Numerical Solution for Partial Differential Equations*

Course Title:	Numerical Solution for Partial Differential Equations*
Course prerequisites:	Optional course
Class hour:	48
Department:	Department of Mathematics
Students:	应用数学(全英文) 信息与计算科学(全英文)

Course description

Numerical solution for PDEs is more exciting now than at almost any time in the past. Its applications continue to spread to more and more fields. Largely due to the computer revolution of the last half century, numerical methods has risen to a role of prominence in the mathematical curriculum rivaling that of calculus. Modern software has also made it possible to dramatically improve the way the course is taught. It also introduces the basics of applied mathematics as well as a software package that is valuable both for learning and using numerical methods for PDEs. The main development of the course will follow the text

Course goals.

- To provide students with a good understanding of the concepts and methods of numerical solutions for PDEs, described in detail in the syllabus.
- To help the students develop the ability to solve problems using numerical solutions for PDEs.
- To connect numerical solutions for PDEs to other fields both within and without mathematics.
- To develop abstract and critical reasoning by studying logical proofs and the axiomatic method as applied to the numerical solutions for PDEs.

Textbook

Partial Differential Equation with Numerical Methods, 科学出版社, Stig J. Larsson, Vidar Thomee.

Prerequisites: The main prerequisite for the course is that you understand the continuous problems for which numerical methods are developed. So you need to know ODEs and PDEs at the level taught in a methods of mathematical physics's course and basic numerical analysis including programming.

Grades

Your course grade will be determined using the following formula:
40% Class Participation
15% Class Notes
25% Homework
50% Programs

Topics

This is a 1-semester course in the numerical solutions for the partial differential equation for students who have completed two semesters of calculus. It covers Systems of Two-point Boundary Value Problem, Elliptic Equation, Parabolic Equation and FEM for Parabolic Equation, Theoretical Analysis for Convergences and Stability. We will follow the textbook and aim to cover in full or in part the following chapters:

1. FDMs for Two-point Boundary Values for ODEs
1.1 Dirichlet Boundary Value Problems
1.2 Difference Schemes
1.3 Derivative of Boundary Values Problems

2. FDMs for Elliptic Equations
2.1 Dirichlet Boundary Problems
2.2 Five Point Boundary Value Problems
2.3 The Compact FDMs
2.4 1.3 Derivative of Boundary Values Problems

3 FDMs for parabolic Equations
3.1 Dirichlet Boundary Problems
3.2 Forward Euler Scheme
3.3 Backward Euler Scheme
3.4 Richardson Scheme
3.5 Crank-Nicholson Scheme
3.6 Compact FDMs
3.7 Nonlinear Parabolic Equations

4 FDMs for Hyperbolic Equations
4.1 Dirichlet Boundary Problems
4.2 Explicit FDMs
4.3 Implicit FDMs
4.4 Compact FDms

5 Introduction for FEMs
5.1 FEMs for ODEs
5.2 FEMs for Elliptic Equations
5.3 Least Squares Problems
5.4 FEMs for Parabolic BVPs