MODULE DESCRIPTION FORM

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

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: Dr Victorita Dolean Maini Dr E Minisci	**Credit Weighting: 20 (ECTS 10)**	**Semester: 1 and 2**	
Assumed Prerequisites: 16132 Engineering Mechanics 1, ME108 Engineering Analysis and Numerical Methods, MM117 Mathematics 1M	**Compulsory class**	**Academic Level: 2**	**Suitable for Exchange: Y**

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

Lecture	Tutorial	Laboratory	Groupwork	External	Online	Project	Assignments	Private Study	**Total**
50	11	8					10	121	200

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 5 weeks of each semester the emphasis changes to the application of the techniques previously developed to a range of engineering problems using the MATLAB 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 MM217 (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 Matlab 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. 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.

Numerical Solution of ordinary differential equations: classification of solution methods with engineering applications in dynamics, thermodynamics, fluid mechanics, solid and structural mechanics using computer-aided engineering techniques. Numerical solution of ordinary differential equations, initial value problems, predictor corrector methods. Runge Kutta methods. Multi-step methods.

Numerical Solution of integrals: methods to solve single and multiple integrals, trapezoidal method, Simpson's rule.

Software applications: Use of 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
C1 How students understand standard methods for solving simple ordinary differential equations of first and second-order, and methodology of the Laplace transform method for solving ordinary differential equations (January exam).
C2 How students appreciate basic aspects of the calculus of functions of several variables, including the notions of directional derivative and double integration (December exam).

LO2
C1 How students understand 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, December/April examinations).

LO3
C1 How to choose and apply a variety of numerical methods to solve ordinary differential equations, simultaneous equations, and to numerically integrate equations (December/April 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.

Principles of Assessment and Feedback
(within Assessment and Feedback Policy at: https://www.strath.ac.uk/staff/policies/academic/)

Please state briefly how these are incorporated in this module.

- In order to promote student engagement and self-regulation in learning, the Principles of Assessment and Feedback are adapted to suit current disciplinary context. The assessment method adopted in this module includes examination, mid-term tests 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.
- Formal, written feedback will be provided by the return of the assessment mark to students. 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

Examination				Coursework		Practical		Project	
Number	Month(s)	Duration	***Weighting***	Number	***Weighting***	Number	***Weighting***	Number	***Weighting***
See below	See below	See below	80%	See below	20%				
* LO1, LO2, LO3				* LO2, LO4		*		*	

* ***L/Os:*** *Indicate which Learning Outcomes (L01, L02, etc) are to be assessed by exam/coursework/practical/project as required.*

Mathematics: Semester 1 - 50% 2 hour December exam.
Note: students who've previously passed MM217 in year 1 are not required to sit the MM217 Dec exam in year 2

Engineering Analysis: Semester 1 - 25% combined assessment (consisting of 15% for one 1hr December exam and 10% for one coursework assignment). Semester 2 - 25% combined assessment (consisting of 15% for one 1hr April/May exam and 10% for one coursework assignment).

Coursework / Submissions deadlines (*academic weeks*):
Week 10

Resit Assessment Procedures:
3hr combined examination in August diet

PLEASE NOTE:
Students must gain a summative mark of 40% to pass the module. Students who fail the module at the first attempt will be re-assessed during the August diet. This re-assessment will consist entirely of exam. No marks from any previous attempts will be transferred to a new resit attempt.

Recommended Reading

*****Purchase recommended **Highly recommended reading *For reference**

Mathematics
* Thomas, G.B. & Finney, R.L. "Calculus and Analytic Geometry" (Addison-Wesley). D515.15 THO, ISBN: 0201400154.
* Kreyszig, E., "Advanced Engineering Mathematics" (Wiley). D510.2462 KRE, ISBN: 047133328X.

Engineering Analysis - Notes are provided on Myplace
** "Numerical Methods for Engineers" by Chapra and Canale, ISBN 0-07-100412-2

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

Date	Time	Room No
Weekly tutorial	TBC	Check timetable webpages for details

Session: 2019/20

Approved:

Course Director Signature:	**Dr Stuart Grey**
Date of Last Modifications:	**04/09/19**

(Updated June 2019)

MODULE TIMETABLE

Module Code:	**ME209**	**Module Title:**	**Mathematical Modelling and Analysis**

Brief Description of Assessment:

Mathematics (Semester 1) – 50% 2 hour December exam

Engineering Analysis
Semester 1 – 25% combined assessment (consisting of 15% for one 1 hour December exam and 10% for 1 coursework assignment).
Semester 2 – 25% combined assessment (15% for one 1h exam in April/May, and 10% for 1 coursework assignment).

For both coursework assignments, the students should submit a professional standard report and the Matlab code as requested and further details are provided on Myplace.

Assessment Timing:-

Indicate on the table below the start/submission dates for each assignment/project and the timing of each exam/assessment using the dropdowns provided. Dropdowns can be left blank. Add extra notes below the dropdowns.

Please note: Timings can and will change, this should only be used as a guide.

Semester One	W&D Wk	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Course work Set	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Course work Submit	Choose an item. Choose an item.	Exam

Semester Two	C&D Wk	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Course work Set	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Course work Submit	Choose an item. Choose an item.	Exam