MST224 Guide
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Introduction

Welcome to Mathematical Methods (MST224). The aim of this 30 credit module is to provide a background in the mathematical methods for students studying physical sciences, engineering, mathematics and economics. The module has been designed to provide the mathematical background required for the third level modules offered by the department of physical sciences, and the third level modules in applied mathematics.

The assumed mathematical starting point is successful completion of MST124. However, we realize that some students will have studied MST121 instead, so we have designed Bridging Material to help bridge the gap between MST121 and MST224 (a link to this material is on the module website). The scientific knowledge needed to study MST224 has been kept to a minimum, and there are no Science prerequisites. Occasionally, topics are best illustrated by a physical or mechanical example, and some of the teaching assumes a very basic knowledge of Newtonian mechanics.

The module is designed to teach the 'pencil and paper' techniques which are at the core of applying mathematics. Although the module does not teach the areas of physics and engineering where the ideas find applications, we believe that it is important to appreciate the context in which the ideas are applied. This is achieved by including background material which is highlighted as optional.

The mathematical techniques which are taught here form a basis for understanding the most sophisticated concepts in science. They distil insights which brilliant minds struggled to capture, so you should not expect it all to be easy. But after mastering these techniques you will find that the same ideas and methods are used in many different areas of science and engineering. We hope that as you study science or engineering you will become increasingly aware of the power of the ideas presented in this module.
Getting started and use of technology

The background knowledge which is assumed corresponds to successful completion of MST124, or equivalents.

This means that you are expected to be familiar with standard mathematical notation and elementary functions (such as sines, cosines, logarithms and exponentials). We also assume that you are familiar with algebra, calculus, and complex numbers. The first chapter is a summary of this background knowledge. We suggest that you read this chapter quickly and decide which parts you might need to study more carefully.

You will need access to a computer in order to download assignments, and in order to do the interactive computer marked assignments (iCMAs) which form part of the assessment. There will also be supplementary teaching materials (such as 'screencasts') made available online. These may vary between presentations. You will find details of these supplementary materials on the module website.

Although the module is teaching the 'pencil and paper' calculation techniques that a scientist or engineer needs to be able to apply, you do need to have access to a scientific calculator, because some continuous assessment questions may ask for a numerical answer. The calculator will not be required in the examination, and you will not be allowed to take a calculator into the examination.

There is no programming or scientific software required for this module. There are numerous pieces of software that can assist with mathematical calculations, ranging from simple scientific calculator functions to sophisticated calculus. These are evolving rapidly and some very useful software is already available free of charge. You are welcome to use these programs (outside the final examination) to check your work, or to give you hints. But you will only receive full credit in your tutor marked assignment if you show sufficient working to demonstrate that you understand the methods.

You will have the option to submit the tutor marked assignments (TMAs) electronically. The process for producing eTMAs on this module is different to what you may have been used to on other modules, so you will need to read the instructions on the MST224 website carefully before submitting your work.
The MST224 components

Study texts

The course is based on printed text, supplied as four books, including numerous colour illustrations. The themes of the texts are

1  *Differential equations*. Book 1 contains an introductory chapter summarising the assumed background knowledge. This is followed by two chapters on differential equations. Many physical laws are described by differential equations, which makes them perhaps the most important tool in applying mathematics.

2  *Linear algebra*. Scientists and engineers often want to understand complicated systems, with a large number of variables (for example, you might want to calculate the electrical current flowing through every part of a complicated circuit). There is a special class of equations, termed linear equations, where these calculations can be done. There are three chapters in our book on linear algebra, describing solutions of systems of linear equations, and the important concepts of eigenvalue and eigenvector.

3  *Vectors calculus*. The calculus that was described in earlier modules was restricted to functions with just one variable. However scientists need to understand phenomena in two or three dimensional spaces, where quantities have direction as well as magnitude: describing how the wind speed varies with position on the surface of the Earth is a typical example. Four chapters are devoted to explaining how ideas about differentiation and integration extend to vector fields and how the ideas of calculus are extended into three-dimensional space.

