

# GCE 2005

## *January Series*



# Mark Scheme

## Mathematics and Statistics B

*(MBD2)*

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Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

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## Key to Mark Scheme

<b>M</b> .....	mark is for .....	method
<b>m</b> .....	mark is dependent on one or more M marks and is for .....	method
<b>A</b> .....	mark is dependent on M or m marks and is for .....	accuracy
<b>B</b> .....	mark is independent of M or m marks and is for .....	method and accuracy
<b>E</b> .....	mark is for .....	explanation
<b>√ or ft or F</b> .....	follow through from previous	incorrect result
<b>CAO</b> .....	correct answer only	
<b>AWFW</b> .....	anything which falls within	
<b>AWRT</b> .....	anything which rounds to	
<b>AG</b> .....	answer given	
<b>SC</b> .....	special case	
<b>OE</b> .....	or equivalent	
<b>A2,1</b> .....	2 or 1 (or 0) accuracy marks	
<b>-x EE</b> .....	deduct $x$ marks for each error	
<b>NMS</b> .....	no method shown	
<b>PI</b> .....	possibly implied	
<b>SCA</b> .....	substantially correct approach	
<b>c</b> .....	candidate	
<b>SF</b> .....	significant figure(s)	
<b>DP</b> .....	decimal place(s)	

## Abbreviations used in Marking

<b>MC – <math>x</math></b> .....	deducted $x$ marks for mis-copy
<b>MR – <math>x</math></b> .....	deducted $x$ marks for mis-read
<b>ISW</b> .....	ignored subsequent working
<b>BOD</b> .....	given benefit of doubt
<b>WR</b> .....	work replaced by candidate
<b>FB</b> .....	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 $p_n = p_1 \cdot 2^{n-1} + 1 \cdot (2^{n-1} - 1) / (2 - 1)$ $= 2^{n-1} - 1$	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
<b>Total</b>			<b>8</b>	
2(a)(i)	$PST \dots$ $\dots QUW \dots$ $\dots RVP$ 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 $\geq$ 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; $PS \quad QT \quad RV \quad UW$ . These do pair off the eight odd vertices and so repeating these roads will create an Eulerian graph.	M1 A1 A1	3	
<b>Total</b>			<b>16</b>	

**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	
<b>Total</b>			<b>12</b>	
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 <u>1</u> 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	
<b>Total</b>			<b>12</b>	

**MBD2 (cont)**

Question Number and Part	Solution	Marks	Total	Comments
5(a)	SC, SB, AT	M1 A1	2	
(b)(i)	$SCT \ 1$	M1 A1	2	
(ii)	$SABCT \ 2$	M1 A1	2	
(c)	any flow $\leq$ any cut so any flow $\leq 16$	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	
<b>Total</b>			<b>10</b>	
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 $\checkmark$	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	
<b>Total</b>			<b>12</b>	
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 $\times (1100100)^T, (0110111)^T$ gives $(0 \ 0 \ 1 \ 1)^T, (1 \ 0 \ 0 \ 0)^T$ So first has error in 5 <sup>th</sup> place and second has error in 1 <sup>st</sup> or 2 <sup>nd</sup> $\Rightarrow 11000001110111$ or $11000000010111$	M1 A1 M1 A1	4	
<b>Total</b>			<b>10</b>	
<b>TOTAL</b>			<b>80</b>	