

IM SYLLABUS (2023)

APPLIED MATHEMATICS

IM 02

SYLLABUS

**Applied Mathematics IM 02
Syllabus**

(Available in September)
1 Paper (3 hours)

Applied Mathematics (Mechanics)

Aims

A course based on this syllabus should

- i) provide a relevant, stimulating and motivating course of advanced study in mathematics including the provision of a suitable foundation for further study in science and engineering;
- ii) develop a variety of skills in modelling, logical reasoning and problem solving;
- iii) encourage student interest and satisfaction through the development and use of mathematics in a variety of applications;
- iv) promote an awareness of the relevance of mathematics to other fields of study and to other practical applications.

Assessment objectives

Candidates should be able to demonstrate that they can:

- i) apply their knowledge of relevant mathematical techniques in a variety of contexts;
- ii) construct rigorous mathematical arguments through an appropriate use of precise statements, logical deduction and by manipulation of mathematical expressions;
- iii) evaluate mathematical models, including an appreciation of the assumptions made, and interpret, justify and present the results from a mathematical analysis in a form relevant to the original problem;
- iv) communicate mathematical ideas and methods, including the use of appropriate mathematical notation, terminology, conventions and diagrams, in a clear, logical and well-structured presentation.

Scheme of Assessment

The examination consists of one paper of three hours. This paper will contain ten questions each carrying between eight to twelve marks. The total number of marks is 100. Candidates will be required to answer all questions.

Grade Description

Grades A, B, C, D, E will be awarded to candidates who pass in this examination, with Grade A being the highest grade, and Grade E the lowest passing Grade. Grade F signifies a failure in this examination.

Candidates who obtain Grade **A** are able to recall and select **almost all** concepts and techniques required in various contexts. Candidates who obtain Grade **C** are able to recall and select **most** concepts and

techniques required in various contexts. Candidates who obtain Grade **E** are able to recall and select **some** concepts and techniques required in various contexts.

Syllabus

Knowledge of the contents of the Intermediate Pure Mathematics syllabus is recommended.

The topics are not arranged in teaching order. Any examination question can test material from more than one topic.

A problem on any part of the syllabus can be set in vector notation. Knowledge of the scalar product will be assumed, but the vector product will not be required.

| <i>Topics</i> | <i>Notes</i> |
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| Vectors | |
| 1. The concept of a vector. Addition of vectors, equality of vectors, the zero vector, multiplication by a scalar. The magnitude of a vector. The unit vectors i, j . Position vectors. Vector equation of a straight line. | Typical applications could include: <ul style="list-style-type: none"> - the line of action, - finding the intersection of two straight lines, - uniform motion, - the magnitude and direction of the resultant force of a single coplanar system of forces, - resolution into components, - locating the centre of mass of a number of particles in two dimensions. |
| Statics | |
| 2. Coplanar forces acting at a point. General equilibrium. Friction, limiting equilibrium, coefficient and angle of friction. Elastic strings and springs: Hooke's law. | The concept of a force as a localised vector. Parallelogram and triangle rules for addition of forces. Resultant of a system of forces acting at a point. Forces in equilibrium. Lami's theorem. Reaction between bodies in contact. An understanding of the inequality $F \leq \mu R$. Tensions in inextensible strings and elastic strings satisfying Hooke's Law in the form $T = \lambda x/a$. |
| 3. Coplanar forces acting on a rigid body. Moment of a system of coplanar forces about an axis perpendicular to the plane containing the lines of action of the forces. Reduction of a coplanar system of forces to a force, to a couple, or to a force and a couple. Frameworks. | Forces may be given in vector form, but the moment of a force as a vector product is not required. Frameworks made up of light smoothly jointed rods. |
| 4. Centre of mass of: <ol style="list-style-type: none"> a) a system of particles, b) a uniform body, c) simple composite bodies. | Problems can involve a lamina suspended from a fixed point. However, the use of integration and problems of toppling are both excluded. |

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| Kinematics in one dimension | |
| 5. Displacement, velocity and acceleration of a particle moving in a straight line. | The derivation and use of the formulae for constant acceleration. Graphical solutions may be required including displacement– time and velocity–time graphs. Motion under gravity in a non-resistive medium. |
| Dynamics of Particles | |
| 6. Newton’s Laws of Motion. Mass, force. | Motion of two connected particles, to include the case when one or both the particles move on a horizontal or inclined plane, and fixed smooth pulleys. |
| 7. Work, power, energy. The principle of conservation of mechanical energy. | The work energy principle. Kinetic energy, elastic and gravitational potential energy. |
| 8. Impulse and momentum. Conservation of momentum in one dimension. Direct elastic impact. Newton’s law of restitution. | Coefficient of restitution, e . Knowledge of the terms <i>perfectly elastic</i> ($e = 1$) and <i>perfectly inelastic</i> ($e = 0$). |
| Motion in a plane | |
| 9. Angular speed, constant angular acceleration. Motion in a horizontal circle with uniform speed. | Including the conical pendulum and banked tracks. |
| 10. Simple problems on projectiles. | Students will be expected to derive the equation of the path of a projectile, its horizontal range, its associated time of flight, and the maximum height. |