University of Dundee — Mathematics Division

MA42003: PDEs And Their Approximation Guide 2009 - 2010

Organisation

The MA42003 module runs for 11 teaching weeks in the second semester. The module leader and lecturer is

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You may bring matters of concern about the course to the attention of the Mathematics Division Staff/Student Committee, which meets once each semester.

Timetable

There will be three classes each week, usually in the form two lectures and one workshop. There will be one class test of one hour duration which will be held around the middle of the semester.

Your Commitment

You should attend all lectures and workshops except on medical grounds or with the special permission of the lecturer concerned. If you are absent from the Test on account of medical problems, you should submit a medical certificate to your School Office. Outside of class hours (3 per week) personal supporting study of additional hours per week is required. This to include background reading, preparation, and writing of assessed coursework, revision for class tests and the degree examination.

Background

Mathematical models in most areas of Science and Engineering give rise to partial differential equations (PDEs) that cannot usefully be reduced to ordinary differential equations. Some typical examples include simulations of chemical reactions, population genetics, cooling systems in power stations and the flow of air around cars and aircraft. Here we give a broad introduction to PDEs that includes classification into different types, classical solution methods, qualitative properties and, for the majority of problems that cannot be solved exactly, we provide techniques for constructing approximate solutions. The module will not tackle specific applications but aims to provide a sound basis by focussing on model situations.

Syllabus

First and Second Order PDEs

Basic Theory; examples of fundamental solutions Second order linear PDEs; classification, characteristics; dAlemberts solution of the one-dimensional wave equation.

Boundary Value Problems for PDEs

Finite-difference methods for second order problems (Poissons equation): the treatment of boundary conditions and curved boundaries in two dimensions.

Initial Value Problems for PDEs

Parabolic and Hyperbolic equations: Fundamental solutions.

General discussion of basic qualitative properties such as dissipation (energy inequalities) and characteristics.

Construction of numerical methods: two-level methods and brief reference to three-level methods (if time permits).

Local truncation errors.

Stability and choice of norm: Maximum norm, L2 norm via von Neumanns method.

Application to hyperbolic systems.

The Method of Lines.

Assessment

There will be a test and an assignment which each count 10%; the remaining 80% will come from a two-hour degree examination.

Feedback

At the end of each section of the module you will be asked to complete a confidential questionnaire regarding the content and presentation of the module. This is an important element in the University's Academic Standards procedures.

Recommended Books

There are many books in the Library which cover the material of the course. Some of these are listed here.

1. G. Stephenson, Partial Differential Equations for Scientists and Engineers, Imperial College Press, 1996.

2. W.A. Strauss, Partial Differential Equations, An Introduction, J. Wiley & Sons, New York, 1992.

3. A. R. Mitchell and D. F. Griffiths, The Finite Difference Method in Partial Differential Equations, J. Wiley & Sons, London, 1980.

4. A. Tveito and R Winther, Introduction to Partial Differential Equations, A Computational Approach, Springer, Texts in Applied Maths, vol. 29, 1998.

5. K.W. Morton and D.F. Mayers, Numerical Solution of Partial Differential Equations, Cambridge University Press, 1994.

6. E. Kreyszig, Advanced Engineering Mathematics, Wiley: 8th Edition, 1999.