

ELEC ENG 3TQ3
Advanced Probability and Random Processes

COURSE OUTLINE

Please refer to course website for updated information.

COURSE DESCRIPTION

Probability theory, random variables, expectations; random processes, autocorrelation, power spectral densities; statistical inference; and analysis of variance.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): Registration in any Computer Engineering or Electrical Engineering Program, MATH 2P04 or MATH 2Z03
Antirequisite(s): COMMERCE 2QA3

SCHEDULE and MODE OF DELIVERY

The material for this course will be delivered through a mixture of online videos, textbook readings, live online lectures and tutorials (which are also recorded), and virtualized laboratories and projects. The platform for each component is noted at the end of each line.

Lecture: in person; notes accessible from *Avenue to Learn*

Tutorial: in person

Lab: none

INSTRUCTOR

Dr. Timothy R. Field
Email: field@mcmaster.ca
Office: ITB-A215
Phone: 905-525-9140 ext. 24194
Office Hours: as posted on *Avenue to Learn*

TEACHING ASSISTANTS

Names, contact information, and office hours are provided on the course website

COURSE WEBSITE/S

<http://avenue.mcmaster.ca>

COURSE OBJECTIVES

The course provides a basic foundation in the understanding of set theory, concepts of randomness, chance and probability for discrete and continuous type events, and the skills necessary to formulate and manipulate mathematical expressions describing such events. Systems evolving in time as a sequence of random events constitute random processes, which abound in the physical world. The course illustrates how to apply probabilistic techniques to investigate these processes in a variety of simple engineering type problems.

Overview of Topics:

Probability and set theory, discrete and continuous random variables, pairs of random variables, random vectors, sums of random variables, statistical estimation of a random variable; stochastic processes: the Poisson process, stationarity; Gaussian processes; random signal processing: autocorrelation, filtering of random processes, power spectral densities, Wiener-Khintchine theorem.

By the end of this course, students should be adept in terms of the following:

- Use of probability density functions for continuous random variables, in the single and multi-variable case. Ability to extract marginal distributions and distributions of functions of multiple variables
- Apply statistical measures to data including sample mean, variance and standard deviation, and quantify the effect of additional data
- Understand the relationship between autocorrelation and spectrum of a random process, and apply these concepts in the design of linear time invariant filters
- Calculation of the moment generating function, and its application to statistical properties of random sums in modelling data streams
- Use of Bayes' theorem in simple problems, including parameter estimation

CEAB GRADUATE ATTRIBUTES (GAs)

Note: The CEAB Graduate Attributes (GAs) defined in this section are measured throughout the course and form part of the Department's continuous improvement process. They are a key component of the accreditation process for the program and will not be taken into consideration in determining a student's actual grade in the course. For more information on accreditation, please ask your instructor or visit: <http://www.engineerscanada.ca>

Attributes	Indicators		Measurement Method(s)
	Number	Description	
Knowledge Base for Engineering	1.1	Competence in Mathematics	Midterm / final exam
Problem Analysis	2.1	Identifies and states reasonable assumptions and suitable engineering fundamentals, before proposing a solution path to a problem	Assignments
Problem Analysis	2.2	Proposes problem solutions supported by substantiated reasoning, recognizing the limitations of the solutions	Assignments / tests
Investigation	3.1	Selects appropriately from relevant knowledge base to plan appropriate data collection methods and analysis strategies	Assignments
Investigation	3.2	Synthesizes the results of an investigation to reach valid conclusions	Tests

ASSUMED KNOWLEDGE

Multi-variable calculus; some familiarity with discrete mathematics and basic concepts in probability.

COURSE MATERIALS

Required Text: Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers, Roy D.Yates & David.J. Goodman. Wiley 3rd Edition.¹ ISBN 9781118324561; the second edition may also be used.

Calculator:

Use of McMaster Standard Calculator only is permitted.

¹ 2nd edition is also acceptable

COURSE OVERVIEW

Week	Topic	Readings
1	Set theory & probability Axioms of probability Independence	Ch. 1
2	Bayes' theorem Counting methods and independent trials - binomial distribution Probability mass functions: Poisson, Geometric, Pascal	Ch. 1-2
3	Cumulative Distribution Function (CDF) Averages Functions of a random variable	Ch. 2-3
4	Variance Probability density functions (PDF) Expected values / functions of a random variable	Ch. 3
5	Families (exponential) Delta functions Generating samples with given distribution / converse (CDF)	Ch. 3
6	Mixed RVs Marginals Independence - geometry	Ch. 3 / notes
7	Functions of two random variables Expected values Correlation	Ch. 4-5
8	Expectation of sum, PDF of sum Correlation and random vectors	Ch. 6
9	Sum of random variables Moment generating function Random sums	Ch. 6
10	Poisson process, Gaussian processes	Ch. 10
11	Expected value, correlation and stationarity	Ch. 10-11
12	Filtering and spectral properties, Wiener-Khintchine theorem	Ch. 11
13	Review	-

A more detailed time line is available on the course web site.

