OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced GCE

Unit **4773:** Decision Mathematics Computation

Mark Scheme for June 2011

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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.

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Subject-specific Marking Instructions for GCE Mathematics (MEI) Decision strand

a   Annotations should be used whenever appropriate during your marking.

        The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

        For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

b   An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

        Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

c   The following types of marks are available.

        M
        A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

        A
        Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

        B
        Mark for a correct result or statement independent of Method marks.

        E
        A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

        Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d   When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e   The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f   Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

g   Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

h   For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question.
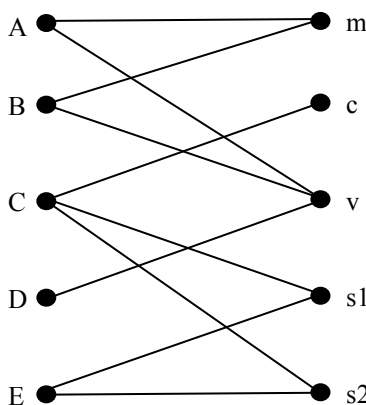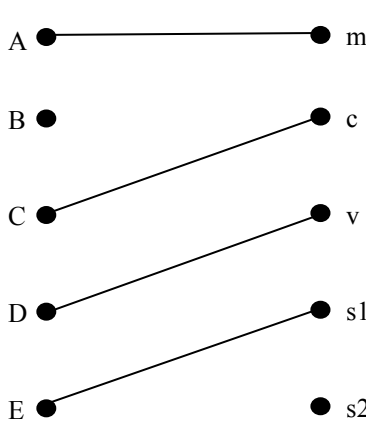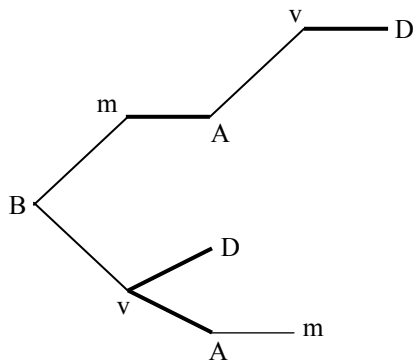
Note that a miscopy of the candidate's own working is not a misread but an accuracy error.
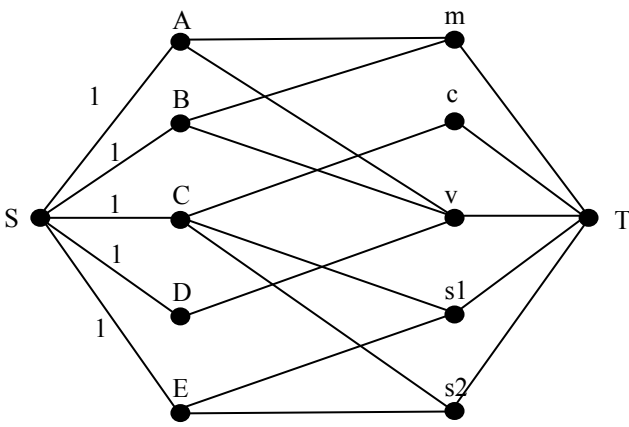
1.

(i) Number of maximal matchings = 4×4 = 16 (note 2 separate graphs)	M1 bipartite A1 A B D / m v A1 C E / c s1 s2 B1 cao
(ii) eg (note ... 4 solutions)	 B1
(iii)	 B1 first branch B1 second branch B1 third branch

(iv)	e.g.
	Max Am+Av+Bm+Bv+Cc+Cs1+Cs2+Dv+Es1+Es2
	st Am+Av<1
	      Bm+Bv<1
	      Cc+Cs1+Cs2<1
	      Dv<1
	      Es1+Es2<1
	      Am+Bm<1
	      Cc<1
	      Av+Bv+Dv<1
	      Cs1+Es1<1
	      Cs2+Es2<1
	end
		M1 A1
		
		M1
		A1
		
		M1
		A1
			people constraints
			
			meal constraints

e.g.

LP OPTIMUM FOUND AT STEP   6

M1   running

OBJECTIVE FUNCTION VALUE

   1)   4.000000

VARIABLE	VALUE	REDUCED COST
AM	1.000000	0.000000
AV	0.000000	0.000000
BM	0.000000	0.000000
BV	0.000000	0.000000
CC	0.000000	0.000000
CS1	1.000000	0.000000
CS2	0.000000	0.000000
DV	1.000000	0.000000
ES1	0.000000	0.000000
ES2	1.000000	0.000000

Arthur has the macaroni
Bertie goes hungry
Charles has the first spaghetti   A1
David has the vegetable lasagne
Edward has the second spaghetti

(v)

B1   source and sink with bipartite connection

B1   arc capacities out of S (or into T).

