MODULE DESCRIPTION FORM

ME209 MATHEMATICAL MODELLING AND ANALYSIS

Module Registrar: Dr H Chen
haofeng.chen@strath.ac.uk

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

Other Lecturers Involved: Prof Nigel Mottram, Dr E Minisci and Dr Zhangming Wu

Credit Weighting: 20 (ECTS 10)

Semester: 1 and 2

Assumed Prerequisites: 16132 Engineering Mechanics 1, ME101 Heat and Flow 1, ME103 Engineering Analysis, MM117 Mathematics 1M

Compulsory class

Academic Level: 2

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>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>12</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>118</td>
<td>200</td>
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</table>

Educational Aim

Mathematics (Semester 1)
To give students competence in the differential and integral calculus of functions of several independent variables, and in the solution of ordinary differential equations (with particular emphasis on the Laplace transform method).

Engineering Analysis (Semester 1 and 2)
This class develops the general approach to the solution of engineering problems and involves mathematical modelling, numerical methods and the application of computer software. A wide range of engineering topics is presented and includes problems in structures, dynamics, fluids and heat transfer to emphasise the general applicability of the solution processes. The integration of mathematical techniques and the use of the computer as an essential tool in the modelling, simulation and solution of problems in engineering is an important objective of the class. It is also designed to demonstrate the power of mathematical methods to the formulation and manipulation of equations to represent complex engineering systems.

The first 6 weeks of both semester 1 and semester 2 present the fundamentals of numerical methods and formulation techniques in an engineering context and is taught in a lecture/tutorial format. In the last 6 weeks of each semester the emphasis changes to the application of the techniques previously developed to a range of engineering problems using the MATHCAD software. This part is taught in a computer based learning environment.

Learning Outcomes

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

Mathematics (Semester 1)
LO1 Have knowledge and understanding of concepts and methods introduced in Mathematics module (MM217).

Engineering Analysis (Semester 1 and 2)
LO2 have an understanding of the use of mathematical methods and their role in formulating equations to represent a variety of problems in engineering, and be able to apply mathematical methods for the formulation of ordinary differential equations and linear equation systems.
LO3 be able to choose and apply a variety of numerical methods to solve ordinary differential equations, simultaneous equations, and to numerically differentiate and integrate data and equations.
LO4 be able to model simple problems involving dynamic simulation techniques and apply mathematical software such as Mathcad to the solution of engineering problems.

Syllabus

ME209 Mathematical Modelling and Analysis is a combined module which consists of two separate modules Mathematics (MM217) and Engineering Analysis 2 (16265). The module will teach the following:
Mathematics (Semester 1)

Ordinary Differential Equations: first-order separable, linear; second-order linear; constant coefficients with forcing functions exp(kx), sin(kx), cos(kx) and polynomials, including sums of these.

Partial Differentiation: first and second derivatives, total differential, small errors, differentiation in a given direction, chain rule, implicit functions, stationary points; indicate extension to functions of more than two variables.

Double Integration: interpretation as a volume, evaluation as an iterated integral, change of order, change of variable from Cartesian to polars, application to centre of mass, moments of inertia.

Laplace Transform: definition, standard results, application to ODEs.

Engineering Analysis (Semester 1 and 2)

Concepts of mathematical modelling: case studies in formulation of equation systems and differential systems for structural, dynamic, fluid and thermal problems.

Mathematical methods: Linear algebra, matrices in engineering mechanics, linear operators, definitions; square matrices; inversion, and determinants and singularity; Gaussian elimination, LU decomposition.

Numerical methods: Solution of simultaneous linear and nonlinear equations; Jacobi and Gauss Seidel Iteration method; Newton Raphson method; Numerical differentiation and integration, applications to multiple integrals, numerical quadrature, evaluation of areas, interpolation and curve fitting.


Software applications: Use of Mathcad and MATLAB.

Assessment of Learning Outcomes

Criteria

For each of the Module Learning Outcomes the following criteria will be used to make judgements on student learning:

LO1
C2 How student appreciates basic aspects of the calculus of functions of several variables, including the notions of directional derivative and double integration (January exam).

