GCE 2005
January 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	method and accuracy
E	mark is for	explanation
√ or ft or F		follow through from previous incorrect result
CAO		correct answer only
AWFW		anything which falls within
AWRT		anything which rounds to
AG		answer given
SC		special case
OE		or equivalent
A2,1		2 or 1 (or 0) accuracy marks
-*x* EE		deduct *x* marks for each error
NMS		no method shown
PI		possibly implied
SCA		substantially correct approach
c		candidate
SF		significant figure(s)
DP		decimal place(s)

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 booklet

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 Jan 2005

Question Number and Part	Solution	Marks	Total	Comments
1(a)	Using the formula gives $p_n = p_1.2^{n-1} + 1.(2^{n-1} - 1)/(2 - 1)$ $= 2^{n-1} - 1$	M1 A1 A1 B1	4	or by iterating with the formula
(b)	$p_4 = 7$, $p_5 = 15$	B1	1	any method
(c)	{a}{bcd} {b}{acd} {c}{abd} {d}{abc} {ab}{cd} {ac}{bd} {ad}{bc}	M1 A1 A1	3	For four pairs For rest
	Total		**8**	
2(a)(i)	*P S T* ... ... *Q U W*... ... *R V P* Total 3+4+3+5+3+5+3+4 = 30 miles	M1 A1 A1 B1	4	
(ii)	e.g. *QT, RV, UW* *TS* *QU, RW* Total 3+3+3+4+5+5 = 23 miles	M1 A1 A1 B1	4	
(iii)	Hamiltonian route ≥ Min conn + lowest two links to P = 23 + 3 + 4 = 30. So the 30 found in (a) is best possible.	M1 A1 A1	3	
(b)(i)	The graph is K_8 with eight vertices of odd degree. This needs at least four edges to make it Eulerian.	M1 A1	2	
(ii)	In order to add only 12 miles of roads look at the 4 roads of length 3 miles; *PS QT RV UW.* These do pair off the eight odd vertices and so repeating these roads will create an Eulerian graph.	M1 A1 A1	3	
	Total		**16**	

MBD2 (cont)

Question Number and Part	Solution	Marks	Total	Comments
3(a)	To spot errors	B1	1	
(b)	3(0+4+2+9)+2+0+3+2+8=60	B1	1	
(c)	Total 61. Need to lose 1 (or 3.7) or gain 9 (or 3.3). 200432298 200422299 200432199 200432229 200435299	M1 A1 A1 A1	 4	
(d)	Need to add 2 (or 12) or take away 8 (or 18), so want 200423296	M1 A1	 2	
(e)	10^4	M1 A1	2	or 9999
(f)	$x_1+3x_2+x_3+3x_4+x_5+3x_6+x_7+3x_8+x_9$ is even, so taking away $2x_2$ etc leaves $x_1+x_2+x_3+x_4+x_5+x_6+x_7+x_8+x_9$ even	M1 A1	 2	
	Total		**12**	
4(a)	Slack variables	B1	1	
(b)	4	B1	1	
(c)	*P* *x* *y* *z* *s* *t* *u* *v* 1 0 0 0 1 0 1 2 100 0 0 0 1 0 0 1 0 55 0 0 0 0 2½ 1 –½ 1½ 5 0 **1** 0 0 –½ 0 ½ ½ 20 0 0 1 0 ½ 0 –½ 3½ 10	M1 A1 M1 A1 A1	 5	Choice of pivot and making it 1 Row operations
(d)	Optimal since no negatives in top row $P = 100$ $x = 20$, $y = 10$, $z = 55$	B1 B1√ B1√	 3	 ft ft
(e)	$s = u = v = 0$, $t = 5$ Slack in one inequality	B1 B1	 2	
	Total		**12**	

MBD2 (cont)

Question Number and Part	Solution	Marks	Total	Comments
5(a)	SC, SB, AT	M1 A1	2	
(b)(i)	*S C T* 1	M1 A1	2	
(ii)	*S A B C T* 2	M1 A1	2	
(c)	any flow ≤ any cut so any flow ≤ 16	B1	1	
(d)	Choose *AT*. The arc must be in the minimum cut in (a). Also it must be in {*AT, BT, CT*} which is a cut of 17.	B1 M1 A1	3	
	Total		**10**	
6(a)	$u_n + 2u_{n-1} - 3u_{n-2} = 0$ $M^2 + 2M - 3 = 0$ M = -3 or 1 General solution $u_n = A(-3)^n + B$	 M1 A1 A1 B1	4	
(b)	$kn + 2k(n-1) - 3k(n-2) = 16 \Rightarrow$ $4k = 16$ and $k = 4$.	M1 A1 B1	3	
(c)	$u_n = A(-3)^n + B + 4n$	B1√	1	ft
(d)	$u_0=1 \Rightarrow A + B = 1$ $u_1=1 \Rightarrow -3A + B + 4 = 1$ Solving gives A=1, B=0. Solution $u_n = (-3)^n + 4n$	M1 A1 A1 B1	4	
	Total		**12**	
7(a)(i)	0000000 1100000 1111000 1110111 0010111 1101111	M1 A1 A1 A1	4	from matrix or by use of matrix/linear relations
(ii)	Hamming distance 2, detect 1 error	B1 B1	2	fuller answers possible
(iii)	Matrix × $(1100100)^T$, $(0110111)^T$ gives $(0\ 0\ 1\ 1)^T$, $(1\ 0\ 0\ 0)^T$ So first has error in 5th place and second has error in 1st or 2nd ⇒ 11000001110111 or 11000000010111	M1 A1 M1 A1	4	
	Total		**10**	
	TOTAL		**80**	