

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	(iii)	$\lambda^2 - \lambda + 1 = 0$ $\lambda = \frac{1 \pm \sqrt{1-4}}{2} = \frac{1 \pm \sqrt{-3}}{2}$ <p>“oscillations” or “cycles”</p>	M1 A1 B1	$\lambda^2 - \lambda + 1$ ft ft if discriminant < 0
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 $\lambda^2 - \lambda + \alpha = 0$ discriminant of auxillary = $1 - 4\alpha = 0$ for $\alpha = 0.25$ or for getting $(\lambda - 0.5)^2 = 0$ when $\alpha = 0.25$, so only one solution	B1 B1 B1 B1 or (B1B1)	discriminant + soln factorisation + comment
1	(v)	130 115 120 128.75 136.25 141.5625 145 147.1094 148.3594 149.082 149.4922 149.7217 149.8486 149.9182 149.9561	B1 B1	by RR by formula

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

Question		Answer										Marks	Guidance
2	(i)	arr rate	0.5	capacity	160	dep time	311					M1 A1	arrival interval table + lookup
				run time	240								
		arrival int	arrival time	number	serv time								
		1	1	1	550	arr time	551					B1	arrival times
		2	3	2	548								
		2	5	3	546							M1	subtraction of arrival times
		2	7	4	544	mean serv	395.56 secs					A1	finding service times
		1	8	5	543	i.e.	6 mins 36 secs						
		1	9	6	542							B1	mean service time
2	(ii)	At an arrival rate of 1 skier every 2 seconds the queue length will not exceed the cabin capacity, so skiers will simply be waiting on the platform rather than in the cabin – each for the same time.										B1	
2	(iii)	e.g. 6m45s 6m38s 6m49s 6m40s 6m24s 6m33s 6m27s 6m54s 6m21s 6m34s										M1A1	
2	(iv)	Skiers rarely arrive singly										B1	
2	(v)	arr rate	0.5	capacity	120	dep time	241					B1	new fill criterion + new run time
				run time	180								
		arrival int	arrival time	number	serv time								
		2	2	1	419	arr time	421						
		1	3	2	418								
		1	4	3	417								
		3	7	4	414	mean serv	296.60 secs						
		2	9	5	412	i.e.	4 mins 57 secs						
		2	11	6	410								
		e.g. 5.02 4.52 4.46 5.25 5.13 4.47 4.53 5.05 5.01 4.43										B1	
		Down from about 6.5 mins to 5 mins.										B1	

Question		Answer										Marks	Guidance
2	(vi)	arr rate	0.5	capacity	120	dep time	240					B1	recording 10 dep times and loadings
				run time	180	loaded	119						
		arrival int	arrival time	number	serv time	loading flag						B1	departure time = min of full time & 4 mins
		3	232	115	188	1	188	arr time	420				
		1	233	116	187	1	187					B1	adjusting mean service time correctly-difficult-needn't be automated
		2	235	117	185	1	185						
		1	236	118	184	1	184	mean serv	297.92 secs				
		3	239	119	181	1	181	i.e.	4 mins 58 secs				
		3	242	120	178	0	0						
		Mean time should be reduced slightly.										B1	
2	(vii)	If the arrival rate is such that more than 120 skiers could arrive during the journey time of 3 minutes. (A queue would then have to be modelled, with some skiers being left behind to impinge on the next trip.)										B1	

Question		Answer	Marks	Guidance
3	(iii)	<p>Need the minimax of the shortest distances from each vertex</p> <p>Find the matrix of shortest distances. Need the minimax row (or column).</p> <p>Solve using LP as per part (ii) (or by inspection for this small problem).</p>	<p>B1</p> <p>B1</p> <p>B1B1</p> <p>B1</p>	<p>minimax</p> <p>shortest distances</p>
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)	<p>e.g.</p> <p>Point midway between A and B has minimax of 6.5.</p> <p>(Or 6 if 0.6 of way from A to B.)</p>	B1	

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

Question		Answer	Marks	Guidance
4	(ii)	Variable Value F1N 0.000000 F1S 965.0000 F2N 750.0000 F2S 0.000000 NS 0.000000 SN 200.0000 NA 0.000000 SA 170.0000 NB 0.000000 SB 70.00000 NC 400.0000 SC 0.000000 ND 150.0000 SD 0.000000 NE 0.000000 SE 80.00000 NF 0.000000 SF 120.0000 NG 0.000000 SG 50.00000 NH 0.000000 SH 175.0000 NI 200.0000 SI 0.000000 NJ 200.0000 SJ 100.0000	B1	running

Question		Answer	Marks	Guidance																																																
		<p>To centres:</p> <table border="1"> <tr> <td></td> <td>F1</td> <td>F2</td> <td>N</td> <td>S</td> </tr> <tr> <td>N</td> <td>0</td> <td>750</td> <td>0</td> <td>200</td> </tr> <tr> <td>S</td> <td>965</td> <td>0</td> <td>0</td> <td>0</td> </tr> </table> <p>From centres:</p> <table border="1"> <tr> <td></td> <td>A</td> <td>B</td> <td>C</td> <td>D</td> <td>E</td> <td>F</td> <td>G</td> <td>H</td> <td>I</td> <td>J</td> </tr> <tr> <td>N</td> <td>0</td> <td>0</td> <td>400</td> <td>150</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>200</td> <td>200</td> </tr> <tr> <td>S</td> <td>170</td> <td>70</td> <td>0</td> <td>0</td> <td>80</td> <td>120</td> <td>50</td> <td>175</td> <td>0</td> <td>100</td> </tr> </table> <p>Total cost = £25175</p>		F1	F2	N	S	N	0	750	0	200	S	965	0	0	0		A	B	C	D	E	F	G	H	I	J	N	0	0	400	150	0	0	0	0	200	200	S	170	70	0	0	80	120	50	175	0	100	<p>M1 A1</p> <p>M1 A1</p> <p>B1</p>	
	F1	F2	N	S																																																
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N	0	0	400	150	0	0	0	0	200	200																																										
S	170	70	0	0	80	120	50	175	0	100																																										
4	(iii)	<p>Deliver direct from factories to some shops.</p> <p>Relax/remove constraint on tonnage moved between centres.</p>	<p>B1</p> <p>B1</p>																																																	

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