OR 335/ SYST 335
Discrete Systems Modeling and Simulation
Spring 2014

Class time: 9:00am-10:15am, Tuesday, Thursday, Jan 21 – May 1, 2014
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Course Description:
Many complex engineering systems and business processes can be modeled as discrete-event systems. Examples include call center, supply chain, hospital emergency rooms, airport terminals, and air traffic control systems. The complexity of the systems and the uncertain nature of the environment often make simulation the only feasible analytical tool to model and study the design and operations of these systems. This course studies the important topics in discrete-event simulation theory and practice. Topics will include stochastic modeling of discrete-event systems, input modeling, random number generation, statistical analysis of simulation output, and techniques to improve the efficiency and accuracy of simulation results. A very important part of this course is for the students to learn to actually build and use simulation to model and analyze a discrete-event system. Simulation packages such as Arena will thus be extensively used through the course. Students will also be required to build simulation models using a general programming language. Therefore, it is very important to have sufficient computer programming skills before taking this course.

Prerequisite:
Programming: CS 211, or CS 112 and CS211 as a co-requisite
Basic probability and statistics: STAT 344, or STAT 346, or MATH 351.
Prerequisite requirements will be strictly enforced.

Grading: Homework 25%; In-class quizzes 10%; midterm 30%; term project 35%.

Late homework submissions will not be accepted. Email submission will not be accepted. Homework problems should be worked out independently but discussions are allowed.

We will have 10 in-class quizzes. Quizzes will be given at the end of a class and only test the materials covered during that class.

In class midterm is tentatively scheduled on Thursday, April 3. Make up exam for certified medical reason only.

Teams with 3-4 members will work on the term project. More details about term project will be given during the semester. You may choose any discrete-event simulation related subjects but will need approval from the instructor. You are strongly encouraged to do a simulation project motivated by a real problem. However, you should be careful to define the scope of the problem you want to address in the project and make sure that your peers can understand the problem you are trying to model and study, and you can finish the project on time. There will be term project proposal, mid-term progress report, and final presentations. Final presentations are tentatively scheduled on April 29 and May 1. Every team member is required to present.

Textbooks

Required text:

J. Banks, J. S. Carson, II, B. L. Nelson, and D. M. Nicol, "Discrete-Event system Simulation," 5th Edition, 2010. Earlier version of this book is fine too. (You may use the 4th Ed., but be aware of the changes, especially exercise questions assigned for homework). This book provides a comprehensive coverage of the fundamentals in simulation modeling & analysis. It is also a valuable reference book for successful simulation applications. It is independent of any specific simulation software package.

(Strongly) recommended text:

W. D. Kelton, R. P. Sadowski, and D. T. Sturrock, "Simulation With Arena," 5th Edition, 2010. ARENA is the probably the most popular simulation software package used in industry. Since ARENA is very powerful in its modeling capability and provides many useful features to assist in building simulation model and analyzing simulation results, many earlier students used it for their term projects. It is highly recommended that each project team buys at least one copy of this book if Arena is used. Lectures will cover materials from Chapters 3 to 7. Some homework assignments will also have problems from this book. You may also use the 3rd or 4th edition of this book but be aware that they were written for earlier versions of Arena.

Another useful book on simulation:

C. H. Chen and L. H. Lee, "Stochastic Simulation Optimization: An Optimal Computing Budget Allocation," 2010. This book gives an introduction to simulation and focuses on the use of optimization via simulation, i.e., optimizing system design using the simulation model of the system.

Simulation software

Arena:

ARENA is a very popular simulation software package and will be used in this class. The student version of Arena is free of charge (http://www.arenasimulation.com/Arena_Home.aspx). The student version of Arena is essentially the same as professional version except the limit on the size of model you can run. As of now, the current version is 14.5.

Please read the instructions in the appendix of the book carefully before installation. If you have a Windows-based computer, you can install Arena on your own PC. Please be aware that models built with a newer version of Arena cannot be opened by an earlier version of Arena. But a higher version of Arena can open models built by an earlier version can be opened by a newer version of Arena.

