MA8005: ADVANCED PARTIAL DIFFERENTIAL EQUATIONS I

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Advanced Partial Differential Equations I

Subject Code
MA - Mathematics
Course Number
8005

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
MA8006 Functional Analysis and Applications

Part II Course Details

Abstract
This course aims to introduce some advanced aspects of the modern theory of linear and nonlinear partial differential equations, such as the existence of a solution to boundary value problems via Lax-Milgram lemma, fixed point theorems or the minimization of functionals.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain clearly mathematical formulation of stationary and time-dependent boundary value problems arising in physical problems	10%	x	x	
2	Describe analytic and structural properties of Green’ s functions	10%	x	x	
3	Find Green’ s functions for boundary value problems by various methods	20%		x	x
4	Describe analytic properties of Sobolev spaces and their applications in analysis of boundary value problems	10%	x	x	
5	Apply Lax-Milgram lemma and Brouwer’ s fixed point theorem to demonstrate existence of solutions to boundary value problems	20%	x	x	x
6	Derive some classical differential equations by using principles of calculus of variations	10%		x	x
7	Obtain minimizers of functional on analytic function spaces as solutions of classical partial differential equations	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, 6, 7	3 hours/week
2	Assignments	Learning through take-home assignments helps students implement more advanced theory and functional analytic techniques of partial differential equations, with applications in mathematical physics	1, 2, 3, 4, 5, 6, 7	After-class

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Test	1, 2, 3, 4	35	Questions are designed for the first part of the course to see how well students have learned classical results in the theory of stationary and time-dependent boundary value problems as well as applications of Green’ s functions and Sobolev spaces in analysing solutions of boundary value problems.	No
2	Hand-in assignments	1, 2, 3, 4, 5, 6, 7	35	These are skills based assessment to help students understand advanced theory and functional analytic techniques of partial differential equations, and their applications in mathematical physics.	No

Continuous Assessment (%)

70

Examination (%)

30

Examination Duration (Hours)

3

Assessment Rubrics (AR)

Assessment Task

Test

Criterion

DEMONSTATION 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
Examination

Criterion
DEMONSTRATION of skills and versatility in advanced theory and partial differential equations

Excellent
High

Good
Significant

Marginal
Basic

Failure
Not even reaching marginal levels

Part III Other Information

Keyword Syllabus
Some basic boundary value problems in solid mechanics, Green’ s functions, maximum principle, weak formulations, introduction to Sobolev spaces, Lax-Milgram lemma, equivalence with the minimization of a functional, the fundamental theorem of the calculus of variations, Brouwer’ s theorem and applications.

Reading List