STA 6246 **Theory of Linear Models** **Fall, 2006**

Course Outline and Policy

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Catalog Description [Credits: 3; Prereq: STA 6208, STA 6327, STA 6329 (matrix algebra)]

Distribution theory for quadratic forms: full rank linear models; fixed-effects models of less than full rank; balanced random and mixed models; unbalanced fixed-effects models; estimation of variance components; unbalanced random and mixed models.

Topics Listing

1. **Introduction**
   - A brief review of important matrix results useful for linear models.
   - The multivariate normal distribution
   - Central and non-central χ^2 distribution
   - Central and non-central F and t distributions
2. **Distribution Theory for Quadratic Forms**
   - Distribution of quadratic forms in normal random variables.
   - Independence of quadratic forms.
   - Expectations and variances of quadratic forms.
   - Cochran's theorem
3. **Full Rank Linear Models**
   - Introduction to the linear model of full rank.
   - Ordinary least squares (OLS) estimation of this model.
   - Gauss-Markov theorem
   - Properties of OLS estimators under normal theory
   - Full versus reduced models, R notation
   - The likelihood ratio approach
   - Tests of hypotheses
   - Confidence intervals and regions
4. **Linear Models of Less than Full Rank, Fixed Effects**
   - Brief review of generalized inverses
   - Distributional properties
   - Use of reparameterization
   - Estimable linear functions
   - Testable hypotheses
   - Scheffé's confidence intervals

5. **Balanced Random and Mixed Models**
   - Notation and definitions
   - Balanced population structures
   - Balanced mixed model
   - Development of rules for the derivation of the appropriate model, degrees of freedom, distribution of sums of squares, and expected mean squares for a balanced mixed-effects model.
   - Estimation of variance components and fixed effects.
   - Confidence intervals of functions of variance components.
6. **Unbalanced Fixed-Effects Models**
   - The R-notation
   - Type I, II, III, IV estimable functions and hypotheses
   - The case of missing data
   - Connected designs
7. **Unbalanced Random and Mixed Models**
   - Unbalanced random and mixed models
   - Derivation of expected mean squares
   - Estimation of variance components
     (a) Henderson's Method 3 (ANOVA) estimates
     (b) Maximum likelihood estimates
     (c) Restricted maximum likelihood estimates (REML)
   - The use of PROC MIXED in SAS.

Textbook: Theory of Linear Models, Notes by Dr. André I. Khuri (available at Target Copy Center on University Avenue).

References:

1. Linear Models. Searle, S.R., Wiley (1971).
2. Linear Models for Unbalanced Data. Searle, S.R., Wiley (1987).
3. Linear Statistical Inference and Its Applications. Rao, C.R., Wiley (1973).
4. An Introduction to Linear Statistical Models. Graybill, F.A., McGraw Hill (1961).
5. Theory and Application of the Linear Model. Graybill, F.A., Duxburg Press (1976).
6. Analysis of Messy Data. Milliken, G.A., and Johnson, D.E (1984).
7. Variance Components. Searle, S.R., Casella, G., and C.E. McCulloch, Wiley (1992).
8. Methods and Applications of Linear Models: Regression and the Analysis of Variance. Hocking, R.R., Wiley (1996).
9. Confidence intervals on Variance Components. Burdick, R.K., and Graybill, F.A., Dekker (1992).
10. Statistical Tests For Mixed Linear Models. Khuri, A.I., Mathew, T., and Sinha, B.K., Wiley (1998).
11. Generalized Linear, and Mixed Models. McCulloch, C.E., and Searle, S.R., Wiley (2001).

Grading Policy

	Points	Date
Test 1	100	Friday, September 29
Test 2	100	Friday, November 17
Homework Assignments	100	to be announced
Final Exam (cumulative)	200	Thursday, December 14 (3-5 P.M.)