Course No.: Math 536
Course Title: Numerical Analysis of PDEs
Core Course: yes
Term: Winter 2018
Instructor: Yau Shu Wong

Syllabus:

This graduate course will focus on computational methods for PDEs. In additional to the study of error propagation and theoretical analysis for convergence, consistency and stability, you are expected to be able to implement numerical algorithms into computer programming to solve model PDEs including elliptic, parabolic and hyperbolic equations. Thus, computing experience is an essential component in Math 536.

Topics:

Discretization techniques:

The focus will be based on Finite Difference (FD) approximations for PDEs. Given a linear BVP and IBVP, the problem will be discretized by FD methods. FD approximations for boundary conditions (Dirichlet, Neumann and mixed conditions) will be discussed. Other discretization methods such as Finite Element will be briefly discussed.

Advanced iterative Solvers for Elliptic PDEs

Conjugate gradient methods including preconditioning version.
Multigrid techniques.

Parabolic PDEs

1-D problems:
Convergence, consistency and stability.
Explicit & implicit schemes, two- and three-level schemes in time domain.

Multi-dimensional Problems:
Splitting algorithms, Alternating Direction Implicit (ADI) and Locally One Dimensional (LOD) methods

Hyperbolic PDEs

Characteristic and CFL condition

Numerical Dissipation and Dispersion

Modified Equation approach

Finite Differencing and Upwind difference schemes for 1D and multi-dimensional equations.

Computational methods for conservation laws.

Solving Nonlinear PDEs and irregular domains.

Prerequisites:

The required background includes courses in Linear Algebra, PDE's and Numerical Analysis. **You must be capable of writing a computer code** in at least one programming language, and also be familiar with standard visualization software (e.g. Matlab, Maple etc.) for your numerical results**.**

References:

Numerical Partial Differential Equations
J.W.Thomas, Texts in Applied Mathematics 22, Springer 1995

The finite difference method in partial differential equations
Andrew Ronald Mitchell; D F Griffiths, Wiley-Interscience publication.

Multigrid Methods
S. F. McCormick, SIAM

Grading:

Homework and project presentation:	25%
Midterm examination (2 hours):	25%
Final examination (3 hours):	50%

The time for the midterm and final exams will be decided in the course of the term so that it is suitable for both the students and the instructor.