Syllabus

Lecturer: Prof. N. Phyllis Ju

1 Course description

Instructor Dr. Nianqiao Phyllis Ju (she/her, nianqiao.ju@dartmouth.edu)

Lectures **10A, T&Th 10:10 am - 12:00 pm, Kemeny 007**. All lectures will be held **in person** unless otherwise stated. Lectures may be rescheduled to the X-hour if needed. If you are not feeling well or have been instructed not to come to class, please get in touch with the instructor prior to class. In this case, the instructor will try to arrange to have a classmate take notes for you.

X Hour 10AX, F 3:30 - 4:20 pm. Used for office hours and lectures as needed.

Office hours F 3:30 - 4:20 pm (Office) and by appointment (https://scheduler.zoom.us/nianqiao-ju/math20-fall25, Zoom or Office).

TA & tutorial sessions Jacob Lehmann Duke (Jacob.Lehmann.Duke.GR@dartmouth.edu) Tutorial sessions, T/Th 7 -9 pm, Haldeman 028.

Tools In addition to Canvas, we also use Ed Discussion for Q&A, Gradescope to streamline grading, and Panopto for lecture recordings.

Textbook **Introduction to Probability** by Joseph Blitzstein and Jessica Hwang. Available online at stat110.net.

Other references

- **All of Undergraduate Probability** by Nianqiao Ju (unpublished book draft).

- **A First Course in Probability** by Sheldon Ross. Any edition.

- **Probability and Random Processes** by Geoffrey R. Grimmett and David R. Stirzaker.

Pre-requisites Math 8. A working knowledge of calculus of several variables is essential for the course. In particular, you should already be familiar with the basic theory of infinite series and integration in 2 or 3 dimensions, as well as partial derivatives.

Contents   This is a comprehensive undergraduate-level introduction to probability. This roughly equates to Chapters 1-12 of Blitzstein & Hwang or Chapters 1-9 of Ross.

- Basics: algebra of sets, sample spaces and events, conditional probability, law of total probability (LOTP), and Bayes' Theorem.

- Univariate distributions: key functions (PDF, CDF, PMF, MGF), expectation, variance, and law of the unconscious statistician (LOTUS). Distributions covered: Uniform, Normal, Bernoulli, Binomial, Geometric, Negative Binomial, Poisson, Beta, and Gamma distributions.

- Multivariate distributions: joint and conditional distributions, independence, transformations, order statistics, covariance and correlation, conditional expectation, and law of total expectation.

- Inequalities: Markov, Chebyshev, Chernoff, Jensen, Cauchy-Schwartz.

- Limit laws: law of large numbers, central limit theorem.

- Markov chains.

Tentative schedule   Below is a tentative schedule. Any adjustments will be posted through the weekly announcements on Canvas.
   Please mark your calendar: Lecture on 9/25 moved to the X-hour on 9/19.

Meeting	Dates	Lectures	Homework	Quiz
1-3	9/16, 18, 19	Introduction, sample space, counting	H1 out	Q0
4	9/23	Axioms of probability, conditional probability	H1 due, H2 out	Q1
5-6	9/30, 10/2	Bayes rule, LOTP, independence	H2 due, H3 out	Q2
7-8	10/7, 9	Random variables, expectation, LOTUS	H3 due, H4 out	Q3
9-10	10/14, 16	Many coin flips, Poisson distribution	H4 due, H5 out	Q4
11-12	10/21, 23	Continuous random variables, Gaussian	H5 due, H6 out	Q5
13-14	10/28, 30	Gamma distribution, joint distributions	H6 due, H7 out	Q6
15-16	11/4, 6	Law of large numbers, central limit theorem	H7 due, H8 out	Q7
17-18	11/11, 13	Covariance, conditional expectation	H8 due, H9 out	Q8
19-20	11/18, 20	Random walk, Markov chains	H9 due	Q9
-	11/24	Final exam	-	-

Learning outcomes   Besides having fun together, we have the following goals.
   We begin with the formal version. By the end of the term, students should:

1. be able to use basic counting techniques (multiplication rule, combinations, permutations) to compute probability and odds;

2. be able to compute conditional probabilities directly and using Bayes' theorem, and check for independence of events; be able to set up and work with discrete random variables; in particular, to understand the Bernoulli, binomial, geometric, and Poisson distributions;

3. be able to work with continuous random variables. In particular, know the properties of uniform, normal, and exponential distributions;

4. know what expectation and variance mean and be able to compute them;

5. understand the law of large numbers and the central limit theorem;

6. be able to compute the covariance and correlation between jointly distributed variables; and

7. be able to use available resources (the internet or books) to learn about and use other distributions as they arise.