In addition, Arena professional version 14.0 is available at the IT&E PC Lab on the first floor of the engineering building. When doing term project and a professional version is needed, the instructor can also lend Arena professional license (up to version 14.5) to students' machines. The professional version allows you to run much bigger models. However, you must only use it for educational purpose!

Excel add-in software packages for simulation:
@Risk and Crystal Ball are two popular Excel add-in Monte Carlo (note that they are not developed for discrete-event simulation) simulation software packages. We will not use them in this class. But keep in mind that in practice, many simulation studies are done on a spreadsheet using software tools like them. Some useful reference books for these tools are: (1) Crystal Ball: "Introduction to Simulation and Risk Analysis" by J. R. Evans & D. L. Olson, Prentice Hall. (2) @RISK: "Simulation Modeling using @RISK", by W. L. Winston, Duxbury.

High-level programming languages:
In principle, all simulation models can be built using a high-level programming language like C++ or Java as long as there is a good random number generator. It gives you the most control and flexibility to build the simulation model but requires much more time and expertise than readily available simulation software packages.

Tentative Course Schedule & Reading Assignment:

Topics	Lectures	Reading Materials
Introduction to discrete-event systems and simulation	2	Chapter 1, 2
Review of basic probability and statistics	2	Chapter 5 and 6.1-6.3
Building simulation model	5	Chapter 3, 4, Arena book Chapter 3, 4.1-4.4
Term Project Proposal Presentation	0.5	
Input modeling	2.5	Sections 9.1-9.6, Arena book chapter 4.6
Generating random numbers from uniform distributions	0.5	Sections 7.1-7.3
Generating random numbers from non-uniform distributions	1.5	Chapter 8
Simulation output analysis	2	Chapter 11, Arena book chapter 7.2
Term Project Mid-term Progress Presentation	1	
More on Arena	2	Arena book Chapters 5
Midterm exam	1	
Verification and validation	1	Chapter 10
More on Arena	3	Arena book Chapters 5
Comparing alternative systems & optimization via simulation	1.5	Sections 12.1-12.2, 12.4, Arena book chapter 6.4-6.6
Monte Carlo Simulation	0.5	Section 2.1, 2.2, 2.4, 2.5

Term project presentation	2	

Academic Integrity

GMU is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

Disabilities Statement

If you have a documented learning disability or other condition that may affect academic performance you should: 1) make sure this documentation is on file with Office of Disability Services (SUB I, Rm. 4205; 993-2474;http://ods.gmu.edu) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs.

Mason Diversity Statement

George Mason University promotes a living and learning environment for outstanding growth and productivity among its students, faculty and staff. Through its curriculum, programs, policies, procedures, services and resources, Mason strives to maintain a quality environment for work, study and personal growth.

An emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals. Diversity is broadly defined to include such characteristics as, but not limited to, race, ethnicity, gender, religion, age, disability, and sexual orientation. Diversity also entails different viewpoints, philosophies, and perspectives. Attention to these aspects of diversity will help promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected.

The reflection of Mason's commitment to diversity and inclusion goes beyond policies and procedures to focus on behavior at the individual, group and organizational level. The implementation of this commitment to diversity and inclusion is found in all settings, including individual work units and groups, student organizations and groups, and classroom settings; it is also found with the delivery of services and activities, including, but not limited to, curriculum, teaching, events, advising, research, service, and community outreach.

Acknowledging that the attainment of diversity and inclusion are dynamic and continuous processes, and that the larger societal setting has an evolving socio-cultural understanding of diversity and inclusion, Mason seeks to continuously improve its environment. To this end, the University promotes continuous monitoring and self-assessment regarding diversity. The aim is to incorporate diversity and inclusion within the philosophies and actions of the individual, group and organization, and to make improvements as needed.

Student Support Resources on Campus

Resources that you may find helpful may be found at:

http://ctfe.gmu.edu/teaching/student-support-resources-on-campus/