

BIO744: Linear Models and Design of Experiments
Fall 2007, MWF 10:10-11:00AM

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Office Hours: M 9-10AM

Text: **Plane Answers to Complex Question**, by R. Christensen (3rd edition).

Supplemental Materials:

Schaum's Outlines of Linear Algebra, Third Edition, by S. Lipschutz and M. Lipson. McGraw-Hill.
An Introduction to R by W.N. Venables, D.M. Smith and the R Development Core Team.
Practical Regression and ANOVA using R by J. Faraway (July 2002).

Grading:

Homework: 25%
Exam 1: 25%
Exam 2: 25%
Final Project (presentation and report): 25%

Course Goals: The aim of this course is to provide students with an understanding of the theory and application of linear models. Topics in advanced matrix algebra are covered to provide a basis for theoretical understanding. Students will learn to program and implement all techniques using the free statistical software package, R (<http://cran.r-project.org/>).

Course Outline

UNIT 1: ADVANCED MATRIX ALGEBRA FOR LINEAR MODELS

- Week 1 (9/5-9/7): 1.1 General linear model, 1.2 Vector spaces, 1.3 Linear dependency,
- Week 2 (9/10-9/14): 2.1 Basis, 2.2 Linear subspace, 2.3 Orthogonality, 2.4 Column space
- Week 3 (9/17-9/21): 3.1 Singular/non-singular, 3.2 Eigenvalues/eigenvectors.
- Week 4 (9/24-9/28): 4.1 Matrix decompositions (Spectral, SVD, QR), 4.2 Positive definite/positive semidefinite.
- Week 5 (10/1-10/5): 5.1 Projection operators, 5.2 Orthogonal projection operators, 5.3 Generalized inverses.

EXAM 1: In class, date TBD

UNIT 2: REGRESSION AND ANALYSIS OF VARIANCE (ANOVA)

- Week 6 (10/8-10/12): 6.1 Solutions to linear equations, 6.2 Random vectors and matrices.
- Week 7 (10/15-10/19): 7.1 Estimable, 7.2 Least squares estimation, 7.3 Estimation of σ^2 , 7.4 BLUE.
- Week 8 (10/22-10/26): 8.1 Weighted least squares.
- Week 9 (10/29-11/2): 9.1 Distribution theory (chi-square, normal, non-central chi-square, t, non-central t, F, multivariate normal), 9.2 Quadratic forms.
- Week 10 (11/5-11/9): 10.1 Maximum likelihood, 10.2 UMVUE, 10.3 Sampling distribution of estimates
- Week 11 (11/12-11/16): 11.1 Hypothesis testing (nested linear models, linear parametric functions, generalized test procedure), 11.2 F test.
- Week 12 (11/19-11/23): 12.1 ANOVA, 12.2 Confidence regions, 12.3 LRTs, 12.4 contrasts

EXAM 2: In class, date TBD

UNIT 3: APPLIED REGRESSION CONCEPTS

- Week 13 (11/26-11/30): 13.1 Types of variables, 13.2 Variable selection
- Week 14 (12/3-12/7): In-class presentations
- Week 15 (12/10-12/14): In-class presentations

FINAL PROJECT Report