Syllabus APPM 5610 Spring Semester 2019

The main topics to be covered include:

Linear Algebra

- Eigenvalue Problem
  - Theoretical Background
  - Numerical Methods
    - QR method
    - Newton's method for eigensystem
- Singular Value Decomposition (SVD)
- Least squares solution of overdetermined linear systems

Algorithms to generate finite difference (FD) formulas

Ordinary Differential Equations (ODEs)

- Introduction
- Taylor method
- Linear multistep methods
  - Euler's method, Adams' methods, Backward Differentiation formulas
  - Accuracy, stability, Dahlquist barriers
  - Predictor-Corrector methods
- Runge-Kutta methods
- Extrapolation methods
- Boundary value problems
  - Shooting and FD-based linear system methods

Partial Differential Equations (PDEs)

- Character of solutions; well posedness
- Wave-type (hyperbolic) equations
  - FD methods
  - Method of lines
  - Stability and convergence
    - CFL condition, von Neumann stability analysis, Lax equivalence theorem
  - Pseudospectral methods (including brief summary of FFTs)
  - Radial Basis Function methods
- Diffusive (parabolic) equations
  - Crank-Nicolson and ADI methods
- Equilibrium (elliptic) equations
  - FD schemes

Iterative methods (Jacobi, Gauss-Seidel, Conjugate gradients)
Fast Poisson solvers
Multi-Grid methods

Chapter 9 in Atkinson describes “The Matrix Eigenvalue Problem” and Chapter 6 describes “Numerical Methods for Ordinary Differential Equations”. Much of the course materials for ODEs and mostly all for PDEs will be collected from other sources, primarily those listed as "Good reading" on the class web page.