Course Specification

(Postgraduate Programs)

Course Title:	**Partial Differential Equations**
Course Code:	**MAT 6231**
Program:	**Master of Science in Mathematics**
Department:	**Mathematics and Statistics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**2024 – V1**
Last Revision Date:	**1446/04/05 (08/10/2024)**

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours:					
4 (3 Lectures, 0 Lab, 2 Tutorial)					
2. Course type					
A.	☐University	☐ College	☒ Program	☐Track	☐Others
B.	☒ Required		☐ Elective		
3. Level/year at which this course is offered: Level 3 / Year 2					
4. Course general Description:					
This course describes the most important ideas and theoretical results in Partial Differential Equations. The course introduces the concept of distributions and study some existence and uniqueness results for the main three types of PDEs: hyperbolic, parabolic, and elliptic PDEs.					
5. Pre-requirements for this course (if any):					
MAT 6111, MAT 6113					
6. Co-requisites for this course (if any):					
None.					
7. Course Main Objective(s):					
This course introduces students to partial differential equations, so that students will be able to analyze, and solve various mathematical models (that involve PDEs). This course has three main aims: • To provide an understanding of the basic of PDEs. • To give the fundamental analytical methods for solving PDEs. • To prove some existence and uniqueness results for PDEs.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	75	100%
2	E-learning	0	0%
3	Hybrid • Traditional classroom • E-learning	0	0%
4	Distance learning	0	0%

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	45
2.	**Laboratory/Studio**	0
3.	**Field**	0
4.	**Tutorial**	30

5.	**Others (specify)**	0
Total		**75**

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Recall the notion of distributions and weak derivatives.**	**K1, K2**	**3 lecture hours\week**	**Direct: Regular Exams**
1.2	**Write main techniques for solving PDEs.**	**K1, K2**	• **2 tutorial hours\week** • **Self-study**	**Direct: Short Quizzes**
2.0	**Skills**			
2.1	**Apply techniques of proof for Cauchy problem for PDE.**	**S1, S2**	**Self-study**	**Direct:** • **Participations** • **Short Quizzes**
2.2	**Develop oral communication and technical writing skills through hyperbolic, parabolic, and elliptic PDE.**	**S4**	**Real-life problems**	**Direct: Homework and Mini projects**
2.3	**Classify Internet searches for Green's functions.**	**S3**	**Real-life problems**	**Direct: Short Quizzes**
2.4	**Justify out deep and not short proofs for maximum principle.**	**S1, S2**	**Self-study**	**Direct: Participations**
3.0	**Values, autonomy, and responsibility**			
3.1	**Generate initiatives with independence and responsibility.**	**V1, V2**	**Personal questions**	**Direct: Participation**
3.2	**Monitor team works.**	**V1, V3**	**Teamwork and class discussions.**	**Direct: Homework and Mini projects**

C. Course Content

No	List of Topics	Contact Hours
1.	**Introduction and Preliminaries:** Transport Equation, Solution of linear first order PDE, characteristic method, the Cauchy problem for first order PDE, Fist order non-linear equations, Charpit's method, classification of second-order equations, canonical forms for hyperbolic, parabolic, and Laplace equation.	**12**

2.	**Introduction to Distributions:** Test functions, support of smooth functions, proprieties of distributions, weak derivatives, space of distributions, convergence of distributions.	**18**
3.	**Hyperbolic Partial Differential Equations:** One-dimensional wave equation and d'Alembert's formula, wave with source, method of characteristic coordinates, method using Green's theorem, energy methods and the uniqueness, separation of variable method.	**15**
4.	**Parabolic Partial Differential Equations:** Fundamental solution of heat equation and heat kernel, maximum principle and the uniqueness, nonnegative solutions, Diffusion on the whole line, diffusion with a source.	**15**
5.	**Elliptic Partial Differential Equations:** Green's identities, Green's function, fundamental solution of Laplace's equation, mean value property, maximum principle, weak solution and weak formulation, Laplace's equation in different coordinate systems.	**15**
Total		**75**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**HomeWorks, Quizzes, Mini projects**	**During the semester**	**30%**
2.	**Midterm**	**Week 9-10**	**30%**
3.	**Final Exam**	**Week 16-17**	**40%**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	• **R. Haberman**, *Applied Partial Differential Equations with Fourier Series and Boundary Value Problems; Pearson 2012. Main reference)*
Supportive References	• **L.C. Evans,** Partial Differential Equations; American Mathematical Society, 2ndEd. 2010. • **F. John**, *Partial Differential Equations (Applied Mathematical Sciences) (v. 1), Springer, 4th Edition, 1991.* • **R. McOwen,** *Partial Differential Equations: Methods and Applications*; 2nd Edition, Pearson, 2002. • **K. Sankara Rao,** Introduction *to Partial Differential Equations;* Third Edition, Prentice-Hall of India Pvt. Ltd, 2010.
Electronic Materials	**None**
Other Learning Materials	**None**

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology equipment (projector, smart board, software)	The rooms should be equipped with data show and Smart Board.
Other equipment (depending on the nature of the specialty)	None

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	During the semester and at the end of the course each student will complete two evaluation forms.
Effectiveness of Students assessment	Instructor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.
Quality of learning resources	Students	During the semester and at the end of the course each student will complete two evaluation forms.
The extent to which CLOs have been achieved	Instructor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.
Other	None	

Assessors (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
REFERENCE NO.	8/1446
DATE	05/04/1446 (08/10/2024)