6.4 APPLICATIONS OF ADVANCED MATHEMATICS, C4 (4754) A2

Objectives

To develop the work in *C1, C2* and *C3* in directions which allow it to be applied to real world problems.

Assessment

Examination

Paper A: (72 marks)
1 hour 30 minutes
The examination paper has two sections.

Section A: 5-7 questions, each worth at most 8 marks.
Section Total: 36 marks

Section B: two questions, each worth about 18 marks.
Section Total: 36 marks

Paper B: (18 marks)
1 hour
A comprehension task. (Further details on page 72.)
Total 18 marks

Assumed Knowledge

Candidates are expected to know the content for *C1, C2* and *C3*.

Subject Criteria

The Units *C1* and *C2* are required for Advanced Subsidiary GCE Mathematics in order to ensure coverage of the subject criteria.

The Units *C1, C2, C3* and *C4* are required for Advanced GCE Mathematics in order to ensure coverage of the subject criteria.

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.

APPLICATIONS OF ADVANCED MATHEMATICS, C4		
Specification	**Ref.**	**Competence Statements**
		ALGEBRA
The general binomial expansion.	C4a1	Be able to form the binomial expansion of $(1+x)^n$ where *n* is any rational number and find a particular term in it.
	2	Be able to write $(a+x)^n$ in the form $a^n\left(1+\frac{x}{a}\right)^n$ prior to expansion.
Rational expressions.	3	Be able to simplify rational expressions.
Partial fractions.	4	Be able to solve equations involving algebraic fractions.
	5	Know how to express algebraic fractions as partial fractions.
	6	Know how to use partial fractions with the binomial expansion to find the power series for an algebraic fraction.
		TRIGONOMETRY
sec, cosec and cot.	C4t1	Know the definitions of the sec, cosec and cot functions.
	2	Understand the relationship between the graphs of the sin, cos, tan, cosec, sec and cot functions.
	3	Know the relationships $\tan^2\theta+1=\sec^2\theta$ and $\cot^2\theta+1=\operatorname{cosec}^2\theta$.
Compound angle formulae.	4	Be able to use the identities for $\sin(\theta\pm\phi)$, $\cos(\theta\pm\phi)$, $\tan(\theta\pm\phi)$.
	5	Be able to use identities for $\sin 2\theta$, $\cos 2\theta$ (3 versions), $\tan 2\theta$.
Solution of trigonometrical equations.	6	Be able to solve simple trigonometrical equations within a given range including the use of any of the trigonometrical identities above.
	7	Know how to write the function $a\cos\theta\pm b\sin\theta$ in the forms $R\sin(\theta\pm\alpha)$ and $R\cos(\theta\pm\alpha)$ and how to use these to sketch the graph of the function, find its maximum and minimum values and to solve equations.
		PARAMETRIC EQUATIONS
The use of parametric equations.	C4g1	Understand the meaning of the terms parameter and parametric equations.
	2	Be able to find the equivalent cartesian equation for parametric equations.
	3	Recognise the parametric form of a circle.
	4	Be able to find the gradient at a point on a curve defined in terms of a parameter by differentiation.

APPLICATIONS OF ADVANCED MATHEMATICS, C4			
Ref.	**Notes**	**Notation**	**Exclusions**
	ALGEBRA		
C4a1	For $\|x\| < 1$ when *n* is not a positive integer.		
2	$\left\|\frac{x}{a}\right\| < 1$ when *n* is not a positive integer.		
3	Including factorising, cancelling and algebraic division.		
4			
5	Proper fractions with the following denominators $(ax+b)(cx+d)$ $(ax+b)(cx+d)^2$ $(ax+b)(x^2+c^2)$		Improper fractions.
6			
	TRIGONOMETRY		
C4t1	Including knowledge of the angles for which they are undefined.		
2			
3			
4			
5			
6	Including identities from earlier units. Knowledge of principal values.		
7			
	PARAMETRIC EQUATIONS		
C4g1			
2			
3			
4	$\frac{dy}{dx} = \frac{\left(\frac{dy}{dt}\right)}{\left(\frac{dx}{dt}\right)}$ Use to find the equations of tangents and normals to a curve.		Stationary points.

