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Office Hours: Mondays, 14:00-15:30.


Objectives: This course is an introduction to the methods of *simulation* and the *Monte Carlo* techniques. Simulation consists of formulating a suitable statistical model for a given system (in economy, industry, insurance etc.) in terms of appropriate random variables and their (joint) distributions, and generating values of those variables on a computer to see how the system works. Monte Carlo techniques are statistical methods for estimating various quantities of interest for the system, based on repeated simulations, which are difficult to compute theoretically based on the model. In Part I of the course we shall review basic probability theory and study methods for generating (pseudo) random variables. In Part-II we shall study simulation of a few complex systems and their estimation using Monte Carlo methods.

Assignments: There will be 3 or 4 assignments. Most of the assignments will involve use of the software –R that will be demonstrated during one class. R is installed on the PCs in the Department’s Computer Lab, and a freely downloadable student version can be found at [http://www.r-project.org](http://www.r-project.org). There will be a few separate questions for undergraduate and graduate students in the assignments and exams.

Final Grade: a) Assignments (15%)
b) Mid-term test (30%)
c) Final examination (55%)

If the grading scheme for this course includes graded assignments, a reasonable and representative subset of each assignment may be graded. Students will not be told in advance which subset of the assigned problems will be marked and should therefore attempt all assigned problems.

IMPORTANT: PLEASE NOTE THAT THERE IS NO “100% FINAL EXAM" OPTION IN THIS COURSE.
**Note:**

1) Assignments are compulsory. Late assignments will not be accepted.
2) A mid-term exam will be held on **Monday, July 23, 2018**. This exam, as well as the final, will be closed book exams.
3) The final examination will cover everything taught in the course.

<table>
<thead>
<tr>
<th>Lectures</th>
<th>Chapters</th>
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| 1        | Chapter 2: Elements of Probability  
Sample Space and Events  
Axioms of Probability  
Conditional Probability and Independence  
Random Variables  
Expectations  
Variance  
Chebyshev’s Inequality and the Laws of Large Numbers |
| 2 & 3    | Chapter 2: Elements of Probability  
Some Discrete Random Variables  
Continuous Random Variables  
Conditional Expectation and Conditional Variance  
Chapter 3: Random Numbers  
Introduction to R  
Pseudorandom Number Generation  
Using Random Numbers to Evaluate Integrals |
| 4 & 5    | Chapter 4: Generating Discrete Random Variables  
The Inverse Transform Method  
Generating a Poisson Random Variable  
Generating Binomial Random Variables  
The Acceptance-Rejection Technique  
The Composition Approach  
The Alias Method of Generating Discrete Random Variables  
Generating Random Vectors |
| 6 & 7    | Chapter 5: Generating Continuous Random Variables  
Introduction  
The inverse Transform Algorithm  
The Rejection Method  
The Polar Method for Generating Normal Random Variables  
Generating a Poisson Process |
| 8 & 9    | Chapter 5: Generating Continuous Random Variables  
Generating a Nonhomogeneous Poisson Process  
Simulating a Two-Dimensional Poisson Process  
Chapter 7: The discrete Event Simulation Approach  
Introduction  
Simulation via Discrete Events  
A Single-Server Queueing System |

**Mid-Term Test**

- Chapter 4: Generating Discrete Random Variables
- Chapter 5: Generating Continuous Random Variables
- Chapter 7: The discrete Event Simulation Approach
### A Queueing System with Two Servers in Series
- An Inventory Model
- An Insurance Risk Model

### 10 & 11
**Chapter 7: The discrete Event Simulation Approach**
- A Repair Problem
- Exercising a Stock Option
- Verification of the Simulation Model

**Chapter 8: Statistical Analysis of Simulated Data**
- Introduction
- The Sample Mean and Sample Variance
- Interval Estimates of a Population Mean
- The Bootstrapping Technique for Estimating Mean Square Errors

### 12 & 13
**Chapter 9: Variance Reduction Techniques**
- Introduction
- The Use of Antithetic Variables
- The Use of Control Variates
- Variance Reduction by Conditioning
- Stratified Sampling
- Applications of Stratified Sampling
- Importance Sampling

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**Academic Integrity and the Academic Code of Conduct**

This course is governed by Concordia University's policies on Academic Integrity and the Academic Code of Conduct as set forth in the Undergraduate Calendar and the Graduate Calendar. Students are expected to familiarize themselves with these policies and conduct themselves accordingly. "Concordia University has several resources available to students to better understand and uphold academic integrity. Concordia’s website on academic integrity can be found at the following address, which also includes links to each Faculty and the School of Graduate Studies: [concordia.ca/students/academic-integrity]." [Undergraduate Calendar, Sec 17.10.2]