Spring 2026
STAT 7024 Linear Models and Multivariate Analysis II

Instructor: Dr. Emily L. Kang
Office: 4428B French Hall West
Email: kangel@ucmail.uc.edu

When: WF 11:00 AM – 12:20 PM
Where: Room 270 60WCharl

Office Hours: R 9:30 AM – 10:30 AM Office
F 12:30 PM – 1:30 PM Office
T 3:00 PM – 4:00 PM Zoom
(or by appointment)

Course Description
This 3-credit graduate-level course covers the theory of the linear model, one of the most widely used statistical modeling frameworks. The course provides an introduction to the multivariate normal distribution and distributions of quadratic forms, and examines the formulation, estimation, and hypothesis testing procedures for linear models. Topics also include methods for multiple comparisons and the underlying assumptions of linear modeling. More advanced material includes random effects and mixed effects models.
Students are responsible for all material covered in class, including content posted on Canvas, assigned readings, and homework assignments.

Transferable Skills
This course is designed to develop a range of transferable skills that are valuable across academic, industry, and government settings:

- Formulate and analyze complex problems using mathematical and statistical reasoning
- Apply linear algebra and probability theory to develop and implement statistical methods and solve real-world data analysis tasks
- Critically evaluate model assumptions, limitations, and sources of uncertainty
- Develop rigorous, reproducible workflows for data analysis and reporting

These skills support professional development in research, data science, quantitative analysis, and related fields, and prepare students to adapt statistical methodologies to new application domains.

Assumed Background Knowledge
Prerequisite: Mathematical Statistics (STAT 6021–6022), Applied Regression (STAT 6031), and Design of Experiments (STAT 6032), or permission of the instructor.
Students are expected to have a solid foundation in linear algebra (particularly matrix theory) and linear regression models. Basic computing skills and prior experience with statistical software are also assumed.

Textbook
Nalini Ravishanker and Dipak K. Dey (2022). *A First Course in Linear Model Theory*, 2nd edition, Chapman & Hall/CRC.

References

Shayle R. Searle (1971). *Linear Models*, Wiley. (available at UC libraries)

Alvin C. Rencher (2008). *Linear Models in Statistics*, Wiley. (available at UC libraries)

Homework

Homework assignments will be announced in class and posted on Canvas. All homework must be submitted through **Gradescope** by the stated due date; this is the only acceptable method of submission. Please do not submit homework by email or leave assignments outside the instructor's office.

Late assignments will not be accepted unless there are extreme and documentable circumstances approved in advance by the instructor. There will be approximately 6–8 homework assignments throughout the semester.

To receive full credit, students must show all work and clearly explain their reasoning for each problem; **final answers without sufficient justification will not receive full credit**. For each assignment, **10% of the grade** will be based on professional presentation, including correctly associating pages with questions in Gradescope. Students are encouraged to prepare homework using LaTeX, although this is not required.

The **lowest homework score** will be dropped when calculating the final course grade.

Exams

There will be two **in-class examinations**, both of which are **closed book and closed notes**. Full credit will be awarded only when solutions are clearly justified using proper mathematical notation and complete written explanations.

If a calculator is permitted (non–cell phone calculators only), this will be announced in advance both in class and on Canvas.

Exam Schedule:	
Exam 1	*[Tentative] Wednesday , February 25, in class*
Exam 2	*[Tentative] Wednesday, April 22, in class*

No alternative exams will be offered; students should plan their travel accordingly. A make-up examination will be granted only in the case of a documented medical emergency, supported by a written excuse signed by a licensed medical or health professional, and only if the student contacts the instructor prior to the scheduled exam.

Final Course Grade

The final course grade will be based on the following weighting of assessment components:

Attendance & Class participation	Homework	Exam 1	Exam 2
5%	30%	30%	35%

The final course letter grade will be assigned according to the following grading scale:

		B+	87 – 89	C+	77 – 79
A	93 – 100	B	83 – 86	C	73 – 76
A-	90 – 92	B-	80 – 82		

Attendance

Beginning Fall 2016, Title IV provisions require undergraduate students to demonstrate participation in each course in order to remain eligible for federal financial aid. To meet this requirement, the University and the College of Arts & Sciences have implemented a simple procedure through Canvas. When you access the Canvas site for each of your courses, you will see a link in the left-hand control panel titled "Attendance Verification." Clicking this link will take you to a short question. Submitting

your response will serve as verification of your participation.

Email Correspondence
The best way to contact the instructor is via email at `kangel@ucmail.uc.edu`. All course-related email communication must be conducted through your UC email account or Canvas. The instructor will not send messages to external accounts (e.g., Gmail).

