Course Syllabus

MATH-UA 233: Theory of probability
Lecture: Mon & Wed 2:00pm - 3:15pm, ONLINE
Recitation: Fri 2:00pm - 3:15pm, ONLINE

Instructor: Mike O'Neil
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Office hours ONLINE

Course website: `https://cims.nyu.edu/~oneil/prob20`

Prerequisites: MATH-UA 123 Calculus III or MATH-UA 213 Math for Economics III (for Economics majors) with a grade of C or better and/or the equivalent, and MATH-UA 140 Linear Algebra or MATH-UA 148 Honors Linear Algebra with a grade of C or better and/or the equivalent. Not open to students who have taken MATH-UA 235 Probability and Statistics.

Note: This course is intended for math majors and other students with a strong interest in mathematics. It requires fluency in topics such as multi-variable integration and therefore a grade of B or better in MATH-UA 123 or MATH-UA 213 (or the equivalent) is strongly recommended.

Description: An introduction to the mathematical treatment of random phenomena occurring in the natural, physical, and social sciences. Axioms of mathematical probability, combinatorial analysis, binomial distribution, Poisson and normal approximation, random variables and probability distributions, generating functions, Markov chains applications.

Objectives: This is an undergraduate course on probability theory for mathematics majors. The goals are:

- to learn the key mathematical concepts in probability theory, such as probability spaces, random variables, mean, variance, conditional expectation, joint distributions, law of large numbers, central limit theorem, and markov chains;
- to become familiar with important distributions, such as binomial, poisson, normal, exponential, etc.;
- to be able to interpret, set up and solve problems involving uncertainty;
- to write clearly about your mathematical reasoning.

The course will emphasize both the mathematical foundations as well as how to solve specific problems. It will also be appropriate for students in non-math majors who who need to use probability theory in their work/studies, but want a more rigorous foundation.

Materials: The course will closely follow

- Sheldon Ross, *A First Course in Probability*, 10th Ed., 2019

Older editions of the textbook are fine, as long as you convert the readings to the pages appropriate for your edition. Additional reference texts that may be helpful are:

- Durrett, *Elementary Probability for Applications*
- R. P. Dobrow, *Probability with Applications and R*

Participation: Part of your grade will be determined based on your participation in the online Campuswire forum for the class. Details of joining Campuswire will be distributed the first week of class.

Asynchronous learning: The course will be fully online this semester. Prior to every lecture, you will be expected to read the relevant sections from the textbook and watch the pre-recorded lecture given by the instructor. Lecture time will then be spent answering any questions you have, and working on sample problems.

Homework: Homework problems will be suggested every week, but will not be collected.

Quizzes: Instead of graded homework, there will be 20-30 minute quizzes in recitation every 2 to 3 weeks. You are expected to be present for the quizzes. No absences will be accommodated, except for emergencies or school-sanctioned events. There will be 5 quizzes total, the dates of which will be announced the first week of class. Each quiz will be weighted equally.

Exams: There will be two preliminary exams and a final exam. The date of the exams will be announced the first week of class.

Recitations: Attendance at recitations is expected, especially since quizzes will be administered during them.

Grading: The overall course letter grade will be determined based on a final numerical weighted average. The following breakdown will be used to compute an overall numerical grade:

- 10% Partcipation (via Campuswire)
- 15% Quizzes
- 20% Exam 1
- 20% Exam 2
- 20% Exam 3

NYU's academic integrity policies will be strictly enforced for quizzes and exams, especially since they will be proctored online.

Weekly schedule:

1. Permutations, combinations
2. Simple probabilities via counting
3. Conditional probability, independence
4. Discrete random variables
5. Review, Exam 1
6. Continuous distributions
7. Change of variables
8. Joint distributions
9. Joint change of variables
10. Review, Exam 2
11. Expectations, variances
12. Laws of large numbers, Central limit theorem
13. Markov chains, Poisson processes
14. Simulation