M 383F/ CS 383D/ CAM 383D

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Prerequisites: 1. Fundamentals of Numerical Methods
2. Linear Algebra
3. Introductory Analysis

Assignments: Approximately six

Examinations: Take-home Mid-term and Take-home Final

Grading: 20% Assignments
35% Mid-Term Examination
45% Final Examination

Topics: 1. Interpolation
2. Least Squares Approximation
3. Numerical Integration
4. Extrapolation and Remainder Theory
5. Numerical Solution of Initial Value Ordinary Differential Equations

Some useful texts:

Philip J. Davis: *Interpolation and Approximation* **1975**
Michael T. Heath: *Scientific Computing: An Introductory Survey* **1997**
Anthony Ralston and Philip Rabinowitz: *A First Course in Numerical Analysis* **1978**

Some of the topics to be covered:

1. Interpolation
   - The General Problem of Finite Interpolation **Davis 2.2**
   - Polynomial Interpolation **Davis 2.1**
   - Systems Possessing the Interpolation Property **Davis 2.3**
   - Unisolvence **Davis 2.4**
   - Representation Theorems: The Lagrange Formula **Davis 2.5**
   - The Cauchey Remainder for Polynomial Interpolation **Davis 3.1**
   - Interpolation at Coincident Points (Generalized Hermite Interpolation) **Davis 3.5**
   - Piecewise Polynomial Interpolation **Heath 7.3**

2. Least Squares Approximation
   - Best Approximation **Davis 7.1**
   - Normed Linear Spaces **Davis 7.2**
   - The Fundamental Problem of Linear Interpolation **Davis 7.4**
   - Inner product Spaces **Davis 8.1**
   - Orthogonal Systems (including Gram Schmidt process) **Davis 8.3**
   - Fourier (or Orthogonal) Expansions **Davis 8.4**
   - Minimum Properties of Fourier Expansion **Davis 8.5**
   - The Normal Equations **Davis 8.6**

3. Numerical Integration
   - Numerical Quadrature **Heath 8.1**
   - Newton-Cotes Quadrature **Heath 8.2**
   - Gaussian Quadrature **Heath 8.3**
   - Composite and Adaptive Quatrature **Heath 8.4**
   - Romberg Integration **R & B 4.10-2**
   - Other Integration Problems **Heath 8.5**

4. Extrapolation and Remainder Theory
   - Richardson Extrapolation **Heath 8.8**
   - Peano's Theorem and Its Consequences **Davis 3.7**

5. Numerical Solution of Initial Value Ordinary Differential Equations
   - Ordinary Differential Equations **Heath 9.1**
   - Numerical Solution of ODEs **Heath 9.2**
   - Accuracy and Stability **Heath 9.3**
   - Implicit Methods **Heath 9.4**
   - Stiff Differential Equations **Heath 9.5**
   - Survey of Numerical Methods for ODEs **Heath 9.6**