Here is the the informal (shorter) version.

1. Understand that randomness and uncertainty are everywhere, and not panic about it. Make you calm.

2. Be able to relate some real world problems with concepts in this class and explain it to your friends. Make you cool.

3. Understand why some of the tools we use are 'truth'. Make you sane.

4. Be able to solve problems. As some of them are related to gambling, this can (potentially) make you rich.

2   Expectations and norms

Student attendance   Mathematics requires that a student understand one concept before moving on to the next, and since our course moves at a fast pace it is critical that you attend each and every class. If you are going to miss any classes this term, please let the instructor know as soon as possible. We will do our best to be supportive. However, ultimately, you are responsible for all required coursework and bear the primary responsibility for your education.

Participation   Students should feel comfortable stopping the instructor to ask her to repeat a particular exposition, to present a concrete example of an abstract concept, or to explain a confusing concept in a new way. Homework 1 will help you warm up your muscles.

Electronic devices   No cellphone use in class. You can use a tablet to take notes if you turn it on airplane mode. No note taking in laptops as they distract other students.

Email etiquette   You are encouraged to post questions and discussions on Piazza. The instructor will respond to emails on weekdays. Please include '[MATH20] HW/exam/policy question...' in your email title, otherwise we might not reply to your emails.

Instructor attendance   You can expect that we will attend lectures. We will arrive at the lecture room prior to the start of lectures, and will end lectures on time. You can expect that we will be prepared for lecture, try our best to convey the information for the course, and show respect for all students. If we are unable to attend lecture you will know in advance, and we will either move it to an X-hour or find a guest lecturer. We will be present for our office hours, and available for scheduled appointments. The amount of material covered in each lecture is governed by the speed with which we complete the material. Every group of students is different, and we would rather teach the material well (and have you learn it) than speed through the topics for the purpose of covering a preset number of topics. Accordingly, the course outline is subject to change as the course progresses.

Generative AI and ChatGPT   Generative AI is your friend, not a replacement of your brain. The general rule is to ask ChatGPT questions you would normally ask a friend. Do not ask ChatGPT to do the work for you. The process of consolidating course material in your brain has to be done in your brain.

You should **never** copy and paste course material (like homework problems) into ChatGPT and ask for a solution. This is not only because those materials are protected by copyright but also because it matters you come up with the solutions on your own. Do not use ChatGPT when you are doing your homework.

However, I do believe that we should learn to work with ChatGPT. You can ask ChatGPT when you find a concept confusing in class. To this end, I have curated a list of prompts that you can use:

- We are learning about [a topic, e.g. axioms of probability, Bayes theorem, etc.] and I do not fully understand it. Specifically, I do not understand [a specific question, e.g. why probabilities cannot exceed 1, what is a prior, etc.]. Can you explain this with an analogy/example?

- What is the difference between [a concept, e.g. conditional probability] and [another concept, e.g. regular probability]?

- Why is [a topic, like the central limit theorem] so important? I am doing a [your major, e.g. quantitative social science] major. Can you give an example relevant to my major?

Please seek instructor permission before you use a prompt outside of the list. I hope to add to the list in the future.

Here is a list of prompts you should **not** use:

- Help me do this homework problem. [problem copy and pasted]

- Give me a list of 10 most important concepts in this class. Or, I have an exam tomorrow what should I study now?

- What will be on the quiz/exam?

- Help me prepare a crib sheet for the final exam.

Keys to Success

- Any skill requires **concentration**, **practice**, and **effort**.

- Repetition is the key to mastery!

- Attend and participate actively in class. Ask questions and answer questions.

- Collaborate with your classmates on homework assignments and while studying. Explain the concepts to your fellow students. Teaching is a great way of learning.

- Seek assistance when necessary: your TA and instructor are all here for you!

- Start to work on your assignments early.

- Practice, practice & more practice. Practice solving problems (read and use your textbook!), but also aim for conceptual understanding.

- Review your errors and redo the problems.

3   Grading

Mathematical writing   You should know that I am a tough grader. Quiz 0 (on 9/19 during X-hour) will help you understand my expectations for how you write up solutions in this class. The same standard will be strictly implemented for all homework, quizzes, and exams.

Mathematical writing is a form of communication and should be treated as such. First and foremost, you need to use sentences and paragraphs. Flowcharts or isolated equations without explanation are not acceptable unless explicitly allowed. Second, make clear what each new symbol or piece of notation stands for before using it. Finally, a good practice is to do only one thing per line of calculation, as do too many calculations in your head at once can lead to errors.

