# MATH 464: Theory of Probability

## Fall 2021 Section 2

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| **Instructor**: | Christina Durón | **Class Module**: | Live and in-person |
| **Email**: | duronc@math.arizona.edu | **Class Time**: | MWF 1:00 – 1:50PM |
| **Office**: | MATH 319 | **Class Location**: | Phys-Atmos Sci, Room 220 |

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**Course Pages:**

1. Homepage: https://cduron.info/

2. D2L: https://d2l.arizona.edu/d2l/home/1066197

3. Gradescope: https://www.gradescope.com/courses/284552

**Office Hours**: Office Hours will be regularly held on Monday from 3 – 4PM (MATH 319), Wednesday from 11AM – 12PM (Upper Division Tutoring), and Friday from 3 – 4PM (MATH 319), and by appointment.

**Course Communications**: All course materials will be posted on D2L and on the course web page. Email, in-class announcements, and D2L announcements will be the primary methods to communicate course information. It is ultimately the student's responsibility to keep informed of any announcements, syllabus adjustments, or policy changes made during scheduled classes, by email, or through D2L.

**Course Prerequisites or Co-requisites**: MATH 323 Formal Mathematical Reasoning and Writing or instructor permission.

**Course Description**: MATH 464 provides an introduction to the theory of probability, the part of mathematics that studies random phenomena. We model simple random experiments mathematically and learn techniques for studying these models. Topics covered include probability spaces, random variables, weak law of large numbers, central limit theorem, various discrete and continuous probability distributions.

**Course Goals and Objectives**: MATH 464 is an introduction to probability theory. Topics to be covered include:

1. Chance experiments, probability spaces, probabilistic models.

2. Conditional probability, Bayes' theorem.

3. Independence.

4. Random variables: probability distributions, expectations and moments, functions of random variables, joint distributions, covariance and correlation, sums and moment generating functions, independence.

5. Limit theorems: Law of Large Numbers and Central Limit Theorem.

This course will prepare students for further courses in stochastic processes and mathematical statistics. It is a prerequisite for MATH-468 Applied Stochastic Processes and STAT-466 Theory of Statistics.

**Learning Outcomes**: Upon completion of the course, the student will

1. be able to set up and interpret probability models for a variety of chance experiments;

2. be able to interpret, explain, and apply probabilistic concepts such as probability, conditional probability, independence, expectations;

3. be able to "think probabilistically", e.g., break down long calculations of probabilities and/or expectations into simpler steps;

4. understand the relationship between random variables and their distributions/densities;

5. understand the meaning, scope, and consequences of the Law of Large Numbers and the Central Limit Theorem, including the meaning of convergence in distribution and convergence with probability 1;

6. be able to carry out concrete calculations with common distributions, e.g., the normal, exponential, and uniform distributions.

**Course Materials**: The required textbook is *Introduction to Probability* by Anderson, Seppäläinen, and Valkó. Reading assignments and homework problems will be given directly from the text.

**Required Materials**: No materials other than the textbook is required. However, you will be expected to download and upload homework online through Gradescope. It is your responsibility to learn how to do this.

**Absence and Class Participation Policy**: Participating in the course and attending lectures and other course events are vital to the learning process. As such, attendance is required at all lectures. Absences may affect a student's final course grade. Prolonged absences and absence during exams should be communicated to the instructor as soon as possible. If you are unexpectedly absent for medical or personal reasons, please inform the instructor within 24 hours, if at all possible.

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop.

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, and is available at https://policy.arizona.edu/human-resources/religious-accommodation-policy.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. The policy is available at https://deanofstudents.arizona.edu/absences.

**Administrative Drops**: If you do not attend every class in the first week and have not informed me of your absence, *you may be dropped from the course.*

**Disability-Related Accommodations**: To request a disability-related accommodation to this attendance policy, please contact the Disability Resource Center at (520) 621-3268 or drc-info@email.arizona.edu. If you are experiencing unexpected barriers to your success in your courses, the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office is located in the Robert L. Nugent Building, room 100, or call (520) 621-7057

**Classroom Behavior Policy**: To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.). Students are asked to refrain from disruptive conversations during lecture. Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion and may be reported to the Dean of Students.

