LTCC Proposed Course

Title: Numerical Methods for Elliptic Partial Differential Equations

Basic Details:

- Core Audience: 1st or 2nd year applied mathematics students
- Course Format: 5 x 2hr lectures

Course Description:

- Keywords: numerical methods, elliptic partial differential equations, boundary value problems, finite difference method, finite element method

- Syllabus: In this course we introduce numerical methods for solving elliptic partial differential equations (PDEs), discuss their analysis and implementation, and compare the advantages and disadvantages of each approach. An outline of the weekly content is as follows:
    1. Introduction and motivation; classification of second order PDEs; definition of key function spaces; Cauchy-Schwarz and Poincaré-Friedrichs inequalities.
    2. Existence and uniqueness of weak solutions to boundary value problems (BVPs) for elliptic PDEs.
    3. Finite difference approximation of elliptic BVPs, via a one-dimensional example.
    4. Finite difference and finite volume methods for elliptic BVPs in higher dimensions.
    5. Finite element methods for elliptic BVPs.

- Recommended reading:
    - A First Course in the Numerical Analysis of Differential Equations, by A. Iserles, Cambridge University Press, 1996.
    - An Introduction to Numerical Analysis, by E. Suli and D. Mayers, Cambridge University Press, 2003.
    - An Analysis of the Finite Element Method, by G. Strang and G. J. Fix, 2nd edition, Wellesley-Cambridge Press, 2008.
    - Finite Difference Methods for Ordinary and Partial Differential Equations, by R. J. LeVeque, SIAM, 2007.
    - Numerical solution of partial differential equations by the finite element method, by C. Johnson, Dover, 2009.
    - The mathematical theory of finite element methods, by S. C. Brenner and L. R. Scott, 3rd edition, Springer, 2008.

- Prerequisites: some familiarity with partial differential equations (PDEs) and basic ideas of numerical approximation would be helpful, as would some programming experience.

Format:

- Weekly problem sheets.
- Electronic lecture notes will be made available.
- Necessary support facilities: students will be expected to implement some numerical methods using a suitable programming language, e.g., Matlab.

Lecturer Details:

- Lecturer: Professor Stephen Langdon
- Lecturer home institution: Brunel University London
- Lecturer e-mail: Stephen.Langdon@brunel.ac.uk