50	70		
			70	50	85	B1	cycling
			85	50	115	DI	cycning
			115	50	130		
			130	50	115		
1	(ii)		$u_{n+2} = u_{n+1} - 50$	$0 + (150 - u_n),$	i.e. $u_{n+2} - u_{n+1} + u_n = 100$	M1	linear 2^{nd} order RR for u_{n+2}
						A1	either expression

	Juestio	on Answer	Marks	Guidance
1	(iii)	$\lambda^2 - \lambda + 1 = 0$	M1	$\lambda^2 - \lambda + 1$ ft
		$\lambda = \frac{1 \pm \sqrt{1-4}}{2} = \frac{1 \pm \sqrt{-3}}{2}$	A1	ft if discriminant < 0
		"oscillations" or "cycles"	B1	
1	(iv)	$u_{n+2} = u_{n+1} - 50 + 50 + \alpha(150 - u_n) (i.e. \ u_{n+2} - u_{n+1} + \alpha u_n = 150\alpha)$ auxiliary equation $\lambda^2 - \lambda + \alpha = 0$	B1 B1	
		discriminant of auxillary = $1 - 4\alpha = 0$ for $\alpha = 0.25$	B1 B1	discriminant + soln
		or for getting $(\lambda - 0.5)^2 = 0$ when $\alpha = 0.25$, so only one solution	or (B1B1)	factorisation + comment
1	(v)	130		
		115		
		120		
		128.75		
		136.25		
		141.5625		
		145	B1	by RR
		147.1094	B1 B1	by formula
		148.3594		-)
		149.082		
		149.4922		
		149.7217		
		149.8486		
		149.9182		
		149.9561		

Q	Question		Answer	Marks	Guidance
1	(vi)		130		
			115		
			120	B1	rounding
			129	DI	Tounding
			137		
			142		
			145		
			147		
			148		
			149		
			150		
			150		
1	(vii)		OK for demand ≤ 87	B1	

Q	uestio	n			Ansv	ver	Marks	Guidance
2	2 (i)		arr rate arrival int arrival ti	0.5 me number	capacity run time serv time	160 dep time 311 240	M1 A1	arrival interval table + lookup
			1 2	1 1 3 2	550 548	arr time 551	B1	arrival times
			2 2	5 3 7 4	546 544	mean serv 395.56 secs	M1 A1	subtraction of arrival times finding service times
_	(1)		1 1	8 5 9 6	543 542	i.e. 6 mins 36 secs	B1	mean service time
2	(ii)			•	·	ength will not exceed the cabin capacity, so skiers wi – each for the same time.	l B1	
2	(iii)		e.g. 6m45s 6m38s	6m49s 6m4	0s 6m24s 6m	133s 6m27s 6m54s 6m21s 6m34s	M1A1	
2	(iv)		Skiers rarely arrive sin	ıgly			B1	
2	(v)		arr rate	0.5	capacity run time	120 dep time 241 180 241 241	B1	new fill criterion +
			arrival int arrival ti 2	me number 2 1	serv time 419	arr time 421		new run time
			1 1	3 2 4 3	417			
			3 2 2	7 4 9 5 11 6	412	mean serv 296.60 secs i.e. 4 mins 57 secs		
				6 5.25 5.13 4		5.01 4.43	B1	
			Down from about 6.5	mins to 5 mins.			B 1	

Q	uestio	n						Answe	er						Marks	Guidance
2	(vi)		arr rate	0.5		capacity run time	120 180		dep time loaded	240 119					B1	recording 10 dep times and loadings
			arrival int 3 1 2 1 3 3 Mean time	arrival time 232 233 235 236 239 242 should be re	115 116 117 118 119 120	serv time 188 187 185 184 181 178	loading flag 1 1 1 1 0	188 187 185 184 181 0		arr time mean serv i.e.	420 297.92 4	secs mins	58	secs	B1 B1 B1	departure time = min of full time & 4 mins adjusting mean service time correctly- difficult- needn't be automated
2	(vii)									urney time of 3 l to impinge on		rip.)			B1	

