Syllabus

**Introduction to Probability and Simulation**

Course description: Basic probability rules, counting methods, conditional probability. Discrete and continuous random variables, expected values, variance and covariance. Properties of linear combinations of random variables with applications to statistical estimators. Simulation analysis of random phenomena using a modern computer language (typically Matlab or R).

Prerequisites: Calculus II, a course in computer programming.

Learning outcomes: By the end of the course, students should be able to

* 1. use definitions, rules, and counting methods to solve probability problems;
  2. calculate probabilities, expected values, and variances related to discrete and continuous random variables;
  3. identify and apply probability distributions to solve probability problems;
  4. apply properties of expected values and variances to linear combinations of random variables; and
  5. simulate random phenomena to approximate probabilities, expected values, and distributions of random variables.

Course content: This content is designed for a 10-week, 4-unit course (about 40 class meetings).

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| Topic | Book sections | No. lectures |
| **Probability rules**  Sample space, event, probability axioms, equally likely events, complement rule, addition rule | 1.1-1.2 | 3 |
| **Simulation**  Random process, simulation, loops, conditional statements | 1.6 | 3 |
| **Counting methods**  Permutations, combinations | 1.3 | 2 |
| **Conditional probability and independence**  Conditional probability, tree diagrams, probability tables, multiplication rule, independent events, law of total probability, Bayes’ rule | 1.4-1.5 | 6 |
| **Discrete random variables**  Probability mass function, expected value, variance, standard deviation, binomial, Poisson distributions, simulation of discrete variables | 2.1-2.6, 2.8 | 7 |
| **Continuous random variables**  Probability density function, cumulative distribution functions, expected value, variance, standard deviation, uniform, normal, exponential distributions, simulation of continuous variables | 3.1-3.4, 3.8 | 7 |
| **Linear combinations of random variables**  Mean and standard deviation of linear combinations, covariance (discrete case only), Central Limit Theorem, applications of CLT, application to sampling distributions of estimators | 4.1-4.3, 4.5 | 8 |