MODULE TITLE	**Partial Differential Equations**	**CREDIT VALUE**	**15**
MODULE CODE	**MTH3008**	**MODULE CONVENER**	**Prof Vadim N Biktashev (Coordinator)**

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

Number of Students Taking Module (anticipated)	**88**

DESCRIPTION - summary of the module content

A PDE is a differential equation in which the unknown function is a function of multiple independent variables and the equation involves its partial derivatives. The order is defined similarly to the case of ordinary differential equations, but further classification into elliptic, hyperbolic, and parabolic equations, especially for second order linear equations, is of utmost importance. Some partial differential equations do not fall into any of these categories over the whole domain of the independent variables and they are said to be of mixed type.
In this module, you will learn how PDEs can be well-posed or ill-posed, and will find out about a range of analytical techniques used to solve PDEs. The module will strengthen your ability to interpret theoretical mathematical concepts, and acquire a deeper understanding of how mathematics relates to real world problems. The module builds on material in the Differential Equation module MTH2003, in particular separation of variables and Fourier series.

AIMS - intentions of the module

Partial differential equations (PDEs) form a central part of mathematics. The laws of physics are formulated in terms of PDEs, so the subject is of great practical importance. However, the range of application of PDEs goes beyond the physical world into the modelling of subjects as diverse as ecology and economics. This leads to interesting connections between subjects that at first seem unrelated. The purpose of this module is to develop some of the main analytical and numerical techniques used to solve PDEs, building on the work done in MTH2003 and MTH2004. We will illustrate the topic using a range of real world examples.

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 understanding of the classification of linear partial differential equations (PDEs) of first and second order;

2 apply a range of analytical techniques and a wider knowledge and appreciation of applications of PDEs in mathematics;

3 exhibit detailed knowledge of specific parabolic, elliptic and hyperbolic second order PDEs.

Discipline Specific Skills and Knowledge:

4 complete extended multi-step calculations using a variety of mathematical techniques;

5 translate unfamiliar problems into ones that can be tackled by familiar techniques;

6 show a knowledge of the relevance of PDEs in applications.

Personal and Key Transferable/ Employment Skills and Knowledge:

7 illustrate self-management and time management skills;

8 express complex abstract arguments in a logical and coherent manner;

9 use learning resources, including e-learning resources to extend their knowledge.

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

- Introduction. Examples of PDE models. First order PDEs. Linear, quasilinear and nonlinear cases;
- Second-order linear PDEs and their classification into elliptic, hyperbolic and parabolic classes. Domains, boundary conditions and well-posedness;
- Hyperbolic equations: method of characteristics, canonical form, wave equation in one and three dimensions, conservation of energy, D'Alembert and Kirchhoff formulas;
- Parabolic equations: canonical form, uniqueness and stability theorems, diffusion equation on finite and infinite domains, solution by transform methods;
- Elliptic equations: canonical form, uniqueness theorem, Laplace equation in finite and infinite domains, solution by transform methods;
- Green's function methods for solving non-homogeneous linear equations;
- Selected examples of solutions to nonlinear PDEs.

LEARNING AND TEACHING

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

Scheduled Learning & Teaching Activities	33.00	**Guided Independent Study**	117.00	**Placement / Study Abroad**	0.00

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description
Scheduled learning and teaching activities	33	Lectures/example classes
Guided independent study	30	Assessment preparation
Guided independent study	57	Study of notes and formative examples
Guided independent study	30	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
Examples Sheets	5 during semester	All	Oral at lecture sessions. Solutions posted on ELE

SUMMATIVE ASSESSMENT (% of credit)

Coursework	20	**Written Exams**	80	**Practical Exams**	0

DETAILS OF SUMMATIVE ASSESSMENT

Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Coursework 1– based on questions submitted for assessment	10	15 hours	All	Annotated script and written/verbal feedback
Coursework 2– based on questions submitted for assessment	10	15 hours	All	Annotated script and written/verbal feedback
Written Exam – closed book	80	2 hours (Summer)	All	Written/verbal on request, 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
Written Exam *	Written Exam (2 hours) (80%)	All	August Ref/Def Period
Coursework 1 *	Coursework 1 (10%)	All	August Ref/Def Period
Coursework 2 *	Coursework 2 (10%)	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 written 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	Ockendon, J., Howison, S. , Lacey, A. & Movchan, A.	Applied Partial Differential Equations		Oxford University Press	2003	978-0198527718	[Library]
Set	Sneddon I.M.	Elements of Partial Differential Equations		McGraw-Hill	1957		[Library]
Set	Smith, G.D.	Numerical Solution of Partial Differential Equations: Finite Difference Methods	3rd	Oxford University Press	1985	978-0198596509	[Library]
Set	Williams, W.E.	Partial Differential Equations		Clarendon Press	1980	978-0198596332	[Library]
Set	Tveito, A, Winther, R	Introduction to partial differential equations: A computational approach	2008	Springer-Verlag	2009	978-3540887041	[Library]
Set	Logan, D.J.	Applied Partial Differential Equations	2nd	Springer	2004	978-0387209531	[Library]

CREDIT VALUE	15	**ECTS VALUE**	7.5
PRE-REQUISITE MODULES	MTH2003		
CO-REQUISITE MODULES			
NQF LEVEL (FHEQ)	6	**AVAILABLE AS DISTANCE LEARNING**	No
ORIGIN DATE	Tuesday 10 July 2018	**LAST REVISION DATE**	Thursday 26 January 2023
KEY WORDS SEARCH	Partial differential equations; parabolic equations; elliptic equations; hyperbolic equations; boundary value; initial value.		