ISE 4100 – Stochastic Modeling and Simulation

Autumn 2022

(Last updated April 3, 2023; changes shown in blue)

Contents

1 Course Overview

Lectures: Mondays and Wednesdays, 11:00AM – 12:00PM.
In person: Baker Systems 470.
Also online via CarmenZoom. See links on the CarmenCanvas page.

Labs: Thursdays, 11:00AM – 12:00PM.
In person: Baker Systems 470.

Instructor: Prof. ⟨PROF_FIRST_NAME⟩⟨PROF_LAST_NAME⟩
Email: ⟨PROF_EMAIL⟩
Office hours: Mondays 4:30-5:30pm (online), and Thursdays 12-1pm (Online, option to join drop by 238 Baker in-person). See links on the CarmenCanvas page.

Lab & Teaching Assistant: ⟨TA_FIRST_NAME⟩⟨TA_LAST_NAME⟩
Email: ⟨TA_EMAIL⟩
Office hours: Tuesday 3-4pm, Fridays 11:30am-12:30pm, or by appointment. Online. See links on CarmenCanvas page.

Second Teaching Assistant (Grading): ⟨TA_FIRST_NAME⟩⟨TA_LAST_NAME⟩
Email: ⟨TA_EMAIL⟩

Both ⟨TA_FIRST_NAME⟩and I can meet with you outside of the office hour times above. To make an appointment with either of us, send an email directly to the respective address given above.

Course website: All lecture notes, homework, project, CarmenZoom links, etc, will be distributed via the CarmenCanvas page for the course. I (as well as the TA, ⟨TA_FIRST_NAME⟩) will be using CarmenCanvas for sending you announcements and emails throughout the semester. Please make sure to check *all* these announcements. We expect that you read all such CarmenCanvas announcements *carefully*, and take any actions outlined in them in a timely manner.

Catalog description: (4 units) Methods for stochastic process and discrete event simulation modeling and system design and decision-making using simulation tools.

Informal description: This course is an introduction to computer modeling and analysis of real-world systems under uncertainty. The goal of this course is to apply probability and computer simulation to model and analyze systems with time varying randomness. Such stochastic systems are commonly encountered in engineering, computer science, biology, finance, and public policy. Through this course, you will gain experience in:

- Understanding the role of stochastic modeling and simulation in system (re-)design and optimization
- Planing and conducting data collection and analysis for discrete event simulation modeling
- Formulating an appropriate simulation model for a system
- Implementing the model as a computer program (in ARENA, as well as Excel, time-permitting)
- Evaluating and interpreting the output of the simulation
- Performing decision analytics by, e.g., making recommendations for system design and management based on the simulated model

Prerequisites: STAT 3470 or equivalent, and enrollment in the Industrial and Systems Engineering major; or permission of instructor. A solid probability and statistics background is important. In particular, you should feel comfortable with topics including probability, random variables, means and variances, confidence intervals, and hypothesis testing. In addition, you should know how to code at an intermediate level: MATLAB, C, C++, or Java.

2 How This Course Works: Delivery Details and Expectations

This course consists of two lectures and a lab session each week, plus office hours.

Mode of delivery of lectures: The lecture component of this course is delivered in-person. The two lectures each week will also be accessible synchronously via CarmenZoom. Please also see section on "attendance and participation" for the related requirements.

Mode of delivery of the lab: The lab component of this course is in-person. Details on software use are given in the "technologies to access labs" section.

Mode of delivery of office hours: Office hours by the instructor and the TA will be online via CarmenZoom. Office hour times are listed in the Course Overview section.

Attendance and participation: There is a 3% class participation grade, and so consistent engagement in the course is expected from all students, and synchronous participation in lectures is highly encouraged. You may be asked to answer short questions (through Kahoot!) during class. Therefore, synchronous attendance will be quite helpful in mastering the course. That being said, I understand that you may have to miss class (hopefully only occasionally), and therefore annotated lecture notes will be made available on CarmenCanvas as well. In case you miss a lecture or lab, you are expected to view the missed material before the next lecture or lab. You are also encouraged to use the discussion board on Carmen after each lecture to ask any questions you may have after the lecture.

3 Textbooks and Course Technologies

Textbooks and reference books: We will have two (non-required) textbooks. The first one will be used in the lectures and the second one will be used in the labs.

- Jerry Banks, John S. Carson II, Barry L. Nelson, and David M. Nicol, Discrete-Event System Simulation, 5th edition, Prentice Hall, 2010
- W. David Kelton, Randall P. Sadowski, and Nancy B. Zupick, Simulation with Arena, McGraw Hill.

I recommend (but do not require) obtaining a copy of the first textbook if possible, as we will be following that book closely. The US edition or the International edition are the same as far as I can tell, and the 4th edition is largely similar to the 5th edition too, so all these editions can work. The second textbook on the Arena software is a good reference if you are looking for one, but not required.

Other useful textbooks and resources include:

- M.D. Rossetti, Simulation Modeling and Arena, 2nd Edition, Wiley, 2015
- A.M. Law, Simulation Modeling and Analysis, 5th edition, McGraw-Hill, 2014
- W.L. Winston, Operations Research: Volume Two. Introduction to Probability Models 4th ed., Thomson Brooks/Cole, 2004

Brief lecture notes will be posted on Carmen. These are intended to provide an overview of all topics covered in each lecture, but will not be a substitute to lectures, as they may not include all details discussed in class.

Copyright disclaimer: The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Technologies to access labs: We will use the ARENA software in the lab. This software is available on computers in OSU Baker Systems labs, and via remote access.

A free student version of the software is available for Windows devices and can be obtained from the software's website; the capabilities of this free version are sufficient for the lab, and therefore you may choose to use this on your personal device to complete labs if you'd like. A Mac version is not available; therefore, if you are a Mac-user, you can plan to use remote desktop to access ARENA on OSU computers when not on campus. Finally, note that while the free student version will have sufficient capabilities for completing the labs, you will likely need the full licensed version, available on Baker System computers, to complete the course project.

4 Grading

Grade breakdown: The grade will be based on homework (20%), a midterm exam (22%), a final exam (25%), quizzes (15%), a final project (15%), and class participation (3%).

Homework: Homework will be given throughout the semester with tentative due dates given in the course outline, and will be completed in groups of 2. There will be 4 homework sets. Homework will be typically due on Tuesdays at 6pm. Late assignments will not be accepted.

Collaboration policy: Students are encouraged to work together on problem sets and on general discussion of course material. Keep in mind however that all written solutions and code handed in by each team must be written solely by them and reflect their independent understanding of the course material.

Exams and quizzes: We will have one midterm exam and a comprehensive final exam. There will also be quizzes which include both the methodology part and the application (software) part. The midterm will be on Wednesday, October 12th, during class time. By the university's Autumn 2022 Final Examination Schedule, the final exam will be Wednesday, December 14th, 10am-11:45am. Tentative dates for quizzes are given in the course outline. Quizzes will be online through Carmen, but both exams will be in-person.

Project: The course will have one project. You will be given the option of working on this project alone, or in groups of two. The project will include an interim report and a final report. The interim report is intended to make sure you are making progress towards team formation, task breakdown, and have done some initial work, and is to make sure we address any issues before we get too close to the final project deadline (this will be tentatively due Tuesday, November 22nd). The final report will be due shortly after the last day of class (tentatively, due Friday, December 9th). Details on the project, including deliverables and deadlines, will be made available in a separate document.

5 Course Outline

A tentative timeline of topics to be covered in each week, and important dates (shown in **bold**), are given in Table 1.

6 Other Course Policies and Information

Health and safety requirements: All students, faculty and staff are required to comply with and stay up to date on all university safety and health guidance (`https://safeandhealthy.osu.edu`), which includes wearing a face mask in any indoor space and maintaining a safe physical distance at all times. Non-compliance will be warned first and disciplinary actions will be taken for repeated offenses.

