Subject Information Guide

A gentle introduction to Partial Differential Equations

MATH4034

Semester 2, 2019

Administration and contact details

Host Department	Department of Mathematics and Statistics
Host Institution	University of Western Australia
	Crawley, WA 6009
Name of lecturer	Enrico Valdinoci
Phone number	Click here to enter text.
Email Address	Click here to enter text.
Homepage	https://research-repository.uwa.edu.au/en/persons/enrico-valdinoci
Name of Honours coordinator	Miccal Matthews
Phone number	0451 382 852
Email Address	enrico.valdinoci@uwa.edu.au

Subject details

Start date:	July 2019 (exact date to be communicated)
End date:	November 2019 (exact date to be communicated)
Contact hours per week:	By appointment, according to the students' necessity
Lecture day and time:	12 weeks, 3 hours per week (exact scheduled to be communicated)

This is a brand new unit, covering a topic that was not covered before and aiming at completely new lines of research. Therefore, some technical details, such as the code of the course and the exact allocation of the teaching hours need further confirmation from the administration. In any case, the unit has been already confirmed and announced to the students.

Subject content

1. **Subject content description**

This unit will cover some important partial differential equations (PDE's) such as the the transport equation, Laplace's equation, the heat equation and the wave equation, as well as some of the general theory and applications of elliptic PDE's via maximum principles, the Hopf lemma, narrow domains, moving planes, the Gidas-Ni-Nirenberg's Theorem and symmetry results. Complementary material such as Fourier transform methods, Sobolev spaces, the Alexandrov Maximum Principle, fully nonlinear equations and nonlocal equations will also be covered.

2. Week-by-week topic overview

Week 1
Preliminaries
Transport equation

Week 2-3
Laplace's equation

Week 4
Heat equation

Week 5
Wave equation

Week 6-8
Maximum Principles, Hopf Lemma, narrow domains

Week 9-11
Moving planes. Gidas-Ni-Nirenberg's Theorem. Symmetry results.

Week 12
Applications.

Complementary material: Fourier Transform, Sobolev spaces, Alexandrov Maximum Principle, fully nonlinear equations, nonlocal equations.

3. Assumed prerequisite knowledge and capabilities

Calculus and mathematical analysis.

4. Learning outcomes and objectives

Learning outcomes:

Possess a coherent and advanced knowledge of the basic concepts of partial differential equations in terms of the development of the theory and the application to several fields of interest, including physics, geometry, and biology.

Develop problem solving abilities, by analysing, consolidating, and synthesising knowledge, in order to identify and provide solutions showing intellectual independence, a rigorous methodology, and an original approach.

Develop advanced communication skills in order to present mathematical results and scientific information with analytical content in a rigorous and coherent framework.

How learning outcomes will be mapped to assessment

Each week of the course will be followed by a list of exercises that students are expected to solve.

These exercises will either review some important aspects of the theory or develop some complementary material, and they will serve as a completion and enrichment of the methods discussed and developed in the course of the lectures.

By solving these exercises in a written form, the students will consolidate both their problem solving abilities and their capacities of efficiently communicating advanced mathematical ideas in a rigorously formalised setting.

The assignments will be the ideal arena for students to test their capacities of mastering advanced mathematical theories and their ability of providing independent ideas to solve complex problems, by combining a creative approach to a rigorous exposition.

In addition, the weekly assignments will provide a very effective training for the final exams, in which students will be asked to face advanced problems and provide original and rigorous solutions by exploiting the

mathematical theories learned in class and the technical expertises consolidated by their weekly training as corroborated by the assignments.

AQF specific Program Learning Outcomes and Learning Outcome Descriptors (if available):

AQF Program Learning Outcomes addressed in this subject	Associated AQF Learning Outcome Descriptors for this subject
K1, K2	Choose from list below
S1, S2, S3, S4, S5	Choose from list below
A2, A4	Choose from list below
Insert Program Learning Outcome here	Choose from list below
Insert Program Learning Outcome here	Choose from list below
Insert Program Learning Outcome here	Choose from list below
Insert Program Learning Outcome here	Choose from list below

Learning Outcome Descriptors at AQF Level 8

Knowledge

K1: coherent and advanced knowledge of the underlying principles and concepts in one or more disciplines

K2: knowledge of research principles and methods

Skills

S1: cognitive skills to review, analyse, consolidate and synthesise knowledge to identify and provide solutions to complex problem with intellectual independence

S2: cognitive and technical skills to demonstrate a broad understanding of a body of knowledge and theoretical concepts with advanced understanding in some areas

S3: cognitive skills to exercise critical thinking and judgement in developing new understanding

S4: technical skills to design and use in a research project

S5: communication skills to present clear and coherent exposition of knowledge and ideas to a variety of audiences

Application of Knowledge and Skills

A1: with initiative and judgement in professional practice and/or scholarship

A2: to adapt knowledge and skills in diverse contexts

A3: with responsibility and accountability for own learning and practice and in collaboration with others within broad parameters

A4: to plan and execute project work and/or a piece of research and scholarship with some independence

5. Learning resources

L. C. Evans, *Partial differential equations*. Graduate Studies in Mathematics, 19. American Mathematical Society, Providence, RI, 1998. xviii+662 pp. ISBN: 0-8218-0772-2.

Q. Han, F. Lin, *Elliptic partial differential equations*. Courant Lecture Notes in Mathematics, 1. New York University, Courant Institute of Mathematical Sciences, New York; American Mathematical Society, Providence, RI, 1997. x+144 pp. ISBN: 0-9658703-0-8; 0-8218-2691-3.

D. Gilbarg, N. Trudinger, *Elliptic partial differential equations of second order*. Reprint of the 1998 edition. Classics in Mathematics. Springer-Verlag, Berlin, 2001. xiv+517 pp. ISBN: 3-540-41160-7.

N. Abatangelo, E. Valdinoci, *Getting acquainted with the fractional Laplacian*, to appear in the Springer-INdAM Lecture Notes Series, https://arxiv.org/abs/1710.11567,

6. Assessment

Exam/assignment/classwork breakdown					
Exam	50%	**Assignment**	50%	**Class work**	Enter %
Assignment due dates		Click here to enter a date.	Click here to enter a date.	Click here to enter a date.	Click here to enter a date.
Approximate exam date				Click here to enter a date.	

Institution Honours program details

Weight of subject in total honours assessment at host department	Click here to enter text.
Thesis/subject split at host department	Click here to enter text.
Honours grade ranges at host department:	
H1	Enter range %
H2a	Enter range %
H2b	Enter range %
H3	Enter range %