[MATH/STAT 310] Probability
Spring 2025

Section:	MATH/STAT 310	**Professor:**	Becky Tang (she/her)
Class hours:	MWF 8:40-9:30AM	**Office:**	Warner 214
Room:	Warner 105	**E-mail:**	btang@middlebury.edu
Prereqs:	MATH 223	**Office Hours:**	MT 3-4pm, F 11am-12pm

Course Description

An introduction to the concepts of probability and their applications, covering both discrete and continuous random variables. Probability spaces, elementary combinatorial analysis, densities and distributions, conditional probabilities, independence, expectation, variance, weak law of large numbers, central limit theorem, and numerous applications. Students learn how to simulate and obtain samples from probability models using the programming language R.

You will work in this class. Probability is hard and frustrating, but there is much joy to be found. A positive attitude and commitment to the course will help you be successful in the course.

Key Learning Outcomes

❏ Apply basic counting techniques (e.g. multiplication rule, combinations, permutations) to compute probabilities using the axiomatic language of sets and functions.

❏ Calculate the expected value, variance and quantiles of common discrete and continuous random variables.

❏ Compare and describe multiple random variables using joint, marginal, and conditional distributions.

❏ Use moment generating functions and their properties to specify a random variable.

❏ Obtain new random variables by applying transformations to a class of elementary distributions.

❏ Use R to sample from probability models and generate simulations.

❏ Understand the law of large numbers and the central limit theorem.

Textbooks and Course Materials

▤ **textbook:** Joseph K. Blitzstein and Jessica Hwang, *Introduction to Probability*, 2nd edition.

You may either purchase a hard copy or access the free, online version provided here: http://probabilitybook.net/. We will focus on Chapters 1-10.

- 🖥 **Course website**: All of the materials for our course will be posted on the course website https://midd-stat310-spring2025.github.io/. Please bookmark this page for quick access.

- ⌨ **R**: We will learn and frequently use the R programming language. We will program using the RStudio interface. In the second week students will be asked to ensure they have access to both R and RStudio, either by downloading the software onto their own computers, or by using a campus computer.

Course Structure

A typical class day involves the following:

1. Reading or video assignment: Every class meeting time will have an assigned reading from the textbook or pre-recorded video. You are expected to do the reading/watch the video before class. By 7:45am on the day of class where we cover the assigned material, you will answer a set of brief reflection questions on the topics covered. You are also encouraged to submit any questions or clarifications from the assigned reading.

2. Class session: Our 50-minute meetings will consist of mostly of lecture, which will extend upon material covered in the pre-class videos. These lectures will often consist of the professor walking through example problems. Time to work on practice problems (typically as a group) will also be provided, though not according to a consistent schedule. Occasionally, we will perform some light coding in R together.

3. Homework: After each class session, several homework problems will be assigned.

A prepared student will attend the 50-minute class, and spend roughly two-four hours per day of class on work outside the classroom (reading assignment, reflection exercises, homework, studying, etc.). As this course meets three days a week, this represents a minimum 9-13 hours weekly commitment.

Class Expectations and Code of Conduct

- 🏠 **You are expected to physically show up to class, actively participate, and make space for everyone to contribute**. You are an integral part of the class community! Exceptions include previously-communicated illness or planned absence.

- 🕐 **Please arrive on time.** I expect everyone, myself included, to arrive on time and dedicate full attention during the class. Class will begin promptly at the scheduled time. In turn, I will do my best to always end class on time.

- 🖥 **Technology.** You are encouraged to bring a laptop and/or tablet to class each day for note-taking, referencing the textbook, and live coding.

- 📱 **Cell phones should be turned to silent**. I don't mind cell phones in class, but please silence them so as to not disrupt the class.

- ❓ **Please ask questions!**

- 🗨 **Positively contribute to your group problem-solving**, which includes asking questions, throwing out ideas, and voicing confusions. There are many ways to solve the problems we will encounter in this class.

- ♿ I expect all members of the class to make participation a harassment-free experience for everyone, regardless of race, creed, color, place of birth, ancestry,

ethnicity, national origin, religion, sex, sexual orientation, gender identity or expression, age, marital status, service in the armed forces of the United States, positive HIV-related blood test results, genetic information, or against qualified individuals with disabilities on the basis of disability and/or any other status or characteristic as defined and to the extent protected by applicable law. We will not tolerate the use of violence against any individual.