LO2
C1 How student understands the use of mathematical methods and their role in formulating equations to represent a variety of problems in engineering, and how to apply mathematical methods for the formulation of ordinary differential equations and linear equation systems (Coursework 1 and 2, Class based examinations).

LO3
C1 How to choose and apply a variety of numerical methods to solve ordinary differential equations, simultaneous equations, and to numerically differentiate and integrate data and equations (Class based examinations).

LO4
C1 how to model simple problems involving dynamic simulation techniques and apply mathematical software to the solution of engineering problems (Coursework 1 and 2).

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/)

- In order to promote student engagement and self-regulation in learning, the Principles of Assessment and Feedback is adapted to suit current disciplinary context. The assessment method adopted in this module includes examination, class test and coursework assignments, with proper feedback for student learning.
• Regular formative feedback will be provided by verbal discussion on an individual or group basis of work during the tutorials timetabled for the classes.

• For the assessment of coursework reports, both summative assessment and formative feedback will be provided. The summative assessment will positively influence how students interact with formative assessment and feedback.

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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</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Month(s)</td>
<td>Duration</td>
</tr>
<tr>
<td>see below</td>
<td>see below</td>
<td>see below</td>
<td>80%</td>
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<tr>
<td>LO1, LO2, LO3</td>
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</table>

Indicate which learning outcomes (LO1, LO2 etc) are to be assessed by exam/coursework/project as required.

Mathematics

Semester 1 – 50% 2 hour January exam.

Note: students who've previously passed MM217 in 1st year are not required to sit the ME209 Jan exam

Engineering Analysis

Semester 1 - 25% continuous assessment (consisting of 15% for 1 class based exam 50mins in week 7 and 10% for 1 coursework assignment).

Semester 2 – 25% continuous assessment (consisting of 15% for 1 class based exam 50 mins in week 7 and 10% for 1 coursework assignment).

Coursework / Submissions deadlines:

Week 12

Resit Assessment Procedures:

3 hour examination in August.

PLEASE NOTE:

Students need to gain a summative mark of 40% 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 exam.

Recommended Reading

**Highly recommended reading; *Simply for reference (do NOT purchase)

Mathematics


Engineering Analysis - Notes are provided on Myplace


Additional Student Feedback

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

Students will receive regular one to one feedback during the tutorials timetabled for the class.

Session: 2014/15

Approved:

Course Director Signature: [Signature]

Date of Last Modifications: 18 August 2014
MODULE TIMETABLE

Module Code: ME209
Module Title: Mathematical Modelling and Analysis

Brief Description of Assessment:
Mathematics (Semester 1) – 50% 2 hour January exam
Engineering Analysis – Semester 1 – 25% continuous assessment (consisting of 15% for 1 class based examination (50 mins) in week 7 and 10% for 1 coursework assignment).  Semester 2 – 25% continuous assessment (15% for 1 class based exam (50 mins) in week 7 and 10% for 1 coursework assignment).
For both coursework assignments, the students should submit a professional standard report not exceeding 3 pages approximately (excluding appendices) detailing:
- Introduction explaining the background to the problem (1/2 page maximum)
- Theory section (1/2 page maximum),
- A brief description of your Mathcad worksheet explaining the functioning of it (1/2 page maximum, a copy of your worksheet should be included as an appendix if your report is produced using Microsoft Word),
- A section describing the evolution of your solution (1 page maximum, any additional graphical data and tabulated numerical results may be included in the appendix),
- A brief concluding statement (1/2 page maximum).

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

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<thead>
<tr>
<th>Semester</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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</thead>
</table>
| One      |     |     |     |     |     |     | Class test | Start Assignment |     |      |      | Submit Assignment after WK12 | Mathematics Exam |}

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<thead>
<tr>
<th>Semester</th>
<th>WK1</th>
<th>WK2</th>
<th>WK3</th>
<th>WK4</th>
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<th>WK9</th>
<th>WK10</th>
<th>WK11</th>
<th>WK12</th>
<th>Exam Period</th>
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<tr>
<td>Two</td>
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<td></td>
<td>Class test</td>
<td>Start Assignment</td>
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<td>Submit Assignment after WK12</td>
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