MA 2631A FALL 2025
PROBABILITY THEORY
COURSE SYLLABUS

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Contents

1. Contact Information

Name	Email	Office Hours	Section	Lec/Dis Time	Location
Dr. Binan Gu	bgu@wpi.edu	M11-12, R1-2, F2-3 SL405A	AL01	MTRF 12:00 - 13:00	SL 402
Taorui Wang	twang13@wpi.edu		AD01	W 12:00 - 13:00	SL 402

2. Course Description

The purpose of this course is twofold:- To introduce the student to probability. Topics to be covered will be chosenfrom: axiomatic development of probability; independence; Bayes theorem; discrete and continuous random variables; expectation; special distributionsincluding the binomial and normal; moment generating functions; multivariatedistributions; conditional and marginal distributions; independenceof random variables; transformations of random variables; limit theorems.- To introduce fundamental ideas and methods of mathematics using thestudy of probability as the vehicle. These ideas and methods may includesystematic theorem-proof development starting with basic axioms;mathematical induction; set theory; applications of univariate andmultivariate calculus.This course is designed primarily for Mathematical Sciences majors and thoseinterested in the deeper mathematical issues underlying probability theory.

Recommended background: working knowledge of single variable and multivariable calculus. No programming knowledge is required.

3. Textbook

Main textbook: *Probability with Applications in Engineering, Science, and Technology* by Matthew A. Carlton and Jay L. Devore, freely available on Springer under WPI wireless network.

The text is intended to serve as a background reference on most but by no means all of the material covered in class. **The material covered in the lectures constitutes the course content for which you will be responsible.**

Supplementary textbook:

(1) *Introduction to Probability* by Joseph K. Blitzstein and Jessica Hwang, available here. The file is meant to be accessed online only, without a download option.
(2) *Introduction to Probability Models* by Sheldon Ross, 11th Edition. Plenty pdfs online.

4. Course Objectives

4.1. **Goal for Each Topic.** For each topic, your main job is to understand

- **Purpose**: Why is this topic introduced and studied?
- **Connections**: What are its fundamental connections to prior knowledge in this area?
- **Flow**: Learn the chronology of the topics introduced in this class, and understand the logic from one topic to the next.

Take these questions with you after every class. The answers may not be clear on the first day, or even the second—but that is part of the process. I can point out the connections, but genuine understanding only comes when you discover them yourself with enough discipline. There is **no other options.**

4.2. **Main Topics.** This course aims to build a foundation of modern probability theory. The primary skill to gain is to be able to converse in the language of mathematics on topics of basic probability and its applications. The technical contents include (optional topics in parentheses):

- Basic Set Theory, Sample Space and Events – Chapter 1 Sections 1-3;
- Conditional Probability and Independence – Chapter 1 Sections 4-5;
- Definition of a Random Variable – Chapter 2 Section 1
- Discrete random variables and their probability distributions – Chapter 2;
- Continuous random variables and their probability distributions – Chapter 3;
- Moment generating functions – Chapter 2 Section 7 (Discrete) and Chapter 3 Section 2 (Continuous)
- Multivariate Distributions and Their Marginals – Chapter 4 Sections 1-4
- Limit Theorems – Chapter 4 Section 5
- Transformations of Jointly Distributed Random Variables – Chapter 4 Section 6
- Possible higher level topics: Bayesian Inference, Chapter 5 Section 6, and Markov Chains – Chapter 6

Meanwhile, the students will develop their scientific writing skills and intuition, including

- Clear and concise use of the **mathematical** language.
- Concept of a Random Variable, Probability, Independence and Conditional Probability, and the ways to show/prove related results.
- The ability to make probabilistic argument during decision-making.

4.3. **Goals.**

4.3.1. *Course Goals.* Two end goals are measured equally in this class:

(1) (Understanding) The ability to recall definitions, provide motivating examples and argue with mathematical logic.
(2) (Mechanical) The ability to calculate using knowledge from algebra, sequence and series, single and multi-variable calculus.

4.3.2. *Personal Goals.* There are a few personal goals I wish everyone achieves by the end of the class.

(1) **Learn how to learn**. This includes
    (a) Forming good learning habits:
        (i) Consistent contact with the course material, i.e., study a little every day.
        (ii) Work on one problem a day.
        (iii) Read for 10 minutes ahead of the lecture.
        (iv) Read for 10 minutes after the lecture.
    (b) Eradicating bad learning habits:
        (i) Give up too quickly before using **all** available (permitted) resources, i.e., lecture notes, examples, office hours and your brain.
        (ii) Immediately look for solutions online.
        (iii) Procrastinate until the due date.
        (iv) Cram before the exam.
(2) Learn about yourself: what are your strengths and weaknesses, academically, and mentally, before, during, and after this class?

