Course Outline

ECE 4860 T05 – Applied Probability and Stochastic Processes

Fall 2021

Instructor
- Prof. Faouzi Bellili.
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Office Hours
- By appointment

Contact Hours
- 4 credit hours
- Lectures:
  3 hours x 13 weeks = 39 hours
- Laboratories:
  1.5 hours x 5 weeks = 7.5 hours
- Tutorials:
  1.5 hours x 5 weeks = 7.5 hours

Prerequisites:
- STAT 2220 Contemporary Statistics for Engineers

Course Website:
http://umanitoba.ca/umlearn

IMPORTANT NOTICE – Mandatory Requirement to Report

This course will be conducted using remote instruction. Students who are accessing the course from outside of Canada or the USA ***must notify the instructor*** and indicate in which country they are located. Access to software may be restricted from some countries and failure to comply with these restrictions may result in criminal prosecution.

Course Objectives

Probability theory and stochastic processes are nowadays heavily used in almost every engineering and scientific discipline. Historically, although probability theory, as a mathematical subject, started to evolve in the seventeenth century and was initially focused on games of chances, the concept of stochastic processes was not introduced until 1930. The importance of the theory of probability and stochastic processes grew rapidly in the twentieth century and they now play a central role in risk assessment, data networks, operations research, information/communication theory, control theory, theoretical computer science, quantum theory, game theory, financial engineering, neurophysiology, biology, and many other fields.

This course is an introduction to probabilistic modeling, including random processes and the basic elements of statistical inference. The overarching objective of this course is to provide the students with a friendly exposure to the theory and applications of probability and stochastic processes, with an emphasis on conceptualization. The ability to think probabilistically is a fundamental component of scientific literacy. You will learn the relevant models, skills, and tools that are the keys to analyzing data and making scientifically sound predictions under uncertainty. We emphasize the basic concepts and methodologies with the following main objectives in mind:

- Become familiar with basic and common probability distributions.
- Learn how to use conditioning to simplify the analysis of complicated models.
- Understand how to manipulate probability mass functions, densities, and expectations.
- Understand the laws of large numbers in probability and how to apply them appropriately.
- Learn how to formulate simple dynamical models as Markov chains and analyze them.
- Become familiar with the basic inference methodologies (for both estimation and hypothesis testing) and be able to apply them.
- Understand how to process random signals with specific applications in estimation theory.

Course Content

- Getting started with probability: A very quick review
- Review of Random Variables
- Random vectors (N>=2 random variables)
- Sums of random variables
- Parameter estimation using sample mean
- Estimation of random variables
- Stochastic processes, Bernoulli process, Poisson process, Markov chains.
- Random signal processing (if time permits)

Textbook

Introduction to Probability, by D. P. Bertsekas and J. N. Tsitsiklis, 2nd Edition, Nashua, NH: Athena Scientific, 2008.

Reference (optional)

Probability & Stochastic Processes: A Friendly Introduction for Electrical & Computer Engineers, by R. D. Yates and D. J. Goodman, 2nd Edition, 2004 Wiley/Jossey-Bass and also the 3rd Edition.

Traditional Territories Acknowledgement

The University of Manitoba campuses and the Department of Electrical and Computer Engineering are located on the original lands of the Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene peoples, and on the homeland of the Métis Nation.

We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

Important Dates

- **Term Test**
  November 2nd, 2021
  6:00PM – 8:00PM
- **Voluntary Withdrawal Deadline**
  November 23rd, 2021
- **National Day for Truth and Reconciliation**
  September 30th, 2021
  No classes or examinations
- **Thanksgiving Day**
  October 11th, 2021
  No classes or examinations
- **Remembrance Day**
  November 11th, 2021
  No classes or examinations
- **Fall Term Break**
  November 8th –12th, 2021
  No classes or examinations

Accreditation Details

Accreditation Units

- Mathematics: 80%
- Natural Science: 0%
- Complementary Studies: 0%
- Engineering Science: 20%
- Engineering Design: 0%

