Course Specifications

Course Title:	Partial Differential Equations
Course Code:	4043504-4
Program:	Bachelor of Science (B.Sc.) Mathematics
Department:	Mathematical Sciences
College:	Applied Science
Institution:	Umm Al-Qura University

Table of Contents

A. Course Identification

1. Credit hours: 4	
2. Course type	
a. University ☐ College ☐ Department ☑ Others ☐	
b. Required ☑ Elective ☐	
3. Level/year at which this course is offered: Level Sixth/Third Year	
4. Pre-requisites for this course (if any)**:** Multivariable Calculus (4042503-4) - Ordinary Differential Equations (4042502-4)	
5. Co-requisites for this course (if any)**:**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	4 hours weekly	100%
2	**Blended**		
3	**E-learning**		
4	**Correspondence**		
5	**Other**		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
Contact Hours		
1	**Lecture**	60
2	**Laboratory/Studio**	
3	**Tutorial**	
4	**Others** (specify)	
	Total	60
Other Learning Hours*		
1	**Study**	85
2	**Assignments**	20
3	**Library**	
4	**Projects/Research Essays/Theses**	20
5	**Others** (specify)	
	Total	125

* The length of time that a learner takes to complete learning activities that lead to achievement of course learning outcomes, such as study time, homework assignments, projects, preparing presentations, library times

B. Course Objectives and Learning Outcomes

1. Course Description

This course aims to provide an introduction to the theory and applications of partial differential equations.

2. Course Main Objective

It trains students to develop a systematic approach of solving elementary partial differential equations.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge:**	
1.1	Describe real-world systems using PDEs	
1.2	Use knowledge of partial differential equations (PDEs), modelling, the general structure of solutions, and analytic and numerical methods for solutions.	
1.3	classify PDEs, apply analytical methods, and physically interpret the solutions	
1.4		
2	**Skills :**	
2.1	Solve first order PDEs using the method of characteristics	
2.2	Formulate physical problems as PDEs using conservation laws.	
2.3	Interpret solutions in a physical context, such as identifying travelling waves, standing waves, and shock waves.	
2.4	Demonstrate accurate and efficient use of Fourier analysis techniques and their applications in the theory of PDE's.	
3	**Competence:**	
3.1	Solve linear second order PDEs using canonical variables for initial-value problems, Separation of Variables and Fourier series for boundary value problems.	
3.2	Demonstrate capacity to model physical phenomena using PDE's (in particular using the heat and wave equations).	
3.3	Apply a range of techniques to find solutions of standard Partial Differential Equations (PDE)	

C. Course Content

No	List of Topics	Contact Hours
1	**Introduction** Definition of a partial differential equation (PDE). Definition of properties such as 'order' and 'linear/nonlinear'. Descriptions of how partial differential equations arise in the context of applications. Specifically, how conservation laws lead to the derivations of Laplace's equation (elliptic), diffusion equation (parabolic) and the Wave Equation (hyperbolic).	4
2	**First order equations** - Define the general form of a first order partial differential equation. Find solution of first order linear equations of the generic type. **Construct** particular solution from given data. - The use of characteristic methods to solve nonlinear first order PDEs	20
3	**Classification of second order linear equation** Classification by reduction to canonical form. Use of change of variable to find the general solution of second order linear partial differential equation in 2 variables. Determination of particular solutions from given information	8
4	**Fourier Series and applications**	12

	- Description of Fourier series, and its particularizations to half-range sine and cosine series. The Dirichlet conditions for the existence of a Fourier series. Proof of Dirichlet's Theorem for the sum to infinity of a one-dimensional Fourier Series. Selected examples of the construction of Fourier series. - Solution of linear partial differential equations by the method of separation of variables. Examples of the application of the method to the solution of boundary value problems for Laplace's equation in two dimensions and initial boundary value problems for the diffusion equation in one-dimension.	
5	**Introduction to Special Functions** The derivation of Bessel's equation and Legendre's equation from Laplace's equation when expressed in Cylindrical Polar coordinates and in Spherical Polar coordinates respectively. Use of Leibnitz rule to construct series expansions for Jn(x) and Pn(x). The concept of a Generating Function and the use of generating functions to establish algebraic and analytical properties of these functions with particular reference to the development of orthogonality conditions and their use in the construction of Fourier-Bessel and Fourier-Legendre series. Properties of the companion solutions Yn(x) and Qn(x) which may be constructed from Jn(x) and Pn(x) respectively.	16
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge**		
1.1	List the theories and concepts used in the Partial Differential Equations	Lectures	Homework and tests
1.2	Identify the steps required to carry out a piece of research on a topic within Partial Differential Equations	Lectures	Homework and tests
1.3	Recognize an understanding of the contribution and impacts of the Partial Differential Equations in science	Lectures, tutorials and e-learning	Homework and tests
2.0	**Skills**		
2.1	Apply appropriate theories, principles and concepts relevant to the Partial Differential Equations	Lectures	Home Assignments
2.2	Analyze and interpret information from a variety of sources relevant to Partial Differential Equations.	Tutorials and brain storming session	Solving problem
3.0	**Competence**		
3.1	Plan practical activities using techniques and procedures appropriate to Partial Differential Equations	Lectures	Homework and tests

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
3.2	Execute a piece of independent research using mathematics techniques of Partial Differential Equations	Lectures	Homework and tests

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Midterm Test (1)	7th week	20%
2	Homework + Reports + Quizzes		5%
3	Midterm Test 2)	12^{th} week	20%
4	Homework + Reports + Quizzes		5%
5	Final Examination	End of semester	50%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

-Each group of students is assigned to a particular faculty where he or she will provide academic advising during specific academic hours. Each staff will provide at least one session/week.

-There will be an academic advisor how will be a responsible for helping the student by doing the general supervision .

-The people in the library will support the students during the time of the course.

F. Learning Resources and Facilities

1.Learning Resources

Required Textbooks	-1. I. Petrovski, Partial differential equations, Translated Mir Publisher, 1966. WALTER A. STRAUSS: Partial Differential Equations: an Introduction, John Wiley & Sons, Ltd, 2008 . -2. M.D. Raisinghania. Advanced Differential equations. S.CHAND. New Delhi 2008.
Essential References Materials	Lecture notes provided by Instructor
Electronic Materials	https://en.wikipedia.org/wiki/Partial_differential_equation.
Other Learning Materials	

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	Lecture theatre which can accommodate 30 students for lectures and tutorials and Computer laboratory.
Technology Resources (AV, data show, Smart Board, software, etc.)	Data show (Projector)
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Strategies for Obtaining Student Feedback on Effectiveness of Teaching	Program Instructor and Head of the Department.	student questionnaire feedback form
Strategies for Evaluation of Teaching	Students and Head of the Department.	staff questionnaire feedback form
Processes for Verifying Standards of Student Achievement.	Program Instructor and the committee responsible for quality check	Compare the standards of students achievements' with standards archived elsewhere (inside KSA or students from outside the kingdom) by checking the marking of a sample of some student work : tests, course work
Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement	Staff members of UQU and other staff members of the university.	Reviewing feedback on the quality of course report from staff members, other university' staffs.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)
Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	
Reference No.	
Date	