2.
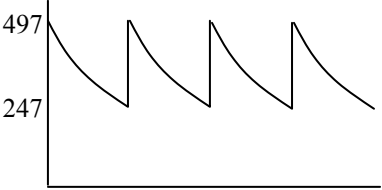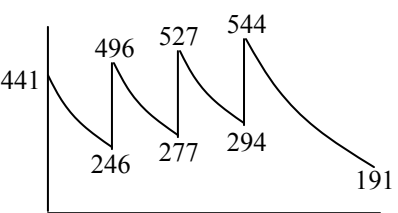
(i)	$x1 + x2 \leq 10000$	B1 $\quad x7 \leq$
	$x3 + x4 \leq 1.04x1$	B1 $\quad 1.09x4$
	$x5 + x6 \leq 1.10x2 + 1.04x3$	B1 $\quad 1.04x5$
	$x7 \quad \leq 1.09x4 + 1.04x5$	B1 $\quad x8 \leq$
	$x8 \quad \leq 1.10x6$	B1 $\quad 1.10x6$
	(Might see extra terms for x4 and x5 feeding to x8.)	
(ii)	$x3 + x4 - 1.04x1 < 0$	
	$x5 + x6 - 1.10x2 - 1.04x3 < 0$	
	$x7 - 1.09x4 - 1.04x5 < 0$	
	$x8 - 1.10x6 < 0$	B1
(iii)	max $1.12x7 + 1.04x8$	B1 max
		B1 B1 (-1 each error)
(iv)	LP OPTIMUM FOUND AT STEP $\quad$ 5	
	OBJECTIVE FUNCTION VALUE	B1 $\quad$ running
	1) $\quad$ 12812.80	
	VARIABLE $\quad$ VALUE	
	X7 $\quad$ 11440.000000	
	X8 $\quad$ 0.000000	
	X1 $\quad$ 0.000000	
	X2 $\quad$ 10000.000000	
	X3 $\quad$ 0.000000	
	X4 $\quad$ 0.000000	
	X5 $\quad$ 11000.000000	
	X6 $\quad$ 0.000000	
	Invest all money in investment 2, thence to investment	M1 $\quad$ words!
	number 5, thence to investment number 7.	A1 $\quad$ strategy
	Gives 12812.80 at end.	B1 $\quad$ outcome
(v)	$1 \rightarrow 3 \rightarrow 5 \rightarrow 7 \quad 1.04 \times 1.04 \times 1.04 \times 1.12 \approx 1.26$	
	$1 \rightarrow 3 \rightarrow 6 \rightarrow 8 \quad 1.04 \times 1.04 \times 1.10 \times 1.04 \approx 1.24$	M1
	$1 \rightarrow 4 \rightarrow 7 \quad 1.04 \times 1.09 \times 1.12 \quad \approx 1.27$	A1 $\quad$ those starting "1"
	$2 \rightarrow 5 \rightarrow 7 \quad 1.10 \times 1.04 \times 1.12 \quad \approx 1.28$	A1 $\quad$ those starting "2"
	$2 \rightarrow 6 \rightarrow 8 \quad 1.10 \times 1.10 \times 1.04 \quad \approx 1.26$	
	Best is as above	A1
(vi)	Formulation + solution would be more easily automated	B1
	for larger problems.	

3.

(i) $u_{n+1} = 0.89^6 u_n + 250$	B1	structure
	B1	0.89^6

(ii) $u_n = 250 \dfrac{1 - 0.89^{6n}}{1 - 0.89^6}$

M1
A1 0.89^{6n}
A1   rest OK
B1   limit

Tends to $\dfrac{250}{1 - 0.89^6} \approx 497$

(iii)

M1   shape
A1   497
A1   247

(iv)

1	250.00	21	440.70	
2	389.60	22	496.09	
3	467.56	23	527.02	
4	511.09	24	544.29	
5	429.06	25	440.70	
6	489.59	26	496.09	
7	523.39	27	527.02	
8	542.26	28	544.29	

M1   5 hour rules
A1
M1   9 hour rule
A1

(v)

B1   shape
B1   upper values
B1   lower values

(vi) Level drops to 103mg

B1   cao

No. Converges back to previous levels more quickly with single dose.

B1   analysis needed

4.

(i)	Lookup tables, or equivalent	M1 A1
	simulating ...	B1
	number of customers	B1
	a dish for a customer	B1
	simulating the correct number of dishes	M1 A1
	collecting results	M1 A1
(ii)	use of relative and absolute addressing	M1 A1
	100 repetitions	B1
	means and standard deviations	B1 B1
(iii)	Not concerned with the variation of the mean, but with the variation of an individual day's demand.	B1 B1
(iv)	Analyse the cost of waste against the cost of loss of goodwill and decide upon an appropriate level of provision, e.g. mean + 1 standard deviation.	B1
	the above would give, arguably, 6, 2, 4 and 8 respectively.	B1

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