RESOURCES

❏ **Office hours**. This time is meant for you! Please come by to ask questions, chat with me, or work on homework. You should never worry about disturbing me during this time.

❏ **One-on-one meetings**. If you would like to meet with me one-on-one, please send me an e-mail or approach me after class so we can schedule a time.

❏ **Your peers**. Unless otherwise noted, I encourage students to work together and discuss material! However, unless the assignment explicitly states that it is to be completed as group work, the submitted material must be your own.

TIPS ON HOW TO SUCCEED

- Come to every class.
- Attend office hours.
- Attempt some problems individually before working with others.
- Complete the pre-class assignment in a timely fashion. A lot of the concepts in this class take time to sink in.
- The assigned readings/videos are not lengthy, but they convey a lot of information.
  - Read through the material at least twice.
  - Do not skim past the Examples in the readings. Make sure you understand the solutions presented in the Example problems.
- Practice problems and homework problems are intended to help you stay up-to-date with the material. We will work on the practice problems in class, and it is my expectation that you will complete whatever you don't finish on your own time.
- Ask questions. I hear that I can be intimidating, but hopefully we can work through that so you do not feel scared to ask questions or seek clarification.
- Do not try to find answers on the internet or ChatGPT. Struggling through problems is how you learn!
- Within 24 hours of taking them, revisit your notes for about 10 minutes The material will stick better, and you will discover if the content you thought you understood in class still makes sense once you're on your own.

College policies and resources

Academic Integrity

As an academic community devoted to the life of the mind, Middlebury requires every student to reflect complete intellectual honesty in the preparation and submission of all academic work. Details of our Academic Honesty, Honor Code, and Related Disciplinary Policies are available in Middlebury's handbook.

Using AI tools (e.g., ChatGPT, Bard) is forbidden in this class. You may not use them to assist in any part of your homework or other assignments. Any use of generative AI tools will be treated as a violation of Middlebury's Honor Code.

Honor Code Pledge

The Honor Code pledge reads as follows: "I have neither given nor received unauthorized aid on this assignment." It is the responsibility of the student to write out in full, adhere to, and sign the Honor Code pledge on all examinations, research papers, and laboratory reports. Faculty members reserve the right to require the signed Honor Code pledge on other kinds of academic work.

Disability Access and Accommodation

Students who have Letters of Accommodation in this class are encouraged to contact me as early in the semester as possible to ensure that such accommodations are implemented in a timely fashion. For those without Letters of Accommodation, assistance is available to eligible students through the Disability Resource Center (DRC). Please contact ADA Coordinators Jodi Litchfield, Peter Ploegman, and Deirdre Kelly of the DRC at ada@middlebury.edu for more information. All discussions will remain confidential.

Center for Teaching, Learning, and Research (CTLR)

The CTLR provides academic support for students in many specific content areas and in writing across the curriculum through both professional and peer tutors. The Center is also the place where students can find assistance in time management and study skills. These services are free to all students. go.middlebury.edu/connect

Types of assignments

- **Daily assignments**. Assigned before each class session and turned in individually. These small assignments include readings from the textbook plus a few assessment questions that are designed to help you reflect on your understanding of the readings. I will review all the assignments prior to each class period. These assignments are graded on good-faith effort so you can receive feedback quickly. Daily assignments are due by 7:45am the day of each class (to give me time to review them before class). For example, the daily assignment for Wednesday 2/12 should be completed by 7:45am on Wednesday 2/12.

  - No extensions on daily assignments will be given, but up to two assignments may be missed without penalty.
  - It is not my intention or desire for you to stay up late or wake up early to complete the daily assignment. Daily assignments will typically be released at least five days in advance so you can plan ahead.

- **Problem sets**. Assigned weekly and turned in individually (though feel free to work with your peers). In the problem sets, you will apply what you have learned during lecture to dive deeper into the material and explore more interesting probability problems. Depending on the week, the problem sets may require R. Problems will be assigned after every class, but each week's problem set is due the following Tuesday by 11:59pm, unless otherwise noted.

- **Participation**. Mastery over the content of this course is attained with frequent practice in problem-solving, and learning about *how* to approach a problem. It is essential that you strive to attend class every day, and that you complete the daily assignment prior to the start of class. Additionally, in order to foster a positive and inclusive classroom environment, you are expected to follow our class code of conduct. Frequent absences, as well as non-constructive in-class participation, will be reflected in your final course grade. If you unable to attend class for any reason, please notify me before the start of class. Prolonged or recurring illness, as well as other emergencies, may require individual adjustment, in which case you should contact me to make appropriate arrangements.