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(Question			Marks	Guidance	
3	(i)		max M			
			st M<65			
			M<37			
			M<19		B1	entering
			M<54			
			M<23		B1	running
			end		DI	running
			Gives $M = 19 \dots$ minimum		B1	M=19
					B1	minimum
					DI	11111111111111
	(ii)		max Y			
			st M-R1<0			
			M-R2<0			
			M-R3<0 M-R4<0			
			M-R4<0 M-R5<0			
			Y-M+2R1+2R2+2R3+2R4+2R5=0			
			R1>23			
			R1>42			
			R1>35		B1	Y constraint
			R1>52		B1	M constraints
			R2>23		B1	rest
			R2>37		DI	iest
			R2>29			
			R2>43			
			R3>42		B1	running
			R3>37		DI	running
			R3>18			
			R3>50			
			R4>35			
			R4>29			
			R4>18 R4>32			
			R5>52			
			R5>43	M gives the row minimax.	B1	
			R5>50	wi gives the row minimax.	ום	
			R5>32	The second science has the extremely and the Dorshid science of the D	D1	
			end	The row is given by the subscript on the R_i which matches M.	B1	
			free Y			

Q	Juestion	Answer	Marks	Guidance
3	(iii)	Need the minimax of the shortest distances from each vertex	B1	minimax
			B1	shortest distances
		Find the matrix of shortest distances. Need the minimax row (or column).	B1B1	
		Solve using LP as per part (ii) (or by inspection for this small problem).	B1	
3	(iv)	Best vertices are A, B, D and F (all with a minimax of 8).	B1	
3	(v)	Problem size big	B1	
3	(vi)	e.g. Point midway between A and B has minimax of 6.5. (Or 6 if 0.6 of way from A to B.)	B1	

	Question		Answer	Marks	Guidance
4	(i)	min st	12F1N+5F1S+7F2N+15F2S+5NS+5SN+13NA+4SA+15NB+12SB+7NC+14SC+7ND+17SD+20NE +11SE+21NF+10SF+14NG+7SG+11NH+8SH+8NI+14SI+9NJ+15SJ F1N+F1S<1000 F2N+F2S<750 SN<200 NS<200 NA+SA=170 NB+SB=70	M1 A2 B1 B1 B1	 1 each error/omission production constraints internal movement constraints (both)
			NC+SC=400 ND+SD=150 NE+SE=80 NF+SF=120 NG+SG=50 NH+SH=175 NI+SI=200	M1 A1	supply requirements
		end	NJ+SJ=300 NA+NB+NC+ND+NE+NF+NG+NH+NI+NJ+NS-F1N-F2N-SN=0 SA+SB+SC+SD+SE+SF+SG+SH+SI+SJ+SN-F1S-F2S-NS=0	B1 B1	linking equations

	Question	1	Answer	Marks	Guidance
4	(ii)	Varia	ble Value		
		F1N	0.00000		
		F1S	965.0000		
		F2N	750.0000		
		F2S	0.00000		
		NS	0.00000		
		SN	200.0000		
		NA	0.00000		
		SA	170.0000		
		NB	0.00000		
		SB	70.00000		
		NC	400.0000		
		SC	0.00000		
		ND	150.0000		
		SD	0.00000		
		NE	0.00000		
		SE	80.00000		
		NF	0.00000		
		SF	120.0000	B1	running
		NG	0.00000	DI	Tulling
		SG	50.00000		
		NH	0.00000		
		SH	175.0000		
		NI	200.0000		
		SI	0.00000		
		NJ	200.0000		
		SJ	100.0000		

