

MTE 501	Differential Equations and Applications	3 Credits (36 hours)
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Prerequisite: Basic Mathematics up to XII/PU.

Course Objectives

1. **Understand Solution Methods:** Recapitulate methods for solving first-order differential equations and their applications.
2. **Analyze Applications:** Explore applications of first and second-order ordinary differential equations in physics, chemistry, and engineering.
3. **Solve Complex Problems:** Develop skills to solve second-order linear differential equations using power series solutions.
4. **Explore Special Functions:** Gain knowledge of special functions in mathematical physics, including Bessel functions and various polynomials.

Course Outcomes

Upon successful completion of this course, students will be able to:

- CO1. Apply methods to solve first-order ordinary differential equations and relate them to real-world problems such as dynamics and chemical reactions.
- CO2. Solve second-order ordinary differential equations and apply them to problems involving vibrations, electric circuits, and more using Laplace transforms.
- CO3. Use power series methods to solve second-order linear differential equations and understand their mathematical properties.
- CO4. Gain proficiency in working with special functions like Bessel functions, Legendre polynomials, and others, essential in mathematical physics.
- CO5. Implement learned techniques to tackle practical problems in physics and engineering, demonstrating a deep understanding of differential equations and their applications.

Contents

Unit I

Recapitulation of methods of solutions of first order differential equations, Applications of First Order Ordinary Differential Equations - Simple problems of dynamics - falling bodies and other motion problems, Simple problems of Chemical reactions and mixing, Simple problems of growth and decay. (10 Hours)

Unit II

Applications of Second Order Ordinary Differential Equations - Undamped simple harmonic motion, damped vibrations, Forced vibrations, Problems on simple electric circuits – Laplace transforms. (10 Hours)

Unit III

Power series solutions of Second Order Linear Differential Equations, their mathematical properties. Special Functions of Mathematical Physics - Bessel functions, Legendre polynomials,

Chebyshev polynomials, Hermite polynomials and Laguerre polynomials.

(16 Hours)

References

- [1] G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw-Hill, New Delhi, 1991.
- [2] D. Rainville and P. Bedient, *Elementary course on Ordinary Differential Equations*, Macmillan, New York, 1972.
- [3] R. Courant and D. Hilbert, *Methods of Mathematical Physics*, Vol. I, Tata McGraw Hill, New Delhi, 1975.