Partial Differential Equations - Web course

COURSE OUTLINE

First order linear and quasi-linear PDEs, The Cauchy problem, Second order PDEs, Classification of PDEs, Characteristics, Well-posed problems, Fourier Series, Solutions of hyperbolic, parabolic and elliptic equations, Dirichlet and Neumann problems, Maximum principles, Fourier Transform methods for PDEs, The method of Green's functions for Laplace, Heat and wave equations.

COURSE DETAIL

Sl. No.	Module/ Lecture Topics	No. of (Total) Hours
1	**Mathematical Preliminaries:** A Review of Multivariable Calculus, Essential Ordinary Differential Equations, Integral Curves and Surfaces of Vector Fields, Solving Equations of the form: dx/P=dy/Q=dz/R.	4
2	**First-Order Partial Differential Equations(PDEs)**– Formation and classification of first-order PDEs, Linear and Quasi-linear first-order PDEs, Cauchy's problem for first order PDEs, The Cauchy Kowalevski Theorem, Integral surfaces passing through a given curve, Nonlinear first-order PDEs, The method of characteristics, Compatible systems, Charpit's method, Jacobi's method for nonlinear PDEs.	7
3	**Second-Order PDEs** - Classification, Canonical forms, Well-posed problems, Superposition principle.	3
4	**Fourier Series** (FS) – Introduction to FS, Convergence of FS for continuous and piecewise continuous functions, Differentiation and integration of FS, Fourier cosine and sine series.	3
5	**The Heat Equation** - Derivation of the heat equation, The maximum and minimum principles, Uniqueness, Continuous dependence, Method of separation of variables, Time-independent boundary conditions, Time-dependent boundary conditions, Duhamel's principle.	5
6	**The Wave Equation** - Derivation of the wave equation, The infinite string problem, The D'Alembert solution of the wave equation, The semi-infinite string problem, The finite vibrating string problem, The method of separation variables, The inhomogeneous wave equation.	5

NP-TEL

NPTEL

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Mathematics

Pre-requisites:

Basic Multivariable Calculus and ODEs

Coordinators:

Dr. Rajen Kumar Sinha
Department of MathematicsIIT Guwahati

7	**Laplace's Equation** – Basic concepts, Types of boundary value problems, The maximum and minimum principle, Green's identity and fundamental solution, The Poisson integral formula, The method of separation of variables, The Dirichlet problem for the rectangle, The Dirichlet problem for Annuli and Disk, The exterior Dirichlet problem.	6
8	**The Fourier Transform Methods for PDEs** –Fourier transform, Fourier sine and cosine transform, Heat flow problem in an infinite and semi-infinite rod, Infinite string problem, Laplace equation in a half-plane.	5
9	**The Method of Green's Functions** – Integral formulation, The method of Green's functions for the Laplace, Heat and Wave equations.	3
	Total	**41**

References:

1. D. Bleecker and G. Csordas, *Basic Partial Differential Equations*, Van Nostrand Reinhold, New York, 1992.
2. C. Constanda, *Solution Techniques for Elementary Partial Differential Equations*, Chapman & Hall/CRC, New York, 2002.
3. L. J. Crowin and R. H. Szczarba, *Multivariable Calculus*, Marcel Dekker, Inc, New York, 1982.
4. S. J. Farlow, *Partial Differential Equations for Scientists and Engineers*, Birkh auser, New York, 1993.
5. F. John, *Partial Differential Equations*, Springer-Verlag, New York, 1982.
6. E. Kreyszig, *Advanced Engineering Mathematics*, Wiley, 2011.
7. J. Marsden and A. Weinstein, *Calculus III*, Springer-Verlag, New York, 1985.
8. T. Myint-U and L. Debnath, *Linear Partial Differential Equations for Scientists and Engineers*, Birkh auser, Boston, 2007.
9. R. K. Nagle and E. B. Saff, *Fundamentals of Differential Equations and Boundary Value Problems*, Addison-Wesley, New York, 1996.
10. I.N. Sneddon, *Elements of Partial Differential Equations*, Dover Publications, New York, 2006.
11. E. C. Zachmanoglou and D. W. Thoe, *Introduction to Partial Differential Equations with Applications*, Dover Publication, Inc., New York, 1986.
12. E. Zauderer, *Partial Differential Equations of Applied Mathematics*, Second Edition, John Wiley & Sons, New York, 1989.