



**SIMON**  
BUSINESS SCHOOL  
UNIVERSITY of ROCHESTER

**AEC 506: PROBABILITY THEORY**

Pre-Fall 2022 (July 25 – August 25)

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<b>Instructor:</b> Junyuan Ke	<b>Time:</b> Mo/Th 13:00 – 15:10
<b>Email:</b> <a href="mailto:junyuan.ke@simon.rochester.edu">junyuan.ke@simon.rochester.edu</a>	<b>Place:</b> Schlegel 102

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**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).

**Recitation:** We 10:30 – 11:30.

**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).
- [Bruce Hansen. \*Econometrics\*](#) (Required).
- [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 ..... 5th class (August 1st)  
 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.

**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**

Specifics: Named distributions; Law of large numbers; Central limit theorem; Correction for continuity.

**Topic 5: Estimation**

[Midterm]

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 and Conditional Expectation**

Specifics: Simple hypotheses; Uniformly most powerful tests; F-tests; Bayes test procedures; Best predictor;

**Topic 8: The Algebra of Least Squares**

Specifics: Linear CEF; Least Squares Estimator; Variance of Least Squares Estimator; Estimation of Error Variance.

**Topic 9: Least Squares Regression**

Specifics: Homoskedasticity; Heteroskedasticity; Inference with Clustered Samples.

**Topic 10: Randomized Controlled Trial**

[Final exam]

Specifics: Assignment Mechanism; Randomization; Conditional Mean Independence; Stable Unit Treatment Value.