**Threatening Behavior Policy**: The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. The policy is available at http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

**UA Nondiscrimination and Anti-harassment Policy** : The University is committed to creating and maintaining an environment free of discrimination; the policy is available at http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy.

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

**Accessibility and Accommodations**: At the University of Arizona we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center at (520) 621-3268 or https://drc.arizona.edu/ to establish reasonable accommodations.

**Assignments and Examinations**:

- *Weekly homework* will be distributed electronically (typically on Gradescope and D2L), based in part on the text. Students are responsible for uploading properly scanned work to Gradescope. The instructor will graded either a subset or all of the problems each week; graded work will be returned through Gradescope.

- *Two in-class midterms* are tentatively scheduled on Friday, October 1 and Wednesday, November 10.

- The *final exam* will take place on Monday, December 13, 2021, at 1 – 3PM in our regular classroom.

You are permitted, indeed encouraged, to work together on homework problems. However, the work you turn in must be your own. For midterms and the final, see University's Exam regulations will be strictly followed: https://www.registrar.arizona.edu/courses/final-examination-regulations-and-information.

**Important Dates**:

**Make-up Exams and Homework Extensions**: In general, there will be no make-up exams. However, in unusual circumstances beyond your control, a make-up exam may be given on a case-by-case basis. This may require providing a detailed account of the situation and, if applicable, supporting documents. Approval in these cases is at the sole discretion of the instructor and/or the Dean of Students. According to University policy, no exams will be held during the week of December 6th.

Homework assignments not turned by the due date receive an automatic zero. Extensions may be granted on a case by case basis, either with prior permission of the instructor (a valid reason must be given) or with instructor's agreement in cases of emergency. In the latter case, the student must contact the instructor within 24 hours, if possible.

**Grading Scale and Policies**: Your letter grade in the course will be based on the following:

- Homework(25%)

- Midterms (40%, 20% each)

- Final (35%)

Your final letter grade will be *no lower* than the following:

A: 100-90%     B: 89-80%     C: 79-70%     D: 69-60%     E: 59-0%

No extra credit or bonus points are offered in this course.

**Incomplete or Withdrawal Requests**: Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, both are available at https://catalog.arizona.edu/policy/grades-and-grading-system.

You may drop the class without a W through September 5 using UAccess. The class will appear on your UAccess record, but will not appear on your transcript. You may withdraw with a W through October 31 using UAccess. The University allows withdrawals through November 21, but only with the Dean's approval. Late withdraws are dealt with on a case by case basis, and requests for late withdraw without a valid reason may or may not be honored.

**Dispute of Grade Policy**: Except with instructor's permission, any questions regarding the grading of any assignment, quiz, or exam need to be raised within one week after the graded item has been returned.

**Code of Academic Integrity**: Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog, which is available at http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

The University Libraries have some excellent tips for avoiding plagiarism, available at http://new.library.arizona.edu/research/citing/plagiarism.

Selling class notes and/or other course materials to other students or to a third party for re-sale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of

Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

**Additional Resources for Students**: UA Academic policies and procedures are available at `http://catalog.arizona.edu/policies`.

Information on the Student Assistance and Advocacy is available at `http://deanofstudents.arizona.edu/student-assistance/students/student-assistance`.

Information on the Confidentiality of Student Records is available at `http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa`.

