Outline

References:

- Strang, *Linear Algebra and its Applications*
- Meyer, *Matrix Analysis and Applied Linear Algebra*

Topics:

1. Vector spaces
   (a) Common examples (Euclidean n-space, spaces of polynomials, function spaces)
   (b) Subspaces, basis and dimension
   (c) Inner products and norms
   (d) Orthogonality; the Projection Theorem; projection operators
   (e) Orthogonal complements; direct sum
2. Linear Transformations
   (a) Kernel (null space) and range (column space)
   (b) Matrix representation (on finite-dimensional spaces)
   (c) Change of basis and similarity transformations
   (d) Rank theorem (the dimension of the column space of $A \in \mathbb{R}^{m \times n}$ equals the dimension of the column space of A^T).
   (e) Fundamental Theorem of linear algebra (relationships between the ranges and kernels of A and A^T).
   (f) Determinants
3. Eigenvalues and eigenvectors
   (a) Characteristic polynomial
   (b) Diagonalization
   (c) Spectral theorem for symmetric matrices
4. Jordan Canonical Form
5. Singular Value Decomposition
6. Algorithms for solving (nonsingular) linear systems; operation counts; advantages and disadvantages
   (a) Gaussian elimination with partial pivoting
   (b) multiplication by the inverse matrix
   (c) Cramer's rule
7.

Least-squares problems

(a) the normal equations

(b) solving least-squares problems using the SVD

8. The condition number of a matrix