Graduate Attributes

KB: A knowledge base for engineering
PA: Problem analysis
IN: Investigation
DE: Design
ET: Use of engineering tools
IT: Individual and team work
CS: Communication skills
PR: Professionalism
IE: Impact of engineering on society/ environment
EE: Ethics and equity
EP: Economics and project management
LL: Life-long learning

Competency Levels

1 - Knowledge (Able to recall information)
2 - Comprehension (Ability to rephrase information)
3 - Application (Ability to apply knowledge in a new situation)
4 - Analysis (Able to break problem into its components and establish relationships.)
5 - Synthesis (Able to combine separate elements into a whole)
6 - Evaluation (Able to judge the worth of something)

Learning Outcomes

1. Understand stochastic process as relates to statistics.
2. Understand different situations in ECE where stochastic processes appear.
3. Learn to mathematically represent basic real life stochastic processes.
4. Learn the mathematical and applied probability tools for analyzing stochastic processes.
5. Learn to use statistics in estimation and their applications in ECE.

Expected Competency Levels

Outcome	KB	PA	IN	DE	ET	IT	CS	PR	IE	EE	EP	LL
1	1	1	1									1
2	3	1	1									1
3	3	2	2									1
4	5	2	2									1
5	5	2	2									1

Evaluation

The final course grade is determined by the student's performance on assignments, in laboratories, and on tests and examinations.

Students must complete all laboratories in order to be eligible to receive a passing grade.

Component	Value (%)	Method of Feedback	Learning Outcomes Evaluated
Assignments	20	F, S	1, 2, 3, 4
Laboratories and Tutorial	15	F, S	3, 4, 5
Term Test	25	F, S	1, 2, 3
Final Examination	40	S	1, 2, 3, 4, 5

* Method of Feedback: **F** - Formative (written comments and/or oral discussion), **S** - summative (numerical grade)

CEAB Graduate Attributes Assessed

PA.3 – Analyzes and solves complex engineering problems.

IN.3 – Interprets results and reaches appropriate conclusions.

Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the *General Academic Regulations* on *Academic Integrity*, students are reminded that plagiarism or any other form of cheating in examinations, term tests, assignments, projects, or laboratory reports is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating by another student is also subject to serious academic penalty.

Retention of Student Work

Students are advised that copies of their work submitted in completing course requirements (i.e. assignments, laboratory reports, project reports, test papers, examination papers, etc.) may be retained by the instructor and/or the department for the purpose of student assessment and grading, and to support the ongoing accreditation of each Engineering program. This material shall be handled in accordance with the University's *Intellectual Property Policy* and the protection of privacy provisions of *The Freedom of Information and Protection of Privacy Act (Manitoba)*. Students who do not wish to have their work retained must inform the Head of Department, in writing, at their earliest opportunity.

Grading Scale

Letter	Mark
A+	95–100
A	85–94
B+	80–84
B	70–79
C+	65–69
C	55–64
D	45–54
F	< 45

Note: These boundaries represent a guide for the instructor and class alike. Provided that no individual student is disadvantaged, the instructor may vary any of these boundaries to ensure consistency of grading from year-to-year.

Requirements/Regulations

- Attendance at lectures and laboratories is essential for successful completion of this course. Students must satisfy each evaluation component in the course to receive a final grade.
- It is the responsibility of each student to contact the instructor in a timely manner if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should also familiarize themselves with the University's *General Academic Regulations*, as well as Section 3 of the Faculty of Engineering *Academic Regulations* dealing with incomplete term work, deferred examinations, attendance and withdrawal.
- No programmable devices or systems (such as calculators, PDAs, iPods, iPads, cell phones, smart watches, wireless communication or data storage devices) are allowed in examinations unless approved by the course instructor.
- Students should be aware that they have access to an extensive range of resources and support organizations. These include Academic Resources, Counselling, Advocacy and Accessibility Offices as well as documentation of key University policies e.g. Academic Integrity, Respectful Behaviour, Examinations and related matters.

Supplemental Resources

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