18.085 Course Outline

This course has three major topics:

1. Applied Linear Algebra

   - Second difference matrices K, T, B, C
   - Positive Definiteness: pivots, eigenvalues, energy
   - $A^{\mathrm{T}}CA$ Framework for Equilibrium Problems

     Springs and masses
     Least squares and covariance matrix
     Graphs, networks, Kirchhoff's Laws
     Deformation of trusses (and mesh generation)
     Minimum principles and constraints
     Finite elements in one dimension

2. Boundary Value Problems

   - Ordinary Differential Equations

     Boundary conditions and delta functions
     Dynamics: $Mu'' + Ku = F(t)$
     Beam equations and cubic splines

   - Partial Differential Equations

     Laplace and Poisson equations
     Divergence, gradient, and curl
     Special solutions from $(x + iy)^n$ and $f(x + iy)$
     Potential, stream function, Cauchy-Riemann equations
     Finite differences and boundary conditions
     Finite element method and weak form

3. Fourier Methods and the FFT

   - Fourier Series (and orthogonal polynomials)

     Orthogonality and Parseval's formula
     Laplace equation on a circle

   - Discrete Fourier Series

     Fourier matrix and the Fast Fourier Transform
     Convolution and filtering in signal processing

   - Fourier Integral

     Shannon Sampling Theorem
     Differential equations
     Integral equations (convolution kernel)
     Wavelets

18.085 has three one-hour exams and regular homeworks and no final exam.

Text: *Applied Mathematics and Scientific Computing* / Gilbert Strang
(Wellesley-Cambridge Press, September 2007)