MODULE TITLE	**Differential Equations**	**CREDIT VALUE**	**15**
MODULE CODE	**MTH2003**	**MODULE CONVENER**	**Prof Vadim N Biktashev (Coordinator)**

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

Number of Students Taking Module (anticipated)	**300**

DESCRIPTION - summary of the module content

Differential equations are at the heart of nearly all modern applications of mathematics to natural phenomena. Computerised applications play a vital role in many areas of modern technology. Mathematically, all rates of change and acceleration can be described by derivative functions. These include the growth of populations, the spread of diseases, movement of physical objects in response to forces acting on them, or even the fluctuations of the stock market. You will learn the basic principles of differential equations, and will apply that knowledge to some every day phenomena. Then you will learn about methods of finding solutions for some classes of differential equations. In particular you will develop methods to solve the wave and heat equations which are fundamental to modelling many physical processes.

This course will enable you to demonstrate an understanding of, and competence in, a range of analytical tools for posing and solving differential equations, and their application to situations in science and technology.

Prerequisite modules: MTH1002 or NSC1002 (Natural Science Students) or equivalent.

AIMS - intentions of the module

The aim of this module is to introduce you to some representative types of ordinary and partial differential equations and to introduce a number of analytical techniques used to solve them exactly or approximately.

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 demonstrate a working knowledge of how to identify, classify and solve a range of types of ordinary and partial differential equations;

2 reveal an insight into their application and derivation;

3 show some knowledge of a selection of special functions and series methods used for solution of these differential equations.

Discipline Specific Skills and Knowledge:

4 exhibit an understanding of range of analytical tools for posing and solving differential equations;

5 display competence in applying these tools;

6 prove an understanding of the concept of using differential equations for mathematical modelling of natural phenomena and engineering applications.

Personal and Key Transferable/ Employment Skills and Knowledge:

7 demonstrate an ability to monitor your own progress and to manage time;

8 show an ability to formulate and solve complex problems.

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

- Review of simple methods for solving first order ordinary differential equations (ODEs). Sufficient conditions to guarantee existence and uniqueness to such ODEs.

- Systems of first-order differential equations. Linear Systems. Constant coefficients case. Variation of Parameters.

- The general linear second order ODE. Equations with constant coefficients, Euler-Cauchy equations. Reduction of Order and Variation of Parameters.
- Boundary value problems, eigenfunctions and eigenvalues. Orthogonality of eigenfunctions of Sturm-Liouville problems.
- Power series methods: Leibniz-Maclauren method and method of Frobenius (selected examples).

- Selected orthogonal systems of functions: trigonometric functions, Legendre polynomials, Bessel functions. Series in orthogonal functions, including Fourier series.
- Examples of linear partial differential equations (PDEs) and their solutions, including initial/boundary-value problems for one-dimensional wave equation and one-dimensional heat equation.
- Solution of PDEs in two and three spatial dimensions using separation of variables, a.k.a. normal modes or (generalised) Fourier series, in Cartesian, polar and spherical coordinates.
- Selected applications of ODEs and PDEs.

LEARNING AND TEACHING

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

Scheduled Learning & Teaching Activities	38.00	**Guided Independent Study**	112.00	**Placement / Study Abroad**	

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description
Scheduled learning and teaching activities	33	Lectures including examples classes
Scheduled learning and teaching activities	5	Tutorials
Guided independent study	112	Lecture and assessment preparation; wider reading

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	5 x 10 hours	All	Discussion at tutorials and solutions provided in ELE; tutor feedback on submitted solutions.

SUMMATIVE ASSESSMENT (% of credit)

Coursework	10	Written Exams	90	Practical Exams	0

DETAILS OF SUMMATIVE ASSESSMENT

Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Written exam – closed book	90	2 hours (January)	All	Written/verbal on request, SRS
Coursework exercises 1	5	15 hours	All	Annotated script and written/verbal feedback
Invigilated class test	5	30 minutes	All	Annotated script and written/verbal feedback

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
Written Exam	Written exam (2 hours) (90%)	All	Referral/deferral period
Coursework Exercises	Coursework exercises (5%)	All	Referral/deferral period
Invigilated class test	Invigilated class test (5%)	All	Referral/deferral period

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

Web based and Electronic Resources: ELE: https://ele.exeter.ac.uk

Reading list for this module:

Type	Author	Title	Edition	Publisher	Year	ISBN	Search
Set	Arfken, G.B. & Weber, H.J.	Mathematical Methods for Physicists	Electronic	Harcourt/ Academic Press	2005	000-0-120-59825-6	[Library]
Set	O'Neil, P.V.	Advanced Engineering Mathematics	2nd	Wadsworth	1987	000-0-534-06792-1	[Library]
Set	Stephenson, G. & Radmore, P.M.	Advanced Mathematical Methods for Engineering and Science Students		Cambridge University Press	1990	000-0-521-36860-X	[Library]
Set	Boyce, W E, Di Prima, R C	Elementary differential equations and boundary value problems	9th edition	John Wiley and Sons	2009	978-0-470-39873-9	[Library]
Set	Kreyszig, E.	Advanced Engineering Mathematics	9th	Wiley	2006	978-0471728979	[Library]

CREDIT VALUE	15	ECTS VALUE	7.5
PRE-REQUISITE MODULES	MTH1002		
CO-REQUISITE MODULES			
NQF LEVEL (FHEQ)	5	AVAILABLE AS DISTANCE LEARNING	No
ORIGIN DATE	Tuesday 10 July 2018	LAST REVISION DATE	Monday 25 September 2023
KEY WORDS SEARCH	Differential equations; orthogonal functions.		