I. Basic Properties of Matrices

- definition of matrix and of vector
- row/column subscript notation
- transpose of a matrix
- matrix addition and subtraction
- matrix multiplication: by scalar; by matrix.
- special types of matrices: square, symmetric, diagonal, identity, scalar, nonsingular.
- vectors and matrices consisting of ones; the zero vector and matrix.
- linear dependence and rank of a matrix
- inverse of a nonsingular matrix; determinant of a square matrix
- some basic theorems on p 194
- quadratic forms p 206-207

II. Random Matrices and Vectors

- definition of a random matrix (random vector)
- expectation of random matrix
- variance-covariance matrix of a random vector
- theorems for \( W = AX \) where \( A \) is a matrix of constants, \( Y \) is a random vector (p 197)

III. Simple Linear Regression Analysis in Matrix Format

- regression model \( Y = X\beta + \epsilon \) where random error vector \( \epsilon \) consists of independent normal rv's
  - with \( \mathbb{E}\{\epsilon\} = 0 \) and \( \sigma^2\{\epsilon\} = \sigma^2 I \).
- regression function \( \mathbb{E}\{Y\} = X\beta \)
- normal equations \( X'Xb = X'Y \) and solution \( b = (X'X)^{-1}X'Y \)
- fitted vector \( \hat{Y} = Xb \) or \( \hat{Y} = HX \) where \( H = (X'X)^{-1}X' \), the hat matrix
- residual vector \( e = Y - \hat{Y} \)
- sums of squares as quadratic forms (\( Y'AY \) form)
  - \( \text{SSTO} = Y'(I - \frac{1}{n} J)Y, \quad \text{SSE} = Y'(I - H)Y, \quad \text{SSR} = Y'(H - \frac{1}{n} J)Y \)
- variance-covariance matrices: \( \sigma^2\{b\} = \sigma^2(X'X)^{-1} \) and \( s^2\{b\} = \text{MSE}(X'X)^{-1} \);
  - \( \sigma^2\{\hat{Y}_h\} = X'_h\sigma^2\{b\}X_h \) where \( X'_h = [1\ X_h] \), \( s^2\{\hat{Y}_h\} = X'_h s^2\{b\} X_h \), and \( \hat{Y}_h = X'_h b \);
  - \( s^2\{\hat{Y}_{\text{new}}\} = \text{MSE} + s^2\{\hat{Y}_h\} \).