Subject Information Guide

Introduction to Nonlinear PDE MATH4101

Semester 1, 2015

Administration and contact details

Host Department	School of Mathematical and Physical Sciences
Host Institution	The University of Newcastle
Name of lecturer	Michael Meylan
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Subject details

Handbook entry URL	http://www.newcastle.edu.au/degrees/bachelor-of-mathematics-honours/handbook
Subject homepage URL	http://www.newcastle.edu.au/course/MATH4101
Honours student hand-out URL	To be advised
Start date:	Monday 23 February 2015
End date:	Friday 5 June 2015
Contact hours per week:	2
Lecture day and time:	To be determined
Description of electronic access arrangements for students (for example, WebCT)	To be advised

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.

Course content

2. Week-by-week topic overview

Week 1. Revision of the method of characteristics for linear partial differential equation.

Weeks 2 – 3. Traffic waves, solution using characteristics and shock dynamics

Weeks 4 – 5. Nonlinear shallow water waves or compressible gas dynamic waves. Solution by characteristics, the dam break problem, shock dynamics, hydraulic jumps and shallow water bores.

Week 6. KdV (Korteweg-De Vries) equation. Travelling wave solutions, solitary and cnoidal waves.

Week 7. Numerical solution of the KdV using the split-step method and computation of the soliton-soliton interaction.

Week 8. Conservation laws for the KdV and Miura's transformation. Introduction to the IST (Inverse Scattering transformation).

Week 9. Properties of the Linear Schrodinger equation. The connection between the KdV and the Schrodinger equation. Example calculations for the KdV and IST.

Weeks 10 – 11. Reaction-Diffusion systems.

Week 12. Burgers equation.

3. Assumed prerequisite knowledge and capabilities

A course in Ordinary differential equations is essential. A course in linear partial differential equations is useful but it not essential.

4. Learning outcomes and objectives

1. Demonstrate an understanding of the content and context of an advanced mathematical topic;

2. Apply advanced mathematical problem solving skills

3. Use sophisticated mathematical communication skills in the presentation of mathematical arguments

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	60 %	**Assignment**	40 %	**Class work**	0%
Assignment due dates		To be advised			
Approximate exam date				Tuesday 9 June – Friday 26 June 2015	

Institution Honours program details

Weight of subject in total honours assessment at host department	Course is 10 units from a total of 80 units for the Honours year.
Thesis/subject split at host department	50 units for courses and 30 units for thesis.
Honours grade ranges at host department:	
H1	85-100 %
H2a	75-84 %
H2b	65-74 %
H3	50-63 %