OCR
Oxford Cambridge and RSA

GCE

Mathematics (MEI)

Unit **4773**: Decision Mathematics Computation

Advanced GCE

Mark Scheme for June 2014

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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

Question			Answer	Marks	Guidance
1	(iii)		$\lambda^2 - \lambda + 1 = 0$ $\lambda = \frac{1 \pm \sqrt{1-4}}{2} = \frac{1 \pm \sqrt{-3}}{2}$ "oscillations" or "cycles"	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 run time 240 arrival int / arrival time / number / serv time 1 / 1 / 1 / 550 arr time 551 2 / 3 / 2 / 548 2 / 5 / 3 / 546 2 / 7 / 4 / 544 mean serv 395.56 secs 1 / 8 / 5 / 543 i.e. 6 mins 36 secs 1 / 9 / 6 / 542	M1 A1 B1 M1 A1 B1	arrival interval table + lookup arrival times subtraction of arrival times finding service times 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 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 Down from about 6.5 mins to 5 mins.	B1 B1 B1 B1	new fill criterion + new run time

Question			Answer	Marks	Guidance
2	(vi)		arr rate 0.5 capacity 120 dep time 240 run time 180 loaded 119 arrival int / arrival time / number / serv time / loading flag 3 232 115 188 1 188 arr time 420 1 233 116 187 1 187 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 B1 B1 B1	recording 10 dep times and loadings departure time = min of full time & 4 mins adjusting mean service time correctly- difficult- needn't be automated
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	(i)		max M st M<65 M<37 M<19 M<54 M<23 end	B1	entering
				B1	running
			Gives M = 19 ... minimum	B1	M=19
				B1	minimum
	(ii)		max Y st M-R1<0 M-R2<0 M-R3<0 M-R4<0 M-R5<0 Y-M+2R1+2R2+2R3+2R4+2R5=0 R1>23 R1>42 R1>35 R1>52 R2>23 R2>37 R2>29 R2>43 R3>42 R3>37 R3>18 R3>50 R4>35 R4>29 R4>18 R4>32 R5>52 R5>43 R5>50 R5>32 end free Y	B1	Y constraint
				B1	M constraints
				B1	rest
				B1	running
			M gives the row minimax.	B1	
			The row is given by the subscript on the R_i which matches M.	B1	

Question			Answer	Marks	Guidance
3	(iii)		Need the minimax of the shortest distances from each vertex Find the matrix of shortest distances. Need the minimax row (or column). Solve using LP as per part (ii) (or by inspection for this small problem).	B1 B1 B1B1 B1	minimax shortest distances
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 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

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td></td><td></td><td>To centres:
<table><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>
From centres:
<table><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>
Total cost = £25175</td><td>M1
A1

M1
A1

B1</td><td></td></tr>
<tr><td>4</td><td>(iii)</td><td></td><td>Deliver direct from factories to some shops.

Relax/remove constraint on tonnage moved between centres.</td><td>B1

B1</td><td></td></tr>
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