EE/CPE 345 Modeling and Simulation

SES
Spring 2025

Instructor: Shirantha Welikala
Canvas Course Address: https://sit.instructure.com/courses/77146
Course Schedule: Tuesday and Thursday: 9:30 AM - 10.45 AM, Edwin A. Stevens 330.
Contact Info: swelikal@stevens.edu
Office Hours: Tue/Thu: 11:00 AM-12:30 PM, Burchard 412 (or by appointment, Zoom)
Corequisite(s): ENGR 243 or ENGR 241

COURSE DESCRIPTION

The goal of the course is to teach all the components required to successfully run a simulation for discrete event-driven systems, with the main application examples being focused on networks. The course has two main threads: a theoretical component focused on modeling discrete event-driven systems and a software implementation component - learning to build simulation models using a simulation environment (OMNET++). The final project requires putting all the elements together to model, code, and obtain and interpret simulation results for a chosen application example.

STUDENT LEARNING OUTCOMES

- Learning outcome 1: The student will be able to statistically characterize physical processes: identify their mean and variance, and probability distribution function (probability mass function) based on underlying properties of the processes, or by empirical measurements, and using goodness of fit tests.
- Learning outcome 2: The student will be able to characterize physical systems using mathematical models based on the description of real systems and their physical variables. This implies the ability of recognizing various queueing models.
- Learning outcome 3: The student will be able to analyze the performance of various systems modeled as queues and interpret the mathematical results in terms of system stability, delay performance, and system utilization (efficiency).

- Learning outcome 4: The student will master basic programming skills using a simulation environment, OMNET++. The student will be able to design and run simple simulation examples, using OMNET++.
- Learning outcome 5: The students will understand the computer implementation of random number generators and will be able to implement their own random number generators with specified parameters: probability distribution function (or probability mass function), mean, and variance.
- Learning outcome 6: The students will be able to validate their analytical or simulation results by using face validity tests based on their understanding of the relationship between input and output data in the analyzed or simulated system.
- Learning outcome 7: The student will be able to develop and assess alternative system designs based on system requirements, cost and time constraints, environmental safeguards, marketing features, and other non-technical issues.

COURSE FORMAT AND STRUCTURE

This course is on campus. No Zoom version is available. To access the course, please visit stevens.edu/canvas. For more information about course access or support, contact the Technology Resource and Assistance Center (TRAC) by calling 201-216-5500.

Course Logistics

- All assignments will be due on Friday end of day (unless stated otherwise). Deadlines are an unavoidable part of being a professional, and this course is no exception. Course requirements must be completed and posted or submitted on or before the specified due date and delivery time deadline.
- Late assignments will have a 10% grade penalty per day. Assignments more than 5 days late are not accepted for credit.

Instructor's Online Hours

I will be available via email and will respond as soon as possible (generally within 24-48) hours. When emailing me, please place in the **subject line: EE/CPE 345 Spring 2024**. This will help me tremendously in locating your emails quicker when I scan the hundreds of emails that seem to make it into my inbox each day.

Virtual Office Hours

Virtual office hours may be available by appointment only. Upon making an appointment, use the Zoom link https://stevens.zoom.us/j/97783108821

TENTATIVE COURSE SCHEDULE (will be updated as the semester progresses)

Week	Topic(s)	Assignment (TBA)
Week 1	System Model, Steps in a simulation study	
Week 2	Manual simulation, System statistics, Discrete event-driven simulation, FEL	
Week 3	Probability distribution for input modeling, Modeling with statistics examples	
Week 4	Input data modeling. Empirical distributions and Goodness of Fit test	
Week 5	Queueing models	
Week 6	Modeling with Queues	
Week 7	Tuesday - Midterm in class Thursday - introduction to Omnet++	
Week 8	Omnet++ fundamentals and example implementations	
Week 9	Omnet++ ARQ simulation	
Week 10	Omnet++ applications	
Week 11	Queues. Models, analysis and omnet++ implementation, continuation	
Week 12	Random number generators	
Week 13	Validation and output analysis	
Week 14	Discussions on projects and modeling	
Week 15	Final project presentations	

COURSE MATERIALS

Textbook(s):

- Banks, Carson, Nelson & Nicol, “Discrete Event System Simulation,” Prentice Hall, any edition – optional
- OMNET++ manual (downloaded on your computer with OMNET++ installation package, look into doc directory for SimulationManual.pdf – required

COURSE REQUIREMENTS

Attendance
Attendance will be taken in each class. An attendance code will be provided.

Classwork
Students will work in groups to solve hands-on applications in class. Classwork should be uploaded at the end of the class unless otherwise specified.

Homework
Weekly homework will be assigned. The homework should be uploaded to Canvas on Fridays by the end of the day.

Quizzes
Short in-class quizzes will test the material presented in the previous lecture and/or the material assigned to be prepared for the current class. No make-up quizzes are provided. The worst quiz grade is dropped.

Project

- The project will be a group project - groups of 3 (or less) students will be assigned.
- Each group will select an example application to simulate that can be modeled as a dynamic discrete event-driven system with a stochastic component.
- The project consists of modeling and implementing a discrete event-driven simulation with the purpose of optimizing some performance metrics.
- The project will follow the steps in the simulation study flowchart outlined in lecture 2 and will require modeling of the system, software implementation using Omnet++, and running experiments and interpreting results.
- Detailed requirements and grading are outlined below.

Project requirements and grading policy

1. Proposal: Title, team members, objective, etc. (5%)
2. Alternative Designs – what will you study? (5%)
3. Mathematical Models – block diagrams, stochastic variables models (with justification – why the proposed model is suitable for your modeled random process). (15%)
4. Computer model and simulation– OMNET++ snapshot of your network, short demo. (20%)
5. Experimental results – results tables and plots showing trends for the simulation (to be used to support conclusions). (20%)
6. Discuss the variability of your results – standard error; confidence intervals. (10%)
7. Validation of your model and simulation results – face validation and/or Turing test (compute theoretical values when possible) (10%)
8. References (Bibliography list) at the end of presentation – use the IEEE conference template as a guideline (see: https://www.ieee.org/conferences/publishing/templates.html), and use in-text citations (i.e., if the stochastic model is taken from a reference, add the reference number within square brackets when you mention the model). (3%)
9. Oral Presentation – graded for clarity of the presentation, completeness, and correctness of information. (10%)

10. Teamwork managing workload (e.g., should include a slide explaining the contributions of each team member to the project) (2%).
11. Bonus: Extra coding (modification of modules, customized module definitions, and coding) and inclusion of directory of codes (10%)

Exams
We will have 1 Midterm Exam and 1 Final Exam in the form of oral project presentations with questions and answers.

TECHNOLOGY REQUIREMENTS

Baseline technical skills necessary for online courses
- Basic computer and web-browsing skills
- Navigating Canvas

Technology skills necessary for this specific course
- Basic knowledge of C++
- Live web conferencing using Zoom
- Recording a slide presentation with audio narration

Required Equipment
- Computer: current Mac (OS X) or PC (Windows 7+) with high-speed internet connection

Required Software
- Omnet++ (free to download on your computer at https:/omnetpp.org/)
- Microsoft Excel
- Microsoft Word
- Microsoft PowerPoint
- Internet browser

GRADING PROCEDURES

Grades will be based on:

Class Participation (Attendance)	**5%**
Homework	**15%**
Classwork	**30%**
Midterm Exam	**20%**
Project	**30%**

Late Policy
Late submissions are accepted up to 5 days late for a 10% penalty per day.

Academic Integrity

Generative AI Technologies

You may use AI programs e.g. ChatGPT to help generate ideas for your projects and brainstorm. However, you should note that the material generated by these programs may be inaccurate, incomplete, or otherwise problematic. Beware that use may also stifle your own independent thinking and creativity.

You may not use the AI program to generate models for you, and you may not submit any work generated by an AI program as your own. If you include material generated by an AI program, it should be cited like any other reference material.

Any plagiarism or other form of cheating will be dealt with under relevant Stevens policies.

Undergraduate Honor System
Enrollment into the undergraduate class of Stevens Institute of Technology signifies a student's commitment to the Honor System. Accordingly, the provisions of the Stevens Honor System apply to all undergraduate students in coursework and Honor Board proceedings. It is the responsibility of each student to become acquainted with and to uphold the ideals set forth in the Honor System Constitution. More information about the Honor System including the constitution, bylaws, investigative procedures, and the penalty matrix can be found online at http://web.stevens.edu/honor/.

The following pledge shall be written in full and signed by every student on all submitted work (including, but not limited to, homework, projects, lab reports, code, quizzes and exams) that is assigned by the course instructor. No work shall be graded unless the pledge is written in full and signed.

"I pledge my honor that I have abided by the Stevens Honor System."

Students who believe a violation of the Honor System has been committed should report it within ten business days of the suspected violation. Students have the option to remain anonymous and can report violations online at www.stevens.edu/honor.

EXAM CONDITIONS

Midterm exams will be in class, open book, open notes, and no laptop or phone allowed. Calculators are allowed.

ACCOMMODATIONS

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. The Office of Disability Services (ODS) works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, psychiatric disorders, and other disabilities to help students achieve their academic and personal potential. They facilitate equitable access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from the ODS staff. The ODS staff will facilitate the provision of accommodations on a case-by-case basis.

For more information about Disability Services and the process to receive accommodations, visit https://www.stevens.edu/student-diversity-and-inclusion/disability-services. If you have any questions please contact the Office of Disability Services at disabilityservices@stevens.edu or by phone: 201.216.3748.

Disability Services Confidentiality Policy
Student Disability Files are kept separate from academic files and are stored in a secure location within the Office of Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

INCLUSIVITY

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in academic discourse and innovation. In this class, the perspective of people of all races, ethnicities, gender expressions and gender identities, religions, sexual orientations, disabilities, socioeconomic backgrounds, and nationalities will be respected and viewed as a resource and benefit throughout the semester. Suggestions to further diversify class materials and assignments are encouraged. If any course meetings conflict with your religious events, please do not hesitate to reach out to your instructor to make alternative arrangements.

You are expected to treat your instructor and all other participants in the course with courtesy and respect. Disrespectful conduct and harassing statements will not be tolerated and may result in disciplinary actions.

Name and Pronoun Usage
As this course includes group work and class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect. This includes the ability for all students to have their chosen gender pronoun(s) and chosen name affirmed. If the class roster does not align with your pronouns and/or name, please inform the instructor of the necessary changes.

Religious Holidays
Stevens is a diverse community that is committed to providing equitable educational opportunities and supporting students of all ethnicities and belief systems. Religious observance is an essential reflection of that rich diversity. Students will not be subject to any grade penalties for missing a class, examination, or any other course requirement due to religious observance. In addition, students will not be asked to choose between religious observance and academic work. Therefore, students should inform the instructor at the beginning of the semester if a requirement for this course conflicts with religious observance so that accommodations can be made for students to observe religious practices and complete the requirements for the course.

MENTAL HEALTH RESOURCES

Part of being successful in the classroom involves a focus on your whole self, including your mental health. While you are at Stevens, there are many resources to promote and support mental health. The Office of Counseling and Psychological Services (CAPS) offers free and confidential services to all enrolled students who are struggling to cope with personal issues

(e.g., difficulty adjusting to college or trouble managing stress) or psychological difficulties (e.g., anxiety and depression). Appointments can be made by phone (201-216-5177), online at https://stevensportal.pointnclick.com/confirm.aspx, or in person on the 2nd Floor of the Student Wellness Center.

EMERGENCY INFORMATION

In the event of an urgent or emergent concern about your own safety or the safety of someone else in the Stevens community, please immediately call the Stevens Campus Police at 201-216-5105 or on their emergency line at 201-216-3911. These phone lines are staffed 24/7, year-round. For students who do not reside near the campus and require emergency support, please contact your local emergency response providers at 911 or via your local police precinct. Other 24/7 national resources for students dealing with mental health crises include the National Suicide Prevention Lifeline (1-800-273-8255) and the Crisis Text Line (text "Home" to 741-741). If you are concerned about the wellbeing of another Stevens student, and the matter is *not* urgent or time sensitive, please email the CARE Team at care@stevens.edu. A member of the CARE Team will respond to your concern as soon as possible.