GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics and Statistics B
MBD2

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Key to Mark Scheme

M	mark is for	method
m	mark is dependent on one or more M marks and is for	method
A	mark is dependent on M or m marks and is for	accuracy
B	mark is independent of M or m marks and is for	accuracy
E	mark is for	explanation
√or ft or F		follow through from previous incorrect result
cao		correct answer only
cso		correct solution only
awfw		anything which falls within
awrt		anything which rounds to
acf		any correct form
ag		answer given
sc		special case
oe		or equivalent
sf		significant figure(s)
dp		decimal place(s)
A2,1		2 or 1 (or 0) accuracy marks
–*x* ee		deduct *x* marks for each error
pi		possibly implied
sca		substantially correct approach

Abbreviations used in Marking

MC – *x*	deducted *x* marks for mis-copy
MR – *x*	deducted *x* marks for mis-read
isw	ignored subsequent working
bod	given benefit of doubt
wr	work replaced by candidate
fb	formulae book

Application of Mark Scheme

No method shown:	
Correct answer without working	**mark as in scheme**
Incorrect answer without working	**zero marks unless specified otherwise**
More than one method / choice of solution:	
2 or more complete attempts, neither/none crossed out	**mark both/all fully and award the mean mark rounded down**
1 complete and 1 partial attempt, neither crossed out	**award credit for the complete solution only**
Crossed out work	**do not mark unless it has not been replaced**
Alternative solution **using a correct or partially correct method**	**award method and accuracy marks as appropriate**

Mathematics and Statistics B Discrete 2 MBD2 June 2004

Question Number and Part	Solution	Marks	Total	Comments
1(a)(i)	Nearest neighbour approach gives *A E B C F G H D A*	M1 A1 A1	 3	
(ii)	It uses **all** the 1p links	B1	1	
(b)(i)	Odd vertices *A B C G* Pairings *AB CG*; 2 + 2 *AC BG*; (2 +1) + 2 *AG BC*; (2 +2) + 1 So repeat *AB* and *CG*	M1 A1 A1 A1	 4	
(ii)	Repeat *BC* (=1), with message starting at *A* and finishing at *G*.	B1 B1	 2	
	Total		**10**	
2 (a)	Auxiliary equation $m^2 - 5m + 6 = 0$ has roots 2 and 3. General solution $u_n = A.2^n + B.3^n$	M1 A1 A1 A1√	 4	 ft
(b)	Try $u_n = k$ to give $k - 5k + 6k = 1$ and $k = \frac{1}{2}$ General solution $u_n = A.2^n + B.3^n + \frac{1}{2}$	M1 A1 A1	 3	
	Total		**7**	
3 (a)(i)	Hamming distance = 4	M1 A1	2	
(ii)	Can correct 1 error per word	B1	1	
(b)(i)	e.g. $\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 \end{bmatrix}$	B1 M1 A1	 3	(or M1 A1 A1 for 2 non-zero words)
(ii)	Matrix × $(1\ 1\ 0\ 0\ 1\ 1)^T$ and $(0\ 1\ 1\ 0\ 0\ 1)^T$ gives $(0\ 0\ 0)^T$ and $(1\ 0\ 1)^T$ So 1st correct, 2nd has error in 4th place, correcting to 110011011101	M1 A1 M1 A1	 4	 **sc** B1 for answer only
	Total		**10**	

MBD2 (cont)

Question Number and Part	Solution	Marks	Total	Comments
4(a)	$P = 3x + 2y + 2z$	B1	1	
(b)(i)	***P x y z s t u***	M1		Choice of pivot
	1 0 1 -½ 0 1½ 0 225	A1		and pivot → 1
	0 0 0 ½ 1 -½ 0 5	M1		Row deductions
	0 (1) 1 ½ 0 ½ 0 75	A1		
	0 0 1 2 0 -1 1 30	A1	5	
(ii)	Still a negative in top row	B1	1	
4(c)	***P x y z s t u***			
	1 0 1 0 1 1 0 230	M1		
	0 0 0 (1) 2 -1 0 10	A1		
	0 1 1 0 -1 1 0 70	A1		
	0 0 1 0 -4 1 1 10	A1	4	
(d)	Maximum of P is 230 at (70,0,10)	B1√ B1√	2	ft near misses
(e)	Slack variable $u \neq 0$. Third inequality has slack; i.e. $2x + 3y + 3z \leq 180$	M1 A1	2	(or test each inequality)
	Total		**15**	
5 (a)	$2^9 = 512$	M1 A1	2	
(b)(i)	Half the number e.g. By symmetry: each code with an even number of blacks corresponds (by colour change) to one with an odd number of blacks.	B1 B1	2	(or direct count)
(ii)	Can detect **one** error per bar code	B1 B1	2	
(c)	9:256, 10:512, 11:1024, 12:2048 So increase to 12 strips (or more)	M1 A1	2	
(d)	Reverse of one code can equal a different code. e.g Add an additional black strip on the left and white strip on the right.	B1 M1 A1	3	
	Total		**11**	

MBD2 (cont)

Question Number and Part	Solution	Marks	Total	Comments
6 (a)	Vertices S and T Arcs SS_1, SS_2, T_1T, T_2T and T_3T Capacities 18, 15, 10, 13, 12 (or more) respectively	M1 A1	 2	
(b) (i)	8 + 2 + 5 + 4 + 12 = 31	B1	1	
(ii)	AB AC DC DE (or AB CB CT_2 CE DE)	M1 A1	 2	
(c)	e.g. SS_1ABT_1T: 8 SS_1DET_3T: 7 SS_2DCET_3T: 5 SS_2DACT_2T: 5 SS_1ACBT_2T: 2 SS_1DCET_2T: 3	M1 A1 A1 A1 A1 A1	 6	
(d)	All flows ≤ all cuts So, by (b)(ii), all flows ≤ 30. Hence the flow of 30 is maximum possible.	M1 A1	 2	
(e)	e.g. For T_1 to get 10 BT_1 will have a flow of 10. Then, looking at vertex B, max inflow = 10. Hence BT_2 has 0 flow. So maximum arriving at T_2 is from CT_2 and ET_2 with a total capacity of 9.	M1 A1 A1	 3	
	Total		**16**	

MBD2 (cont)

Question Number and Part	Solution	Marks	Total	Comments
7 (a)(i)	Can take any 1 of the 6 vertical paths	M1 A1	2	(or draw the paths)
(ii)	$n + 1$	B1	1	
(b)(i)	Answer = no. of ways of proceeding from C to B = $n + 1$ from (a)(ii)	B1	1	
(ii)	From D same situation as from A but $n - 1$ wide	B1	1	
(iii)	From A can move to D or C ; R_{n-1} of first type, $n + 1$ of second. R_1 = no of routes with just two vertical squares (so three choices of horizontal route) = 3	M1 A1 B1	3	
(iv)	$R_n = R_{n-1} + (n + 1)$ $= R_{n-2} + n + (n + 1)$ … $= R_1 + (3 + 4 + \ldots + (n + 1))$ $= 3 + (3 + 4 + \ldots + (n + 1))$ $= 1 + 2 + 3 + \ldots + (n + 1)$	M1 A1 A1	3	(or formally solve the recurrence relation)
	Total		**11**	
	TOTAL		**80**	