Syllabus
STAT 545, Theory of Linear Models
Spring 2019, MWF 1:00-1:50pm in Math 311

Course Information:

- **Instructor**: Jon Graham, Math 204, 243-2561, jgraham@mso.umt.edu.
- **Textbook:** *Linear Models in Statistics, 2nd ed.,* by Rencher & Schaalje
- **Office Hours**: To be announced, By appointment
- **Course Webpage**: Accessed through Moodle
- **Grading**: Homework: 30% Exams 1,2: 40% Final: 30%
- **Prerequisites:** STAT 422 (Math/Stat II) or consent of instructor

Homework

Homework will typically be assigned every Friday, to be handed in at the beginning of class the following Friday. **NO LATE HOMEWORK WILL BE ACCEPTED FOR ANY REASON**, and the lowest homework grade will be dropped. Homework is not only a fairly substantial portion of your grade, but is vital to your success in this class. Working with other students on homework is encouraged, as long as you hand in your own work, and do not simply copy someone else's work. Solutions to all problems will be provided.

Exams

Exams 1 & 2 will be cumulative and closed book. More about the exams, including the exact dates of the exams will be given later. If you cannot make it to an exam, you must let me know **BEFORE** the exam is given. No make-up exams will be given without a documentable reason for missing the exam.

Final Exam

The **Final exam** is scheduled for 3:20pm-5:20pm on Tuesday, April 30. More will be said about the final at a later date.

Course Material and Objectives

This course is an introduction to linear statistical models. After a brief review of some matrix algebra theory, we will cover topics such as parameter estimation, probability distributions, and hypothesis testing as they pertain to linear models. Some goals of this course are to recognize linear models, learn how to use them for inference, and understand how to apply them to real data. Computer use will be limited to approximately one problem per week with **R** highly recommended.

Questions are strongly encouraged, both during class and at office hours. If you are lost and confused, please let me know.

Important Dates

Friday, January 18: Last day to add courses by CyberBear.

Monday, January 21: Martin Luther King Jr. Day holiday

Thursday, January 31: Last day to drop courses/change grading option in Cyberbear.

Monday, February 18: President's Day holiday

Friday, March 15: Last day to drop courses. Paper form must be signed by advisor and instructor. A W will appear on your transcript. After this date, drops can only be done by with the Dean's signature.

Monday, March 25 – Friday, March 29: Spring Break

Friday, April 26: Last day to change grading option (letter grade to CR/NCR or vice-versa). Requires paper form signed by advisor and instructor.

Disability Services

The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students (DSS). If you think you may have a disability adversely affecting your academic performance, and you have not already registered with DSS, please contact DSS in Lommasson 154. I will work with you and DSS to provide an appropriate accommodation.

Academic Honesty

All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary action by the University. All students need to be familiar with the Student Conduct Code. You can find it in the A-Z index on the UM home page.

Tentative Topic Outline

1. Linear Models Overview (Chapter 1)
2. Matrix Algebra Concepts (Chapter 2)
    a. Matrix notation, operations, symmetric matrices (2.1, 2.2, 2.12)
    b. Rank, inverse, determinant, trace, idempotency, orthogonality (2.4, 2.5, 2.9, 2.11, 2.13, 2.10)
    c. Partitioned matrices (2.3)
    d. Positive definite/semidefinite matrices (2.6)
    e. Systems of equations (2.7)
    f. Generalized inverses (2.8)
    g. Properties of eigenvalues/eigenvectors (2.12)
    h. Vector and matrix calculus (2.14)
3. Random Vectors and Matrices (Chapter 3)
    a. Means, variances, covariances, correlations (3.1-3.5)
    b. Linear functions of random vectors (3.6)
4. Multivariate Normal Distribution (Chapter 4)
    a. Univariate and multivariate moment generating functions (4.1-4.3)
    b. Properties of univariate/multivariate normal distributions (4.4)
5. Distribution of Quadratic Forms (Chapter 5)
    a. Mean and variance of quadratic forms (5.1-5.2)
    b. Central/non-central χ^2, F, and t distributions (5.3-5.4)
    c. Distribution of quadratic forms (5.5)
    d. Independence of quadratic and linear forms (Cochran's Theorem) (5.6)
6. Simple Linear Regression (Chapter 6)
7. Multiple Linear Regression: Estimation (Chapter 7)
    a. Least squares estimation of β and σ^2 (Gauss-Markov Theorem) (7.1-7.3)
    b. Geometry of least squares (7.4)
    c. Maximum likelihood estimation (7.6)
    d. R^2, the coefficient of determination (7.7)
    e. Generalized least squares estimation (7.8)
    f. Best linear unbiased estimation (BLUE) (7.3)
8. Multiple Linear Regression: Inferences (Confidence Intervals & Tests) (Chapter 8)
    a. Sums of squares, ANOVA, test of overall regression (8.1-8.3)
    b. The General Linear Hypothesis, t-tests (8.4-8.5)
    c. Confidence and prediction intervals (8.6)
9. Multiple Linear Regression: Model Validation & Diagnostics (Chapter 9)
10. Multiple Regression: Random x's (**SKIPPING THIS SECTION**)
11. Multiple Regression: Bayesian Inference (Chapter 11)

12. Analysis of Variance (ANOVA) Models (Chapter 12)
    a. Non-full rank models (12.1)
    b. Estimation of β, $\lambda'\beta$, σ^2 (12.2-12.3)
    c. Estimable functions (12.2)
    d. Testing hypotheses, General linear hypothesis (12.7-12.8)
    e. Testable hypotheses (12.7)
13. 1-way Balanced ANOVA (Chapter 13)
    a. Parameter estimation (13.3)
    b. Estimable functions (13.2)
    c. Testing hypotheses, testable hypotheses (13.4-13.5)
    d. Linear contrasts (13.6)
14. 2-way ANOVA (Chapter 14)
15. Unbalanced ANOVA (Chapter 15)
16. Analysis of Covariance (Chapter 16)
17. Linear Mixed Models (Chapter 17)