SYLLABUS
BIOS/EPID/STAT 687: Theory of Linear Models
Fall 2020

Time: Monday and Wednesdays, 1:00 – 2:15 p.m.
Location: Online via ZOOM

Instructor: Edward J. Bedrick
Professor of Biostatistics
BSRL 262
edwardjbedrick@email.arizona.edu

Office Hours: After class (2:30-3:30 via ZOOM) or by appointment via email

Catalogue Description:
Theory of linear models including full-rank models and less than full rank fixed effects models. Topics will include distributional properties of quadratic forms, estimation methods, tests of hypothesis and confidence intervals as well as an introduction to computational aspects.

Course Description:
This is a foundational graduate course that provides the student with the linear models background needed for a career in industry or academia. This course will give students a firm grounding in the statistical theory that underlies regression analysis and the analysis of designed experiments.

Course Prerequisites:
A semester of graduate statistical theory, fluency in matrix algebra. or consent of instructor. Experience with SAS or R is helpful but not necessary.

Course Objectives:
During this course students will:
- be presented with the necessary linear algebra and statistical theory to understand, derive, and implement standard statistical procedures for regression analysis and analysis of variance.

Course Learning Outcomes:
Upon completion of this course, students will
- understand the necessary linear algebra and statistical theory to derive and implement standard procedures for regression analysis and analysis of variance.
- have a greater appreciation for why it is so easy to get nonsense from standard statistical/mathematical software if you do not really know what the software is doing.
PHD/Section Competencies Obtained:

Upon completion of the homework assignment, students will have advanced their proficiency in the following program competencies:

- Apply descriptive and inferential methodologies according to the type of study design for answering a particular research question.
- Communicate understanding of the assumptions necessary for a given statistical procedure as well as the ability to determine if the assumptions are met for a given study design or data set.
- Demonstrate the ability to identify, articulate and implement sound study design, methodological and computational strategies for addressing scientific questions.
- Demonstrate the use of statistical theory necessary for the development and study of new statistical methods or to adapt existing methods to new or unique problems.

*Assessment of competencies will be based on homework exercises, as detailed below.*

Course Notes:

Course notes and handouts will be posted sequentially on D2L. The course site also contains complete notes for the 2018 version of this class.

Recommended Texts/Readings:

The texts listed below are not required, only recommended. The material will closely follow the presentation in Monahan.


Stapleton and Rencher & Schaalje are available electronically from the UofA Library and on the D2L course site.

Course Requirements:

This course will assess competencies and student performance based on one homework assignment, with \( N = 12 \) parts. Parts will be made available on D2L approximately every week, typically on Wednesday. Students are required to hand in an electronic copy of their solutions no later than the end of class one week after assignment. Late homework will not be accepted. One or two of the parts may be assigned as a group project.

Grading: Each of the \( N \) parts of the assignment will be graded on an A,B,C,D,F scale with A=90%, B=80%, C=70% etc. Students are allowed to miss \( L = 2 \) assignments. Final grade will be based on the average of HW scores, using the same A,B,C scale. Average will be based on the best \( N - L \) scores.
Course outline

I will cover Chapters 1-7 in Monahan’s book, plus special topics. This is a rough course outline.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic (Reference: Chapter = C)</th>
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<tbody>
<tr>
<td>1</td>
<td>The General Linear Model (C1)</td>
</tr>
<tr>
<td>2</td>
<td>Basic Linear Algebra (Appendix A)</td>
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<tr>
<td>3</td>
<td>Solving Equations, Generalized Inverses, Projections (Appendix A)</td>
</tr>
<tr>
<td>4-5</td>
<td>The Linear Least Squares Problem (C2)</td>
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<tr>
<td>6-7</td>
<td>Model Reparametrization and Estimability (C3)</td>
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<tr>
<td>8-9</td>
<td>Gauss Markov Theorem (C4)</td>
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<tr>
<td>10</td>
<td>Distribution Theory (C5)</td>
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<tr>
<td>11</td>
<td>Statistical Inference (C6)</td>
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<tr>
<td>12</td>
<td>Further Topics in Testing (C7)</td>
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<tr>
<td>13-15</td>
<td>Selected topics: best prediction, asymptotics, mixed models, Bayesian methods</td>
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**Class Attendance and Participation:** This is essentially a PhD level class. I will treat you as professionals, and assume that you are taking the course because you or your program views that the material important to learn. I do not require that you attend (virtually) class. If you believe you can learn the material without attending my lectures, then you have that option. Students are also not required to participate in the classroom nor does participation enter into your final grade. However, active participation in the classroom (when not viewed by the instructor as a strategy to slow down the lecture) and attendance at office hours does influence my overall impression of your abilities and understanding of the material, and further presents some insights on certain intangibles that may play a role in subsequent evaluations during your academic career and beyond.

**Communications:** You are responsible for reading emails sent to your UA account from your instructor and the announcements that are placed on the course D2L site. Information about readings, news events, your grades, assignments and other course related topics will be communicated to you with these electronic methods. The official policy can be found at: [https://www.registrar.arizona.edu/personal-information/official-student-email-policy-use-email-official-correspondence-students](https://www.registrar.arizona.edu/personal-information/official-student-email-policy-use-email-official-correspondence-students)

**Accessibility and Accommodations:** At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, you are welcome to let me know so that we can discuss options. You are also encouraged to contact Disability Resources (520-621-3268) to explore reasonable accommodation. If our class meets at a campus location: Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable. For additional information on Disability Resources and reasonable accommodations, please visit [http://drc.arizona.edu/students](http://drc.arizona.edu/students)

**Code of Academic Integrity:** Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercise must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity, available through the office of the UA Dean Students: [http://deanofstudents.arizona.edu/policies-and-codes/code-academic-integrity](http://deanofstudents.arizona.edu/policies-and-codes/code-academic-integrity)
Classroom Behavior: Students are expected to act and behave in a respectful, professional manner. Students are expected to be familiar with the UA Policy on Disruptive Student Behavior in an Instructional Setting found at: http://policy.arizona.edu/education-and-student-affairs/disruptive-behavior-instructional-setting

Threatening Behavior Policy: The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to one’s self, http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students

Nondiscrimination and Anti-Harassment Policy: The University of Arizona is committed to creating and maintaining an environment free of discrimination, http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

UA Smoking and Tobacco Policy: Students are expected to act in accordance with and be familiar with this policy, the purpose of which is to establish the University of Arizona’s (University) commitment to protect the health of University faculty, staff, students, and visitors on its campuses and in its vehicles, http://policy.arizona.edu/ethics-and-conduct/smoking-and-tobacco-policy

Syllabus Changes: Information contained in the course syllabus, other than the grading policy, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor.