COMPUTATIONAL LINEAR ALGEBRA WITH MATLAB

Course Code: BMA- 583 **L-T-P-C:** 3-0-2-4

Course Learning Outcomes:

	On satisfying the requirements of the course and upon its successful completion, students will have knowledge and skills to:
CLO 1	explain the vector space structure with related concepts and use basic algorithms of matrix multiplication
CLO 2	discuss basic linear algebraic concepts, norms, principle underlying SVD etc and solve triangular systems of linear equations using LU factorization / parallel LU, Gaussian elimination and pivoting strategies,
CLO 3	apply various methods to solve special linear systems of equations and perform matrix orthogonalization and factorization as well as solve the full – rank and rank –deficient least squares problems,
CLO 4	solve modified least squares problems and unsymmetric eigen value problems by select methods / algorithms,
CLO 5	utilize select algorithms to solve the symmetric eigen value problems and to compute SVD and evaluate matrix functions,

Unit-I Vector Space and Matrix Multiplication: Overview of Vector space, Basic algorithm and notations, Structure and efficiency, Block matrices and algorithms, Fast matrix - vector products, Vector products , Vectorization and locality, Parallel matrix multiplication.

Unit-II Matrix Analysis: Basic ideas from linear algebra, Vector norms, Matrix norms, The singular value decomposition, Subspace matrices, The sensitivity of square systems, Finite precision matrix computation.

General Linear Systems: Triangular systems, The LU factorization, Round off error in Gaussian elimination, Pivoting, Improving and Estimating Accuracy, Parallel LU.

Unit-III Special Linear Systems: Diagonal Dominance and symmetry, Positive definite systems, Banded systems, Symmetric indefinite systems, Block tri-diagonal systems, Vandermonde systems, classical methods for Toeplitz systems, Circulant and discrete Poisson systems.

Orthogonalization and Least Square: Householder and Givens transformations, The QR factorization, The full – rank least square problem, Other orthogonal factorizations, The rank deficient least square problem, square and undetermined systems.

Unit-IV Modified Least Square problems and Methods: Weighting and regularization, Constrained least squares, Total least squares, Subspace computations with SVD, Updating matrix factorizations. Un-symmetric Eigen Value Problems: properties and Decomposition, Perturbation theory, Power iterations, The Heisenberg and real Schur Forms, The practical QR algorithm, Invariant subspace computations, The generalized Eigen value problem, Hamiltonian and product Eigen value problems, Pseudo spectra.

Unit-V Symmetric Eigen Value Problems: Properties and decompositions, Power iterations, the symmetric QR algorithm, more methods for tri-diagonal problems, Jacobi methods, Computing the SVD, Generalized Eigen value problem with symmetry.

Functions of Matrices: Eigen value methods, approximation methods, The matrix exponential , the sign, Square root and Log of a matrix.

LAB WORK: Implementation of any 2-3 techniques from each **UNIT** (selected by the instructor) using MATLAB.

Text Book:

1. Gene. H. Golub, Charles F. Van Loan, Matrix Computations, Fourth Edition, The Johns Hopkins University Press, Baltimore 2013.

Reference Books:

1. J. W. Demmel, Applied Numerical Linear Algebra, SIAM, 1997.
2. P.G. Ciarlet, Introduction to numerical linear algebra and optimization
3. William Ford, Numerical linear algebra with applications, AP
4. Richard Bronsom, G.B. Costa, Matrix Methods: Applied Linear Algebra, Third Edition, AP.

Any other text recommended by the instructor.