SYS 501: Probability and Statistics for Systems Engineering

School of Systems and Enterprises
Fall 2023

Instructor:	David Nowicki
Contact Info:	dnowicki@stevens.edu
Canvas Site:	https://sit.instructure.com/
Meeting Times:	Thursday, 8:00- 9:00 p.m. (Hoboken time)
Classroom Location:	N/A
Office Hours:	Listed on course home page
Credit Hours:	3.0
Prerequisite(s):	None
Corequisite(s):	None
Cross-listed with:	N/A

COURSE DESCRIPTION

This course is designed for students with a background in engineering, technology, or science who have not taken a class in statistics or need a refresher class. In this class we will apply probability and statistics throughout a system's life cycle. Topics include the roles of probability and statistics in systems engineering, the nature of uncertainty, axioms and properties of probability models and statistics, hypothesis testing, design of experiments, basic performance requirements, quality assurance specification, functional decomposition, technical performance measurements, statistical verification, and simulation.

STUDENT LEARNING OUTCOMES

By the end of the course, learners should be able to:

- Understand and apply probability distributions to a variety of data sets.
- Understand statistics associated with probability distributions.
- Understand concepts of confidence intervals.
- Apply hypothesis testing.
- Understand basic simulation steps.

COURSE FORMAT AND STRUCTURE

Students are expected to attend class sessions, participate in classroom activities, and complete weekly online quizzes, homework, and discussions. There will be two exams, after Modules 6 and 13. Exams assess mastery of fundamental concepts developed in homework assignments. Exam 1 covers homework assignments 1-6 and Exam 2 emphasizes homework assignments 7-13.

TENTATIVE COURSE SCHEDULE

Week Starting	Topic(s)	Readings	Assignment
Sep 10 Module 1	Visualizing Data	Required: - Course syllabus - Module reading: Communicating Uncertainty Through Data Visualization - Module reading: Descriptive Statistics Optional: Sections 1.2–1.4 from textbook (Devore)	Quiz* Discussion** Homework assignment**
Sep 17 Module 2	Probability Basics	Required: - Module reading: Marginal, Joint and Conditional Probabilities - Module reading: Using Excel to Simulate Random Events	Quiz Discussion Homework assignment
Sep 24 Module 3	Modeling Uncertainty with Discrete Probability Distributions	Required: - Module reading: Discrete Random Variables and Probability Distributions - Module reading: Common Discrete Probability Distributions Optional: - Video: Understanding Discrete Random Variables and Probability Distributions - Chapter 3 from the textbook	Quiz Discussion Homework assignment

Oct 01 Module 4	Modeling Uncertainty with Continuous Probability Distributions	Required: - Module reading: Continuous Random Variables and Probability Distributions - Module reading: Common Continuous Probability Distributions Optional: - Video: Understanding Continuous Random Variables and Probability Distributions - Chapter 4 from textbook	Quiz Discussion Homework assignment
Oct 08 Module 5	Joint Probabilities	Required: - Module reading: Joint distributions and sums of independent random variables - Module reading: Relationships between multiple random variables	Quiz Discussion Homework assignment
Oct 15 Module 6	Generating Simulated Data	Required: - Pseudo Random Number Generators - RandU: A bad example of Pseudo RNG - Module Reading: Simulations with Pseudo Random Number Generators	Quiz Discussion Midterm Exam
Oct 22 Module 7	Inferential Statistics	Required: Module reading: Estimating Population Mean and Variance Optional: Chapter 7 from the textbook	Quiz Discussion Homework assignment
Oct 29 Module 8	Hypothesis Testing and Analysis of Variance	Required: Module reading: Hypothesis Testing Optional: Chapters 8-10 from the textbook	Quiz Discussion Homework assignment
Nov 05 Module 9	Design of Experiments for Data Collection	Required: - Experimental design principles - Sample weighting	Quiz Discussion Homework assignment
Nov 12 Module 10	Data-Driven System Modeling	Required: Readings on linear regression	Quiz Discussion Homework assignment

Nov 26 Module 11	Bayesian Statistics (Part 1)	Required: - Module Reading: Bayesian Statistics - Bayesian vs frequentist statistics - Seeing theory - Bayesian influence	Quiz Discussion Homework assignment
Dec 03 Module 12	Bayesian Statistics (Part 2)	Required: Readings on Bayesian hypothesis testing, calculating Bayes factors, and credible intervals	Quiz Discussion Homework assignment
Dec 10 Module 13	Decision Analysis	Required: Readings on decision trees, the expected value of perfect information, and the expected value of sample (imperfect) information	Quiz Discussion Homework assignment Final Exam: Due Dec 19

*Weekly quizzes are due each week on Thursday at noon.

**Homework and discussions are assigned weekly during the live session and are due the day before the next live session (Wednesday at 11:59 p.m).

COURSE MATERIALS

Textbook: Devore, J. L. (2016). *Probability and statistics for engineering and the sciences* (9th ed.). Cengage Learning. ISBN: 978-1305251809

COURSE REQUIREMENTS

You may find that this course is set up a little differently than other courses you've experienced.
As you move through the topics in each module, rather than simply viewing lecture content, you will be asked to read, listen to, and watch a variety of media. You'll also be regularly prompted to actively evaluate your knowledge as you're building it.
The components in each module are designed to be completed sequentially in order. In addition to videos, readings, and interactives, I want to bring your attention to a few types of learning activities you'll encounter.

