Course Syllabus

offered by Department of Mathematics
with effect from Semester A 2022/23

Part I Course Overview

Course Title:	Advanced Methods for Scientific Computation
Course Code:	MA8014
Course Duration:	One Semester
Credit Units:	3
Level:	R8
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	MA3514 Numerical Methods for Differential Equations or MA6612 Numerical Partial Differential Equations
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. 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.

2. Course Intended Learning Outcomes (CILOs)

No.	CILOs[#]	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Explain mathematical theory underlying numerical methods for solutions of partial differential equations	10%	✓	✓	
2.	Perform error and stability analysis to investigate applicability of numerical methods for solving partial differential equations	20%	✓	✓	✓
3.	Carry out finite difference and finite element methods to approximate solutions of initial-boundary value problems	20%	✓	✓	✓
4.	Implement discretization methods, including spectral collocation, to stationary and time-dependent boundary value problems	30%		✓	✓
5.	Apply numerical and computational methods to obtain and analyse solutions of boundary value problems arising in physical science and engineering	20%		✓	✓
		100%			

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 self-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.

3. Teaching and Learning Activities (TLAs)

TLA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lectures	Learning through teaching is primarily based on lectures	✓	✓	✓	✓	✓	3 hours/week
Assignments	Learning through take-home assignments helps students implement and analyse numerical methods for approximating solutions of boundary value problems	✓	✓	✓	✓		After-class

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					✓	After-class

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.					Weighting*	Remarks
	1	2	3	4	5		
Continuous Assessment: 50%							
Test	✓	✓	✓	✓		25-50%	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.
Hand-in assignments	✓	✓	✓	✓	✓	0-25%	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.
Project(s)					✓	0-25%	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.
Examination: 50% (duration: 3 hours)	✓	✓	✓	✓	✓	50%	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 boundary value problems.
						100%	

5. Assessment Rubrics

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-,C+,C)	Failure (F)
1. Test	DEMONSTRATION of the understanding of the first part of the course	High	Significant	Basic	Not even reaching marginal levels
2. Hand-in assignments	DEMONSTRATION of the understanding of the basic materials	High	Significant	Basic	Not even reaching marginal levels
3. Project (s)	DEMONSTRATION of the ability to implement required computational techniques and present numerical results with analysis	High	Significant	Basic	Not even reaching marginal levels
4. Examination	DEMONSTRATION of skills and versatility in numerical methods of solving boundary value problems	High	Significant	Basic	Not even reaching marginal levels

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Test	DEMONSTRATION of the understanding of the first part of the course	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Hand-in assignments	DEMONSTRATION of the understanding of the basic materials	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Project (s)	DEMONSTRATION of the ability to implement required computational techniques and present numerical results with analysis	High	Significant	Moderate	Basic	Not even reaching marginal levels
4. Examination	DEMONSTRATION of skills and versatility in numerical methods of solving boundary value problems	High	Significant	Moderate	Basic	Not even reaching marginal levels

Part III Other Information (more details can be provided separately in the teaching plan)

1. 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.

2. Reading List

2.1 Compulsory Readings

1.	
2.	
3.	
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2.2 Additional Readings

1.	
2.	
3.	
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