ELEC ENG 3TQ3
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

Lecture: Monday, Wednesday, Thursday 5:30pm - 6:20pm, BSB 147
Tutorial: Tuesday 5:30pm - 6:20pm, BSB 147
Lab: (None)

INSTRUCTOR

Dr. Timothy R. Field
Email: field@mcmaster.ca
Office: ITB-A215
Phone: 905-525-9140 ext. 24194
Office Hours**:** Thursdays 14:30pm - 16:00pm; and by appointment

TEACHING ASSISTANTS

Contact information and office hours are provided on the course website.

- Seyed Mehdi Ayyoubzadeh
- Abdullah Ghazy
- Tongyu Ge
- Weijian Chen
- Jingxin Wang

COURSE WEBSITE

http://www.ece.mcmaster.ca/~field/courses/ee3tq3

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

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. ISBN 9781118324561; the second edition may also be used.

Calculator:
Any calculator is permitted on tests and exams.

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	20 %
Midterm	25 %
Final Exam	55 %
Total	100 %

Late submissions of assignments or project report are subject to 20% penalty per day (less than one day is counted as one day).
No make-up midterm tests will be granted. Weight of a missed midterm test will be transferred to final exam.

ACCREDITATION LEARNING OUTCOMES

Note: The *Learning Outcomes* 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 .

Outcomes	Indicators	Measurement Method(s)
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	1.1	Exam / test / assignments
Apply statistical measures to data including sample mean, variance and standard deviation, and quantify the effect of additional data	2.2	as above
Understand the relationship between autocorrelation and spectrum of a random process, and apply these concepts in the design of linear time invariant filters	12.1	as above

Calculation of the moment generating function, and its application to statistical properties of random sums in modelling data streams	1.1	as above
Use of Bayes' theorem in simple problems, including parameter estimation	2.1	as above

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.
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.
It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at www.mcmaster.ca/academicintegrity .
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.

ACADEMIC ACCOMMODATIONS

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail sas@mcmaster.ca . 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 requiring a RISO accommodation should submit their request to the Engineering Student Services 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.

STUDENT ABSENCE AND SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

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 is for users of ECE instructional laboratories in the Information Technology Building.

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.

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following:

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 condition.
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 sufficiency of existing safety equipment should be confirmed before beginning new operations.
8. Proper waste disposal procedures should be followed.

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 (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 Lab, press 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 Course Instructor	Please contact your specific course instructor directly	
ECE Administrator	Kerri Hastings- ITB A111	hastings@mcmaster.ca
ECE Chair	Tim Davidson- ITB A111	davidson@mcmaster.ca