Syllabus

**Introduction to Probability Models**

Course description: Introduction to probability and applied probability models. Topics include basic probability rules, counting rules, conditional probability, discrete and continuous random variables, and expectation. Applied models include Poisson processes, Markov chains, and reliability models.

Prerequisites: Calculus II, linear algebra.

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

1. use definitions, rules of set theory, and combinatorics to solve probability problems;
2. solve problems involving conditional probability, Bayes’ Rule, and independence;
3. calculate and understand expectation and variance of random variables;
4. apply discrete univariate distributions, especially the binomial, hypergeometric, and Poisson distributions;
5. apply continuous univariate distributions, especially the normal and exponential distributions; and
6. use a variety of applied probability models, including Markov chains, Poisson processes, and reliability models, to solve problems.

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 | 4 |
| **Discrete random variables**  Probability mass function, expected value, variance, standard deviation, binomial, Poisson distributions, simulation of discrete variables | 2.1-2.5, 2.8 | 5 |
| **Continuous random variables**  Probability density function, cumulative distribution functions, expected value, variance, standard deviation, uniform, normal, exponential, Erlang distributions | 3.1-3.4, 3.8 | 5 |
| **Joint distributions and their applications**  Joint distributions (discrete case only), covariance and correlation (discrete case only), mean and standard deviation of linear combinations (brief), Central Limit Theorem | 4.1-4.3, 4.5 | 5 |
| **Markov chains**  Definition, transition probabilities, Chapman-Kolmogorov equations, initial distributions, long-run behavior, Steady State Theorem, absorbing states | 6.1-6.5 | 5 |
| **Poisson processes (brief)**  Definition, relation to exponential and Erlang distributions, nonhomogeneous processes | 7.5 | 2 |
| **Reliability (brief)**  Concept of reliability, reliability/survival function, series and parallel designs, mean time to failure, hazard rate | 4.8 | 2 |
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