

NORTHWESTERN UNIVERSITY  
DEPARTMENT OF INDUSTRIAL ENGINEERING AND MANAGEMENT SCIENCES  
SPRING 2001

**IEMS 315: Stochastic Models and Simulation**

Monday, Wednesday, Friday  
9:00 to 10:00 am.

**Instructor:** Bahar Deler

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Office Hours: Tuesday & Thursday 1-2 pm or by appointment.

**GTA:** Liming Feng

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Office Hours: Fridays 12-2 pm or by appointment.

**Course Description:** This course is designed to provide an understanding of modeling and analyzing dynamic systems that are subject to uncertainty. Illustrative examples are provided from manufacturing, service, communication, computer, and health-care systems. The main emphasis is on rough-cut models that allow quick mathematical/numerical analysis. We primarily cover Poisson arrival process, Markov chains, and queueing processes and use computer simulation to build intuition about these models.

**Overview:** The course assumes no prior knowledge of simulation modeling and begins with an introduction to the discrete-event-sample-path view of stochastic processes, which is the basis for discrete-event simulation. Along the way, this view is exploited to make sense of many mathematically tractable processes. There is a *building block* effect for materials covered through the first exam and failure to keep up with the assignments will adversely affect your performance.

Your success in this course will be based on your effort and how well you follow the instruction provided. You should come to each class prepared, having read the appropriate material and the assigned problems. Classes will be conducted so that the issues pertaining to each assignment are discussed, followed by illustrative examples from the course pack.

In this course, you will simulate relatively simple processes using a new computer package. This will help you to develop some intuition about simulation and gain an understanding of the supporting probability structure that is hidden by most simulation languages. So that, at the completion of this course, you will be able to use simulation modeling effectively in order to model more complex systems for real applications.

**Prerequisites:** IEMS 302: Introduction to Probability and IEMS 303: Statistics and Data Analysis.

- Computing, especially the use of spreadsheets and menu-driven programs.
- Probability and statistics, especially random variables; expected values; probability distribution functions and cumulative distribution functions; the exponential, normal, uniform, Poisson and binomial distributions; sample mean and variance; and histograms.
- Linear algebra, especially addition, multiplication and inversion of matrices; and the solution of systems of linear equations.
- Calculus, especially integration.

**Required Materials**

- B. L. Nelson (1995), Stochastic Modeling: Analysis and Simulation. McGraw-Hill, New York.
- *Course Supplement for IEMS 315 Course Notes*. Available at Copy Cat.

- A number of computer packages, including Arena, Microsoft Excel, and Maple, which are all installed in the IEMS lab.

**Computing:** All course computing can be accomplished in the IEMS PC Lab. However, you may do course computing on *any* computer system with appropriate software, including your own computer or computers in other Northwestern labs.

**Course Web Page:** A web page will be available for this course at <http://courses.nwu.edu>. You will need to access this web page for announcements about class and solutions to problems and exams.

**Assessment:** The course grade will be based on the following components:

Case Study	10 %
Homework	25 %
Quiz	5 %
Midterm Exam	25 %
Final Exam	35%

**Homework:** The homework assignments will be graded for completeness and effort based on the judgment of the grader. The homework with the least score will be eliminated. All homework is due at the *beginning* of the class on the day it is assigned. Homework solutions will be made available after the class on the due date. **NO LATE HOMEWORK WILL BE ACCEPTED FOR ANY REASON.** If you cannot attend class, you can mail your homework to me as long as it is received by the beginning of class.

Regular reading and further problems assignments are listed in the outline. Supplemental problem sets (and solutions) are available on the website. You should expect similar problems on the exams.

**Labs:** All lab reports are due by the end of the lab session (or 5 pm Friday). You do not have to attend the lab, but the instructor and the teaching assistant will only help you with labs during lab time or office hours. The lab reports will be checked, but not graded. However, you will be responsible for the lab material covered in the exams.

**Quiz:** There will be one **unannounced** quiz every week during the quarter. It will cover the material taught until this point in the quarter. However, the emphasis will be on the material discussed in the previous week. The quiz with the least score will be eliminated.

**Case Study:** In week 7, you will be assigned a comprehensive problem and expected to solve the problem in two weeks. This will be a group assignment, which will be carried out by groups of three. Each group is expected to hand in a paper no longer than 5 pages (excluding Appendices).

**Regrades:** Exams and homework assignments will not be reviewed in class, but solution sets will be made available. Regrades of homework and exams will be considered only if you submit the exam/homework along with a **written statement** explaining why you believe it was misgraded **during the following class**.

**Working together:** You are encouraged to discuss homework problems. However, all homeworks have to be done individually. Please do not "write-up" the homework together. If you got an idea from someone, please give him or her credit, e.g., "Mary Smith pointed out to me that ...". Keep in mind that rules of the University regarding academic integrity will be enforced in the strictest manner.

**Exams:** The midterm and final exams are open book and notes. The final will be on June 7, Thursday, 9-11 am, it will be comprehensive, and it will not be optional. The date for the midterm exam is given on the course outline and students enrolled in the course are expected to adjust their schedules accordingly. **NO MAKE UP EXAMINATION WILL BE GIVEN.**

**Office Hours:** Please respect the office hours of the instructor and the teaching assistant by planning ahead. Use e-mail to obtain answers at other times, but first check out the Frequently Asked Questions (FAQ) to see if someone else has already obtained an answer to your question. The FAQ will be updated throughout the quarter.

### Course Outline

Week	Topic	Reading	Lab
1	Sample paths & Hand simulation	Chapters 1-2	Introduction to Maple
2	Probability review & Random-variate generation	Chapter 3	Sample paths & simulation in a spreadsheet
3	Simulation	Chapter 4	Learning ARENA by simulating CD Express
4	Arrival processes	Chapter 5 (except 5.6.3,5.8,5.9)	Simulating the Football State University
5	Arrival processes	Same	No lab – Review session
6	Discrete-time processes & <b>Midterm</b> , Friday, April 5	Chapter 6.1-6.6	Fitting distributions to data
7	Discrete-time processes	Same	Using the Maple library
8	Continuous-time processes & Queueing processes	Chapter 8.1-8.8	Queueing simulation (Buffer Overflow Model)
9	Queueing processes	Chapter 8.10-8.10.1	Animating Queueing Simulation
10	Non-Markovian queues & Networks of queues	Same	No lab – Review session
11	<b>Final Exam</b>		

### Assignments due date

Week	Date	Assignment Due
2	April 4	Homework 1
3	April 11	Homework 2, case study groups
4	April 18	Homework 3
5	April 25	Homework 4
7	May 9	Homework 5
8	May 16	Homework 6
9	May 23	Homework 7
11	June 4	Case study

**Expectations:** It is assumed that you will attend all class meetings, and you will be held accountable for any lecture material, handouts, information, etc., provided in the class. If you must miss a class, please let me know. But it is your responsibility to arrange for a colleague to collect any class materials for you.