4  *Advanced topics*. The most sophisticated physical theories which are treated in our modules involve differential equations in three-dimensional space. The differential equations are termed partial differential equations, and a technique called Fourier analysis is required to obtain solutions.

Our final book contains chapters on Fourier series and partial differential equations. It concludes with a brief introduction to dynamical systems, which is discussed in terms of models for populations of animals.

Handbook

The Handbook is provided to give you a convenient source of notation and definitions, for use throughout the year and during the examination. It is a good idea to start using the Handbook right from the beginning of the module, so that you may familiarize yourself with its contents.

You may annotate the Handbook with whatever written material you feel would help you. (Note, however, that you are not permitted to add extra pages or sticky notes when taking it into the examination.) Only the printed version of the Handbook that is sent to you in the MST224 mailing can be
taken into the examination. Copies downloaded from the MST224 website are not allowed into the examination.

**Website**

You can access the MST224 website from your StudentHome page. There you will find the Study planner, the tutor-marked assignments (TMAs), iCMAs, the specimen examination paper and its solutions which are available only through the MST224 website. It is important that you check the website frequently, as Errata and News items will be posted there.

The MST224 website will give you access to the forums, which you can use to communicate with other students and with the MST224 team.

You will also find links to 'screencasts', which are online presentations illustrating how to solve some typical exercises.

**Assessment**

There are five assessment tasks on MST224 (the four TMAs count as separate tasks and the fifth is the iCMA task). You must satisfactorily complete four out of the five assessment tasks; this means that you need to achieve the 30% threshold in each of the TMAs or achieve the 30% threshold in three of the four iCMAs. If you want to omit a TMA you must score more than 30% in each of the remaining TMAs and also score more than 30% on three iCMAs. If you want to omit the iCMAs then you must score more than 30% on each TMA.

You only have one opportunity to complete each iCMA, so we have added some practice quizzes to the website so that you can get used to answering these types of questions.

Both the iCMAs and TMAs will focus strongly on learning through practice rather than on assessment. The feedback you receive on your answers will help you to improve your knowledge and understanding of the study material and to develop important skills associated with the course.

Although your scores on all these assignments will not contribute directly to your course grade, they form an essential part of the learning process and you will be required to submit a proportion of them to complete the module.

Your overall grade will be based on the end of module written examination. Please note that the Assessment Calculator is not available on this module.
Examination

There is a three-hour examination at the end of MST224 that is based upon the material in Books 1 to 4. You should familiarize yourself with the format of the examination well in advance.

A specimen examination paper will be added to the MST224 website in due course, and you should work through this carefully before the examination. Sample solutions are also provided. You will be allowed to take into the examination the MST224 Handbook, which you may annotate as described above. No other materials will be allowed.
Support for your studies

It is important to try to keep up to schedule. The assignment cut-off dates are usually very soon after the end of the last study week for the relevant book. We recommend that you try to finish the assignment questions relating to each part of a book as soon as you finish that part. Otherwise, you will have a lot of work to do in a few days before the cut-off date.

Your tutor

Your tutor is there to help you understand the ideas in MST224, and will provide comments and feedback on your written assignments to help you with your studying. You are advised to go through each marked assignment in detail and to take note of the comments written by your tutor; they will help you avoid similar errors in later TMA's and in the examination. Try to attend tutorials – either face to face or electronic - there you will have the opportunity to talk to your tutor directly and, just as important, to talk to other students.

Your fellow students

One of the best ways of learning is by talking about your work with fellow students. Unfortunately, in Level 2 modules you may see them only at the infrequent tutorials during the year. That leaves a lot of weeks when you could be on your own. A convenient way to keep in touch is to use the MST224 forums.

Other support

You are not expected to study alone. Support is available from your tutor, through face-to-face and electronic tutorials, and via the MST224 website. If you experience difficulties that are not directly related to the content of MST224, you are welcome to contact your Learner Support Team (see your StudentHome page for details).