# MATH 244: Introduction to Probability Theory
## *Spring 2023 Course Syllabus*

**NJIT Academic Integrity Code**: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

## COURSE INFORMATION

**Course Description**: Topics include basic probability theory in discrete and continuous sample space, conditional probability and independence, Bayes' theorem and event trees, random variables and their distributions, joint distribution and notion of dependence, expected values and variance, moment generating functions, useful parametric families of distributions including binomial, geometric, hypergeometric, negative binomial, exponential, gamma, normal and their applications, simple case of central limit theorem and its uses.

**Prerequisites**: MATH 112 with a grade of C or better.

**Course-Section and Instructors:**

| Course-Section | Instructor |
|---|---|
| Math 244-002 | Professor K. Wicke |

**Office Hours for All Math Instructors:** Spring 2023 Office Hours and Emails

**Required Textbook**:

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| **Title** | *Probability* |
| **Author** | Jim Pitman |
| **Edition** | 1st |
| **Publisher** | Springer |
| **ISBN #** | 9780387979748 |

**University-wide Withdrawal Date**: The last day to withdraw with a **W** is **Monday, April 3, 2023**. It will be strictly enforced.

## COURSE GOALS

**Course Objectives:**

- Understand the basic principles of probability including laws for unions, intersections, and complements, as well as Bayes' theorem, and use them to calculate probabilities.
- Understand the definitions of discrete and continuous random variables and their distributions (including joint, marginal, and conditional distributions), compute expectation, variance, covariance, and correlation of random variables, know the definitions of density and distribution functions of random variables, and be able to compute them.
- Learn about uniform, binomial, multinomial, geometric, hypergeometric, Poisson, negative binomial, normal, exponential, and gamma random variables, know their distributions and parameters, and understand when to use them.
- Become familiar with moment generating functions, transformation techniques, and basic limit theorems in probability, including the law of large numbers and the central limit theorem.

**Course Outcomes:** On successful completion students will

- have a greater understanding of central concepts and ideas in probability, in particular random variables and their distributions, and have learnt how to interpret probabilistic statements;
- be able to solve introductory level and more challenging problems that involve randomness and chance;
- be prepared for more advanced mathematics and statistics courses.

**Course Assessment:** Will be based on weekly homework and quizzes, two midterm exams, and one (comprehensive/cumulative) final exam.

## POLICIES

DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

**Grading Policy**: The final grade in this course will be determined as follows:

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| **Homework** | 15% |
| **Quizzes** | 15% |
| **Midterm Exam I** | 20% |
| **Midterm Exam II** | 20% |
| **Final Exam** | 30% |

Homework will be marked out of 10 points each and quizzes will be marked out of 5 points each (in both cases, the lowest score will be dropped), while exams will be marked out of 100 points; all scores will be converted into percentages.

Your final letter grade will be based on the following tentative curve.

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|---|---|---|---|
| **A** | 90 - 100 | **C** | 68 – 74 |
| **B+** | 85 - 89 | **D** | 50 – 67 |

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|---|---|---|---|
| **B** | 80 - 84 | **F** | 0 - 49 |
| **C+** | 75 - 79 | | |

**Attendance Policy**: Attendance at all classes will be recorded and is **mandatory**. Please make sure you read and fully understand the Math Department's Attendance Policy. This policy will be strictly enforced.

**Homework**: Homework assignments will be posted on the class website and will usually be due at 11:59pm on Tuesdays unless announced otherwise. No late homework will be accepted. You are encouraged to work together on the homework, but do not copy any part of the homework or look up/request solutions to homework problems in online forums or websites. Each student must submit their own homework to be submitted online as a PDF file through the class website. Feel free to ask me for help during my office hours after you have made an attempt at the question. I will also provide homework solutions that are detailed enough to allow you to understand how the question could be approached.

Homework assignments will contain both graded and ungraded parts and only the graded problems will need to be submitted. However, you should always make an attempt at the ungraded problems as well. For submission, put your name and the homework assignment number on the top right corner of every page and submit the problems in order. The purpose of written homework is to assess and provide feedback on your understanding of and ability to explain the reasoning behind complex derivations or probabilistic arguments. Therefore, answers with little or no explanation or work shown will receive no credit. **The lowest homework score will be dropped at the end of the semester.**

**Quizzes:** There will be a weekly online quiz on Fridays when there is no midterm exam or holiday (except for the first and last week of the semester). The quizzes will contain similar but not identical problems as the homework assignment due that week. It thus makes sense to revise the content of the homework due on Tuesday before taking the quiz on Friday. All quizzes will be administered through the class website, and you will have a 24-hour window to start the quiz. Once the quiz is started it will need to be completed within a set time window of 15-25 minutes (depending on the complexity of the problems). **The lowest quiz score will be dropped at the end of the semester.**

**Exams**: There will be two midterm exams and one final exam. The midterm exam dates are tentative and may be subject to change.

