ECE 203: PROBABILITY AND STATISTICS 1

COURSE OUTLINE (FALL 2022)

Teaching Staff

Instructor.

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Calendar Description

Ensemble model of randomness. Conditional probability, independence, and Bayes' theorem. Random variables, probability distribution functions. Expected values. Collections of random variables, joint and marginal probability distributions, and correlation. Introduction to random processes.

Prerequisites, Co-requisites, and Post-requisites

Prerequisites: ECE 103, (ECE 205 or MATH 211), MATH 119 (level at least 2B Computer or Electrical Engineering)

Antirequisites: ECE 306, 316

Purpose

This is the first in a sequence of two courses. This course concentrates mostly on probability theory. The second course will concentrate mostly on statistics.

Course Content

1. **Introduction to probability**
   - 3.1. Axioms
   - 3.2. Sample spaces and events
   - 3.3. Set operations and probabilities
   - 3.4. Inclusion/exclusion principle
   - 3.5. Sample spaces with equally likely outcomes
2. **Independence and conditioning**
   - 3.1. Independence
   - 3.2. Conditional probabilities
   - 3.3. Law of total probability
   - 3.4. Bayes' formula

3. **Random variables and distributions**
    3.1. Expectation
    3.2. Moments
    3.3. Common distributions
4. **Continuous random variables**
5. **Joint distributions and jointly distributed random variables**
    5.1. Joint distributions
    5.2. Sums of independent random variables
    5.3. Conditional distributions
6. **Expectations and their properties**
    6.1. Moments
    6.2. Characteristic and moment generating functions
    6.3. Conditional expectation and its properties
    6.4. Jointly Gaussian (normal) random variables
7. **Limit theorems**
    7.1. Probability inequalities
    7.2. Limit theorems
    7.3. Central Limit Theorem (CLT)
    7.4. Weak Law of Large Numbers

Course Website

Lecture slides and other relevant material are available at the course website at `www.ece.uwaterloo.ca/~ece203`.

Grading Scheme

The final grade consists of three components as detailed below.

- Home assignments: 20% (8 assignments $\times$ 2.5%)
- Midterm exam: 30 %
- Final exam: 50 %

The home assignments are allowed to be submitted in teams of 2 students, although one submission per student is still required. If this is the case, to avoid confusion the students should make sure to indicate the names of all teammates.

Both exams (i.e., the midterm and the final) will be administered in an *open-book format*. In particular, the students are allowed to bring in the printouts of the lecture notes/slides (with or without individual annotations) as well as non-programable calculators.

Course textbook and references

This course is based on *A First Course in Probability*, (10th edition), Sheldon Ross, Pearson/Prentice-Hall, 2019. It is a well written book and well worth investing in. Although completely voluntary, obtaining a copy of the textbook (either a hard copy, or soft copy) is definitely recommended.

There are many other good books that deal with the material. Additional good references include:

- *Introduction to Probability*, D. P. Bertsekas and J. N. Tsitsiklis, Athena Scientific, 2002.
- *Probability and Random Processes for Electrical Engineering*, Albert Leon-Garcia, Pearson, 2007
- *Probability, Random Variables and Stochastic Processes*, (4th Edition), A. Papoulis, S. U. Pillai, McGraw-Hill, 2002.