Department of Mathematics & Statistics
Concordia University

STAT 461
Statistical Simulation
Summer 2018

Instructor: Dr. D. Sen, Office: LB 1041-21 (SGW), Phone: 514-848-2424, Ext. 3241
Email: debaraj.sen@concordia.ca

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

Text: *Simulation, 5*th Edition, by Sheldon M. Ross (Academic Press).

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. 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.

Lectures	Chapters
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 **Mid-Term Test**
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

	A queueing System with Two Servers in Series A queueing System with Two Parallel Servers 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

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]*