Academic misconduct statement: The Ohio State University and the Committee on Academic Misconduct expect that all students have read and understand the University's Code of Student Conduct, and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the University's Code of Student Conduct and this syllabus may constitute "Academic Misconduct," as defined in the University's Code of Student Conduct (Section 3335–23–04). Any student found to have engaged in academic misconduct will be subject to disciplinary action by the university. Please contact me if you have any questions about what might constitutes academic misconduct in this course.

Statement on Title IX: All students and employees at Ohio State have the right to work and learn in an environment free from harassment and discrimination based on sex or gender, and the university can arrange interim measures, provide support resources, and explain investigation options, including referral to confidential resources.

If you or someone you know has been harassed or discriminated against based on your sex or gender, including sexual harassment, sexual assault, relationship violence, stalking, or sexual exploitation, you may find information about your rights and options at `titleix.osu.edu` or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu. Title IX is part of the Office of Institutional Equity (OIE) at Ohio State, which responds to all bias-motivated incidents of harassment and discrimination, such as race, religion, national origin, and disability. For more information on OIE, visit `equity.osu.edu` or email equity@osu.edu.

Your mental health: As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you find yourself feeling isolated, anxious or overwhelmed, please know that there are resources to help: `ccs.osu.edu`. You can reach an on-call counselor when CCS is closed at (614) 292-5766 and 24 hour emergency help is also available through the 24/7 National Prevention Hotline at 1-(800)-273-TALK or at `suicidepreventionlifeline.org`. The Ohio State Wellness app is also a great resource available at `go.osu.edu/wellnessapp`.

Accessibility accommodations for students with disabilities: The University strives to make all learning experiences as accessible as possible. In light of the current pandemic, students seeking to request COVID-related accommodations may do so through the university's request process, managed by Student Life Disability Services. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately (within the first two weeks of the course) so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. SLDS contact information: slds@osu.edu; 614-292-3307; `slds.osu.edu`; 098 Baker Hall, 113 W. 12th Avenue.

Accessibility of course technology: This online course requires use of Carmen (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor. Information about accessibility within CarmenCanvas and CarmenZoom is avilable in the following links:

`https://community.canvaslms.com/docs/DOC-2061Informationabout`
`https://resourcecenter.odee.osu.edu/carmenzoom/accessibility-carmenzoom`

Table 1: Course outline (subject to change)

Lecture	Date	Topics covered
1	8/24	Introduction to simulation and its applications, course logistics
2	8/29	Concepts in discrete event simulation
3	8/31	Simulation examples I: manual and spreadsheet simulations
	9/1	**Quiz 0**
4	9/7	Simulation examples II: examples continued
5	9/12	Review of probability and statistics I
	9/13	**Homework 1 due**
6	9/14	Review of probability and statistics II
7	9/19	Review of probability and statistics III
8	9/21	Random number generation I
	9/21	**Quiz 1**
9	9/26	Random number generation II
10	9/28	Random variate generation I
11	10/3	Random variate generation II
	10/4	**Homework 2 due**
12	10/5	Random numbers wrap up
13	10/10	Introduction to input modeling
14	10/12	**Midterm exam**: during class time
15	10/19	Input modeling I
16	10/20	Input modeling II
	10/25	**Homework 3 due**
17	10/26	Input modeling III
18	10/27	Poisson processes I
19	10/31	Poisson processes II
20	11/2	Queueing models I
	11/7	**Quiz 2**
21	11/7	Queueing models II
22	11/9	Input modeling and queueing theory wrap up
23	11/14	Verification and validation I
	11/15	**Homework 4 due**
24	11/16	Verification and validation II
25	11/21	Output analysis I
	11/22	**Interim project report due**
	11/23	Thanksgiving break begins (no classes)
26	11/28	Output analysis I
27	11/30	Output analysis III
28	12/5	Output analysis wrap up
29	12/7	Last day of class: course review
	12/9	**Final project reports due**
	12/14	**Final exam**: 10am-11:45am