MA6612: NUMERICAL PARTIAL DIFFERENTIAL EQUATIONS

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Numerical Partial Differential Equations

Subject Code
MA - Mathematics
Course Number
6612

Academic Unit
Mathematics (MA)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims to
· introduce further numerical methods for the solutions of partial differential equations; and
· provide an overview of criteria for analyzing stability and accuracy properties of numerical solutions of boundary value problems.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	explain mathematical theory underlying basic numerical methods for the solutions of partial differential equations.	20	x		
2	perform stability and convergence analysis to investigate applicability of numerical methods for solving partial differential equations.	20	x		
3	carry out finite difference and finite element methods to approximate solutions of initial-boundary value problems.	20	x	x	
4	implement discretization methods, including spectral collocation and Galerkin approximation, to special types of partial differential equations.	20	x	x	
5	apply numerical and computational methods to obtain and analyze solutions of partial differential equations arising in physical science.	20		x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Learning through teaching is primarily based on lectures.	1, 2, 3, 4, 5	39 hours in total
2	Take-home Assignments	Learning through take-home assignments helps students implement and analyze numerical methods for approximating solutions of partial differential equations.	1, 2, 3, 4	after-class

3	Project(s)	Learning through project(s) helps students obtain approximate solutions of physically-arising initial/boundary value problems with mathematical justification by principles and numerical techniques introduced in this course.	5	after-class

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Test	1, 2, 3	15	15-30% Questions are designed for the first part of the course to see how well the students have learned mathematical criteria for analyzing numerical methods of solving partial differential equations, as well as the methods of finite difference and finite element.
2	Hand-in assignments	1, 2, 3, 4, 5	10	0-15% These are skills-based assessment which enables students to demonstrate techniques of approximating solutions of partial differential equations by numerical methods and analyzing accuracy of solutions with the aid of computing softwares.
3	Project(s)	5	5	0-15% Students are assessed on their ability in implementing numerical and computational techniques to formulate physical applications as initial/boundary value problems, as well as on the presentation of numerical results with analysis.

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

3

Additional Information for ATs

Examination questions are designed to see how far students have achieved their intended learning outcomes. Questions will primarily be skills and understanding based to assess the student’ s versatility in numerical methods of solving partial differential equations.

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

Assessment Rubrics (AR)

Assessment Task

1. Test (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Independent problem solving skills on progressive learning based on lecture

Excellent

(A+, A, A-) Consistently demonstrates a thorough understanding of numerical and computational methods and strong ability to solve partial differential equations

Good

(B+, B, B-) Adequately demonstrates an understanding of numerical and computational methods and ability to solve partial differential equations

Fair

(C+, C, C-) Demonstrates some understanding of numerical and computational methods to solve simple partial differential equations

Marginal

(D) Demonstrates some understanding of numerical and computational methods and can seldom apply them to solve partial differential equations

Failure

(F) Demonstrates little understanding of numerical and computational methods but cannot solve partial differential equations

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Assessment Task

2. Hand-in assignments (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Understanding based on both lecture and outsource reference

Excellent

(A+, A, A-) Consistently demonstrates a thorough understanding of numerical and computational methods and strong ability to solve partial differential equations

Good

(B+, B, B-) Adequately demonstrates an understanding of numerical and computational methods and ability to solve partial differential equations

Fair

(C+, C, C-) Demonstrates some understanding of numerical and computational methods to solve simple partial differential equations

Marginal

(D) Demonstrates some understanding of numerical and computational methods and can seldom apply them to solve partial differential equations

Failure

(F) Demonstrates little understanding of numerical and computational methods but cannot solve partial differential equations

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Assessment Task

3. Project(s) (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Comprehensive understanding and creativity on combination of class learning and relative resources

Excellent

(A+, A, A-) Demonstrates a comprehensive understanding of numerical and computational methods and strong ability in programming to solve partial differential equations in physical science

Good

(B+, B, B-) Demonstrates an understanding of numerical and computational methods and ability in programming to solve partial differential equations in physical science

Fair

(C+, C, C-) Demonstrates some understanding of numerical and computational methods and ability in programming to solve simple partial differential equations in physical science

Marginal

(D) Demonstrates some understanding of numerical and computational methods and little ability in programming to solve simple partial differential equations in physical science

Failure

(F) Demonstrates little understanding of numerical and computational methods but cannot program to solve simple partial differential equations in physical science

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Assessment Task

4. Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Comprehensive problem solving skills on learning materials

Excellent

(A+, A, A-) Consistently demonstrates a thorough understanding of numerical and computational methods and strong ability to solve partial differential equations

Good

(B+, B, B-) Adequately demonstrates an understanding of numerical and computational methods and ability to solve partial differential equations

Fair

(C+, C, C-) Demonstrates some understanding of numerical and computational methods to solve simple partial differential equations

Marginal

(D) Demonstrates some understanding of numerical and computational methods and can seldom apply them to solve partial differential equations

Failure

(F) Demonstrates little understanding of numerical and computational methods but cannot solve partial differential equations

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Assessment Task

1. Test (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Independent problem solving skills on progressive learning based on lecture

Excellent

(A+, A, A-) Consistently demonstrates a thorough understanding of numerical and computational methods and strong ability to solve partial differential equations

Good

(B+, B) Adequately demonstrates an understanding of numerical and computational methods and ability to solve partial differential equations

Marginal

(B-, C+, C) Demonstrates some understanding of numerical and computational methods to solve simple partial differential equations

Failure

(F) Demonstrates little understanding of numerical and computational methods but cannot solve partial differential equations

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Assessment Task

2. Hand-in assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Understanding based on both lecture and outsource reference

Excellent

(A+, A, A-) Consistently demonstrates a thorough understanding of numerical and computational methods and strong ability to solve partial differential equations

Good

(B+, B) Adequately demonstrates an understanding of numerical and computational methods and ability to solve partial differential equations

Marginal

(B-, C+, C) Demonstrates some understanding of numerical and computational methods to solve simple partial differential equations

Failure

(F) Demonstrates little understanding of numerical and computational methods but cannot solve partial differential equations

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Assessment Task

3. Project(s) (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Comprehensive understanding and creativity on combination of class learning and relative resources

Excellent

(A+, A, A-) Demonstrates a comprehensive understanding of numerical and computational methods and strong ability in programming to solve partial differential equations in physical science

Good

(B+, B) Demonstrates an understanding of numerical and computational methods and ability in programming to solve partial differential equations in physical science

Marginal

(B-, C+, C) Demonstrates some understanding of numerical and computational methods and ability in programming to solve simple partial differential equations in physical science

Failure

(F) Demonstrates little understanding of numerical and computational methods but cannot program to solve simple partial differential equations in physical science

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Assessment Task

4. Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Comprehensive problem solving skills on learning materials

Excellent

(A+, A, A-) Consistently demonstrates a thorough understanding of numerical and computational methods and strong ability to solve partial differential equations

Good

(B+, B) Adequately demonstrates an understanding of numerical and computational methods and ability to solve partial differential equations

Marginal

(B-, C+, C) Demonstrates some understanding of numerical and computational methods to solve simple partial differential equations

Failure

(F) Demonstrates little understanding of numerical and computational methods but cannot solve partial differential equations

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Part III Other Information

Keyword Syllabus

Description and numerical analysis of the main approximation methods for stationary and time-dependent boundary value problems: Finite differences, finite elements, spectral and collocation methods. Stability, consistency and convergence.

Reading List

Compulsory Readings

	Title
1	Lecture Note by Graeme Fairweather and Ian Gladwell; and Lecture Note by Weiwei Sun.

Additional Readings

	Title
1	Nil