UNIVERSITY OF EXETER

MODULE TITLE	**Mathematical Modelling**	**CREDIT VALUE**	**30**
MODULE CODE	**MTH1003**	**MODULE CONVENER**	**Prof Andrew Gilbert (Coordinator)**

DURATION: TERM	**1**	**2**	**3**
DURATION: WEEKS	**11**	**11**	**0**

Number of Students Taking Module (anticipated)	**200**

DESCRIPTION - summary of the module content

This module will introduce you to the theory and tools for analysing real physical systems, such as pendulums, planetary motion, and predator-prey models. You will also develop programming and coding skills using a package such as Matlab, and learn how mathematical theory and computer-based modelling can complement each other to help us understand and predict the world around us.

This module will also introduce you to the process of mathematical research and help you to understand the nature of the mathematical research community that you will be joining at the University of Exeter. You will work individually or as part of a team to carry out three short projects that will develop a range of individual and group research and communication skills. The ideas and skills in the module are developed further in MTH2005 Modelling: Theory and Practise.

AIMS - intentions of the module

The module aims to introduce you to Newtonian dynamics and its applications; to show you the use of calculus and vectors in the modelling of physical systems; to introduce you to applied mathematics as a tool for investigating natural phenomena. As examples, you will explore the consequences of physical laws, as well as the behaviour of physical and natural systems from projectiles to predator-prey systems and planetary motion.

The module aims also to develop your abilities to: express mathematical problems in a form suitable for solution by computer; use computer packages such as Matlab to develop computer models for independent exploration; programme in order to solve mathematical problems; collaborate in small teams to tackle mathematical projects. The module will provide reinforcing material for other core stage one modules in mathematics.

INTENDED LEARNING OUTCOMES (ILOs) (see assessment section below for how ILOs will be assessed)

On successful completion of this module, you should be able to:

Module Specific Skills and Knowledge:

1 recall and apply basic techniques in classical mechanics to model simple mechanical and dynamical systems;

2 work on your own and as part of a small team to formulate and solve both well-defined and more open-ended problems in mathematics;

3 use a high-level programming language for basic numerical analysis, simulation and data visualisation.
Discipline Specific Skills and Knowledge:

4 formulate models of the physical world, applying mathematical machinery such as vectors and calculus to develop and analyse these models;

5 present your findings in a logical and coherent manner;

6 use mathematical computing software (such as Matlab) to assist problem solving.

Personal and Key Transferable/ Employment Skills and Knowledge:

7 formulate and solve problems;

8 work effectively as part of a small team;

9 communicate orally with team members and via written presentation;

10 undertake research using a variety of sources.

SYLLABUS PLAN - summary of the structure and academic content of the module

basic concepts: modelling; point particles, space, time, velocity, acceleration; Newton's laws;
projectiles: gravity; trajectories; envelope of trajectories;
simple harmonic motion: elasticity, Hooke's law; strings and springs; equilibria and oscillations;
energy: kinetic energy and gravitational potential energy; elastic potential energy; motion under general potentials, equilibria, stability and small oscillations;
oscillations: damping, forcing and resonance; coupled oscillations; normal coordinates;
nonlinear systems: first order systems; phase plane; classification of equilibria in linear systems; linearisation about equilibria in nonlinear systems; examples of predator-prey models;
planetary motion: motion in plane polar coordinates; velocity and acceleration; central forces and angular momentum;
numerical methods for solving equations using a computer: root finding; finite differences; order of accuracy, stability, and convergence; implementation in a typical high-level programming language.

LEARNING AND TEACHING

LEARNING ACTIVITIES AND TEACHING METHODS (given in hours of study time)

Scheduled Learning & Teaching Activities	88.00	**Guided Independent Study**	212.00	**Placement / Study Abroad**	0.00

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description
Scheduled learning and teaching activities	66	3 x 1 hour lecture per week.
Scheduled learning and teaching activities	11	1 hour practical in a computer lab per fortnight.
Scheduled learning and teaching activities	11	1 hour tutorial per fortnight.
Guided independent study	212	Reading lecture notes; formative coursework; independent research for assessments; development of LaTeX and other computing skills; preparation and revision for examination.

ASSESSMENT

FORMATIVE ASSESSMENT - for feedback and development purposes; does not count towards module grade

Form of Assessment	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Exercise sheets	10 x 5 hours	All	Peer and tutor
Programming assignment	10 x 1 hour	3, 6	Online tools (e.g. Matlab Grader)

SUMMATIVE ASSESSMENT (% of credit)

Coursework	40	Written Exams	60	Practical Exams	0

DETAILS OF SUMMATIVE ASSESSMENT

Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Coursework – Individual Project	10	Computer code	3, 6	Feedback sheet
Coursework - Group Project 1	10	Poster presentation	All	Feedback sheet
Coursework - Group Project 2	20	5,000 words or equivalent	All	Feedback sheet
Written Exam	60	2 hours (Summer)	All	Via SRS

DETAILS OF RE-ASSESSMENT (where required by referral or deferral)

Original Form of Assessment	Form of Re-assessment	ILOs Re-assessed	Time Scale for Re-reassessment
Coursework - individual Project*	Coursework Individual Project	3,6	August Ref/Def period
Coursework - Group Project 1*	Coursework - Individual Poster	All	August Ref/Def period
Coursework - Group Project 2*	Coursework - Individual Report	All	August Ref/Def period
Written Exam*	Written Exam	All	August Ref/Def period

*Please refer to reassessment notes for details on deferral vs. Referral reassessment

RE-ASSESSMENT NOTES

Deferrals: Reassessment will be by coursework and/or exam in the deferred element only. For deferred candidates, the module mark will be uncapped.
Referrals: Reassessment will be by a single written exam worth 100% of the module only. As it is a referral, the mark will be capped at 40%.

RESOURCES

INDICATIVE LEARNING RESOURCES - The following list is offered as an indication of the type & level of information that you are expected to consult. Further guidance will be provided by the Module Convener

ELE: http://vle.exeter.ac.uk

Reading list for this module:

Type	Author	Title	Edition	Publisher	Year	ISBN	Search
Set	Collinson C.D. and Roper T.	Particle Mechanics		Arnold	1995	000-0-340-61046-8	[Library]
Set	Lunn M.	A First Course in Mechanics		Oxford University Press	1991	978-0198534334	[Library]
Set	Dyke P. & Whitworth R.	Guide to Mechanics		Macmillan	1992	000-0-333-51072-0	[Library]
Set	Smith P. & Smith R.C.	Mechanics	2nd	Wiley	1990	000-0-471-92737-6	[Library]
Set	Hahn, Brian D.	Essential MATLAB for Engineers and Scientists	4th	Academic Press	2010	9780123748836 012	[Library]

CREDIT VALUE	30	ECTS VALUE	15

PRE-REQUISITE MODULES	None
CO-REQUISITE MODULES	None

NQF LEVEL (FHEQ)	4	AVAILABLE AS DISTANCE LEARNING	No
ORIGIN DATE	Wednesday 11 January 2017	LAST REVISION DATE	Friday 03 February 2023

KEY WORDS SEARCH	Dynamics; projectiles; oscillations; coupled oscillators; stability theory; planetary motion; mathematical research; Computer; programming; algorithms; problem solving; Matlab.