Communication Devices
Personal communication devices (e.g., cell phones) must be **turned off or set to vibrate** during class. Please refrain from texting or using devices in a way that disrupts class.

Virtual Office Hours
In addition to in-person office hours, the instructor will hold virtual office hours via Zoom. Students may reserve a time slot by going to *Canvas* → *Calendar* → *Find an Appointment*.

Campus Safety Measures
All faculty, staff, instructors, and students are required to follow campus safety measures, which can be found here: https://www.uc.edu/about/publicsafety.html.

Academic Integrity
Please help maintain an academic environment of mutual respect and fairness. You are expected to produce original and independent work on exams. For homework, discussion is encouraged; however, copying someone else's work and presenting it as your own constitutes plagiarism. All students must submit their own written work in their own words. Academic misconduct **will not** be tolerated. For more information, see: `https://www.artsci.uc.edu/student-experience/academic-forms-and-policies/misconduct-process.html`.

Accessibility Resources
Reasonable accommodations will be provided for students with documented needs. To access these accommodations, students must contact Accessibility Resources as described on their website: `https://www.uc.edu/campus-life/accessibility-resources.html`.

Religious Accommodations
Ohio law and the University's Student Religious Accommodations for Courses Policy 1.3.7 permits a student, upon request, to be absent for reasons of faith or religious or spiritual belief system or participate in organized activities conducted under the auspices of a religious denomination, church, or other religious or spiritual organization and/or to receive alternative accommodations with regard to examinations and other course requirements due to an absence permitted for the above-described reasons. Not later than fourteen days after the first day of instruction in the course, a student should provide the instructor with written notice of the specific dates for which the student requests alternative accommodations. University policy can be found at: `https://www.uc.edu/about/equity-inclusion/equal-opportunity/student-religious-accommodations-for-courses-policy.html`. Additional information about or questions related to the policy can be directed to the Office of Equal Opportunity (OEO).

Drop and Withdraw Dates
The last day to drop without entry to academic record is January 22. The last day to withdraw is April 5.

Holidays
There will be no class on the following days:
Dr. Martin Luther King Jr.'s Birthday: Monday, January 19, 2026
Spring break: Monday – Sunday, March 16 – 22, 2026

Receiving an 'I' for the course:
You cannot receive receive an incomplete for the course unless 70% of the work in the course (especially the attendance) has been completed. Extenuating circumstances will be handled on a case-by-case basis.

Course Outline

- Introduction
  - Linear Model – Definition and Examples
- Background Material
  - Review of Vector and Matrix Algebra
  - Special Matrices
  - Solutions to Linear Systems and Generalized Inverses
- The General Linear Model - Estimation
  - Least Square Estimation
  - Estimable Functions in Non-full rank case
  - Gauss Markov Theorem
  - Estimation subject to Linear Restrictions
  - Generalized Least Squares ($\sigma^2\mathbf{I}$ to $\sigma^2\mathbf{V}$)
- Relevant Distribution Theory for Inference
  - Multivariate distributions
  - Multivariate Normal Distributions
  - Noncentral Chi-Square, T, and F Distributions
  - Distributions of Quadratic Forms
- Inference for the General Linear Model
  - Distributional Properties of Least Squares Estimates and Residuals
  - General Linear Hypotheses
  - Testing Several Hypotheses
    1. Nested Hypotheses
    2. Underfitting, Overfitting and Lack of Fit Test
    3. Non-Testable Hypotheses
  - Connections with Multiple Regression Models
    1. Departure from model assumption
    2. Orthogonal and Collinear Predictors

3. Dummy Variables in Regression

- Simultaneous Confidence Intervals and Multiple Comparisons
  - Joint and Marginal Confidence Intervals
  - Introduction to Multiple Comparison Procedures
    - Scheffe Procedure, Bonferroni t-intervals
  - Other Multiple Comparison Procedures
- Fixed Effects Linear Models
  - Checking model Assumptions
  - Inference for Unbalanced ANOVA models
  - Analysis of Covariance
- Random-Effects and Mixed Effects Models
  - One-factor random-effects model
  - Mixed-Effects Linear Models
- Special Topics (If time permitting)

Note: The instructor reserves the right to change the class syllabus to meet class needs.

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I acknowledge that I have read and understand the course syllabus, including all policies and expectations.

Name (Last, First): _____

Major: _____

Graduate-Level Math/Stat Courses Taken (including all STAT and MATH courses):

Signature: _____

Date: _____