5. Course Organization

The class typically meets 5 times per week: 4 lectures on MTRF, and 1 discussion section on W. Students are responsible for all material presented in lecture and discussion. My expectations for these activities are:

5.1. **Lectures:** The 200 quality minutes we spend together every week in lecture are meant to **introduce** the subjects. Students are expected to **know of** (i.e. *Lehr*) the introduced topics after every lecture. **Mastery** comes later after exercises. Lecture videos are captured by Echo360 and can be accessed through the course Canvas page.

There will be complementary videos on worked examples posted every week. Students are responsible for learning these examples in depth.

5.2. **Practice Problems:** The majority of your association with this course lies in **problem solving outside the classroom**. Students are expected to take the intuitions gained from lectures and put them into careful examinations by doing suggested practice problems (i.e. *Kunst*). Solutions to these problems are neither collected nor graded, but they form the main topics of discussion during the Discussion section. The problem selection is a combination of examples of the types of problems to be found on the exams, along with problems that are more detailed and which enhance learning the topics at a deeper level.

Extra credit problems may be assigned during lecture time. They normally involve filling out the details of a derivation and/or more challenging problems within the context of the course. Grades earned from these problems will be complemented to your overall HW grade (see below), though they will not help one exceed the maximum number of points possible.

5.3. **Discussion:** Students have an opportunity to sit down and work through the practice problems on a topic with an instructor and have their individual questions addressed. It is through the Discussion that the student can get major questions asked so that after Discussion, the student can continue to work through the practice problems to develop mastery.

In each Discussion session,

- For the first 30 minutes, everyone will solve some of the practice problems posted under Discussion on a clean piece of paper, to be submitted at the end of the Discussion. You will be graded on attendance and work completeness (not correctness), equally weighted. Each submission is worth 1% of the term. See Grade Weights in Grades.
- For the last 20 minutes, everyone will take a quiz of two to three problems. See Course Schedule for details of the quiz content and sections covered each week.

5.4. **Canvas:** Course materials can be found on the Canvas page. The material is organized by the section number of the topic in the text. In the event that lectures need to be delivered remotely, they will take place through Zoom.

Students are expected to spend an additional **10-14 hours per week** studying outside of class. This includes reading the text, organizing notes, and solving problems.

5.5. **Communications:** The primary interface for communication with the instructor & course staff will be email, the Canvas course website, office hours, and discussions. All information about the course will be maintained on the course web page in WPI's Canvas system. Check it often.

Check your WPI email daily. Students can expect a response to email within 24 hours on weekdays and within 48 hours on weekends.

6. Assignments

There are three different types of assignments for this course.

6.1. **Written Homework.**

Written Assignments weigh **considerably** in this course (see Grades). Take them seriously. These assignments involve handwritten solutions (electronic handwriting, using Goodnotes or similar apps, is allowed and even prefered) to mathematical problems from the course textbook and my lecture notes. Written solutions should be **second drafts** and thoroughly demonstrate your thought process, including justifications of steps. These assignments are due once a week, containing approximately **four lectures** worth of materials. They can be accessed through the Assignments Module on Canvas.

6.1.1. *Collaborations and References.* Collaborations among classmates are welcome. Every HW submission must declare a list of collaborators at the beginning, though each student is expected to compose his/her own solutions. **Extensive similarities between assignments without collaboration declarations will be considered as plagiarism and will be penalized severely.**

If the solution depends on online sources or textbooks, the student is responsible for citing them with a reference style of your choosing. Uncited solutions, if confirmed, will be considered as plagiarism and will not receive any credit. Please review AI Policy at the end of the syllabus.

6.1.2. *Return-and-correct Policy.* Each student has 1 day to correct his/her solutions after HW is returned. Resubmissions may be graded without penalty if the initial submission has sufficient effort in solving **every** problem. Poor attempts at the initial submission will receive little credit and no resubmission opportunities.

Every resubmission shall contain the original copy or state clearly which problems you are correcting. You must address every query for the correction to be considered valid, e.g., it is not allowed to just correct one out of two mistakes. The corrections should be written using a different colored pen/pencil, either in a side column clearly marked for short corrections, or on new sheets of paper for long corrections.

6.1.3. *File Type.* The initial submission and later corrections are to be submitted as **a single PDF file** via the canvas assignment module.

6.1.4. *Grading Rubric.* For each HW, we select four problems and grade each out of the four equally important points. We will comment on which criterion is missing from your assignment, to which you must pay more attention when revising.

Type	Submission Qualities
Presentation	Quality is neat and easily readable. Ample spacing between each problem.
Completion	Every problem has a committed attempt.
Syntax	Correct use of basic mathematical symbols: $=$ (equal to), $\Longrightarrow$ (implies), lim (limit sign before evaluation), $\to$ (converges), $\int f(x)\,dx$ (correct variable), etc.
Correctness	Completely correct, clear, & thorough write-up of problem solution, citing appropriate rules & theorems where appropriate.

