MATH-353 Partial Differential Equations

Credit Hours: 3-0

Prerequisite: MATH-251 Ordinary Differential Equations

Course Objectives: The course aims at developing an understanding about fundamental concepts of partial differential equations. Thus, the subject will provide students with the knowledge and skills necessary for an adequate understanding of other subjects of both mathematics and other disciplines in which differential equations are involved, with the final aim of being able to solve problems that arise in all the engineering fields that are governed by differential equations.

Core Contents: First order partial differential equations, second order partial differential equations, The Cauchy problem, and wave equations, Methods of separation of variables, Integral transform methods

Course Contents: Basic concepts and definitions, Mathematical problems, Linear operators, Superposition principle, Classification of first-order equations, Construction of a first-order equation, Geometrical interpretation of a first-Order Equation, Method of characteristics and general Solutions, Canonical forms of first-order linear equations, Method of separation of variables (1st order PDEs), Second-order equations in two independent variables, Canonical forms, Equations with constant coefficients, General solutions, The Cauchy, problem, Homogeneous wave equations, Initial boundary-value problems, Equations with nonhomogeneous boundary conditions, Vibration of finite string with fixed ends, Nonhomogeneous wave equations, Separation of variables, The vibrating String Problem, Dirichlet problem for a cube, Dirichlet problem for a cylinder, Dirichlet problem for a sphere, Three-dimensional wave and heat equations, Fourier transforms, Properties of Fourier transforms, Convolution theorem of the Fourier transform, The Fourier transforms of step and impulse functions, Fourier Sine and Cosine transforms, Solving PDEs by Laplace transforms.

Course Outcomes: Upon completion of this course, the student should be able to:

- Recognize and classify first order partial differential equations
- Reduce second order partial differential equations to canonical form and find general solution.
- Derive heat and wave equations.
- Solve partial differential equations by method of separation of variables.
- Apply transform methods to solve partial differential equations.

Text Book: Tyn Myint-U, Lokenath, Debnath Linear Partial Differential Equations for Scientists and Engineers, Birkhäuser, (2007).

Reference Books:

1. David. Bleecker, George. Csordas, Basic Partial Differential Equations, Chapman & Hall (1995).
2. Prem K. Kythe, Michael R. Schäferkotter and P. Puri, Partial Differential Equations and Boundary Value Problems (2nd Ed), Chapman & Hall, (2002).
3. J. Wloka, Partial Differential Equations, Cambridge University press, (1987).
4. David Borthwick, Introduction to Partial Differential Equations, Springer (2016).

Weekly Breakdown		
Week	***Section***	***Topics***
1	1.2,1.3, 1.4,1.5	Basic concepts and definitions, Mathematical problems, Linear operators, Superposition principle
2	2.2-2.4	Classification of first-order equations Construction of a first-order equation Geometrical interpretation of a first-Order Equation
3	2.4	Method of characteristics and general Solutions
4	2.6,2.7	Canonical forms of first-order linear equations, Method of separation of variables (1st order PDEs)
5	4.1, 4.2	Second-order equations in two independent variables, Canonical forms
6	4.3, 4.4	Equations with constant coefficients General solutions
7	5.1, 5.3,5.4	The Cauchy problem, Homogeneous wave equations, Initial boundary-value problems
8	5.5-5.7	Equations with nonhomogeneous boundary conditions, Vibration of finite string with fixed ends, Nonhomogeneous wave equations
9	**Mid Semester Exam**	
10	7.1, 7.2, 7.3,	Separation of variables, The vibrating String Problem
11	7.5, 7.7	The Heat conduction problem, The Laplace and beam equations
12	7.8, 12.1, 12.2	Nonhomogeneous problems, Introduction, Fourier transforms
13	12.3, 12.4	Properties of Fourier transforms, Convolution theorem of the Fourier transform
14	12.5,12.6	The Fourier transforms of step and impulse functions, Fourier Sine and Cosine transforms
15	12.8-12.9	Laplace transform, Properties of Laplace transform.
16	12.10-12.11	Convolution Theorem of the Laplace Transform, Solving PDEs by Laplace transforms
17		Review
18	**End Semester Exam**	