APPLICATIONS OF ADVANCED MATHEMATICS, C4		
Specification	**Ref.**	**Competence Statements**
CALCULUS		
Numerical integration.	C4c1	Be able to use the trapezium rule to find an integral to a given level of accuracy.
Partial fractions.	2	Be able to use the method of partial fractions in integration.
Volumes of revolution.	3	Be able to calculate the volumes of the solids generated by rotating a plane region about the x-axis or the y-axis.
Differential equations.	4	Be able to formulate first order differential equations.
	5	Be able to solve first order differential equations.
VECTORS		
Vectors in two and three dimensions.	C4v1	Understand the language of vectors in two and three dimensions.
	2	Be able to add vectors, multiply a vector by a scalar, and express a vector as a combination of others.
The scalar product.	3	Know how to calculate the scalar product of two vectors, and be able to use it to find the angle between two vectors.
Coordinate geometry in two and three dimensions.	4	Be able to find the distance between two points, the midpoint and other points of simple division of a line.
The equations of lines and planes.	5	Be able to form and use the equation of a line.
	6	Be able to form and use the equation of a plane.
The intersection of a line and a plane.	7	Know that a vector which is perpendicular to a plane is perpendicular to any line in the plane.
	8	Know that the angle between two planes is the same as the angle between their normals.
	9	Be able to find the intersection of a line and a plane.
COMPREHENSION		
The ability to read and comprehend a mathematical argument or an example of the application of mathematics.	C4p1	Be able to follow mathematical arguments and descriptions of the solutions of problems when given in writing.
	2	Understand the modelling cycle and realise that it can be applied across many branches of mathematics.

APPLICATIONS OF ADVANCED MATHEMATICS, C4			
Ref.	**Notes**	**Notation**	**Exclusions**
	CALCULUS		
C4c1	Use of increasing numbers of strips to improve the accuracy. Use of increasing numbers of strips to estimate the error.		Questions requiring more than 3 applications of the trapezium rule.
2			
3			Axes of rotation other than the *x*- and *y*-axes.
4	From given information about rates of change.		
5	Differential equations with separable variables only.		
	VECTORS		
C4v1	Scalar, vector, modulus, magnitude, direction, position vector, unit vector, cartesian components, equal vectors, parallel vectors.	**i**, **j**, **k**, $\hat{\mathbf{r}}$ $\begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix}$	
2	Geometrical interpretation.		
3	Including test for perpendicular vectors. The angle between two lines.	$\mathbf{a.b} = a_1b_1 + a_2b_2 + a_3b_3$ $= \lvert\mathbf{a}\rvert\lvert\mathbf{b}\rvert\cos\theta$	
4			
5	In vector and cartesian form.	Line: $\mathbf{r} = \mathbf{a} + t\mathbf{u}$ $\frac{x-a_1}{u_1} = \frac{y-a_2}{u_2} = \frac{z-a_3}{u_3} (= t)$.	
6	In vector and cartesian form.	Plane: $(\mathbf{r} - \mathbf{a}).\mathbf{n} = 0$ $n_1x + n_2y + n_3z + d = 0$ where $d = -\mathbf{a.n}$.	
7	If a vector is perpendicular to two non-parallel lines in a plane, it is perpendicular to the plane.		
8			
9			
	COMPREHENSION		
C4p1	This may be assessed using a real world modelling context.		
2	Abstraction from a real-world situation to a mathematical description; approximation simplification and solution; check against reality; progressive refinement.		

Applications of Advanced Mathematics (C4) Comprehension Task

Rationale

The aim of the comprehension task is to foster an appreciation among students that, in learning mathematics, they are acquiring skills which transcend the particular items of the specification content which have made up their course.

The objectives are that students should be able to:

- read and comprehend a mathematical argument or an example of the application of mathematics;
- respond to a synoptic piece of work covering ideas permeating their whole course;
- appreciate the relevance of particular techniques to real-world problems.

Description and Conduct

Paper B of *Applications of Advanced Mathematics (C4)* consists of a comprehension task on which candidates are expected to take no more than 40 minutes. The task takes the form of a written article followed by questions designed to test how well candidates have understood it. Care will be taken in preparing the task to ensure that the language is readily accessible.

Candidates are allowed to bring standard English dictionaries into the examination. Full regulations can be found in the JCQ booklet *Instructions for conducting examinations*, published annually.

The use of bi-lingual translation dictionaries by candidates for whom English is not their first language has to be applied for under the access arrangements rules. Full details can be found in the JCQ booklet *Access Arrangements, Reasonable Adjustments and Special Consideration*, published annually.

Content

By its nature, the content of the written piece of mathematics cannot be specified in the detail of the rest of the specification. However knowledge of GCSE and *C1*, *C2* and *C3* will be assumed, as well as the content of the rest of this unit. Candidates are expected to be aware of ideas concerning accuracy and errors. The written piece may follow a modelling cycle and in that case candidates will be expected to recognise it. No knowledge of mechanics will be assumed.