MATH4351 Numerical Solutions of Partial Differential Equations

Course Outline- Spring 2024

1. Instructor

Prof. Yang XIANG, Email maxiang@ust.hk, Office 3425

Office Hour: Monday 16:30-17:30 (or by appointment)

2. Teaching Assistant

Mr. Tiankai HU, Email: thuah@connect.ust.hk

3. Meeting Time and Venue

Lectures:L1

Date/Time: Mo 03:00PM - 04:20PM, Fr 10:30AM - 11:50AM

Venue: Rm 6602, Lift 31-32

Tutorials:T1A

Date/Time: We 06:00PM - 06:50PM

Venue: Rm 1032, LSK Bldg

4. Course Description

Credit Points: 3

Pre-requisite: (MATH 2350 OR MATH 2351 OR MATH 2352) AND MATH 3312 AND MATH 4052

Exclusion: NIL

Brief Information/synopsis:

Introduction to finite difference and finite element methods for the solution of elliptic, parabolic and hyperbolic partial differential equations; including the use of computer software for the solution of differential equations.

5. Intended Learning Outcomes

Upon successful completion of this course, students should be able to:

No.	ILOs
1	Recognize and use appropriately numerical technique in computation.
2	Develop numerical approximation to discretize partial derivatives.
3	Apply numerical analysis to understand numerical schemes, and construct reliable and accurate numerical methods for different type of partial differential equations.
4	Solve real and hypothetical problems by applying the numerical schemes.

6. Assessment Scheme

a. Examination duration: 2.5 hours

b. Percentage of coursework, examination, etc.:

Assessment	Assessing Course ILOs
15% by homework	1, 2, 3
15% by project and report	4
70% by final exam	1, 2, 3, 4

7. Student Learning Resources

Textbooks:

1. K.W. Morton & D.F. Mayers, Numerical solution of partial differential equations, Cambridge University Press, 2nd edition, 2005.

8. Teaching and Learning Activities

Scheduled activities: 3 hours lecture, 1 hour tutorial

9. Course Topics (subject to minor changes)

(1) Parabolic equations in one space variable
Explicit Euler scheme, Truncation error, Convergence analysis, Fourier analysis of the error, Implicit Euler scheme, Thomas algorithm for implicit schemes, The weighted average method and convergence, More general linear problems.

(2) Parabolic equations in two and three dimensions
Explicit Euler scheme, ADI method in two dimensions.

(3) Hyperbolic equations in one space variable
CFL condition, Error analyses of the upwind scheme, Lax-Wendroff scheme.

(4) Consistency, convergence and stability
Formal definitions of consistency, convergence and stability, Lax Equivalence Theorem.

(5) Elliptic equations in two dimensions
Finite difference method, Maximum principle and error analysis, Finite element method.

(6) Iterative solution of linear algebraic equations
Basic iterative methods, Fourier analysis of convergence, The conjugate gradient method