SYLLABUS: MATH 340 ADVANCED INTRODUCTION TO PROBABILITY, SPRING 2026

Instructor. Alexander Dunlap, Ph.D. (he/him). Office: Physics 297. Office hours: Tuesdays 9:45am–11am and Wednesdays 3:30pm–4:45pm, or by appointment. Email: alexander.dunlap@duke.edu.

Course meetings. Tuesdays and Thursdays, 8:30–9:45am, Physics 235.

Course websites. The course will use Canvas, Gradescope, Ed Discussions and the course website at https://services.math.duke.edu/~ajd91/teaching/340-s26/. All of these are linked from the Canvas site. An outline of the topics to be covered in the course is included on the course website, and will be updated throughout the semester.

Please only use email for administrative issues. If you have questions about course content, please come to office hours or use our Ed Discussions site (accessible via Canvas). Haotian and the instructor will check emails and Ed Discussions at least once each workday; please do not expect immediate responses (e.g. on weekends or right before the homework is due).

Course outline. This is a first course in probability, the branch of math concerned with the modeling of "random" or "uncertain" events and quantities. We will discuss the following topics:

- The mathematical formalisms (probability spaces, outcomes, events, random variables, distributions, ...) necessary for making precise (deterministic!) statements about things we think of as random.
- Properties of events and random variables (probability, conditional probability, expectation, variance, covariance, correlation, independence ...) that are important in classifying and studying them.
- Tools and techniques for performing computations about random systems.
- Theorems about when the "large scale" behavior of a system composed of many "small" independent random pieces can be predicted without knowing too much about the pieces (the Law of Large Numbers, the Central Limit Theorem, the Poisson process).
- Many examples and applications; for example:
  - Some applications of the probabilistic method in combinatorics.
  - Poisson process.
  - Markov chains.

A detailed schedule, with suggested readings from the textbooks, will be kept updated on the course webpage.

Prerequisites. The prerequisites for this course are multivariable calculus and linear algebra.

Textbooks. We will roughly follow Meester, *A Natural Introduction to Probability*, 2nd ed. We will also supplement from Grimmett and Stirzaker, *Probability and Random Processes*, 4th ed.

Introduction. Please send the instructor an email during the first week of classes to introduce yourself. Include your name, your major, something about your math background (e.g. what math courses you have taken), and what you hope to get out of this class.

Homework. A homework assignment will be due most Thursdays at 8am on Gradescope. Homework can be either *neatly* handwritten and scanned, or typed (e.g. in LaTeX). There will be a 15-minute grace period (i.e. until 8:15am) to account for technical issues in submitting the homework; after that, no late homework will be accepted unless an extension has been granted in advance by the instructor, or in the case of serious (documented) emergency that would prevent you from requesting an extension in advance. Students are responsible for ensuring that their uploaded homework is easy to read, and that pages have been assigned correctly on Gradescope. If there are technical issues with Gradescope that prevent you from uploading the homework, please send it by email to the instructor before the deadline.

Exams. There will be two in-class midterm exams and a final exam:

- Midterm 1: Tuesday, February 10, in class (75 minutes).
- Midterm 2: Thursday, March 24, in class (75 minutes).
- Final exam: as scheduled by the registrar's office, currently Tuesday, April 28, 9am–12pm (180 minutes).

Grading. Homework will count for 10% of the final grade, each midterm will count for 25%, and the final exam will count for 40%. The two lowest homework grades will be dropped.

Homework grading rubric. Homework problems will be graded on a 3-point scale:

- 3 points: the solution is correct and clearly explained/proved.
- 2 points: the essential ideas of a solution are present but there are inaccuracies or miscalculations, or explanation/detail is lacking.
- 1 point: some correct ideas are present but there are major errors or omissions and so the solution is substantially incorrect.
- 0 points: the submission contains little progress, or there is no submission.

Regrade requests. If you have any questions or concerns about how any assignment or exam was graded, you must contact the instructor or submit a regrade request on Gradescope within five working days of when it was returned for the grade to be reviewed.

Academic integrity. Most students do not cheat. Consequences for cheating may be as severe as a failing grade in the course and a letter to the applicable dean, who may impose further disciplinary sanctions. Here are some specific rules on collaboration in this course:

- Students are encouraged to discuss the homework assignments with each other. However, writing the final solutions for submission must be done individually. **It is forbidden to search the internet or use any kind of AI tool or large language model to search for solutions to homework problems, except with the specific permission of the instructor**.
- No collaboration is allowed on exams. Exams will be closed-book and closed-notes. Calculators will be neither allowed nor required on exams.

Accommodations. Students who require academic accommodations, due to a disability or other reason, should request these through the Student Disability Access Office as appropriate. Please contact the instructor if there are other things he can do to facilitate your access to the course.

Advice from the instructor. I hope you will find this course engaging and challenging, since that means you are learning a lot. On the other hand, if you feel you are falling behind, getting help immediately is essential—the longer you wait, the harder it will be to catch up.

I am always happy to talk to students. Please feel invited to come to office hours, whether to discuss the course material, the homework assignments, mathematics in general, the world, etc. If you cannot come to my usual office hours time, please feel free to email me to make an appointment for another time.

Students are strongly encouraged to form study groups. Discussing and thinking through the material with peers is a great way to learn. Please be mindful of the rules for collaboration above. Please also remember that your fellow students have backgrounds different from your own. Some things that seem

obvious to you may feel more difficult for your colleagues, and some things that you find difficult may seem more straightforward to those around you. Remember that mathematical ability is not innate or fixed, but is built through practice over time. Be kind to and supportive of each other as you develop your skills!

The landscape of AI tools is rapidly evolving, and it remains to be seen what role they will play in mathematics in the future. You may find various AI tools useful in your learning process, and I don't discourage you from doing so. However, you must not ask AI tools for solutions to the homework problems, as this deprives you of the experience of learning through the experience of working through the problems yourself.