

Course Code CSE-931

Title Advanced Numerical Methods

Text/Ref Books

1. *Numerical Linear Algebra.*

by Bau III, David, and Lloyd N. Trefethen.

Philadelphia, PA: Society for Industrial and Applied Mathematics, 1997.

2. *Templates for the Solution of Algebraic Eigenvalue Problems: A Practical Guide.*

by Bai, et al.

Philadelphia, PA: Society for Industrial and Applied Mathematics, 2000.

3. *Templates for the Solution of Linear Systems: Building Blocks for Iterative Methods.*

by Barrett, et al.

Philadelphia, PA: Society for Industrial and Applied Mathematics, 1993.

Goals/Objective

This course offers an advanced introduction to numerical linear algebra. Topics include direct and iterative methods for linear systems, eigenvalue decompositions and QR/SVD factorizations, stability and accuracy of numerical algorithms, the IEEE floating point standard, sparse and structured matrices, preconditioning, linear algebra software. The problem sets require some knowledge of MATLAB®.

Applications

Modeling & Simulation of Scientific and Engineering problems.

Topics of the Course

- Introduction, Basic Linear Algebra NLA 1
 - Orthogonal Vectors and Matrices, Norms NLA 2 & 3
 - The Singular Value Decomposition NLA 4 & 5
 - The QR Factorization NLA 6 & 7
 - Gram-Schmidt Orthogonalization NLA 8
 - Householder Reflectors and Givens Rotations NLA 10
 - Least Squares Problems NLA 11
 - Floating Point Arithmetic, The IEEE Standard NLA 13 FP
 - Conditioning and Stability I NLA 12,14,15
 - Conditioning and Stability II NLA 16 & 17
 - Gaussian Elimination, The LU Factorization NLA 20 & 21
 - Stability of LU, Cholesky Factorization NLA 22 & 23
 - Eigenvalue Problems NLA 24 & 25
 - Hessenberg / Tridiagonal Reduction NLA 26
 - The QR Algorithm I NLA 27 & 28
 - The QR Algorithm II NLA 29
 - Other Eigenvalue Algorithms NLA 30

- The Classical Iterative Methods It 2.2
- The Conjugate Gradients Algorithm I NLA 38, CG
- The Conjugate Gradients Algorithm II NLA 38, CG
- Sparse Matrix Algorithms It 4.3, Eig
- Preconditioning, Incomplete Factorizations NLA 40, It 3
- Arnoldi / Lanczos Iterations NLA 33 & 36
- GMRES, Other Krylov Subspace Methods NLA 35 & 39,
It 2.3
- Linear Algebra Software Eig
- **Numerical Methods of Differential Equations**

