Engineering 5420: Probability and Random Processes

Instructor: Cecilia Moloney
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Phone 864-8961
Office Location EN-3072
Office Hours Normally Tuesdays and Thursdays, 4:00-5:00pm
Other office hours prior to tests and exam, as needed
Other times by appointment
Website D2L shell for the course
Preferred methods of communication: By email to cmoloney@mun.ca, or speak to me in person after class, or during my office hours, or during another office meeting time requested via email. I will occasionally use D2L email to send information messages to the entire class; you can also email me by D2L email.

Teaching Assistants: Faghihe Massaeli (1) and Mohsen Nazari (0.5)

Calendar Entry: includes basic concepts in probability, random variables, multiple random variables, descriptive statistics, random processes and selected applications for engineering.

Course Objectives

- To build upon students' past experience in engineering, and elsewhere, in order to foster understanding of the role, importance, and scope of descriptive statistics, probability and random processes, specifically within Electrical and Computer Engineering (ECE), as well as more widely;
- To promote the development of understanding and of basic problem solving skills in descriptive statistics, probability and random processes;
- To highlight and examine a selection of applications of probability and random processes across ECE;
- To prepare students for the application of probability and random processes in higher level ECE courses, notably those that list Engi 5420 as a pre-requisite, namely: Engi 6871, Communication Principles, and Engi 6876, Communication Networks.

Calendar Prerequisites: Engi 4823

Timing within B.Eng. programs: Engi 5420 is a required course for all students in Electrical and Computer Engineering (ECE), and is open to ECE students entering Term 5 (3rd academic year). These students will have successfully completed the following relevant courses:

- Engi 4823, Introduction to Systems and Signals and its pre-requisites
- Other basic engineering, programming, math, and physics courses taken in the first two years of electrical and computer engineering

Schedule: Lectures MWF 3:00-3:50 pm Room: EN-2007

Credit Value: 3 credits

[Required Resources] Textbook: C.W. Therrien and M. Tummala, *Probability and Random Processes for Electrical and Computer Engineers*, Second edition, CRC Press/ Taylor and Francis, 2012, ISBN 978-1-4398-2698-0. Available at MUN bookstore, or in print or e-book formats from various online vendors. [This text has been used previously in Engi 5420.] A copy of the textbook is available on Reserve in the QEII Library.

[Required Resources] Software: This course will require the use of Matlab software (Mathworks) as well as Excel (Microsoft Office). Matlab is available for student use on faculty computers, and is also available for students to download under the Memorial campus-wide license (via your student my.mun portal) – but note the full Matlab download requires significant space, so you may wish to do a limited download as will be noted in class. Online tutorials to review Matlab's basic functionality will be noted on the course D2L shell; also notes and examples to get you started with using Matlab for probability problems will be discussed in class and made available via D2L.

Major Topics:

- descriptive statistics
- basic probability
- random variables
- multiple random variables
- random processes
- selected applications in engineering, and in ECE in particular

Learning Outcomes:

Upon successful completion of this course, students will be able to:

	Learning Outcomes	**Graduate Attribute-Level***	**Methods of Assessment**
1	Articulate the role of statistics & probability in engineering and in social contexts	KB-D, Comm-D, Impacts-D	Assignments, Tests, Final Exam
2	Collect, analyze, and discuss data in terms of basic descriptive statistics	KB-D, PA-D	Assignments, Tests, Final Exam
3	Apply the basic axioms of probability, the total probability theorem and Bayes rule	KB-D, PA-D	Assignments, Tests, Final Exam
4	Analyze random variables via probability mass/density functions (PDF) and cumulative distribution function (CDF)	KB-D, PA-D	Assignments, Tests, Final Exam
5	Apply standard probability distributions to engineering examples	KB-D, PA-D	Assignments, Tests, Final Exam
6	Compute mean, variance & higher moments of a random variable from its distribution	KB-D, PA-D	Assignments, Tests, Final Exam

7	Develop probability models for multiple random variables including correlation	KB-D, PA-D	Assignments, Tests, Final Exam
8	Explain and provide engineering examples of discrete and continuous random processes	KB-D	Assignments, Tests, Final Exam
9	Characterize one random process by its ensemble means, variances, & autocorrelation	KB-D	Assignments, Tests, Final Exam
10	Characterize and give examples of ergodicity and stationarity in a random process	KB-D	Assignments, Tests, Final Exam
11	For linear systems describe the output in terms of the system transfer function	KB-D, PA-D	Assignments, Tests, Final Exam

*Each Graduate Attribute for each learning outcome is rated at a Content Instructional Level of I=Introduced, D=Developed, or A=Applied.
See www.mun.ca/engineering/undergrad/graduateattributes.pdf for definitions on the 12 Graduate Attributes and the Content Instructional Levels.

Assessment:

Deliverable	Value	Due Date(s)	
Assignment 1	4%	Feb 5	
Assignment 2	5%	March 27	
Problem Sets (see note below)			
Quiz 1	10%	January 29	(in EN-2043)
Midterm Test (2 hours)	21%	February 26	(in EN-2043)
Quiz 2	10%	March 18	(in EN-2043)
Final Exam (2.5 hours)	50%	Date and location TBD	
Total *	100%		

* Students must pass the tests and exam assessment portion of the course. That is, you must achieve at least 45.5/91 on the combination of the two quizzes, mid-term test and final exam; otherwise, if you achieve $M/91$, with $M < 45.5$, on the combination of the two quizzes, mid-term test and final exam, then your final course grade will be $100 \times M/91$.