Mark Scheme

Quest	ion		Answer											Marks	Guidance	
		To cent	res:													
				F1	F2	N	S								M1	
			Ν	0	750	0	200								A1	
			S	965	0	0	0									
		From ce	entres:					1	1	1	1		7			
							E	F	-		Ι	J	_		N/1	
				Ŷ		00 150		0	0	0	200		_			
			S	170	70 0) 0	80	120	50	175	0	100			AI	
															D 1	
		Total co	$\operatorname{ost} = \pounds 2$	25175											DI	
(•••)			1	<u>с с</u>	, · ,										D1	
(m)		Deliver	direct	from fac	ctories t	o some sl	nops.								RI	
		Doloy/r	movo	oonstrai	nt on to	nnogo m	oved be	twoon	contro						D 1	
		Kelax/I	emove	constrai	nt on to	image m	oved be	tween	centre	.8.					DI	
	Quest	Question	To cent From ce (iii) Deliver	NSFrom centres:NS \overline{S} Total cost = £2(iii)Deliver direct for the second	To centres: I I I N 0 S 965 From centres: A N 0 S 170 S 170 Total cost = £25175(iii)Deliver direct from factors	To centres: F1 F2 N 0 750 S 965 0 From centres: A B C N 0 0 40 S 170 70 C Total cost = £25175 Deliver direct from factories to	F1 F2 N N 0 750 0 S 965 0 0 From centres: A B C D N 0 0 400 150 S 170 70 0 0 Total cost = £25175 Total cost some sl Image: State s	F1 F2 N S N 0 750 0 200 S 965 0 0 0 From centres: A B C D E N 0 0 400 150 0 S 170 70 0 0 80 Total cost = £25175 Image: Cost = £25175 Image: Cost = £25175 Image: Cost = £25175	F1 F2 N S N 0 750 0 200 S 965 0 0 0 From centres: A B C D E F N 0 0 400 150 0 0 S 170 70 0 80 120 Total cost = £25175 (iii) Deliver direct from factories to some shops.	F1 F2 N S N 0 750 0 200 S 965 0 0 0 From centres: A B C D E F G N 0 0 400 150 0 0 0 S 170 70 0 0 80 120 50 Total cost = £25175 (iii) Deliver direct from factories to some shops.	To centres: F1 F2 N S N 0 750 0 200 S 965 0 0 0 From centres: A B C D E F G H N 0 0 400 150 0 0 0 S 170 70 0 0 80 120 50 175 Total cost = £25175 Total cost = £25175 F <th>Image: Figure 1 bit is a structure of the image in the image in</th> <th>To centres: F1 F2 N S N 0 750 0 200 S 965 0 0 0 From centres: A B C D E F G H I J N 0 0 400 150 0 0 0 200 200 S 170 70 0 0 80 120 50 175 0 100 Total cost = £25175 Identification of the stories to some shops.</th> <th>Image: Too centres: F1 F2 N S N 0 750 0 200 S 965 0 0 0 From centres: A B C D E F G H I J N 0 0 400 150 0 0 0 200 200 S 170 70 0 0 80 120 50 175 0 100 Total cost = £25175 Image: Cost = £25175 I</th> <th>F1 F2 N S N 0 750 0 200 S 965 0 0 0 From centres: A B C D E F G H I J N 0 0 400 150 0 0 0 200 200 S 170 70 0 0 80 120 50 175 0 100 Total cost = £25175 (iii) Deliver direct from factories to some shops. Image: Some shops. Image: Some shops. Image: Some shops.</th> <th>Image: Construct of the image of the i</th>	Image: Figure 1 bit is a structure of the image in	To centres: F1 F2 N S N 0 750 0 200 S 965 0 0 0 From centres: A B C D E F G H I J N 0 0 400 150 0 0 0 200 200 S 170 70 0 0 80 120 50 175 0 100 Total cost = £25175 Identification of the stories to some shops.	Image: Too centres: F1 F2 N S N 0 750 0 200 S 965 0 0 0 From centres: A B C D E F G H I J N 0 0 400 150 0 0 0 200 200 S 170 70 0 0 80 120 50 175 0 100 Total cost = £25175 Image: Cost = £25175 I	F1 F2 N S N 0 750 0 200 S 965 0 0 0 From centres: A B C D E F G H I J N 0 0 400 150 0 0 0 200 200 S 170 70 0 0 80 120 50 175 0 100 Total cost = £25175 (iii) Deliver direct from factories to some shops. Image: Some shops. Image: Some shops. Image: Some shops.	Image: Construct of the image of the i

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