Final grade calculation   This class uses a 'many low stake items' grading system. This is to help ensure that you have understood one material before we move on to the next one.

Throughout the quarter, there are 500 points for you to collect. They come from the following categories:

- Homework: $(9 - 2) \times 30 = 210$;

- Quiz: $(9 - 2) \times 20 = 140$;

- Exam: 150.

Final grade will be decided by the percentage out of total grades. $\pm$ within each letter grade will be decided after the exams end. The grading scale is predetermined so as to eliminate competition with other students, and to ensure that you always know your grade in the class. Your grade is based upon your performance only, not by other students'. While grades will not be curved, the instructor can control the grade distribution by adjusting the difficulty of exams.

Grade	Range (by percentage)
A	90.00-100.00
B	80.00-89.99
C	70.00-79.99
D	60.00-69.99
F	0.00-59.99

Final exam Mark your calendar: November 24, 2025, 11:30 am - 2:30pm.

This is a comprehensive exam, covering all materials from the entire semester. We will provide practice exams. It is closed-book, closed-notes, and written. But you can bring 2 pages (4 sides total) of self-prepared and hand-written crib sheets in US letter-sized paper. Do **not** use ChatGPT when you prepare the crib sheets!

If you show up 20 minutes after the exam starts, your grade is automatically a zero.

Quiz We will have a quiz **every Tuesday in class**, starting from the second week of the quarter. All quizzes are closed-book and closed-notes. After Quiz 0, there will be **9 quizzes** and **two lowest quiz scores are dropped**.

Homework Weekly assignments are **due Fridays at 6 pm**. There might be some due date adjustments towards the end of the semester.

- There will be **9 assignments** this semester. To help with various circumstances (expected or unexpected), your **lowest 2 homework score will be dropped**.

- **No late homework will be accepted**. Late homework will automatically receive a score of 0.

- Each assignment consisting of roughly 5 problems, which can contain multiple parts. You are encouraged to start working on homeworks early and to spread your efforts throughout the week. Each problem is worth 10 points. For every assignment, we randomly select 30 points worth of problems to grade.

- Unless otherwise specified, **please show your work, simplify fully, and give clear, careful justifications for your answers** (using words and sentences to explain your logic, not just formulas).

- Do not use external resources on assignments. When you are doing homework, you can use anything posted on Canvas, your notes, and you can talk to other students in the class. Calculators are allowed for homework assignments, but not on exams. In short, no Google, no ChatGPT, just Canvas.

- You are welcome to discuss the homework problems with your classmates (but not Chat-GPT), but **you must write up solutions yourself and in your own words**. This is because your submissions should be genuine representations of your own understanding of the materials. Additionally, you must list the names of the students with whom you collaborated for each problem (if any).

- Please submit your homework as a readable pdf file to Gradescope. **No submissions on paper or by email will be accepted.** This submission must be a single PDF file containing all your answers. The PDF file can be typeset or scanned, but must be clear and easily legible (not blurry or faint) and correctly rotated (e.g., not upside down).

Re-grading   All grade disputes are to be submitted directly to Dr. Ju via email. Discussions or arguments for re-grades will not be done in person. A student has until one week after receiving his/her grade to dispute the grade (in writing). Handling re-grades in this manner eliminates the "end of the semester" digging for points.

When disputing a grade, you should state the question, the dispute, and the number of points you feel you should have received for the question.

Please note that when you ask for a question to be re-graded, the entire assignment may be re-graded, and **there is a possibility of losing points.**

4 Statements and resources

Inclusion and diversity   I am committed to supporting the learning of **all** students in my class. I am dedicated to present materials and activities that are respectful of diversity in gender, gender identity, gender expression, sexual orientation, age, socioeconomic status, ethnicity, beliefs, race, culture and educational background, and other visible and non-visible categories. Your suggestions are always encouraged and appreciated. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements. Finally, I will gladly honor your request to address you by any name or pronoun.

Academic integrity   Academic integrity is foundational to a Dartmouth education. All members of the Dartmouth community—faculty, staff, and students—are responsible for maintaining a culture of integrity, honesty, and respect in teaching, learning, scholarship, and creative work. By upholding this principle, we foster an atmosphere of intellectual growth and personal development both within and beyond Dartmouth. Please read Dartmouth's Academic Honor Principle as well as Arts and Sciences Academic Honor Policy for Undergraduates. Please also note that you are expected to take reasonable precautions to prevent others from using your work.