- Quizzes: At the conclusion of most modules, you will complete a graded quiz covering concepts introduced in the module. These quizzes are designed to assess your learning at regular intervals and identify gaps in knowledge.
- Discussion: In all modules, you'll find detailed discussion prompts where you are invited to post a response. These discussions are graded by your instructor according to posted rubrics.
- Homework Assignments: In all modules, you will also have homework assignments where you are asked to apply the techniques you learn in these modules to a given set of problems primarily using MS Excel. These assignments will be graded by your instructor based on a rubric.

- Live Sessions: Weekly Live Sessions with scheduled activities are an integral part of the course. In most sessions, you will work collaboratively with your classmates to solve a problem. Attendance is mandatory.
- Office Hours and Q&A: Use this time to ask your instructor about any concepts you are struggling with, difficulties with assignments, or to simply share something relevant to the class you encountered this week.

GRADING PROCEDURES

Grades will be based on:

Assignment/ Assessment	Competency & Behavior	Percentage of Final Grade	Due Date
Weekly Quizzes	Assess comprehension of reading assignment.	6.5%	Noon on the day of the Live Session
Homework Assignments x 13	Evaluate student understanding of and ability to apply the week's key concepts.	33.5%	11:59 p.m. the day before the live session in the week after it is assigned
Discussion Assignments x 13	Open-ended questions for thought-provoking collaboration with classmates.	13%	11:59 p.m. the day before the live session in the week after it is assigned
Live Session	Synchronous learning and application of the week's ideas.	13%	Day of the Live Session
Midterm Exam	Evaluate student comprehension of concepts learned in the first 6 modules of the course.	16%	Module 6
Final Exam	Evaluate student comprehension of concepts learned in modules 7-13.	18%	Module 13
	TOTAL:	100%	

Late Policy

Homework assignments must be submitted on the course website by 11:59 p.m. on the due date. Late assignments are penalized 10% per day and will not be accepted after solutions are posted (approximately 1 week after deadline). Extensions must be requested in writing at least 48 hours before the deadline.

ACADEMIC INTEGRITY

Collaboration is allowed on homework provided each student completes their own work. List any collaborators on your assignment cover sheet and submit all final source code and models. **Copying code, scripts, programs, saved models, or answers from others will not**

be tolerated and will result in a 0 for the assignment and referral to the Honor Board or Office of Graduate Academics.

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*."

Reporting Honor System Violations
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.

Graduate Student Code of Academic Integrity

All Stevens graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student's submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.

All graduate students are bound to the Graduate Student Code of Academic Integrity by enrollment in graduate coursework at Stevens. It is the responsibility of each graduate student to understand and adhere to the Graduate Student Code of Academic Integrity. More information including types of violations, the process for handling perceived violations, and types of sanctions can be found at www.stevens.edu/provost/graduate-academics.

Special Provisions for Undergraduate Students in 500-level Courses

The general provisions of the Stevens Honor System do not apply fully to graduate courses, 500 level or otherwise. Any student who wishes to report an undergraduate for a violation in a 500-level course shall submit the report to the Honor Board following the protocol for undergraduate courses, and an investigation will be conducted following the same process for an appeal on false accusation described in Section 8.04 of the Bylaws of the Honor System. Any student who wishes to report a graduate student may submit the report to the Dean of Graduate Academics or to the Honor Board, who will refer the report to the Dean. The Honor Board Chairman will give the Dean of Graduate Academics weekly updates on the progress of any casework relating to 500-level courses. For more information about the scope, penalties, and procedures pertaining to undergraduate students in 500-level courses, see Section 9 of the Bylaws of the Honor System document, located on the Honor Board website.

EXAM ROOM CONDITIONS

The following procedures apply to quizzes and exams for this course. The instructor reserves the right to modify any conditions set forth below by printing revised Exam Room Conditions on the quiz or exam.

1. Students may use the following devices during quizzes and exams. Any electronic devices that are not mentioned in the list below are not permitted.

Device	**Permitted?**	
	Yes	No
Laptops	X	
Cell Phones		X
Tablets		X
Smart Watches		X

2. Students may use the following materials during quizzes and exams. Any materials that are not mentioned in the list below are not permitted.

Material	**Permitted?**	
	Yes	No
Handwritten/Typed Notes	X	
Textbooks	X	
Readings	X	

3. Students are not allowed to work with or talk to other students during quizzes and/or exams.

PROCTORIO

This course will use Proctorio, a remote proctoring solution designed to protect the integrity of this course's assessments. Proctorio is a trusted remote proctoring provider because of its commitment to student privacy. Proctorio uses Single Sign-On through our LMS and only approved institution individuals, including me as your instructor, will have access to your exam data. Proctorio only runs during your exam as a browser extension. Before getting started on your first exam, make sure to follow the instructions in Proctorio's Quick Start Test Taker Guide for how to install and use the extension. To verify your computer system meets the requirements and everything is installed correctly, take the practice quiz. This will ensure that everything will run smoothly on the day of the exam.

LEARNING 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 such disabilities in order to help students achieve their academic and personal potential. They facilitate equal 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.

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; 34 CFR, 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.

For more information about Disability Services and the process to receive accommodations, visit https://www.stevens.edu/office-disability-services. If you have any questions please contact: Phillip Gehman, the Director of Disability Services Coordinator at Stevens Institute of Technology at pgehman@stevens.edu or by phone (201) 216-3748.

INCLUSIVITY

Name and Pronoun Usage

As this course includes group work and in-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 name and/or pronouns, please inform the instructor of the necessary changes.

Inclusion Statement

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.

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).

EMERGENCY INFORMATION

In the event of an urgent or emergent concern about the safety of yourself or 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. Other 24/7 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.