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| Midterm Exam I | Feb 17, 2023 |
| Midterm Exam II | Mar 31, 2023 |
| Final Exam Period | May 5 - May 11, 2023 |

The final exam will test your knowledge of all the course material taught in the entire course. Make sure you read and fully understand the Math Department's Examination Policy. This policy will be strictly enforced.

**Makeup Exam Policy**: There will be **NO MAKE-UP QUIZZES OR EXAMS** during the semester. In the event an exam is not taken under rare circumstances where the student has a legitimate reason for missing the exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the Math Department Office/Instructor that the exam will be missed.

**Cellular Phones**: All cellular phones and other electronic devices must be switched off during all class times.

## ADDITIONAL RESOURCES

**Math Tutoring Center**: Located in the Central King Building, Lower Level, Rm. G11 (See: Spring 2023 Hours)

**Further Assistance**: For further questions, students should contact their instructor. All instructors have regular office hours during the week. These office hours are listed on the Math Department's webpage for Instructor Office Hours and Emails.

**Accommodation of Disabilities**: The Office of Accessibility Resources and Services (OARS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please contact Scott Janz, Associate Director of Disability Support Services at 973-596-5417 or via email at scott.p.janz@njit.edu. The office is located in Kupfrian Hall, Room 201. A Letter of Accommodation Eligibility from the Office of Accessibility Resources and Services office authorizing your accommodations will be required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Office of Accessibility Resources and Services (OARS) website at:

https://www.njit.edu/accessibility/

**Important Dates** (See: Spring 2023 Academic Calendar, Registrar)

| Date | Day | Event |
|---|---|---|
| January 17, 2023 | Tuesday | First Day of Classes |
| January 23, 2023 | Monday | Last Day to Add/Drop Classes |
| March 13, 2023 | Monday | Spring Recess Begins |
| March 18, 2023 | Saturday | Spring Recess Ends |
| April 3, 2023 | Monday | Last Day to Withdraw |
| April 7, 2023 | Friday | Good Friday - No Classes |
| May 2, 2023 | Tuesday | Friday Classes Meet |
| May 2, 2023 | Tuesday | Last Day of Classes |
| May 3 - May 4, 2023 | Wednesday and Thursday | Reading Days |
| May 5 - May 11, 2023 | Friday to Thursday | Final Exam Period |

# Course Outline (tentative)

| Week | Dates | Topic (sections in textbook, roughly) |
|---|---|---|
| 1 | Jan 17, 20 | Introduction and basic concepts (1.1, 1.2)<br>Rules of probabilities and first examples of distributions (1.3) |

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|---|---|---|
| 2 | Jan 24, 27 | Conditional probability and independence (1.4)<br><br>Bayes' Rule (1.5)<br><br>**Quiz 1 on Jan 27** |
| 3 | Jan 31, Feb 3 | Multiplication rule, tree diagrams, and sequences of events (1.6)<br><br>Binomial distribution (2.1)<br><br>**Quiz 2 on Feb 3** |
| 4 | Feb 7, 10 | Normal distribution and normal approximation (2.2)<br><br>Poisson distribution and Poisson approximation (2.4)<br><br>**Quiz 3 on Feb 10** |
| 5 | Feb 14, 17 | Review<br><br>**Midterm Exam I on Feb 17** |
| 6 | Feb 21, 24 | Discrete random variables, probability mass functions, and discrete distributions (3.1)<br><br>Expectation, indicators, and Markov's inequality (3.2)<br><br>**Quiz 4 on Feb 24** |
| 7 | Feb 27, Mar 3 | Expectation, indicators, and Markov's inequality continued (3.2)<br><br>Variance, standard deviation, Chebychev's inequality, and the Central Limit Theorem (3.3)<br><br>**Quiz 5 on Mar 3** |
| 8 | Mar 7, 10 | More discrete distributions: geometric and negative binomial (3.4, 3.5)<br><br>Continuous random variables and probability densities (4.1)<br><br>**Quiz 6 on Mar 10** |
| 9 | Mar 21, 24 | Examples of continuous distributions: uniform, normal, exponential, and gamma (4.1, 4.2)<br><br>Cumulative distribution functions, the CDF technique, and transformations (4.4, 4.5)<br><br>**Quiz 7 on Mar 24** |
| 10 | Mar 28, 31 | Review<br><br>**Midterm Exam II on Mar 31** |

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|---|---|---|
| 11 | Apr 4<br>no class on Apr 7 | Cumulative distribution functions, the CDF technique, and transformations continued (4.4, 4.5) |
| 12 | Apr 11, 14 | Moment generating functions (supplemental material)<br>Uniform distributions over planes and volumes (5.1)<br>**Quiz 8 on Apr 14** |
| 13 | Apr 18, 21 | Conditional distribution: Discrete case (6.1)<br>Conditional expectation: Discrete case (6.2)<br>**Quiz 9 on Apr 21** |
| 14 | Apr 25, 28 | Covariance and correlation (6.4)<br>**Quiz 10 on Apr 28** |
| 15 | May 2 | Final Review |

*Updated by Professor K. Wicke - 4/7/2023*
*Department of Mathematical Sciences Course Syllabus, Spring 2023*