6.17 DECISION MATHEMATICS 1, D1 (4771) AS

Objectives

To give students experience of modelling and of the use of algorithms in a variety of situations.

To develop modelling skills.

The problems presented are diverse and require flexibility of approach. Students are expected to consider the success of their modelling, and to appreciate the limitations of their solutions.

Assessment

Examination (72 marks)
1 hour 30 minutes
The examination paper has two sections:

Section A: three questions, each worth 8 marks
Section Total: 24 marks

Section B: three questions each worth 16 marks
Section Total: 48 marks

Assumed Knowledge

Candidates are expected to know the content of Intermediate Tier GCSE*.

*See note on page 34.

Calculators

In the MEI Structured Mathematics specification, no calculator is allowed in the examination for *C1*. For all other units, including this one, a graphical calculator is allowed.

DECISION MATHEMATICS 1, D1		
Specification	**Ref.**	**Competence Statements**

MODELLING

The three units in Decision Mathematics are based on the use of the modelling cycle in solving problems

The modelling cycle applied to real-world problems.	D1p1	Be able to abstract from a real world problem to a mathematical model.
	2	Be able to analyse the model appropriately.
	3	Be able to interpret and communicate results.
	4	Be able progressively to refine a model as appropriate.

ALGORITHMS

Background and definition.	D1A1	Be able to interpret and apply algorithms presented in a variety of formats.
	2	Be able to develop and adapt simple algorithms.
Basic ideas of complexity.	3	Understand the basic ideas of algorithmic complexity.
	4	Be able to analyse the complexity of some of the algorithms covered in this specification.

GRAPHS

Background and definitions.	D1g1	Understand notation and terminology.
Use in problem solving.	2	Be able to model appropriate problems by using graphs.

NETWORKS

Definition.	D1N1	Understand that a network is a graph with weighted arcs
Use in problem solving.	2	Be able to model appropriate problems by using networks
The minimum connector problem.	3	Know and be able to use Kruskal's and Prim's algorithms
The shortest path from a given node to other nodes.	4	Know and be able to apply Dijkstra's algorithm

DECISION MATHEMATICS 1, D1			
Ref.	**Notes**	**Notation**	**Exclusions**

MODELLING

The three units in Decision Mathematics are based on the use of the modelling cycle in solving problems

Ref.	Notes	Notation	Exclusions
D1p1	Approximation and simplification.		
2	Solution using an appropriate algorithm.		
3	Implications in real world terms.		
4	Check against reality; adapt standard algorithms.		

ALGORITHMS

Ref.	Notes	Notation	Exclusions
D1A1	Flowcharts; written English; pseudo-code.		
2	To include sorting and packing algorithms. Sorting: Bubble, Shuttle, insertion, quick sort. Packing: Full-bin, first-fit, first-fit decreasing. Candidates will be expected to know these packing algorithms.		Candidates will not be required to memorise sorting algorithms.
3	Worst case; size of problem; that for quadratic algorithms doubling the size of a large problem can quadruple the solution time, etc.	Order notation, e.g. $O(n^2)$ for quadratic complexity.	
4	Kruskal; Prim (network and tabular forms); Dijkstra. The requirements will also apply to algorithms in later modules (D2 and DC) at the stage when they are met.		

GRAPHS

Ref.	Notes	Notation	Exclusions
D1g1	Nodes/vertices; arcs/edges; trees; node order; simple, complete, connected and bipartite graphs; walks, trails, cycles and Hamilton cycles; trees; digraphs; planarity.	Pictures (i.e. graphs), incidence matrices.	
2	e.g. Königsberg bridges; various river crossing problems; the tower of cubes problem; filing systems.		

NETWORKS

Ref.	Notes	Notation	Exclusions
D1N1			
2	Use in modelling 'geographical' problems and other problems e.g. translating a book into different languages, e.g. the knapsack problem.		
3	Kruskal's algorithm in graphical form only. Prim's algorithm in graphical or tabular form.		
4			

DECISION MATHEMATICS 1, D1		
Specification	**Ref.**	**Competence Statements**

LINEAR PROGRAMMING		
Linear inequalities in two or more variables.	D1L1	Be able to manipulate inequalities algebraically.
	2	Be able to illustrate linear inequalities in two variables graphically.
Formulation of constrained optimisation problems.	3	Be able to formulate simple maximisation of profit and minimisation of cost problems.
Solution of constrained optimisation problems.	4	Be able to use graphs to solve 2-D problems, including integer valued problems.
Algebraic interpretation of the graphical solution in 2 dimensions.	5	Be able to interpret solutions, including spare capacities.

CRITICAL PATH ANALYSIS		
Using networks in project management.	D1X1	Be able to construct and use a precedence network.
	2	Be able to construct and interpret a cascade chart.
	3	Be able to construct and interpret a resource histogram.
	4	Understand the use of alternative criteria in project optimisation.
	5	Be able to crash a network.

SIMULATION		
Random variables.	D1Z1	Know how to generate realisations of a discrete uniformly distributed random variable.
	2	Be able to use random variables to model discrete non-uniform random variables.
Simulation modelling.	3	Be able to build and use simple models.
	4	Be able to interpret results.
	5	Understand the need for repetition.

DECISION MATHEMATICS 1, D1			
Ref.	**Notes**	**Notation**	**Exclusions**

LINEAR PROGRAMMING			
D1L1			
2			Non-linear problems.
3		Max $2x+3y$ s.t. $x+y\le 6$ $5x+2y\le 12$ $x\ge 0,\ y\ge 0$	Non-linear problems
4	Showing alternating feasible points and their associated costs/profits.		Solving problems in more than 2 dimensions.
5			

CRITICAL PATH ANALYSIS			
D1X1	Including forward and backward passes, the identification of critical activities and the calculation of float (total and independent).	Activity on arc.	Knowledge of an algorithm for constructing a precedence network from a precedence table. Knowledge of an algorithm for numbering activities. Knowledge of an algorithm for resource smoothing.
2			
3			
4	Time; cost; use of resources.		
5	Checking critical activities and for activities becoming critical.		

SIMULATION			
D1Z1	Drawing numbers from a hat; coins; dice; pseudo-random numbers from a calculator; simple pseudo-random number generators; random number tables.		Continuous random variables.
2	Cumulative frequency methods, including rejecting values where necessary.		
3	Hand simulations, including queuing situations.		
4			
5			