MS327 Guide
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Introduction

Welcome to MS327, *Deterministic and stochastic dynamics*. This module is designed to be studied as your first applied mathematics module at OU level 3 to follow on from MST210 (Mathematical methods, models and modelling) or its predecessor MST209, or MST224 (Mathematical models). It introduces core topics in applied mathematics at this level and is structured around three books: *Fundamental concepts of dynamics; Deterministic dynamics; and Stochastic processes and diffusion*. The module will use the Maxima computer algebra system to illustrate how computers are used to explore properties of dynamical systems. To study this module, you should have a good prior knowledge of the subject area, including differential equations, and some knowledge of mechanics, as provided by the appropriate OU level 2 study.

The module is designed to give you an overview of modern approaches to dynamics. The Units will introduce many new concepts, and you should expect to find the material challenging, as well as interesting. The module includes topics which almost all students find difficult at their first encounter, and which are only clearly understood after you have thought about them in a few different contexts. If you did well on a second-level module, you should be able to cope with this one.

Because the material is quite challenging, we do not expect you to acquire a deep and sophisticated understanding of all of the topics. The assessment questions will reflect this.

The assessment materials will consist of some continuous assessment exercises and an examination. Your grade will be determined by your performance in the examination, but tackling the continuous assessment exercises is a very important part of the learning process, and you must achieve a certain threshold mark to be qualified to sit the exam.
Getting started and use of technology

You will need access to a computer in order to download assignments, and in order to do the interactive computer-marked assignments (iCMAs) that 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.

In addition to this, modern developments in the understanding of dynamics have benefited from using computers to investigate solutions to dynamical problems. Although most of the module depends upon using ‘pencil and paper’ techniques, there are numerous exercises that illustrate the use of computers to investigate dynamical problems.

The computer experiments use a multi-purpose mathematical package called Maxima. You may have used this package for other Open University modules. The Software Guide explains how to install this package on your computer, and gives a general description of how to use it. Further advice is also available on the OU Maxima website. The module books contain computer exercises which are used to explore the use of computers in dynamics. These exercises are described in rather general terms in the units.

Unless you have a really excellent knowledge of the Maxima software package, you will need to look at a Maxima worksheet, (called a Computer Exploration Worksheet), for additional hints about how to tackle the computing exercises, as well as for working codes to solve the problems. These worksheets will be available from your Study Planner.

We recommend that you install Maxima and familiarise yourself with what help is available from the Software Guide before starting work on the units. You should also check that you are able to access the Computer Exploration Worksheets, and run code that you find there.

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 module website carefully before submitting your work.

Although the module is mainly teaching the ‘pencil and paper’ calculation techniques that a scientist or engineer needs to be able to apply, you do need access to a scientific calculator, because some continuous assessment questions may ask for a numerical answer. Please see the MS327 website for details of which calculators will be allowed into the examination.
The module components

The module consists of a set of printed study texts, a handbook, a website and various assessment elements as described in the following pages.

Study texts

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

Book 1: Fundamental concepts of dynamics

The first book considers ordinary differential equations, Newton's second law, conservation of energy, and the concepts of fixed point, limit cycles and constants of motion. It will also introduce a framework for discussing random processes, such as random walks.

Book 2: Deterministic dynamics

The second book will develop some more advanced concepts. In the case of conservative systems, it introduces the calculus of variations and develops Lagrangian dynamics from Hamilton's principle. In the case of dissipative systems, it will consider the use of maps to model dynamical processes. ‘Chaos’ will be defined and explored using the strange attractor. The book will introduce the notions of Lyapunov exponents, fractal dimensions of attractors, and their connection via the 'Lyapunov dimension' formula.

Book 3: Stochastic processes and diffusion

Finally, the third book will investigate the random walk as the archetypical random dynamical process, and explain its connection to the diffusion equation. Fourier methods (both series and transforms) will be treated by illustrating their role in treatment of the diffusion equation and probability theory. The module will conclude with a look at some further applications of random dynamical systems, including the models used for option pricing in mathematical finance.

Handbook

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

Only the printed copy of the Handbook sent to you in the mailing can be taken into the exam; copies downloaded from the module website will not be allowed. The rule for annotation is described in the Examination Arrangements booklet under the heading 'special annotation’, which states: ‘Unrestricted annotation is allowed in module materials listed as permitted in the examination (including any end-papers or blank pages sent to you as
part of the module materials), but no additional sheets of notes, inserts, ‘post-its’ or ‘index tabs.’ Further details can be found on the module website.

Website

You can access the module website from your StudentHome web page; if you are reading this you have successfully found the website. Here you will find the Study planner, the tutor-marked assignments (TMAs), the interactive computer-marked assignments (iCMAs), and the specimen exam paper and its solutions, which are available only through the module website. It is important that you check the website frequently, as Errata and News items will be posted here.

The module website will give you access to the forums, which you can use to communicate with other students and with the MS327 team. Access to online rooms (if your tutorials are electronic) is also via the module website.

You will also find links to ‘screencasts’, which are short online presentations illustrating how to solve some typical problems.
Assessment

Continuous Assessment

The assessment comprises 4 tutor-marked assignments (TMAs), 4 interactive computer-marked assignments (iCMAs) and an examination.

You must achieve 30% on any given TMA or iCMA for it to count as ‘satisfactorily submitted’. Though the module team would encourage you to submit all of the assignments, we do not require this. To pass the continuous assessment requirement, you must satisfactorily submit either (a) all 4 TMAs or (b) 3 TMAs and 3 iCMAs. If you meet this continuous assessment requirement, then your result will be determined on the basis of the exam alone.

You will have only one opportunity to submit each iCMA, so we have added several practice quizzes to the module website so that you can get used to answering questions of a similar nature.

Both the iCMAs and the TMAs will focus strongly on learning through practice rather than on assessment. The feedback that 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 module.

Although your scores in the continuous assessment will not contribute directly to your overall grade, these assignments form an essential part of the learning process.

Please note that the Assessment Calculator is not available on this module.

Exam

There is a three-hour exam at the end of MS327 that is based on the material in Books 1 to 3. You should familiarise yourself with the format of the exam well in advance.

A specimen exam paper will be added to the MS327 website in due course, and you should work through this carefully before the exam. Sample solutions are also provided. You will be allowed to take into the exam the MS327 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. Each assignment cut-off date is usually very soon after the end of the last study week for the relevant units. We recommend that you try to finish the assignment questions relating to each part of a unit 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 to understand the ideas in MS327, 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 to avoid similar errors in later TMAs and in the exam. 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 3 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 with other students is to use the MS327 forums: these are moderated by an academic member of staff, and MS327 tutors and the module team may also pop in from time to time.

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 MS327 website. If you experience difficulties that are not directly related to the content of MS327, you are welcome to contact your Learner Support Team (see your StudentHome page for details).