ME511 MATHEMATICAL MODELLING IN ENGINEERING SCIENCE

Module Registrar: Dr J Biggs james.biggs@strath.ac.uk

Taught To (Course): Cohorts for whom class is optional

Other Lecturers Involved: None

Credit Weighting: 10 (ECTS 5)

Semester: 2

Assumed Prerequisites: MM215 Maths

Optional class

Academic Level: 5

Module Format and Delivery (HOURS i.e. 1 credit = 10hrs of study):

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Tutorial</th>
<th>Laboratory</th>
<th>Groupwork</th>
<th>External</th>
<th>Online</th>
<th>Project</th>
<th>Assignments</th>
<th>Private Study</th>
<th>Total</th>
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<tbody>
<tr>
<td>24</td>
<td>6</td>
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<td>20</td>
<td>50</td>
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Educational Aim

This module is designed to provide insights into generic problems in Engineering Science through the use of ordinary differential equations. Mathematical modelling will be presented as an important tool for Engineers to understand complex phenomena and to predict the behaviour of complex systems. The development of key topics in differential equation theory will be cast in the context of real problems in Engineering Science. An example is the use of bifurcation methods to understand buckling. Since the main goal of the class is to explore the relationship between mathematics and real phenomena, simple differential equations are used for illustration to avoid excessive mathematical complexity. This course requires a strong mathematical ability and understanding.

Learning Outcomes

On completion of the module the student is expected to be able to

LO1 An appreciation of the role of mathematical modelling in Engineering Science.

LO2 An understanding of the relationship between real engineering phenomena and the mathematical models which describe them.

LO3 The ability to pose and solve problems in Engineering Science using the properties of differential equations.

Syllabus

Engineering Science: Overview of common themes in Engineering Science.

Applied mathematics: Review of required mathematical methods.

Mathematical modelling: Models, assumptions, scaling and real data.

Linear systems: 1st and 2nd order linear ODEs with applications, phase space methods.

Non-linear systems: Non-linear ODEs with applications, simple prototype equations.

Stability: Classification of fixed points, linearization, Lyapunov methods, limit cycles.

Bifurcations: Bifurcation in simple prototype equations, application to buckling.

Perturbation methods: Regular and singular, application to fluid boundary layers.

Chaotic systems: Routes to chaos, chaotic systems in Engineering Science.

Assessment of Learning Outcomes

Criteria

LO1
C1: students should demonstrate understanding of nonlinear ordinary differential equations for modelling engineering systems.

LO2
C2: students should demonstrate the ability to analyse simple coupled nonlinear differential equations using analytical methods and relate them to real world engineering phenomena.
C3: students should demonstrate the ability to analyse simple coupled nonlinear differential equations using numerical methods and relate them to real world engineering phenomena.

C4: students should demonstrate an appreciation of both the usefulness of analytical and numerical methods for studying nonlinear phenomena.

LO3

C5: students should demonstrate an understanding of parameter sensitivity and bifurcations in nonlinear systems and how they relate to real world engineering problems.

C6: students should understand what is meant by chaos in systems of differential equations and how this explains certain phenomena in real engineering problems.

The standards set for each criterion per Module Learning Outcome to achieve a pass grade are indicated on the assessment sheet for all assessment.

12 Principles of Assessment and Feedback
(on Learning & Teaching web pages: www.strath.ac.uk/learnteach/informationforstaff/staff/assessfeedback/12principles/)

Formal, written feedback will be provided by the return of the assessment mark to students (note: final exam scripts will not be returned to students).

Informal feedback will be provided at tutorial sessions primarily through verbal discussion with individuals or groups on tutorial exercises attempted in advance by students (note: to receive this feedback students should participate in these tutorials but attendance is not mandatory).

Feedback will be provided on return of the assignment and during tutorials.

Assessment Method(s) Including Percentage Breakdown and Duration of Exams

<table>
<thead>
<tr>
<th>L/Outcomes</th>
<th>Examinations</th>
<th>Courseworks</th>
<th>Projects</th>
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<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Month(s)</td>
<td>Duration</td>
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<tr>
<td>LO1, LO2, LO3, LO4</td>
<td>1</td>
<td>May</td>
<td>2 hours</td>
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Indicate which learning outcomes (LO1, LO2 etc) are to be assessed by exam/coursework/project as required.

Coursework / Submissions deadlines:
The coursework will be submitted in week 8.

Resit Assessment Procedures:
2hr examination (answer 3 questions from 4) in the August diet.

PLEASE NOTE:
Students need to gain a summative mark of 50% to pass the module. Students who fail the module at the first attempt will be re-examined during the August diet. This re-examination will consist entirely of an exam.

Recommended Reading

The following book can be used as a useful reference but the course does not follow it explicitly.


Additional Student Feedback
(Please specify details of when additional feedback will be provided)

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Session: 2014/15

Approved:

Course Director Signature: 

Date of Last Modifications: 13 August 2014
# MODULE TIMETABLE

**Module Code:** ME511  
**Module Title:** Mathematical Modelling in Engineering Science

**Brief Description of Assessment:**
A single coursework (CW) that involves mathematical calculations by hand and numerical simulation in Matlab, plus a 2 hour examination.

**Assessment Timing:**
Indicate on the table below the submission dates for each assignment/project and the timing of each exam/assessment(s).

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<tr>
<th>Semester One</th>
<th>WK1</th>
<th>WK2</th>
<th>WK3</th>
<th>WK4</th>
<th>WK5</th>
<th>WK6</th>
<th>WK7</th>
<th>WK8</th>
<th>WK9</th>
<th>WK10</th>
<th>WK11</th>
<th>WK12</th>
<th>Exam Period</th>
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<th>WK10</th>
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- CW

May