ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics and Statistics 6320
Specification B

MBD2 Discrete 2

Mark Scheme

2005 examination - June series

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.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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
$\surd$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

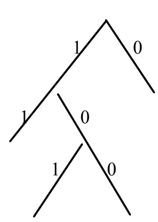
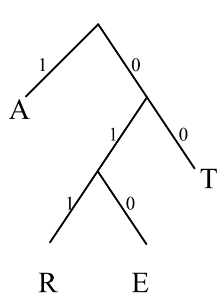
Abbreviations used in Marking

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 2005

Q	Solution	Marks	Total	Comments
1(a)(i)	There are vertices of odd degree, so the network is not Eulerian.	B1	1	
(ii)	Odd vertices: *A B F H*	M1		
	Pairings *AB FH*: adds 80+60	A1		
	AF BH: adds >>140			
	AH BF: adds >>140	A1		
	So shortest route has length 1100 + 140 = 1240 metres.	B1	4	
(iii)	e.g.*AHFDBACGHFBCEGFEBA*	M1A1		
		A1	3	
(b)(i)	*ACEGHFDBA*	M1A1		
	50+50+50+50+60+70+60+80=470	A1	3	
(ii)	*AH* + seven other arcs each ≥ 50	B1	1	
(iii)	Only two footpaths out of *A* are *AB, AC*. Similarly for *D* and *H*.	B1		
	Then the only way to complete the route via *E* is with *CE, EG*.	B1	2	
(iv)	(ii) the route of 470 beats any involving *AH*.	M1		
	By (iii) the route of 470 is the *only* one not using *AH* and hence is the shortest.	A1	2	
	Total		**16**	
2(a)	111101100	B1	1	
(b)	REAR	B1	1	
(c)		M1 A1	2	
(d)(i)	T=00	B1		
	T is at start and finish and T=0 $\Rightarrow$ word starts TT	B1	2	
(ii)		M1 A1	2	
	Total		**8**	

MBD2 (cont)

Q	Solution	Marks	Total	Comments
3(a)	Aux: $M^2 - M - 2 = 0$, roots 2, –1	M1A1		(or substitute given answer into the relation)
	So comp function is $A.2^n + B.(-1)^n$	A1		
	Particular solution $u_n = -\frac{1}{2}$ gives	M1		
	$(-\frac{1}{2}) - (-\frac{1}{2}) - 2.(-\frac{1}{2}) - 1$	A1	5	
	So general solution is these two added.			
(b)(i)	$u_0=0 \Rightarrow A + B - \frac{1}{2} = 0$			
	$u_1=1 \Rightarrow 2A - B - \frac{1}{2} = 1$	M1		
	Solving gives A = 2/3, B= –1/6	A1		
	and $u_n = (2/3)2^n - (-1)^n/6 - \frac{1}{2}$	A1	3	
(ii)	$u_n = 2^{n+1}/3 - 1/6 - 1/2$ (n even)	B1		
	$u_n = 2^{n+1}/3 + 1/6 - 1/2$ (n odd)	B1		
	So the integer u_n is $2^{n+1}/3$ with its fractional bit removed.	B1	3	
	Total		**11**	
4(a)	000000	B1		
	e.g. 001110 + 110011 = 111101	M1		
	and 110011 + 100010 = 010001	A1	3	
(b)	$3^{rd} = 4^{th}$	B1		
	$\begin{pmatrix} 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 & 0 \end{pmatrix}$	M1 A1√	3	ft
(c)	matrix $\times (0\ 1\ 0\ 0\ 0\ 1)^T = (0\ 0\ 0)^T$	M1		
	matrix $\times (1\ \ 0\ 1\ 0\ 1\ 0)^T = (1\ 0\ 1)^T$ 3rd column	A1		
	so first half correct and second half should be 100010.	B1	3	
	Total		**9**	

MBD2 (cont)

Q	Solution	Marks	Total	Comments
5(a)	e.g. $S\ A\ B\ T$ 4 $S\ A\ C\ B\ T$ 2 $S\ C\ D\ T$ 2 $S\ E\ D\ F\ T$ 3 $S\ E\ F\ T$ 3 (total 14)	M1 A1 A1 A1 A1	5	Any two paths Remaining paths to make total 14 (or 2 for cao)
(b)	*EF, ED, CD, BT* (3 + 3 + 2 + 6 = 14)	M1 A1	2	
(c)(i)	Flow in *SE* ≤ flow out at *E* ≤ 3+3	B1	1	
(ii)	Flow into *C* = flow out of *C* ≤ 3+2 = 5 So if *AC* has a flow of 4 then *SC* has a flow of at most 1.	M1 A1	2	
(iii)	If *AC* is saturated the maximum flows in *SA, SC* and *SE* are 6 (its capacity), 1 (by part (ii)) and 6 (by part (i)). So if *AC* is saturated the maximum flow out of *S* is 6+6+1=13 which is less than the unrestricted maximum flow.	M1 A1	2	
	Total		**12**	

MBD2 (cont)

Q	Solution	Marks	Total	Comments
6(a)	$p_2 = 1,\ p_3 = 3,\ p_4 = 6$	B1 B1	2	
(b)	4 new points created, hence p_5 = existing points + 4 Similarly when the nth line is added it adds n-1 new points.	 B1 B1	 2	
(c)	$p_n = p_{n-1} + (n-1)$ $= p_{n-2} + (n-2) + (n-1)$ … $= p_1 + 1 + 2 + \ldots + (n-1)$ $= 0 + 1 + 2 + \ldots + (n-1)$ $= \frac{1}{2} n(n-1)$	M1 A1 A1	 3	 (or direct verification by substitution)
	Total		**7**	
7(a)	Maximise $P = 15x + 10y + 10z$ Subject to $(x\ge0\quad y\ge0\quad z\ge0)$ $x + 2y + z \le 60$ $x + y + z \le 55$ $3x + 6y + 2z \le 140$	B1 B1 B1	 3	 one inequality the two others
(b)	1 -15 -10 -10 0 0 0 0 0 1 2 1 1 0 0 60 0 1 1 1 0 1 0 55 0 3 6 2 0 0 1 140	 B1 B1	 2	 coefficients of x,y,z appropriate slacks
(c)	1 -5 0 0 0 10 0 550 0 0 1 0 1 -1 0 5 0 1 1 **<u>1</u>** 0 1 0 55 0 1 4 0 0 -2 1 30	M1A1 M1A1 A1	 5	pivot row operations
(d)	1 0 20 0 0 0 5 700 0 0 1 0 1 -1 0 5 0 0 -3 1 0 3 -1 25 0 **<u>1</u>** 4 0 0 -2 1 30	 M1A1 M1A1	 4	
(e)	Maximum profit £700 Make 30 Xtrafast, 0 Yourelax, 25 Zizz e.g. Not helpful for people who want Yourelax.	B1√ B1√ B1	 3	ft ft
	Total		**17**	
	TOTAL		**80**	