RUTGERS UNIVERSITY, DEPARTMENT OF ECE
COURSE SYLLABUS: 14:332:226

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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 and 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
  - Bonus Project: 1 times×20 credits
  - Optional Final: 1 times×20 credits
- Exam Formats:
  - In total 100 points in each exam. Each will convert to 50 credits in final grade.
  - 80 points questions from HW. Fill the blank. No partial credit.
  - 20 points questions from anywhere. With partial credit.

Textbook and Materials:

1. **(Best 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

   Student 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

Extended Reading:

1. **(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
2. **(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
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 Day1 to Day9)

Day 14 **(Chapter 7)** Conditional Probability Models

Day 15 Examples and Exercises

Day 16 **(Chapter 6,9)** Derived Random Variables, Moment Generating Function and Central Limit Theorem

Day 17 Examples and Exercises

Day 18 Introduction of Information Theory

Day 19 Examples and Exercises

Day 20 Review

Day 21 Exam 2 (Cover Day10 to Day19)

Day 22 Random Topics

Day 23 Bonus Presentation and Optional Final