OFFICIAL SYLLABUS

466 - NUMERICAL LINEAR ALGEBRA WITH APPLICATIONS

Adopted - Fall 2018 (Committee: Drs. Leem, Liu, Sewell, Song)

Course Description: Direct and iterative methods for linear systems, approximation of eigenvalues, solution of nonlinear systems, numerical solution of ODE and PDE boundary value problems, function approximation.

Prerequisites: Math 223, Math 250, Math 321, and CS 145 with a grade of C or better.

Textbook: Fundamentals of Numerical Computation, by Tobin A. Driscoll and Richard J. Braun
ISBN 978-1-611975-07-9

Course Outline: (Instructor may choose to cover either Chaper 4 or Chapter 9 as specified below)

Chapter 1, Numbers, problems, and algorithms
1.1 Floating point numbers

Chapter 2, Square linear systems
2.2 Computing with matrices
2.3 Linear systems
2.4 LU factorization
2.5 Efficiency of matrix computations
2.6 Row pivoting
2.7 Vector and matrix norms
2.8 Conditioning of linear systems
2.9 Exploiting matrix structure

Chapter 3, Overdetermined linear systems
3.1 Fitting functions to data
3.2 The normal equations
3.3 The QR factorization
3.4 Computing QR factorizations

Chapter 4, Roots of nonlinear equations
4.5 Newton for nonlinear systems
4.6 Quasi-Newton methods
4.7 Nonlinear least squares

Chapter 8, Krylov methods in linear algebra
8.2 Power iteration
8.4 Krylov subspaces
8.5 GMRES
8.6 MINRES and conjugate gradients

Chapter 9, Global function approximation
9.3 Stability of polynomial interpolation
9.4 Orthogonal polynomials
9.5 Trigonometric interpolation

Chapter 10, Boundary-value problems
10.2 Differentiation matrices
10.3 Collocation for linear problems
10.4 Nonlinearity and boundary conditions
10.5 The Galerkin method

Chapter 13, Two-dimensional problems
13.1 Tensor-product discretizations
13.3 Laplace and Poisson equations

Course objectives:

At the conclusion of this course, students should be able to

- Solve linear systems using direct methods and iterative methods
- Solve eigenvalue problems using numerical methods
- Learn about numerical approximation theory
- Learn how to obtain numerical solutions to nonlinear systems and boundary value problems for Ordinary Differential Equations and Elliptic Partial Differential Equations.
- Implement numerical methods that appear in objectives 1-4 above using MATLAB and apply them to solving various real-life applications.