III Semester

MTE 501	Differential Equations and Applications	3 Credits (36 hours)

Prerequisite: Basic Mathematics up to XII/PU.

Course Outcome: Students will have the knowledge and skills to apply the theory of differential equations in formulating many fundamental laws of physics and chemistry, set up second order differential equations in different models to describe damped/undamped vibrations and forced vibrations and derive properties of Special Functions of Mathematical Physics like Bessel functions, Legendre polynomials, etc.

Course Specific Outcome: At the end of the course Students will have the knowledge and skills to

- Illustrate the applications of theory of differential equations in economics and biology to model the behaviour of complex systems
- Create and analyze mathematical models using first and second order differential equations to solve application problems such as mixture problems, population modeling harmonic oscillator and LCR circuits
- Describe solutions of differential equations by the use of Laplace transforms and study the properties of special functions of mathematical physics through series solutions.

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.

MTE 512	Mathematical Finance	3 Credits (36 hours)

Course Outcome: To introduce the concepts and to develop working knowledge on fundamentals of Mathematical Finance. Students will have the knowledge and skills to apply the concepts of the course in Banking activities and Economical sectors.

Course Specific Outcome: At the end of the course students will have the knowledge and skills to understand, explain in depth and apply the fundamental concepts-

- In Mathematical Background
- Simple interest, Bank Discount, Compound Interest, Annuities.

Unit I - Preliminaries :

Percentages, Base Amount, Percentage Rate, and Percentage Amount, Ratios, Proportions, Exponents, Laws of Exponents, Exponential Function, Natural Exponential Function, Laws of Natural Exponents, Logarithms, Laws of Logarithms, and Antilogarithm, Logarithmic Function.

Growth and Decay Curves, Growth and Decay Functions with a Natural Logarithmic Base.
Basic Combinatorial Rules and Concepts, Permutation, Combination, Probability, Mathematical Expectation and Expected Value, Variance, Standard Deviation, Covariance, Correlation, Normal Distribution.

(8 Hours)

Unit II - Simple Interest and Bank Discount Simple Interest:

Total Interest, Rate of Interest, Term of Maturity, Current Value, Future Value, finding 'n' and 'r' when the current and future values are both known, Simple Discount, Calculating the Term in Days, Ordinary Interest and Exact Interest, Obtaining Ordinary Interest and Exact Interest in terms of each other, Focal Date and Equation of Value, Equivalent Time: Finding an average due date, partial payments, finding the simple interest rate by the Dollar-Weighted method.
Bank Discount**:** Finding FV using the discount formula, Finding the Discount Term and the Discount Rate, difference between a Simple Discount and a Bank Discount, comparing the Discount Rate to the Interest Rate, discounting a Promissory Note, discounting a Treasury Bill.

(12 Hours)

Unit III - Compound Interest:

The Compounding Formula, finding the Current Value, Discount Factor, finding the Rate of Compound Interest, finding the Compounding Term, The Rule of 72 and other rules, Effective Interest Rate, Types of Compounding, Continuous Compounding, Equations of value for a Compound Interest, Equated Time for a Compound Interest.

(8 Hours)

Unit IV - Annuities:

Types of Annuities, Future value of an ordinary Annuity, Current value of an ordinary Annuity, finding the payment of an ordinary Annuity, finding the Term of an ordinary Annuity, finding the Interest Rate of an ordinary Annuity, Annuity Due: Future and Current Values, finding the Payment of an Annuity Due, finding the Term of an Annuity Due, Deferred Annuity, Future and Current Values of a Deferred Annuity, Perpetuities.

(8 Hours)

References:

1. M. J. Alhabeeb, *Mathematical Finance*, WILEY publication, 2012.
2. Romagnoli, S. , *Mathematical Finance- Theory*, Italy: SocietàEditriceEsculapio., 2019.
3. Samuel A. Broverman, *Mathematics of Investment and Credit*, 4th ed., ACTEX Publications, 2008.
4. Stephen G. Kellison, *The Theory of Interest*, 3rd ed., McGraw-Hill, 2009.
5. John McCutcheon and William F. Scott, *An Introduction to the Mathematics of Finance*, Elsevier Butterworth-Heinemann, 1986.
6. Petr Zima and Robert L. Brown, *Mathematics of Finance*, 2nd ed., Schaum's Outline Series, McGraw-Hill, 1996.