Course outline - APPM 3310 - Spring 2005

1. Introduction
    - $Ax = b$ applications
        - Discretization of continuous problems
        - Networks
        - Minimization of quadratics
    - $Ax = \lambda x$ applications
        - Linear maps
        - Linear ODES
2. Operations on vectors and matrices
    - Addition and scalar multiplication
    - Matrix multiplication
    - Inverses and transposes
    - Block matrices
    - Square matrices
        - Matrix polynomials
        - Trace
        - Determinants
3. $Ax = b$: methods
    - Gaussian elimination and $PA = LU$ factorization
    - Inverses via elimination
    - Inverses via determinants
    - Cramer's rule
    - Condition number

4. $\mathbb{R}^n$ as a vector space
    - Geometry of solutions to $Ax = b$
    - Matrices as linear operators on $\mathbb{R}^n$
    - Elementary vector space concepts
    - Fundamental subspaces of a matrix
    - Application to networks
5. Function spaces as vector spaces
    - Polynomial vector spaces
    - Periodic functions
    - Linear operators on function spaces
6. $\mathbb{R}^n$ as an inner product space
    - Dot product and geometry of $\mathbb{R}^n$
    - Geometry of fundamental subspaces of a matrix
    - Projections and least squares
    - Gram-Schmidt orthogonalization and $A = QR$ factorization
7. Function spaces as inner product spaces
    - $L^2_{per}[0, 2\pi]$ and trigonometric basis functions
    - $L^2[-1, 1]$ and Legendre polynomials
8. Diagonalization
    - Eigenvalues and eigenvectors
    - $A = MJM^{-1}$ factorization, similarity, and change of basis
    - Cayley-Hamilton theorem
    - Application to linear maps
    - Application to linear ODEs
    - Singular value decomposition