DEPARTMENT: BIOS

COURSE NUMBER: 707 **SECTION NUMBER:**

CREDIT HOURS: 4 **SEMESTER:** Fall 2020

COURSE TITLE: Advanced Linear Models

CLASS HOURS AND LOCATION:
Monday and Wednesday, 10:00am-11:50am

INSTRUCTOR NAME: Suprateek Kundu

INSTRUCTOR CONTACT INFORMATION

EMAIL: Suprateek.kundu@emory.edu

1518 Clifton Road NE, Atlanta, GA 30322

OFFICE HOURS

COURSE DESCRIPTION

- This is a theoretical course in linear models for continuous responses, motivated by
  Applications, designed for Bios doctoral students who are about to appear for their qualifying exam the next year. The focus will be on problem solving. The goal of the class is to make the students familiar with fundamental concepts which they will need for your doctorate program, and also to build your problem solving skills. The class will be taught in an interactive style. Some results will be proved in class, some others will be just stated, while you will be asked to prove some in homework assignments

EVALUATION

Assignments: 30% of the total grade. One assignment every week with some gaps. One week to turn in the assignments before class. No late assignments accepted. Students are expected to complete weekly homework assignments. Each assignment will evaluate the students' understanding in three areas: statistical theory, application, and computation. Multiple questions for each area will be included in each assignment. Students will have the ability to choose which problems to answer but must complete at least one problem in each category. An example of a theory question is to derive a maximum likelihood estimator. An example of an application question is to analyze a

data set, interpret, and write about the results. An example computation question is to execute a simulation study to compute the coverage of a confidence interval

Quizzes: Three in-class quizzes will comprise 10% of the total grade. These quizzes will test the student's knowledge about the course material in an in-class setting.

Midterm Exam: 25% of the total grade. Will consist of an in-class, closed book, theory and methods exam.

Final Exam: 25% of the total grade. Will consist of a take home exam where students are expected to work independently. Research type questions designed to test the students' understanding of the course materials and their ability to think outside the box. Innovation solutions are encouraged.

Attendance: 10% of the total grade. Attending *ALL* classes will maximize you chances of success in the course. If you cannot make it to a class for some reason, you are encouraged to email the instructor in advance. Your grade will also depend on your participation in class.

Students are expected to complete weekly homework assignments. Each assignment will evaluate the students' understanding in three areas: statistical theory, application, and computation. Multiple questions for each area will be included in each assignment. Students will have the ability to choose which problems to answer but must complete at least one problem in each category. An example of a theory question is to derive a maximum likelihood estimator. An example of an application question is to analyze a data set, interpret, and write about the results. An example computation question is to execute a simulation study to compute the coverage of a confidence interval.

Grade scale:

- A+ = 95 -- 100%
- A = 90 -- 95%
- A- = 87 -- 90%
- B+ = 83 – 87%
- B = 80– 83%
- B- = 70 – 80%
- C = 65 – 70%
- F = <65%

COURSE STRUCTURE

The course will be organized into weekly lectures consisting of a combination of electronic slides, whiteboard problem solving, and computational demonstrations. Students are expected to ask and answer questions in class.

Course Syllabus

- Motivating examples for linear models in biostatistics, including regression analysis, analysis of variance (ANOVA), longitudinal data and repeated measures
- Vector spaces, subspaces, orthogonal bases, Gram-Schmidt decomposition, column space of a matrix. Review of matrix and vector operations and linear algebra, including trace, rank, inverse, determinant, null space, eigenvalues, orthogonal complement of vector subspaces
- Matrix decompositions including spectral, singular value, QR, idempotent matrices, projection operators
- Estimability in the univariate linear model, least squares, BLUE, maximum likelihood, Gauss-Markov theorem, applications
- Multivariate normal distribution, distribution of quadratic forms
- UMVUE, sampling distributions of estimates, weighted least squares, normal equations
- Breaking up sums of squares, testing linear hypothesis and generalizations.
- F-test for testing parameters and contrasts in linear models. Applications and Theory.
- Maximum likelihood and likelihood ratio test. Asymptotic distributions and equivalence with F-test statistic.
- One-way ANOVA, estimating and testing contrasts, two-way anova with and without interaction, contrasts, applications
- ANCOVA models with applications to missing data problems
- Regression, best linear predictor, coefficient of determination, partial correlation coefficients, pure error, and lack of fit
- General linear mixed effects model for repeated measures. Applications and theory. EM algorithm for fitting linear mixed models. Extra assigned reading.
- Model/variable selection in linear models – forward and backward selection, R-square, partial correlations and goodness of fit

COURSE POLICIES

Students are expected to attend lectures and ask questions during class. For computational assignments, students are encouraged, but not required, to bring a laptop to class to follow along with code demonstrations. An encouraged textbook companion to the course is by Seber, George AF, and Alan J. Lee**. Linear Regression Analysis**. John Wiley & Sons.

As the instructor of this course I endeavor to provide an inclusive learning environment. However, if you experience barriers to learning in this course, do not hesitate to discuss them with me and the Office for Equity and Inclusion, 404-727-9877.

RSPH POLICIES

Accessibility and Accommodations

Accessibility Services works with students who have disabilities to provide reasonable accommodations. In order to receive consideration for reasonable accommodations, you must contact the Office of Accessibility Services (OAS). It is the responsibility of the student to register with OAS. Please note that accommodations are not retroactive and that disability accommodations are not provided until an accommodation letter has been processed.

Students who registered with OAS and have a letter outlining their academic accommodations are strongly encouraged to coordinate a meeting time with me to discuss a protocol to implement the accommodations as needed throughout the semester. This meeting should occur as early in the semester as possible.

Contact Accessibility Services for more information at (404) 727-9877 or accessibility@emory.edu. Additional information is available at the OAS website at http://equityandinclusion.emory.edu/access/students/index.html

Honor Code

You are bound by Emory University's Student Honor and Conduct Code. RSPH requires that all material submitted by a student fulfilling his or her academic course of study must be the original work of the student. Violations of academic honor include any action by a student indicating dishonesty or a lack of integrity in academic ethics. *Academic dishonesty refers to cheating, plagiarizing, assisting other students without authorization, lying, tampering, or stealing in performing any academic work, and will not be tolerated under any circumstances.*

The RSPH Honor Code states: "Plagiarism is the act of presenting as one's own work the expression, words, or ideas of another person whether published or unpublished (including the work of another student). A writer's work should be regarded as his/her own property."
(http://www.sph.emory.edu/cms/current_students/enrollment_services/honor_code.html)