Mathematical Skills for Masters Programmes

1. Introduction

This document gives a brief description of the mathematical skills expected from candidates for the Masters programmes in the School of Engineering. It is intended for people considering applying for one of the courses as a guide for what to expect from some of the modules on the course.

The entry requirements for all of the MSc programmes include holding an undergraduate degree in Engineering. Taught masters degrees use the mathematical skills learned during undergraduate study to build new and more advanced learning in a variety of subjects including materials science, reliability modelling, communications theory and control to name a few.

The standard textbook used by many institutions for undergraduate engineering courses in the U.K. is K. A. Stroud’s book `Engineering Mathematics’[1]. The textbook is split into two parts. The first deals with foundation issues of mathematics and contains 12 sections. The second part contains 28 separate learning programmes on a range of topics required by engineers. Part 1 reviews some of the main topics learned up to Higher and A-Level in the U.K. while Part 2 constitutes the new material that is learned during a university undergrad degree. One or two more advanced topics are contained in a second volume `Advanced Engineering Mathematics’[2].

The next section of this document sets out some of the most important topics that will be used to some extent during the MSc modules. A brief description of each topic is given, together with the relevant section of [1] and [2].
2. Mathematical Content

The following topics in Stroud are of particular importance:

- **Foundation Mathematics**: Arithmetic; Algebra; Equations; Graphs; Linear equations and simultaneous linear equations; Polynomial equations; Partial Fractions; Trigonometry; Binomial series; Differentiation; Integration; Functions. – All of Part 1; pgs 1-434 of [1].

- **Complex Numbers**: Uses of the number \( \sqrt{-1} \), particularly in the description of random functions and hyperbolic functions. Applied in dynamics and control theory problems. Programmes 1 and 2; pgs 437-494 of [1].

- **Determinants**: Solution method for simultaneous equations. Used for aspects of solid mechanics, structural engineering and control. Programme 4; pgs 521-554 [1].

- **Matrices**: More advanced solution method for groups of simultaneous equations. Used in reliability theory; solid mechanics; finite element method; control theory. Programme 5; pgs 555-589 of [1].


- **Differentiation and Partial Differentiation**: Rates of change form the basis of much of mechanics and the dynamics of engineering systems. Programmes 7-11 pgs 619-728 of [1].

- **Integration - Direct and Approximate Solutions**: Application of integration to engineering problems including area under a function; mean values of functions; RMS values of functions; Surfaces of revolutions; Volumes of revolutions; Locating centroids; Moments of inertia; Second moments of area. Programmes 15 and 16 for Integration theory pgs 823-884; Applications in Programmes 18-20 pgs 901-979; Approximate Integration in Programme 21 pgs 981-1000 of [1].

- **Multiple Integrals**: Multiple integrals used to describe multi-dimensional systems including structural analysis; reliability theory. Programme 23; pgs 1025-1049 of [1]

- **Polar Co-Ordinates**: Use of polar co-ordinate system to describe behaviour of engineering systems. Programme 22 pgs 1001-1024 of [1].

- **Differential Equations and Laplace Transforms**: Used for the description of dynamic behaviours of engineering systems. Laplace Transforms used as solution method for certain types of differential equations. Programmes 24-26 pgs 1051 1138 of [1].
- **Fourier Transforms**: Mapping of time domain functions into frequency domain using Fourier pairs. Use of both real and imaginary components for signals analysis; random functions; and dynamics. Programmes 6 and 7 pgs 172-276 of Advanced Engineering Mathematics [2].

- **Probability Theory and Statistics**: Probability calculus used describe physical and knowledge based uncertainties in engineering systems. Used in reliability theory. Statistics used in failure data analysis and collection of data from engineering systems. Programmes 27 and 28 of [1].

The above list should not be taken as definitive, but is intended to give applicants an insight into the level of understanding required for some of the content present in the MSc programmes in the School of Engineering.

Applicants should be prepared to have this knowledge assessed if they have not done so already through an undergraduate level course. In this case, the list should be used as a guide for self-study; a task for which ‘Engineering Mathematics’ is well designed.

### 3. Further materials:
- Calculus ([https://www.khanacademy.org/math/calculus-home](https://www.khanacademy.org/math/calculus-home))

### References


General Recommended Reading