Notes on Assessment Categories and Deliverables

Problem sets will be assigned regularly in order to help you learn the material of the course. Each problem set will have a "due" date after which answer keys, solutions, figures, Matlab code, etc., as pertinent, will be posted. These problems will not be due for marking, but rather it is intended that you will work the problems and then compare your work with the posted solutions/figures/code which will be available after the "due" date for each problem set. As well, some of these problems will be worked in class. It is recommended that you work all of the problems in each problem set, as well as read extra examples and problems from the text, so that you are well-prepared to do the more exploratory problems in the assignments as well as to write the quizzes, mid-term test and final exam.

Assignments: There are 2 assignments in this course to be submitted for marking. In addition to

problem analysis and solution, and the writing of comments and conclusions, etc., these assignments will require you to use and program Matlab for simulation or the processing of data. More information will be made available with each of the Assignments. The Assignment problems will be made available at least one week in advance of each due date.

Quizzes, Test and Exam: There are two full-class quizzes and one mid-term test during the term as well as a comprehensive final exam. Since the material of the course builds cumulatively, you will be expected to know and be prepared to use material from the beginning of the course for each of the quizzes / test, as well as for the final exam. Note that, due to the small size of the lecture class-room assigned to this course, the quizzes and mid-term test will be written in a larger classroom (EN-2043).

Course Materials on D2L: This course will use D2L (now Brightspace) for the distribution of course materials, including assignments, problem sets and their solutions, gap notes for advance reading and review, sample Matlab code, sources of data, articles, and other information as pertinent, as well as for occasional email notices to the whole class. Materials will be posted as we progress through the course, and organized in modules for ease of navigation.

Software: In this course we will use Matlab, and occasionally Excel, in class examples and problem set solutions. Since Matlab has greater functionality than Excel, and can be programmed through script and function files, Matlab will be required for use in assignments.

Calculator Policy: In order to ensure fair assessment of students' understanding of course materials, there is a restriction on the calculators which can be used during the tests and exam. Basic scientific calculators can be used in the quizzes, test and exam which have none of the following capabilities: graphing, text memory, programmability, symbolic computation, or built-in numerical algorithms beyond those of basic calculations of **functions** (e.g. roots, powers, logarithms, exponents, trigonometric functions) – note that numerical computations by algorithms, e.g. numerical integration, is not a basic calculation. Similarly, the use of notebook computers, tablets, and all communicating devices such as smartphones are prohibited during the tests and exam. Suitable calculator models will be noted in class; if you are uncertain, please check ahead of time with the instructor or TA prior to the tests or exam to be sure that the calculator you plan to use complies with the calculator policy.

Engi 5420 Policy on Extensions and Deferrals: A missed quiz or midterm test will not be made up but will have its marks spread proportionately over the final exam and the other term quiz(zes) or test. Extensions of deadlines for out-of-class assignments will not be permitted.

Useful References

1. Hwei Hsu, *Probability, Random Variables, and Random Processes*, Third edition, Schaum's Outlines Series, McGraw-Hill, 2014. [Contains many useful examples and exercises.]
2. David J. Hand, *Statistics: A Very Short Introduction*, Oxford University Press, 2008. [Short overview text, available www.oupcanada.com/catalog/9780199233564.html]

3. John Haigh, *Probability: A Very Short Introduction*, Oxford University Press, 2012. [Short overview text, available www.oupcanada.com/catalog/9780199588480.html]

The Required Fine Print – *Please review and observe the following:*

Academic Integrity and Professional Conduct: Students are expected to conduct themselves in all aspects of the course at the highest level of academic integrity. Any student found to commit academic misconduct will be dealt with according to the Faculty and University practices. More information is available at https://www.mun.ca/engineering/undergrad/academicintegrity.php .

The Memorial University of Newfoundland Code: "All members of the Memorial University of Newfoundland Community, which includes students, faculty, and staff, shall treat others with respect and fairness, be responsible and honest, and uphold the highest standards of academic integrity." (http://www.mun.ca/regoff/calendar/sectionNo=GENINFO-1502)

Faculty of Engineering Student Code of Conduct: "Like Professional Engineers, engineering students are expected to behave in a professional manner at all times. Students are encouraged to conduct themselves in a manner consistent with the PEG-NL Code of Ethics." Read more at https://www.mun.ca/engineering/undergrad/policies/CodeOfConduct.pdf

Safety: Students are expected to demonstrate awareness of, and personal accountability for, safe conduct within the classroom and building. Take note of emergency exits. Students will immediately report any concerns regarding safety to the teaching assistant and/or professor.

Inclusion and Equity: Students who require physical or academic accommodations are encouraged to speak privately to the instructor so that appropriate arrangements can be made to ensure your full participation in the course. All conversations will remain confidential.

The university experience is enriched by the diversity of viewpoints, values, and backgrounds that each class participant possesses. In order for this course to encourage as much insightful and comprehensive discussion among class participants as possible, there is an expectation that dialogue will be collegial and respectful across disciplinary, cultural, and personal boundaries.

Student Assistance: Student Affairs and Services offers help and support in a variety of areas, both academic and personal. More information can be found at www.mun.ca/student.