

# RUTGERS UNIVERSITY, DEPARTMENT OF ECE

## COURSE SYLLABUS: 14:332:226

Kailong Wang

Probability theory studies random phenomena in a formal mathematical way. It is essential for all engineering and scientific disciplines dealing with models that depend on chance. Probability provides a well-defined way to quantify the uncertainty of a random event. With this framework, we can analyze the behavior of complex systems and **make informed decisions** (i.e., minimize the negative effect of bad behavior or maximize the positive effect of good behavior). With a long history development of probability theory, it plays a central role in e.g., telecommunications and finance systems. Telecommunications systems strive to provide reliable and secure transmission and storage of information under the uncertainties coming from various types of random noise and adversarial behavior. Finance systems strive to maximize profits in spite of the uncertainties coming from natural and man-made events. The students will learn the fundamentals of probability that are necessary for several ECE courses and related fields and help them prepare for the career in the industry and academia.

**Class Time and Place:** Monday~Thursday 10:30am~12:20pm, Busch SEC-203.

**Office Hour:** TBD.

**Contact:** kw414@scarletmail.rutgers.edu.

**Prerequisites:** Calculus (Mandatory), Linear Algebra (Recommended).

**Grading:**

- Structure:
  - HW Presentation: 20 times×1 credit
  - Exam: 2 times×50 credits
  - Project Presentation: 1 times×15 credits
  - Project appraisal: 1 times×15 credits
- Exam Formats:
  - 40 credits questions from HW. Fill the blank.
  - 10 credits questions from anywhere. True or False with punishment.

**Textbook and Materials:**

1. **(For Beginner and Engineer)** Roy D. Yates and David J. Goodman. *Probability and stochastic processes: A friendly introduction for electrical and computer engineers*. 3rd ed. Wiley, 2015 **Companion Site**
2. **(Beginner Alternative)** Sheldon M. Ross. *A First Course in Probability, Global Edition*. 10th ed. Pearson, 2020
3. **(Engineer Alternative)** Introduction to Probability, Statistics, and Random Processes by Pishro-Nik
4. **(Lecture Note)** Probability and Random Processes by Kailong Wang
5. **(Alternative Note)** Introduction to Mathematical Statistics Chapter 1 ~ 7 by Gordanz

**Extended Reading:**

1. **(Publication of Nobel Memorial Prize in Economic Sciences Recipients)** Amos Tversky (eds.) Daniel Kahneman Paul Slovic. *Judgment under Uncertainty: Heuristics and Biases*. 1st ed. Cambridge University Press, 1982
2. **(Publication of Turing Award Recipients)** Dana Mackenzie and Judea Pearl. *The book of why: the new science of cause and effect*. 1st ed. Basic Books, 2018
3. **(Read at Your Own Risk!!!)** G. Larry Bretthorst and Edwin T Jaynes. *Probability theory: the logic of science*. 22nd ed. Cambridge Univ. Press, 2019

**Topics Covered By Day (Based on Textbook item 1):**

- Day 1** Course Introduction and Review of Calculus
- Day 2 (Chapter 1,2)** Combinatorics, Counting Methods, Set Theory, Axioms of Probability, Venn Diagrams
- Day 3** Examples and Exercises
- Day 4 (Chapter 1,2)** Conditional Probability, Bayes Theorem, Independence, Tree Diagrams
- Day 5** Examples and Exercises
- Day 6 (Chapter 3)** PMF, Discrete Random Variables, CDF, Expectation
- Day 7** Examples and Exercises
- Day 8 (Chapter 4)** CDF, Continuous Random Variables, PDF, Gaussian Random Variable, Delta Function
- Day 9** Examples and Exercises
- Day 10 (Chapter 5)** Joint CDF, Joint Random Variables, Joint PMF, Joint PDF, Marginal PMF, Marginal PDF, Joint Expectation, Covariance, Correlation, Linear Independence
- Day 11** Examples and Exercises
- Day 12** Review
- Day 13** Exam 1 (Cover Day2 to Day9)
- Day 14 (Chapter 7)** Conditional Probability Models
- Day 15** Examples and Exercises
- Day 16** Examples and Exercises
- Day 17 (Chapter 6,9)** Derived Random Variables, Moment Generating Function and Central Limit Theorem
- Day 18** Examples and Exercises
- Day 19** Introduction of Information Theory
- Day 20** Review
- Day 21** Exam 2 (Cover Day10 to Day17)
- Day 22** Applications of Probability Theory in Modern Technology
- Day 23** Final Presentation and Appraisal