Linear Algebra and ODEs

Course Code	Credit Hours
MATH-121	**3-0**

Course Description

This course covers essential mathematical techniques for engineering applications, beginning with the System of Linear equations and Applications with real-world civil engineering case studies. The Eigenvalues and Eigenvectors explore the concepts and applications of linear algebra in constructing curves and surfaces. Linear Programming introduces optimization principles. Basic concepts and Modelling cover linear/ non-linear differential equations and initial/ boundary value problems. Analytical methods for first-order ODEs, separable variable, homogeneous, exact, and linear equations are discussed, alongside applications such as mixing problems and temperature prediction. The subsequent section investigates the analytical methods for second order ODEs covering homogeneous and non-homogeneous, Cauchy-Euler equations, with practical applications in earthquake modeling and bridge collapse scenarios. The course concludes with an exploration of Laplace Transform and its applications in solving second-order ODEs.

Text Book:

1. Dennis G. Zill and Michael Cullen, Differential Equations (3rd Edition)
2. E. Kreyszig, Advanced Engineering Mathematics, 9th ed.

Reference Book:

1. Glyn James, Modern Engineering Mathematics

Prerequisites:

Math-101 Calculus and Analytical Geometry.

ASSESSMENT SYSTEM FOR THEORY

	Without Project (%)	With Project/Complex Engineering Problems (%)

Quizzes	15	10-15
Assignments	10	5-10
Mid Terms	25	25
Project	-	5-10
End Semester Exam	50	45-50

ASSESSMENT SYSTEM FOR LAB

Lab Work/ Psychomotor Assessment/ Lab Reports	70%
Lab Project/ Open Ended Lab Report/ Assignment/ Quiz	10%
Final Assesment/ Viva	20%

Teaching Plan

Week No	Topics/Learning Outcomes
1	**Linear Algebra** Basic Concepts. Matrix Addition. Scalar Multiplication, Matrix Multiplication. Linear Systems of Equations. Gauss Elimination. Application of matrices.
2	Solution of Linear Systems: Existence, Uniqueness, General Form. Application of linear systems.
3	Inverse of a Matrix. Gauss-Jordan Elimination.
4	Vector Spaces, Sub Spaces and Linear Transformations. Application of linear transformation.
5	Linear dependence, linear independence, spanning set, basis.
6	Eigenvalues and Eigenvectors and their applications.
7-8	First Order Ordinary Differential Equations Separable Variables, Homogeneous Equations. Exact Equations and Integrating Factors, Linear Equations.
9	Mid Semester Exam
10	Equations of Bernoulli. Applications of Linear and Non-Linear first order ODEs.
11	**Linear Differential Equations of Higher Order** Preliminary Theory. Initial and Boundary Value Problems. Linear Dependence and Linear Independence. Homogeneous Linear Equations with constant coefficients.
12	**Non-Homogeneous Linear Equations** with constant coefficients, Undetermined Coefficients.

13	Variation of Parameters, Non-Homogeneous Linear Equations with Variable Coefficients Cauchy-Euler Equation. Applications
14	**Laplace Transform** Laplace Transform and Inverse Transform.
15	Unit step function, Dirac delta function.
16	Solution of 1st and higher order initial value problem using Laplace Transform.
17-18	**End Semester Exam**

Practical: Nil.