- **Quizzes and Midterm exam**. Two quizzes and one midterm exam are designed as an opportunities to assess the knowledge you've learned. The midterm is cumulative, whereas the quizzes will focus on content from specific weeks. The *tentative* dates for these assessments are as follows. Exact dates and times will be confirmed at least two weeks in advance.

  - Quiz 1: Friday, 2/28 at 2:30pm
  - Midterm: Thursday 3/27 at 7:30pm
  - Quiz 2: Friday 4/25 at 2:30pm

  Except in the cases of extreme illness or family emergency, students must take these assesssment on the scheduled date and time.

- **Final exam**. The final exam is designed to fully assess what you've learned in the semester. The final exam is cumulative, with an emphasis on material covered after the Midterm. The college-assigned final exam date for this course is 5/15.

GRADING

✸ Unless otherwise noted, assignments should be submitted to Canvas.

✸ For problem sets, late work will always be considered within one week of the original due date. Unless otherwise stated, the late policy is as follows: for every 24-hour period the assignment is late, 10% from the maximum possible grade will be deducted.

✸ I will do my best to return assignments within one week of submission.

✸ Regrade requests: I do allow regrade requests, which must be submitted in-person within one week of when the assignment is returned. Keep in mind that regrade requests do not guarantee points back.

✸ **You must sit for the midterm and final exam in order to pass the course.**

Component	Percentage
Daily assignments	5%
Homework	25%
Quiz I	10%
Quiz II	10%
Midterm	20%
Final Exam	30%

✸ Letter grades will be assigned based on the following course percentages, with the upper 3% and lower 3% of each category corresponding to + and −, respectively:

- A: 90−100%
- B: 80-89%
- C: 70-79%
- D: 60-69%
- F: <60%

These percentages reflect lower bound guarantees. For example, if you earn a 90% in the course, you are guaranteed an A-. Grades will typically not be rounded up in the case of decimal points, although I can adjust upwards if I have reason based on my assessment of student learning.

Tentative Course Content

(Last updated: 02/05/25)

Week	Date	Topic
1	2/10	M - Welcome! Course logistics
		W - Foundations of probability, set theory
		F - Naive definition, Counting methods
2	2/17	M - Axioms of probability
		(T - Problem Set 01 due)
		W - Intro to R, RStudio
		F - Conditional probability, Bayes rule, LoTP
3	2/24	M - Independence
		(T - Problem Set 02 due)
		W - Monty Hall, Gambler's Ruin (maybe)
		F - Random Variables, PMF, Bernoulli
		- Quiz 1 at 2:30pm
4	3/03	M - More discrete RVs, CDF
		(T - Problem Set 03 due)
		W - Function of RVs, independence of RVs
		F - Expected values, linearity of expectation, LOTUS
5	3/10	M - Infinite series, Geometric, Neg. Binomial
		(T - Problem Set 04 due)
		W - Indicators, bridge
		F - Flex day
	3/17	Spring Break
6	3/24	M - Variance
		(T - Problem Set 05 due)
		W - Poisson
		F - Continuous RVs, Uniform
7	3/31	M - Normal
		W - Exponential, Continuous RVs in R
		R - Midterm at 7:30pm
		F - Moments, power series

8	4/07	M - Recap Taylor series, MGFs
		(T - Problem Set 06 due)
		W - Joint distributions (discrete)
		F - Joint distributions (continuous)
		- Last day to drop classes
9	4/14	M - Covariance and correlation
		(T - Problem Set 07 due)
		W - Multinomial
		F - Spring symposium (no class)
10	4/21	M - Change of variable (calculus)
		W - Beta, Gamma
		F - Change of variable (CDF method)
		- Quiz 2 at 2:30pm
11	4/28	M - Order statistics
		(T - Problem Set 08 due)
		W - Conditional Expectation (given event)
		F - Conditional Expectation (given RV)
12	5/05	M - Conditional Variance
		(T - Problem Set 09 due)
		W - Inequalities, WLLN
		F - Central Limit Theorem
	5/12	M - CLT (cont.) and/or Review
	5/15	Final exam