SIMON
BUSINESS SCHOOL
UNIVERSITY of ROCHESTER

AEC506: Probability Theory

Summer 2021 (July 26 – August 21)

Instructor: Junyuan Ke	**Time:** Mo/Th 13:00 – 15:10
Email: junyuan.ke@simon.rochester.edu	**Place:** TBA

Course Pages:

1. Course Blackboard Link (The Zoom link for class will be found there. Lectures slides will be uploaded before each class).
2. MIT Open Course for Probabilistic Systems Analysis and Applied Probability (useful for learning the basics, suggested).
3. Causal Data Science with DAG by Paul Hünermund (good intro class to Causal Inference, suggested).

Office Hours: After class, or by appointment.

Main References: This is a restricted list of various interesting and useful books that will be touched during the course. You need to consult them occasionally.

- Bruce Hansen. *Introduction to Econometrics* (Required).
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- DeGroot & Schervish. *Probability and Statistics* (Suggested).
- Angrist & Pischke. *Mostly Harmless Econometrics: An Empiricist's Companion* (Suggested).
- Scott Cunningham. *Causal Inference: The Mixtape* (Suggested).

Course Description and Learning Objectives: The primary purpose of the course is to help students establish a solid foundation in probability methods and master basic analytical and quantitative techniques in various empirical setups. This course introduces students to the basic concepts in applied probability theory & empirical methods. The course will cover the following topics: Probability, Random Variables and Distributions, Expectation, Special Distributions, Large Random Samples, Estimation, Sampling Distributions of Estimators, Testing Hypotheses, Linear Statistical Models.

Relation with other Courses at Simon Business School: This course is primarily designed for incoming PhD students at Simon Business School to help them establish a solid foundation in probability theory and prepare them for future coursework. This course serves as a prerequisite for the advanced econometric courses (ECO484, ECO485). We will also touch on Causal Inference if time permits, which students will continue to learn in ECO487 and AEC520. Overall, this course should substitute for other graduate level introductory statistics courses such as GBA462 and POLS404.

Grading Policy*:

- Class participation (10% of final grade)
- 3 weekly homework assignments (30% of final grade)
- Midterm (30% of final grade) and non-cumulative final exam (30% of final grade)

* This course is graded as Pass/Fail for the incoming Simon PhD Students.

Important Dates:

Midterm ..... 4th class (August 5th)
Final Exam ..... last class (August 19th)

Class Policy: Regular attendance is essential and expected.

Academic Integrity: Simon's Code of Academic Integrity (see Section 2 of the Student Handbook) states: "Every Simon student is expected to be completely honest in all academic matters. Simon students will not in any way misrepresent their academic work or attempt to advance their academic position through fraudulent or unauthorized means. No Simon student will be involved knowingly with another student's violation of this standard of honest behavior." Issues pertaining to academic integrity will be dealt with according to the Simon school code on academic integrity.

Tentative Course Outline:

Topic 1: Set Theory and Probability
Specifics: Sample Spaces, Events, Event Spaces; Set Algebra; Definition of probability; Conditional probability; Independent events; Bayes Theorem. (Sigma Fields; Probability Measures)

Topic 2: Random Variables and Distributions
Specifics: Random variables; PDFs & CDFs; Random Continuous variables and their probability distributions; Moments of Random Variables; Conditional Distributions. (Transformation of Random Variables Moments of Random Variables)

Topic 3: Expectation
Specifics: Expectation of a random variable; Variance; Moments; Covariance and Correlation; Conditional Expectation.

Topic 4: Special Distributions and Large Random Samples
[Midterm]
Specifics: Named distributions; Law of large numbers; Central limit theorem; Correction for continuity.

Topic 5: Estimation
Specifics: Statistical inference; Prior and posterior distributions; Conjugacy; Bayes Estimators; MLE; Sufficient statistics.

Topic 6: Sampling Distributions of Estimators

Specifics: Overview of Population; Specifying Population Models; Random Sampling; Sampling distributions; Interval estimation; Bayesian analysis of samples from a normal distribution; Unbiased estimator; Fisher information; Efficient estimator.

Topic 7: Testing Hypotheses, Conditional Expectation and The Algebra of Least Squares

Specifics: Simple hypotheses. Uniformly most powerful tests. F-tests. Bayes test procedures. Best predictor; Linear CEF; Least Squares Estimator; Variance of Least Squares Estimator; Estimation of Error Variance.

Topic 8: Least Squares Regression

[Final exam] Specifics: Homoskedasticity. Heteroskedasticity. Inference with Clustered Samples. (Causal Inference)