At certain points in the course it may make good sense to modify the schedule. The instructor may modify elements of the course and will notify students accordingly (in class, on the course website).

ASSESSMENT

Component	Weight
Assignments (3)	25 %
Mid-term Exam (1)	25 %
Final Exam	50 %
Total	100 %

Grading and Evaluation Policies

- There are four (4) assignments, one (1) mid-term exam, and one (1) final exam to be evaluated in this course.
- All grades are final unless error(s) in marking is proven.
- No make-up/deferred mid-term exam
- MSAF transfers the weight of a missed mid-term exam to that of the final exam.
- The deferred final exam may be oral, depending on the number of students examined.

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. The academic credentials you earn are rooted in principles of honesty and academic integrity. It is your responsibility to understand what constitutes academic dishonesty.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g., the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the University. For information on the various types of academic dishonesty, please refer to the Academic Integrity Policy, located at <https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/>

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g., the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student-submitted work. For courses using such software, students will be

expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g., A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., online search, other software, etc.). For more details about McMaster's use of Turnitin.com, please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ONLINE ELEMENT

Some courses may use online elements (e.g., email, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster email accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses online elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright-protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical, and artistic work, including lectures by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the Instructor for the purpose of authorized distribution or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the Instructor if this is a concern for you.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience and the responsibility to demonstrate respectful and dignified interactions within all of our living, learning, and working communities.

These expectations are described in the Code of Student Rights & Responsibilities (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, whether in person or online. It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g., use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATIONS

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

www.eng.mcmaster.ca/ece

Electrical and Computer Engineering Lab Safety

Information for Laboratory Safety and Important Contacts

This document provides important information for the healthy and safe operation of ECE instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in ECE. It is expected that revisions and updates to this document will be done continually. A McMaster University lab manual is also available to read in every laboratory and online <https://hr.mcmaster.ca/app/uploads/2019/07/2019-McMaster-Lab-Manual.pdf>

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following whether conducting lab work at school or at home:

1. Food and beverages are not permitted in the instructional laboratories.
2. A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.
3. Laboratory equipment should only be used for its designed purpose.
4. Proper and safe use of lab equipment should be known before using it.
5. The course TA leading the lab should be informed of any unsafe conditions.
6. The location and correct use of all available safety equipment should be known.
7. Potential hazards and appropriate safety precautions should be determined, and the sufficiency of existing safety equipment should be confirmed before beginning new operations.
8. Proper waste disposal procedures should be followed.
9. Personal ergonomics should be practiced when conducting lab work. <https://bit.ly/3fOE71E>
10. Current University health and safety issues and protocol should be known. <https://hr.mcmaster.ca/resources/covid19/workplace-health-and-safety-guidance-during-covid-19/>

Location of Safety Equipment

Fire Extinguisher

On walls in halls outside of labs

First Aid Kit

ITB A111, or dial "88" after 4:30 p.m.

Telephone

On the wall of every lab near the door

Fire Alarm Pulls

Near all building exit doors on all floors

Who to Contact

Emergency Medical / Security: On McMaster University campus, call Security at extension **88** or **905-522-4135** from a cell phone.

Non-Emergency Accident or Incident: Immediately inform the TA on duty or Course Instructor.

University Security (Enquiries / Non-Emergency): Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.

See TA or Instructor: For problems with heat, ventilation, fire extinguishers, or immediate repairs

Environmental & Occupational Health Support Services (EOHSS): For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.

ECE Specific Instructional Laboratory Concerns: For non-emergency questions specific to the ECE laboratories, please contact 24103.

In Case of a Fire (On Campus Dial 88)

When calling to report a fire, give name, exact location, and building.

1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "*Fire!*" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.
6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

Clothing on Fire

Do not use a fire extinguisher on people

1. Douse with water from safety shower immediately or
2. Roll on floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

Equipment Failure or Hazard

Failure of equipment may be indicative of a safety hazard - You must report all incidents.

Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In power labs, press the wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

Protocol For Safe Laboratory Practice

Leave equipment in a safe state for the next person - if you're not sure, ask!

In general, leave equipment in a safe state when you finish with it. When in doubt, consult the course TA.

Defined Roles

TA	The first point of contact for lab supervision	
ECE Lab Supervisor	Steve Spencer - ITB 147	steve@mail.ece.mcmaster.ca
ECE Chair	Mohamed Bakr - ITB A111	mbakr@mcmaster.ca
ECE Administrator	Shelby Gaudrault - ITB A111	gaudraus@mcmaster.ca
ECE Course Instructor	Timothy R. Field – ITB A215	field@mcmaster.ca