Basic Info:

**Instructor:** Abdus S. Wahed, PhD  
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**Office:** 318C Parran Hall  
**Office hours:** Wednesdays 11:30am - 12:30pm.

Textbook:
No formal textbook (notes will be provided).

**Essential Reference Book:**
A first course in linear model theory, by Ravishanker and Dey, Chapman & Hall/CRC.

**Test and Final Exam:**
There will be an in-class mid-term test and a final examination. Tentative dates are:

- Mid-term: Thursday, October 23, 2008, and
- Final: Tuesday, December 9, 2008.

No makeup tests are allowed for missed tests and/or exams except in the cases of university excused absences.

**Grade Calculation:**
The weighting factors are as follows: Midterm, 30%; final 35%; homework, 35%. The nominal cut-off for computing the letter grades for this course are: lowest A, 90%; lowest B, 80%; lowest C, 70%; lowest D, 60%; and audit, 50%. Plus-minus grades will be assigned by dividing the respective intervals into thirds.

**Homework:**
Homework will supplement lecture material, so that the solution methods will always have been covered at least the day before the due date. Homework assignments will be given at the beginning of the class. There will be approximately 5-6 HW assignments throughout the whole semester. No late homework will be accepted unless it is due to some excused absence.

**Happy days:**
October 14, 2008: Our class does not meet (Monday classes meet at this day).
November 27, 2008: No classes (Thanksgiving).

**Notice**
If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services, 216 William Pitt Union (412.648.7890 or TTY 412.383.7355), as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.
Detailed Syllabus

Materials to be covered

1. Introduction to linear models with examples
   (a) Estimating mean of a normal population
   (b) Testing the equality of means of two normal populations
   (c) Simple linear regression
   (d) Polynomial regression
   (e) Multiple linear regression
   (f) Transformations
   (g) One-way ANOVA
   (h) Two-way ANOVA
   (i) General linear model

2. A short review of Matrix Algebra
   (a) Vectors, linear combinations, linear independence and orthogonality
   (b) Vector space, span, rank, column space and null space and orthogonal complements
   (c) Trace, determinants and eigenvalues, and factorizations

3. Random vectors, multivariate normal distribution and quadratic forms
   (a) Random vectors, expectations and variance-covariance matrices
   (b) Multivariate normal distribution
      i. Moment generating function
      ii. Expectation and variance-covariance matrix
      iii. Linear transformations
      iv. Marginal distributions
      v. Correlation and independence
      vi. Conditional distributions
   (c) Quadratic forms
      i. Chi-square distribution
      ii. Non-central chi-square distribution
      iii. Distribution of quadratic forms
      iv. Independence of quadratic forms
      v. Independence of linear and quadratic forms
      vi. Cochran’s theorem

4. General linear model: Linear least squares problem
(a) Normal equations
(b) Generalized inverse and solution to the normal equations
(c) Projections
(d) Properties of least squares estimator
   i. Estimability
   ii. Best linear unbiased estimator (BLUE)
   iii. Gauss-Markov theorem
(e) Least squares estimation under linear constraints

5. Generalized least squares
   (a) GLS estimator (Aitken’s model)
   (b) Properties of GLS
   (c) GLS vs. OLS

6. Statistical inference for the general linear model
   (a) More on the properties of LS estimator: sufficiency, completeness, maximum likelihood, MVUE and normality
   (b) Testable hypothesis
   (c) Motivation and derivation of F-test
   (d) Extra sum of squares
   (e) Partially testable hypothesis
   (f) Uniqueness of F-statistic
   (g) Likelihood ratio test
   (h) Power of F-test
   (i) Testing independent and orthogonal contrasts
   (j) Confidence intervals

7. Sequential and hierarchical sums of squares

8. Sensitivity of assumptions in general linear model: Underfitting, overfitting, Misspecification of covariance structure, and non-normality

9. Fixed, random effect, and mixed models
   (a) One-Way ANOVA, Two-Way ANOVA, and ANCOVA
   (b) Random-effect model
   (c) Mixed model (definition only, to learn more sign up for mixed model course)

10. A short introduction to generalized linear model