Gokaraju Rangaraju Institute of Engineering and Technology
(Autonomous)

LINEAR ALGEBRA AND SINGLE VARIABLE CALCULUS

Sub. Code: GR14A1001	**L T P C**
I Year I Sem	2 1 0 3

Prerequisites: Vector algebra, Matrix algebra and Pre-calculus

Course objectives

- To introduce the ideas of linearity and linear systems, which lie at the core level of many engineering concepts.
- To explore the extensions of differential calculus, which form the stepping stones to a broader subject called " approximation theory".
- To learn the skill of seeing a mathematical equation in many commonly occurring natural phenomena and acquire preliminary skills to predict their behavior.

Course outcomes: At the end of the course, the student will be able to

- Apply the concepts of matrix rank to analyze linear algebraic systems
- Compute eigen values and vectors for engineering applications
- Understand, model and solve linear dynamical systems

Unit-I Linear Algebra and Matrix eigen value problem: Rank of a matrix, Consistency of a system of linear equations-Pseudo inverse of a matrix-Condition number of a matrix-Approximate solution of an over determined system of linear equations using the pseudo inverse-Solution of a system of homogeneous linear equations.
Vector norms, Linear dependence of vectors, Gram-Schmidt orthogonalization of vectors, Matrix norms.
Determination of eigen values and eigen vectors of a square matrix-Properties of eigen values and eigen vectors of real and complex matrices.

Unit-II Matrix factorizations and Quadratic Forms: Diagonalization of a matrix- Orthogonal diagonalization of symmetric matrices-Computation of matrix powers- Computation of $e^A,\ \sin(A),\ \cos(A)$ -Singular value decomposition - QR factorization.
Quadratic forms-Definiteness of a quadratic form-Rank, index and signature of a quadratic form- Reduction of a quadratic form into a canonical form by Lagrange's method and by an orthogonal transformation.

Unit-III Differential Calculus of functions of a single variable: Mean value theorems (Rolles', Lagrange's, Cauchy's, Taylor's and Maclaurin's theorems Geometrical Interpretation without proof) - Approximation of functions by Taylor's and Maclaurin's theorems-Series expansion of functions.

Unit-IV Linear differential equations of the first order and their applications: Formation of ODE-Methods to solve first order LDE (exact, reducible to exact, linear and Bernoulli equations).
Applications-Growth and decay models-Newton's law of cooling-Applications to electrical circuits (LR and RC circuits)-Geometrical applications-Orthogonal trajectories.

Unit-V Linear differential equations of the higher order and applications: Equations with constant coefficients-Particular integrals for functions of the type $e^{ax}, \cos ax, \sin ax, x^n$ - $x^n V$ - Exponential shift - Method of variation of parameters.
Applications-Deflection of beams, Simple harmonic motion (simple pendulum, spring-mass systems) and RLC circuits.

Teaching methodologies

1. Tutorial sheets uploaded in website
2. NPTEL video lectures
3. MATLAB exercises for visualization

Text Books

1. Advanced Engineering Mathematics: R.K.Jain and S.R.K.Iyengar- Narosa Publishing House
2. Advanced Engineering Mathematics: Erwin Kreyszig, Wiley.

3. Higher Engineering Mathematics: B.S.Grewal-Khanna Publications.

References

1. Introduction to Linear Algebra-Gilbert Strang
2. Schaum's outline series on Linear Algebra
3. GRIET reference manual