Foundation Module Course

Introduction to Partial Differential Equations

**EPSRC Centre for Doctoral Training in Partial Differential Equations
Michaelmas Term
4-8 October 2018 (8 hours)**

By Professor Gui-Qiang G. Chen

Overview

- **Introductory course on PDE** that is central to the other CDT courses.
- **Rigorous treatment and analysis of PDEs** through examples, representation formulas, and properties that can be understood by using relatively elementary mathematical tools and techniques.
- **Transport equation, Heat equation, Wave equation, Laplace's equation**
- **Nonlinear first order PDEs, Conservation laws, Hamilton-Jacobi equations**

Prerequisites

- Recommended prerequisites include undergraduate-level **Advanced Calculus, Linear Algebra, ODE Theory** and some exposure to **Complex Analysis**.

- W. Strauss, **Partial Differential Equations**: An Introduction, John Wiley and Sons, 1992

- H. Weinberger, **A First Course in Partial Differential Equations**, with Complex Variables and Transform Methods, Dover, 1965

Core Reading

- **L.-C. Evans: Partial Differential Equations,** American Mathematical Society, 2nd edition, 2010.

- **G. Folland: Introduction to Partial Differential Equations**, 2nd ed., Princeton University Press, 1995.

- **M. Renardy and R. Rogers: An Introduction to PDEs**, 2nd ed., Springer-Verlag, 2004.

- **F. John: Partial Differential Equations**, 4th edition, Springer-Verlag 1982.

- **J. Kevorkian: PDEs: Analytical Solution Techniques**, 2nd ed., Springer-Verlag, 1999.

- **Q. Han, A Basic Course in PDEs,**   AMS, 2011.

- **P. Garabedian, Partial Differential Equations**, 2nd revised edition, AMS Chelsea Publishing, 1998.

- **R. McOwen, Partial Differential Equations: Methods and Applications**, 2nd edition, Prentice Hall, 2003

Further Reading

- **R. Courant and D. Hilbert: Methods of Mathematical Physics I-II,** John Wiley & Sons, 1953, 1989.

- **R. Hormander: Lectures on Nonlinear Hyperbolic Differential Equations**, Springer-Verlag: Berlin, 1997.

- **M. Taylor: Partial Differential Equations,** Vols. 1-3, Springer-Verlag: New York, 1996.

- **J. Jost: Partial Differential Equations**, Springer-Verlag: New York, 2002.

- **R. Guenther and J. Lee: PDEs of Mathematical Physics and Integral Equations**, Dover, 1996.

Brief History

- **Analysis of Differential Equations can date back as early as the period when Calculus was invented.**

- **1671: Newton called Fluxional Equations**

- **1676: Leibniz introduced the term Differential Equations (Aequatio Differentialis, in Latin)**

- **It is fair to say that every subject that uses Calculus involves differential equations.**

- **Many subjects revolve entirely around their underlying PDEs: Euler equations, Navier-Stokes equations, Maxwell's equations, Boltzmann equation, Schrödinger equation, Einstein equation,…**