Course: Engineering Mathematics I (0301202)
Credits: 3-credit hours
Prerequisite: Calculus III (0301201)
Text Book: Advanced Eng. Math. By E. Kreyszig, John Wily 2011, 10th Ed.
Objective: To identify and solve ordinary differential equation using different strategies.

Chapter 1: First order ordinary differential equations (ODE)
1-1: Basic concepts: differential equation, ordinary, order, linear, non-linear, solution, homogeneous, non-homogeneous, initial value problem .Examples.
1-3: Separable ODEs, Reduction to separable, Examples.

$$(y' = f\left(\frac{y}{x}\right), u = \frac{y}{x})$$

Problems: (2-17) odd numbers
1-4: Exact ODEs, Integrating Factor, Examples. Problems: (1-15) odd numbers
1-5: Linear ODEs, Bernoulli Equation, Examples. Problems: (3-13, 22-28) odd numbers

Chapter 2: Second Order Linear ODEs
2-1: Homogeneous Linear ODEs of Second Order, independence, Basis, general solution, particular solution. Reduction of order: x-missing, y-missing, if one solution is known find another linearly independent solution,
Examples Problems: (1,2,3-15) odd numbers,16,18,19.
2-2: Homogeneous Linear ODEs with Constant Coefficients, exponential solution, characteristic equation, three cases (two different real roots, one repeated real root, complex roots and Euler formula) Problems: (1-20) odd numbers, 17,19,24,31,34.
2-3: Differential Operators: Problems: (1-12) odd numbers
2-5: Euler- Cauchy Equations: auxiliary equation, solution, Three cases: Two distinct real roots, one repeated x^m real root, complex roots. Examples Problems: (1-12) odd numbers, Problems: (12-20) odd numbers
2-6: Existence and uniqueness of the solutions, independence , Wronskian.
Problems: (6,9-15) odd number
2-7: Non-homogeneous ODE, general solution of homogeneous + particular solution of non-homogeneous = general solution of non-homogenous. Finding particular solution using method of undetermined coefficients. Examples. Problems: (1-18) odd numbers
2-10: Solution by variation of parameters. Examples. Problems: (1-13) odd numbers

Chapter 3: Higher order Linear ODEs .
3-1: Homogeneous linear ODEs, general solution, initial value problem, existence and uniqueness of solution, linear independence ,Wronskian.
Examples. Problems: (1-6,8-15) odd numbers
3-2: Homogeneous linear ODEs with constant coefficients, exponential solution, characteristic equation of order n, cases of roots .
Examples. Problems: (1-13) odd numbers
3-3: Nonhomogeneous linear ODEs, general solution of non-homogeneous = general solution of homogeneous + particular solution of non-homogeneous. Finding particular solution by method of undetermined coefficients and by method of variation of parameters for Euler- Cauchy equation can be made of constant coefficients By finding auxiliary equation using solution $y = x^m$, Examples
Problems: (1-14) odd numbers

Chapter 4 : System of ODEs
4-0: Basics of Matrices and Vectors: Some definitions and terms, calculations with matrices and vectors, System of ODEs as vector equations, Some further operators and terms, Eigenvalues and Eigenvectors
4-2: Basic Theory of System of ODEs.
4-3: Constant Coefficient Systems.
Examples . Problems: (1-15) odd numbers

4-6: Non-homogeneous Linear Systems of ODEs: Method of Undetermined Coefficients. Method of variation of parameters .
Examples. Problems: (2-7, 10-15) odd numbers

Chapter 5 : Series Solutions of ODEs .
5-1: Power Series Method: Review of basic properties of power series. Shifting the index, starting the index of the sum, real analytic functions, existing of power series solution, regular points and singular points of a differential equation, Recurrence relation. Examples. Problems: (1-14) odd numbers ; Problems: (16-19) odd numbers
5-4 : Extended Power Series Method: (Frobenius Method) Solution of ODE near regular singular points, Indicial equation ,roots , three cases . Examples. Problems: (1-17) odd numbers

Chapter 6: Laplace Transforms.
6-1: Laplace Transform: Linearity, First shifting theorem, Existence and uniqueness of Laplace transform. Examples. Problems: (1-15), (25-45) odd numbers
6-2: Transforms of Derivative and   Integral ODEs. Problems: (1-15), (16-21), (23-29) odd numbers
6-3: Unit Step Function, writing branch functions as a linear combination of functions using unit step function , Second shifting theorem , Solving initial value problems containing branch functions. Examples. Problems: (1-27) odd numbers
6-4: Short Impulses. Dirac Delta function: Examples. Problems: (1-12) odd numbers
6-6: Differentiation and integration of transforms.
ODEs with variable coefficients. Problems: (2-11) odd numbers
6-7: System of ODEs. Examples. Problems: (2-15) odd numbers
6-8: Laplace Transform: General Formulas
6-9: Table of Laplace Transform

Chapter 7: Linear Algebra: Matrices, Vectors, Determinants.   Linear systems
7-1: Matrices, Vectors: Examples. Problems: (5-16) odd numbers.
7-2:   Matrices Multiplication: Examples. Problems: (5-16) odd numbers.
7-3: Linear Systems Equations, Coefficient matrix, Augmented matrix, Elementary row operations, row Equivalent systems, (Gauss elimination method. Examples. Problems: (1-14) odd numbers
7-5 : Solutions of Linear System: Existence and Uniqueness, Examples .
7-7 : Determinants . Cramer's Rule . Examples. Problems: (5-14) odd numbers
7-8 : Inverse of a Matrix , Gauss-Jordan Elimination, adjoint method . Examples. Problems: (1-10) odd numbers

Chapter 8: Linear Algebra: Matrix Eigenvalue Problems
8-1: Determining eigenvalues and eigenvectors Examples. Problems: (1-16) odd numbers