MATLAB CDT Course

Aims:

- To introduce the MATLAB environment and increase familiarity with data structures in MATLAB and their manipulation.
- To introduce the basic ideas of solving PDE's in a computational environment and the practical interpretation of stability, convergence and accuracy.
- To be able to write a finite difference scheme to solve an ODE/PDE in MATLAB.
- To appreciate the benefits of a computational approach to understanding PDE's.

Class outline: (week 2 Tuesday 12.30 to 2.30pm C2
week 4 to 8 Thursdays 2.00-3.00pm C2
week 9 2.00 to 3.00pm C5)

Class 1 and 2: Give an overview of the course. Introduction to scientific computation, numerical solution to PDE's and an introduction to MATLAB environment. Including basic functions, for loops, data structures etc. Demonstrate and practice the manipulation of these. Good coding practices, debugging etc.... Introduction to linear algebra in Matlab.

Class 3: Introduction to finite difference schemes for ODE's. Demonstrate and work through deriving the Euler step and coding this in Matlab showing pre-written code. (his will relate to the first problem sheet question.)

Class 4: Coding 1D Poisson PDE solver, how to implement Dirichlet boundary conditions and setting the domain of the PDE.

Class 5: Coding a 2D Poisson equation using a pre-prepared skeleton code. Discussion of implementing Neumann boundary conditions using ghost cells.

Class 6: Time stepping in PDE's. Demonstration of using 1D poisson solver with a time-stepping routine to solve heat equation.

Class 7: Conservation laws and Burger's equation (wave equations). Homework submissions.

Class 8: Homework discussion and non-linear problems e.g. cubic non-linearity in elliptic and parabolic problems.

Recommended reading:

- A. Iserles, A First Course in the Numerical Analysis of Differential Equations. Second edition. Cambridge Texts in Applied Mathematics, Cambridge University Press.
    - A nice easy to read introduction - goes into PDE's at the end.
- T. A. Davis, MATLAB Primer, CRC Press.

Further reading of the background material:

- Boško Jovanović and Endre Süli: **Analysis of Finite Difference Schemes for Linear Partial Differential Equations with Generalized Solutions**, Springer, 2014.