Differential Equations

1.1 Course Number: MA121

1.2 Contact Hours: 3-1-0 Credits: 11

1.3 Semester-offered: 1st Year-Even

1.4 Prerequisite: None

1.5 Syllabus Committee Member: Dr. Alpesh Kumar (Convenor), Dr. C. Kundu, and Dr. M. K. Rajpoot

2. **Objective:** Most of the fundamental phenomena occurring in the nature are expressed as a differential equation. Students must know how to model any physical phenomena using differential equations.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	First Order Differential Equations	Introduction to a differential equation, order of differential equation. Concept of solution: general solution, singular solution, implicit solution explicit solution. Separable form, reduction to separable form, exact differential equations, integrating factors. Bernoulli equations, orthogonal trajectories. Picard's existence and uniqueness theorem, Picard's iteration method.	06
2	Second Order Differential Equations	Second-order Homogeneous equations: fundamental system and general solutions of homogeneous equations, Wronskian. Second-order Homogeneous equations with constant coefficients, auxiliary equations: real distinct roots, complex roots, repeated roots, reduction of order. Non-homogeneous equations: undetermined coefficients, variation of parameters. Euler-Cauchy equation, extensions of the results to higher order linear equations.	06
3	Power Series Solution of Linear Equation	Power series solutions: ordinary points, Legendre equation. Legendre polynomials and properties. Frobenius series solutions: regular singular points, Bessel equation.	06
4	Laplace Transformation and Fourier Series	Laplace transforms & properties, inverse Laplace transforms, convolution theorem, applications. Fourier series.	06
5	Partial Differential Equation	Partial Differential Equation: introduction, linear, nonlinear (semi-linear, quasi-linear) examples, well-posedness. First order linear PDEs, method of characteristics. Classification of second order PDEs, hyperbolic, parabolic and elliptic. Wave equations:	

		d'Alembert's formula, Duhamel's principle. Heat equations: Solutions for initial boundary value, method of separation of variables. Solutions of Laplace's and Poisson's equation.	15
		Total	**39**

4. Readings

4.1 Textbook:

i. Differential Equations with Applications and Historical Notes by G.F. Simmons.
ii. Applied Partial Differential Equations: An Introduction by A. Jeffrey.

4.2 Reference books:

i. Differential Equations by S.L. Ross.
ii. Advanced Engineering Mathematics by E. Kreyszig.
iii. An Elementary Course in Partial Differential Equations by T. Amaranth.
iv. Elements of Partial Differential Equations by Ian N. Sneddon.
v. Partial Differential Equations by Fritz John.

5 Outcome of the Course:

This course will provide the fundamental concept of differential equations for obtaining the solutions of science and engineering problems.