SYST/OR 335 Discrete Systems Modeling and Simulation
Spring 2018

Class time: 1:30pm-2:45pm, Tuesday, Thursday
Room: Planet 206
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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:
CS 112 or equivalent, and STAT 344, or STAT 346, or MATH 351.

Corequisite(s): CS 211.

Grading: Homework 25%; In-class quizzes 15%; midterm 30%; term project 30%.

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 5 in-class quizzes. **Quizzes will be given at the beginning of a class and only test the materials covered in the past 2 lectures**. Each quiz has 3 points.

Make-up midterm exam and quiz can **only** be granted on the following basis (**the only exception is medical emergencies that you cannot know beforehand)**:

You notify the instructor **at least 2 days before the exam or quiz** that you must be absent because of medical conditions (documentation from doctors required) or other circumstances

that you have no control over. **Make-up will then be given one day before your scheduled absence** and the exam/quiz will at least be at the same level of difficulty as the regular exam/quiz.

Teams with 4-6 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. Every team member is required to present.

Final letter grades are assigned as follows:
A+: 97-100, A: 93-96, A-: 90-92, B+: 87-89, B: 83-86, B-: 80-82, C+: 77-79, C: 73-76, c-: 70-72, D+: 67-69, D: 63-66, D-: 60-62, F: <60

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. 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," 6th Edition. 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.

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.

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 is available at the IT&E PC Lab on the first floor of the engineering building, room 1506. When doing term project and a professional version is needed, the instructor can also lend Arena professional license to students' machines. The professional version allows you to run much bigger models. However, you must only use it for educational purpose! **If you have a Windows-based computer with an Ethernet port (Windows virtual machine on Mac does not work)**, you can borrow an Arena professional license to use on your own PC. To do so, you must download and install the **FactoryTalk Activation Manager** from Rockwell Automation (it comes as part of your Arena installation file). You can then bring your laptop to the instructor's office to borrow a professional license. You must agree to leave the computer with the instructor for about 10 minutes to go through the procedure of checking out a license to your local machine. There is a limit of total number of licenses available. Each team will only be guaranteed one license.

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.

Topics to be covered & reading materials:

Topics	Reading Materials
Introduction to discrete-event systems and simulation	Chapter 1, 2
Review of basic probability and statistics	Chapter 5 and 6.1-6.3
Introduction to simulation modeling	Chapter 3, 4, Arena book Chapter 3, 4.1-4.4
Generating random numbers from uniform distributions	Sections 7.1-7.3
Generating random numbers from non-uniform distributions	Chapter 8
Input modeling	Sections 9.1-9.6, Arena book chapter 4.6

Intermediate Arena modeling	Arena book Chapter 5
Simulation output analysis	Chapter 11, Arena book chapter 7.2
Verification and validation	Chapter 10
Monte Carlo Simulation	Section 2.1, 2.2, 2.4, 2.5

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/