ACE Network Subject Information Guide

Introduction to Nonlinear PDEs

Semester 2, 2021

Administration and contact details

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Host institution	The University of Newcastle
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Subject details

Handbook entry URL	NA
Subject homepage URL	NA
Honours student hand-out URL	NA
Start date:	19 July
End date:	29 October
Contact hours per week:	TBA
Census date:	13 August
Lecture day(s) and time(s):	TBA
Description of electronic access arrangements for students (for example, WebCT)	TBA

Subject content

1) Subject content description

This course is an introduction to nonlinear partial differential equations, focusing on nonlinear wave phenomena. We will consider applications from physics, ocean engineering, chemical engineering, civil engineering and biology. The underlying partial differential equations will be derived and the properties of the solutions will be investigated. Simulations of the PDEs will be obtained using MATLAB.

2) Week-by-week topic overview

1. Revision of the method of characteristics for linear partial differential equation.
2. Traffic waves, solution using characteristics and shock dynamics
3. Nonlinear shallow water waves or compressible gas dynamic waves. Solution by characteristics, the dam break problem, shock dynamics, hydraulic jumps and shallow water bores.
4. KdV (Korteweg-De Vries) equation. Travelling wave solutions, solitary and cnoidal waves.
5. Numerical solution of the KdV using the split-step method and computation of the soliton-soliton interaction.
6. Conservation laws for the KdV and Miura's transformation.
7. Introduction to the IST (Inverse Scattering transformation).
8. Properties of the Linear Schrodinger equation
9. The connection between the KdV and the Schrodinger equation.
10. Example calculations for the KdV and IST
11. Reaction-Diffusion systems.
12. Burgers equation.

3) Assumed prerequisite knowledge and capabilities

A course in ordinary differential equations is essential. Knowledge of separation of variables for linear partial differential equations is helpful but not essential.

4) Learning outcomes and objectives

- Understand the different approaches to solving nonlinear Partial differential equations.
- Implement split step spectral methods.
- Analyse travelling wave solutions using phase plate analysis.
- Solve nonlinear PDEs analytically.

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
Solve nonlinear partial differential equations numerical using the split step spectral method.	S2, A2
Interpret nonlinear partial differential equations in a modelling context.	S1, A1
Solve nonlinear partial differential equations analytically.	S2, A2
Solve nonlinear partial differential equations using phase plane methods	S2, A2
Conceptualise nonlinear partial differential equations.	S5, A4

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

Detailed course notes are available at
http://www.wikiwaves.org/Category:Nonlinear_PDE%27s_Course

In addition the following books will be useful

- *Wave Motion*, by Billingham and King.
- *Solitons and the Inverse Scattering Transform*, by Ablowitz and Segur
- *Solitons, Nonlinear Evolution Equations and Inverse Scattering*, by Ablowtiz and Clarkson
- *Spectral methods in MATLAB*, by Trefethen

6) Assessment

Exam/assignment/classwork breakdown					
Exam	50%	**Assignment**	40 %	**Class work**	Enter %
Assignment due dates		**01/09/2021**	**01/10/2021**	**01/11/2021**	Click here to enter a date.
Approximate exam date				10/11/2021	

Institution honours program details

Weight of subject in total honours assessment at host department	12.5%
Thesis/subject split at host department	37.5% thesis, 62.5% subjects
Honours grade ranges at host department	
H1	85-100
H2a	75-84
H2b	65-74
H3	50-64

Institution masters program details

Weight of subject in total masters assessment at host department	NA
Thesis/subject split at host department	NA
Masters grade ranges at host department	
H1	NA
H2a	NA
H2b	NA
H3	NA