6.1.5. *Completion Policy.* Each HW is out of 20 points, 16 of which go to the four graded problems. The remaining 4 points account for the completion of the ungraded problems. This completion is graded via an all-or-nothing scheme, i.e., if you miss one problem, you earn 0 points. You must make up for the solutions of the missed problems in revisions for the revision to be considered valid and earn at most 1 out of the 4 (completion) points back, should the resubmitted work be satisfactory.

6.1.6. *Poor work policy.* The instructor and the TA reserve the rights to reject HW with poor presentation and careless completion without further review of its content. The first rejection acts as a warning, and its resubmission incurs a penalty of 15% of total points; any HW rejection after the first offense automatically receives a score of zero.

6.1.7. *Late Work Policy.* Any late HW abides by a "15% of total points off per day late submission policy" unless a valid excuse is supported with proper documentation, provided before the deadline.

6.2. **Exams.** Two exams: 9/12 (Friday), and 10/10 (Friday). See Course Schedule (on Canvas) for details.

6.2.1. *Makeup Policy.* Unless there is extenuating circumstances, no makeup quizzes/exams are allowed. Students requesting quizzes/exams to be taken at times other than the proposed dates must provide valid reasons with proper documentation (medical, familial, or religious reasons), or notices at least a week in advance. A temporary grade of Incomplete is assigned until all makeup exams are finished (typically given during the first week of B-term).

7. Grades

Written HW: 42% = 7×6%.

Discussion attendance and work completion: 7% = 7×1%.

Quizzes: 15% = 5×3%.

Better Exam: 20%.

Worse Exam: 16%.

Tentative Final Grades: A (>90), B(80-89), C(70-79), NR (<70).

Remark. There is no need to ask me to round up your grade as I will consider this option for everyone. Rounding up to a higher letter grade is only possible when the following conditions are simultaneously met: 1) your current numerical grade is at most 1.00 point away (up to two digits past the dot) from a letter grade change, i.e., 89.00-89.99, but not 88.99; 2) the two exam scores do not differ by more than 20 points.

8. Special Arrangements

If you need course adaptations or accommodations because of a disability, or if you have medical information to share with me, please make an appointment with me as soon as possible. My office location and office hours are listed above. If you have not already done so, students who believe that they may need accommodations in this class are encouraged to contact the Office of Accessibility Services (OAS) as soon as possible to ensure that these accommodations are implemented in a timely fashion. The OAS is in Unity Hall, (508) 831-4908. Students who need accommodations for exams are required to make the arrangements to take these exams at the Exam Proctoring Center (EPC) on the day of the exam.

9. Additional Policies

9.1. **Electronic Policy.** All lectures (audio and video) are captured through course capture and can be found on the course Canvas page. **NO** recording of audio or video by students is allowed during lecture or during discussion. Laptops, phones, and tablets should be turned off during the lecture and conference sessions. If you take notes (typing/stylus only) using these devices during lecture, then you should sit somewhere in the room where your screen activity is not distracting to your neighbors.

9.2. **Exam Policy.** Prior to the start of each exam, you must place all of your belongings (e.g., cell phone, study materials, smart watches, etc.) in your backpack and under your desk, so that no items are visible during the exam. **All quizzes this term are closed book, closed notes, and no electronic devices are permitted.** Cheating is an extreme offense. Students involved in plagiarism will be reported to the Dean without grace periods and negotiations.

9.3. **AI Policy .**

Artificial intelligence (AI) language models and online homework-help platforms are widely available (examples include ChatGPT (OpenAI), Claude (Anthropic), Gemini (Google), Microsoft Copilot, Perplexity, as well as platforms such as Chegg®, Course Hero, and Brainly). Use of these or similar tools to generate assignment solutions is not permitted unless you follow the requirements below. This policy applies to all current and future AI-powered systems, whether or not they are explicitly listed here. In this course, you must not submit AI-generated or platform-generated solutions verbatim as your own work.

If you ues AI tools as part of your learning process, you **must:**

(1) **Cite the tool and provide a direct link** to the generated response at the end of your submission (so the grader is one click away; written links do NOT count).
(2) **Explain in your own words** how you used the output to inform your solution (e.g. what you agreed with, what you adapted, what you corrected).
(3) **Show your full reasoning and intermediate steps**, not just a final answer.

Submissions that do not follow these rules may receive zero credit. If the instructor or TA has reason to believe that a submission does not represent the student's own understanding, they will withhold the assignment and require the student to complete an oral exam to demonstrate mastery. Failure to demonstrate sufficient understanding will result in a failing grade on the assignment and may be reported as academic dishonesty under the WPI policy "What is Academic Dishonesty".