MATH-251: Ordinary Differential Equations-I

Credit Hours: 3-0

Prerequisite: None

Course Objectives: The course aims to provide an understanding of ordinary differential equations and to introduce methods for solving them. The course is also expected to provide students with the knowledge and skills necessary for understanding of courses from both Mathematics and allied disciplines in which differential equations are involved.

Core Contents: First order ordinary differential equations, Second and higher order linear differential equations, Linear Systems, Orthogonal Functions.

Detailed Course Contents: Introduction; Classification of differential equations; Initial value problems (IVPs); Differential equations as mathematical models; Separable variable equations; Linear equations; Exact equations; Solution by substitution; Bernoulli's equation; Linear and non-linear models; Higher-order linear equations: Initial-value and boundary value problems; Homogeneous and non-homogeneous equations; Undetermined coefficients-superposition approach; Undetermined coefficient-annihilator approach; Variation of parameters; Cauchy-Euler equations; Modeling with sytem of 1^{st} order ordinary differential equations; Solving systems of linear differential equations by elimination; Nonlinear differential equations; Homogeneous linear systems; Eigenvalues and eigenvectors; Non-homogenous linear systems; Undetermined coefficients; Variation of parameters; Orthogonal functions; Fourier series; Fourier cosine and sine series; Half-range expansions; Complex Fourier series; Sturm-Liouville problems.

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

- Solve any type of first order differential equations
- Set up and solve physical motion problems and problems of population dynamics with first- order differential equations
- Solve system of differential equations.

- Solve second order linear differential equations with constant and variable coefficients.
- Solve linear systems of equations.
- Solve Sturm-Liouville problems.

Text Book: Dennis G. Zill, Michael R. Cullen: Differential equations with boundary value problems, (7 Edition), 2009, Brooks/Cole Cengage Learning, Canada.

Reference Books:

1. William E. Boyce and Richard C. Di Prima: Elementary Differential Equations and Boundary Value Problems (9Edition), 2009.
2. V. I. Arnold, Ordinary Differential Equations, Springer, 1991**.**

Weekly Breakdown		
Week	***Section***	***Topics***
1	1.1, 1.2	Introduction, classification of differential equations by type, Classification of differential equations, Initial value problems (IVPs)
2	1.3	Differential equations as mathematical models
3	2.2, 2.3	Separable variables; Linear equations
4	2.4, 2.6	Exact equations, Solution by substitution; Homogenous equations; Bernoulli's equation
5	3.1, 3.2	Linear Models, Non-linear Models
6	4.1, 4.2	Preliminary Theory-Linear Equations; Reduction of Order
7	4.3, 4.4	Homogeneous linear equations with constant coefficients; Undetermined Coefficients-Superposition approach

8	4.6, 4.7	Variation of parameters; Cauchy-Euler equations.
9	**Mid Semester Exam**	
10	3.3, 4.8	Modeling with Sytem of 1st order ordinary differential equations; Solving systems of linear differential equations by elimination
11	4.9, 8.1	Nonlinear differential equations; Preliminary Theory-Linear Systems
12	8.2	Homogeneous linear systems (Eigenvalues and eigenvectors, distinct realeigenvalues, repeated eigenvalues, complex eigenvalues)
13	8.3, 8.4	Non-homogeneous linear systems; (undetermined coefficients, variation of parameters); Matrix Exponential
14	11.1, 11.2	Orthogonal functions, Fourier series
15	11.3	Fourier cosine and sine series, half-range expansions, complex Fourier series (Handouts)
16	11.4	Sturm-Liouville problems
17		Review
18	**End Semester Exam**	