Mental health resources   Your instructor is committed to support your mental health and wellbeing, although she is not an expert. Dartmouth College has many mental health resources to support your wellbeing. You can learn more at https://home.dartmouth.edu/mental-health-resources. When in need, seek help.

University emergency information   You should sign up for emergency notifications and review safety tips prepared by the Department of Safety and Security.

Accessibility services   Students requesting disability-related accommodations and services for this course are required to register with Student Accessibility Services (SAS; Apply for Services webpage;student.accessibility.services@dartmouth.edu; 1-603-646-9900) and to request that an

accommodation email be sent to me in advance of the need for an accommodation. Then, students should schedule a follow-up meeting with me to determine relevant details such as what role SAS or its Testing Center may play in accommodation implementation. This process works best for everyone when completed as early in the quarter as possible. If students have questions about whether they are eligible for accommodations or have concerns about the implementation of their accommodations, they should contact the SAS office. All inquiries and discussions will remain confidential.

Nondiscrimination   Darmouth College's nondiscremination and anti-harassement policy can be found from the policy portal. Dartmouth College ("Dartmouth"), inclusive of all its schools and faculties, does not discriminate on the basis of sex, race (actual or perceived), color, religion, age, disability, status as a veteran, national or ethnic origin, actual or perceived shared ancestry or ethnic characteristics, or citizenship or residency in a country with a dominant religion or distinct religious identity, familial status, marital status, sexual orientation, gender identity, gender expression, or any other category protected by applicable law, in the administration of its educational policies, admission policies, scholarship and loan programs, employment, or other school administered programs.

Socioeconomic differences and financial difficulty   Our community is composed of students from a variety of financial backgrounds. Socioeconomic diversity can be invisible, and you may be experiencing financial difficulties related to the cost of textbooks, materials, or other necessities for our class of which I am not aware.

If you encounter financial challenges related to this class, there may be sources of support for you. If you feel comfortable sharing your experience with me, you may. You may also consider meeting with a financial aid officer to discuss options, reaching out to the First-Generation Office if you are a first-generation student, browsing the Funding Resources page, or, applying for the Dartmouth 4E Fund which provides supplemental funds for essentials, enrichment, experiences, and emergencies.

Title IX   At Dartmouth, we value integrity, responsibility, and respect for the rights and interests of others, all central to our Principles of Community. We are dedicated to establishing and maintaining a safe and inclusive campus where all community members have equal access to Dartmouth's educational and employment opportunities. We strive to promote an environment of sexual respect, safety, and well-being. Through the Sexual and Gender-Based Misconduct Policy (SMP), Dartmouth demonstrates that sex and gender-based discrimination, sex and gender-based harassment, sexual assault, dating violence, domestic violence, stalking, etc., are not tolerated in our community.

For more information regarding Title IX and to access helpful resources, visit eoatix.dartmouth.edu. As a faculty member, I am required to share disclosures of sexual or gender-based misconduct with the Office of Equal Opportunity, Accessibility, and Title IX (EOATIX).

If you have any questions or want to explore options for support and assistance, please contact the EOATIX office at 603-646-0922 or equal.opportunity.accessibility.and.title.ix@dartmouth.edu. Speaking to the EOATIX office does not automatically initiate a college resolution. Instead, much

of their work is centered around providing supportive measures to ensure you can continue to engage in Dartmouth's programs and activities.

Use of copyrighted materials   Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by the instructors are protected by copyright unless the instructors have stated otherwise. Students enrolled in, and authorized visitors to, Dartmouth College courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the College generally.

Notes taken in class are, however, generally considered to be "derivative works" of the instructors' presentations and materials, and they are thus subject to the instructors' copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor. To obtain permission to sell or barter notes, the individual wishing to sell or barter the notes must be registered in the course or must be an approved visitor to the class. Course instructors may choose to grant or not grant such permission at their own discretion, and may require a review of the notes prior to their being sold or bartered. If they do grant such permission, they may revoke it at any time, if they so choose.

Content to recording   By enrolling in this course,

- I affirm my understanding that the instructor may record meetings of this course in our classroom.

- I further affirm that the instructor owns the copyright to their instructional materials, of which these recordings constitute a part, and my distribution of any of these recordings in whole or in part to any person or entity other than other members of the class without prior written consent of the instructor may be subject to discipline by Dartmouth up to and including separation from Dartmouth.

Disclaimer

This syllabus is subject to change. Students will be notified through Canvas announcements of any changes.

Parts of the syllabus are inspired by the syllabus of Professor Andrew Schultz (Wellesley Math) and Professor Vinayak Rao (Purdue Statistics).