MA8014: ADVANCED METHODS FOR SCIENTIFIC COMPUTATION

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Advanced Methods for Scientific Computation

Subject Code
MA - Mathematics
Course Number
8014

Academic Unit
Mathematics (MA)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
R8 - Research Degree

Medium of Instruction
English

Medium of Assessment
English

Precursors
MA3514 Numerical Methods for Differential Equations or MA6612 Numerical Partial Differential Equations

Part II Course Details

Abstract
This course gives students the opportunity for further studies in numerical methods of scientific computation. It
- introduces numerical methods for solutions of partial differential equations;
- provides an overview of criteria for analysing 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 numerical methods for solutions of partial differential equations	10%	x	x	
2	Perform error and stability analysis to investigate applicability of numerical methods for solving partial differential equations	20%	x	x	x
3	Carry out finite difference and finite element methods to approximate solutions of initial-boundary value problems	20%	x	x	x
4	Implement discretization methods, including spectral collocation, to stationary and time-dependent boundary value problems	30%		x	x
5	Apply numerical and computational methods to obtain and analyse solutions of boundary value problems arising in physical science and engineering	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	
2	Assignments	Learning through take-home assignments helps students implement and analyse numerical methods for approximating solutions of boundary value problems	1, 2, 3, 4	

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 advanced numerical techniques	5	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Test	1, 2, 3, 4	30	Questions are designed for the first part of the course to see how well the students have learned criteria for analysing numerical methods of boundary value problems, as well as implementation of finite element, finite difference and collocation methods.	No
2	Hand-in assignments	1, 2, 3, 4, 5	10	These are skills based assessment which enables students to approximate solutions of boundary value problems by numerical methods and to analyse accuracy of solutions with the aid of computing softwares.	No

3	Project(s)	5	10	Students are assessed on their ability in implementing computational techniques to formulate physical/ engineering applications as boundary value problems, as well as on the presentation of numerical results with analysis.	No

Continuous Assessment (%)
50

Examination (%)
50

Examination Duration (Hours)
3

Assessment Rubrics (AR)

Assessment Task
Test

Criterion
DEMONSTRATION of the understanding of the first part of the course

Excellent
High

Good
Significant

Marginal
Basic

Failure
Not even reaching marginal levels

Assessment Task
Hand-in assignments

Criterion
DEMONSTRATION of the understanding of the basic materials

Excellent
High

Good
Significant

Marginal
Basic

Failure
Not even reaching marginal levels

Assessment Task
Project(s)

Criterion
DEMONSTRATION of the ability to implement required computational techniques and present numerical results with analysis

Excellent
High

Good
Significant

Marginal
Basic

Failure
Not even reaching marginal levels

Assessment Task
Examination

Criterion
DEMONSTRATION of skills and versatility in numerical methods of solving boundary value problems

Excellent
High

Good
Significant

Marginal
Basic

Failure
Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

Finite element, finite difference and collocation methods for stationary and time-dependent boundary value problems, error analysis and stability analysis, applications in science and engineering.

Reading List