

# CS 661: System Simulation

## Spring Semester at NJIT

### Thursdays, 2:30 – 5:25pm

## Instructor

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## Description

Simulation is one of the most widely used tools for analyzing complex processes and systems. Its use in business and engineering has increased dramatically in recent years, in part because of the increased power of personal computers and workstations, on which the vast majority of simulations are carried out. The uses of simulation in a business environment include evaluating alternative operational policies, viewing the impact of changes in personnel or equipment on business performance, assessing the capabilities of a proposed factory, performing risk analysis of a proposed business plan, and pricing financial instruments. Examples of the use of simulation in engineering include the design and analysis of computer systems, networking, web-based systems, and fault-tolerant computing.

This course covers the use of simulation as a tool for analyzing business and engineering problems. The two primary goals of the course are to learn how to plan, build and use simulation models and to develop an understanding of when simulation is an appropriate tool for analysis. Much of the work in the course involves learning the mathematical and software tools for building simulation models, performing experiments with them, and interpreting the results.

Although the focus of the course is on general simulation concepts and techniques, independent of a simulation package, we also illustrate some of the material using the software package ARENA, a popular simulation package. ARENA is well suited for creating large and detailed discrete-event simulation models. We also use Excel to carry out some Monte Carlo simulations. The course covers many applications of simulation, including finance, computer-performance modeling, and analysis of service-sector systems.

## Prerequisites

An undergraduate or graduate calculus-based course in probability and statistics at the level of Math 244 or Math 333, and working knowledge of at least one higher-level programming language (e.g., C or Java). **Students who do not have a solid background in calculus-based probability should not take the course.**

## Tentative Course Outline

1. Introduction to simulation modeling, and review of basic probability and statistics (2 weeks)
2. Fundamental simulation concepts (1 week)
3. Probability distributions and input modeling (2 weeks)
4. Generating uniform and non-uniform random variates (2 weeks)
5. Building simulation models using Arena (2 weeks)
6. Output data analysis for simulations (1 week)
7. Monte Carlo simulation, including project management and finance (2 weeks)
8. Variance-reduction techniques (2 weeks)

Throughout the course, we cover many topics in finance, including stochastic models for risky asset prices (geometric Brownian motion, jump-diffusion models, Markov regime-switching models), interest-rate models, portfolio valuation, pricing options (including exotic path-dependent options), estimating value-at-risk, and variance-reduction techniques for pricing path-dependent options.

## Textbook

There is no required text for the course, but there are two optional texts:

- S. M. Ross, *Simulation*, 5th Edition, Academic Press, 2012, ISBN: 0124158250.
- P. Glasserman, *Monte Carlo Methods in Financial Engineering*, Springer, 2003, ISBN: 0387004513.

Students interested in finance should consider buying the Glasserman book, and all other students should consider buying the Ross book, but neither is required.