**Tentative Schedule**:

| Monday | | Wednesday | | Friday | |
|---|---|---|---|---|---|
| **Aug 23rd** | 1 | **25th** | 2 | **27th** | 3 |
| Probability Spaces (Section 1.1) | | Counting (Section 1.2) | | Infinite Sample Spaces (Section 1.3) | |
| **30th** | 4 | **Sep 1st** | 5 | **3rd** | 6 |
| Rules of Probability (Section 1.4) | | Conditional Probability (Section 2.1) | | Bayes' (Section 2.2) | |
| HW #1 Due | | | | | |
| **6th** | 7 | **8th** | 8 | **10th** | 9 |
| NO CLASS | | Independence (Section 2.3) | | Random Variables (Section 1.5) | |
| | | HW #2 Due | | | |
| **13th** | 10 | **15th** | 11 | **17th** | 12 |
| Distribution of Random Variables (Section 3.1) | | Cumulative Distribution Functions (Section 3.2) | | Independent Trials (Section 2.4) | |
| HW #3 Due | | | | | |
| **20th** | 13 | **22nd** | 14 | **24th** | 15 |
| Independent Trials (Section 2.4) | | Expectation (Section 3.3) | | Expectation (Section 3.3) | |
| HW #4 Due | | | | | |
| **27th** | 16 | **29th** | 17 | **Oct 1st** | 18 |
| Variance (Section 3.4) | | Midterm #1 Review | | Midterm #1 | |
| HW #5 Due | | | | | |

| Monday | Wednesday | Friday |
|---|---|---|
| **4th**    19 <br><br> Gaussians <br> (Section 3.5) <br><br> **HW #6 Due** | **6th**    20 <br><br> Normal Approximations <br> (Section 4.1) | **8th**    21 <br><br> Law of Large Numbers <br> (Section 4.2) |
| **11th**    22 <br><br> Applications of the Normal Approximation <br> (Section 4.3) <br><br> **HW #7 Due** | **13th**    23 <br><br> Poisson Approximation <br> (Section 4.4) | **15th**    24 <br><br> Exponential Distribution <br> (Section 4.5) |
| **18th**    25 <br><br> Moment Generating Function <br> (Section 5.1) <br><br> **HW #8 Due** | **20th**    26 <br><br> Moment Generating Function <br> (Section 5.1) | **22nd**    27 <br><br> Distribution of a Function of a Random Variable <br> (Section 5.2) |
| **25th**    28 <br><br> Joint Distribution of Discrete Random Variables <br> (Section 6.1) <br><br> **HW #9 Due** | **27th**    29 <br><br> Joint Distribution of Discrete Random Variables <br> (Section 6.1) | **29th**    30 <br><br> Jointly Continuous Random Variables <br> (Section 6.2) |
| **Nov 1st**    31 <br><br> Jointly Continuous Random Variables <br> (Section 6.2) <br><br> **HW #10 Due** | **3rd**    32 <br><br> Joint Distributions and Independence <br> (Section 6.3) | **5th**    33 <br><br> Sums of Independent Random Variables <br> (Section 7.1) |
| **8th**    34 <br><br> Midterm # 2 Review <br><br> **HW #11 Due** | **10th**    35 <br><br> **Midterm # 2** | **12th**    36 <br><br> Linearity of Expectation <br> (Section 8.1) |
| **15th**    37 <br><br> Expectation and Independence <br> (Section 8.2) <br><br> **HW #12 Due** | **17th**    38 <br><br> Covariance and Correlation <br> (Section 8.4) | **19th**    39 <br><br> Sums and Moment Generating Functions <br> (Section 8.3) |

| Monday | Wednesday | Friday |
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| **22nd**    40<br><br>Law of Large Numbers<br>(Section 9.2)<br><br>**HW #13 Due** | **24th**    41<br><br>Central Limit Theorem<br>(Section 9.3) | **26th**    42<br><br>Conditional Distribution of a<br>Discrete Random Variable<br>(Section 10.1) |
| **29th**    43<br><br>Conditional Distribution for<br>Jointly Continuous Random<br>Variables<br>(Section 10.2)<br><br>**HW #14 Due** | **Dec 1st**    44<br><br>Conditional Expectation<br>(Section 10.3) | **3rd**    45<br><br>NO CLASS |
| **6th**    46<br><br>Final Exam Review<br><br>**HW #15 Due** | **8th**    47<br><br>Final Exam Review | **10th**    48 |
| **13th**    49<br>**Final Exam: 1-3PM** | **15th**    50 | **17th**    51 |

**Note**: This calendar is tentative. For up-to-date information, see D2L.

**Subject to Change Statement**: Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.