

## MATH 345: Multivariate Distributions

### *Spring 2022 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.

Please be sure you read and fully understand our [DMS Online Exam Policy](#).

### COURSE INFORMATION

**Course Description:** Topics include discrete and continuous multivariate distributions and their moments, multivariate distributions including multivariate normal and multinomial distributions, order statistics, conditional probability and the use of conditioning, discrete time Markov chains and their examples, discrete time branching processes, homogeneous and nonhomogeneous Poisson processes.

**Number of Credits:** 3

**Prerequisites:** [MATH 244](#) with a grade of C or better or [MATH 333](#) with a grade of C or better.

**Course-Section and Instructors:**

Course-Section	Instructor
Math 345-002	Professor S. Dhar

**Office Hours for All Math Instructors:** [Spring 2022 Office Hours and Emails](#)

**Required Textbook:**

<b>Title</b>	<i>Fundamentals of Probability with Stochastic Processes</i>
<b>Author</b>	Saeed Ghahramani
<b>Edition</b>	4th
<b>Publisher</b>	Pearson Prentice Hall
<b>ISBN #</b>	978-1498755092
<b>Website</b>	Canvas

**University-wide Withdrawal Date:** The last day to withdraw with a W is **Monday, April 4, 2022**. It will be strictly enforced.

## **COURSE GOALS**

### **Course Objectives**

Discrete and continuous multivariate distributions and their moments, multivariate distributions including multivariate normal and multinomial distributions, order statistics, conditional probability and the use of conditioning, discrete time Markov chains and their examples, discrete time branching processes, homogeneous and nonhomogeneous Poisson processes.

**Course Outcomes** *Students are able to:*

- Do problem solving on the topics.
- Analyze discrete and continuous multivariate distributions.
- Use Markov chains.
- Use homogeneous and nonhomogeneous Poisson processes
- Use branching processes.
- Read multivariate distribution journal publications for concepts.
- Gain ideas to do statistical computations.

**Course Assessment:** Understand topics at the level at which one is able to apply the methods to do problem solving.

## **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:

<b>Homework/Quizzes</b>	20%
<b>Class Participation and worksheets (please see rubric)</b>	10%
<b>Midterm Exam</b>	35%
<b>Final Exam</b>	35%

Your final letter grade is on a curve, which ensures A's in the class.

Download Canvas app on your phone - it will help.

Assignment (one will be created for this purpose by the instructor) in Canvas describes the HW assignments due weekly.

**Course Policies:** It is required that the student read the textbook for the material already covered in class by

the instructor and confirm that the basic solved problems are understood and practice solving textbook problems. More explicitly, students must work on the examples and exercises and problems from the textbook on the topics already covered in class, and learn to solve them correctly (please see class participation). The student should compare his or her answers with those given at the end of the textbook or by the instructor. Instructor holds the right to modify in class exams, homework, quizzes dates in the best interest of the class. Instructor uses NJIT student emails or emails provided by students to NJIT as official emails, to make official announcements.

**Class Participation:** Class attendance is required, and students are encouraged to contribute to class discussion. Participation is the key to a lively class. Ten percent (10%) of the course grade will depend upon contributions to our class sessions or worksheet scores. Class participation provides the opportunity to practice speaking and persuasive skills, as well as the ability to listen. Comments that are vague, repetitive, unrelated to the current topic, disrespectful of others, or without sufficient foundation receive negative evaluation. Note that simply being present for class attendance with no response will yield zero score. What matters is the quality of one's contributions to the class discussion, not the number of times one speaks (please see [rubric](#)).

**Calculator:** Bring a scientific basic calculator to all the lectures. No calculators allowed with graphic display/storage capabilities. Exams allow only simple scientific calculators.

**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. NOTE: Tardiness to class counts as a half absence (please see class participation above).

Instructors will maintain a detailed record of you attendance, as the administrators need to know the dates you missed classes.

**Homework:** Homework is generally due within a week unless announced otherwise. Instructor immediately gives handout and discusses the solution key as needed, soon after the submitted HW assignment by students. Hence, late homework is not accepted.

**Exams:** There will be one midterm exam during the semester and a comprehensive final exam.

Midterm Exam	March 12, 2022
Final Exam Period	May 6 - May 12, 2022

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:** No cell phones communications (e.g. texting, etc.) during lectures/exams. Please switched off all cellular phones (unless one is using them for learning the current topic) and beepers must be during all class times.

No eating allowed in class.

**Wandering:** Do not wander in and out of the classroom.

## ADDITIONAL RESOURCES

**Math Tutoring Center:** Located in the Central King Building, Lower Level, Rm. G11 (See: [Spring 2022 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](tel:973-596-5417) or via email at [scott.p.janz@njit.edu](mailto: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/studentssuccess/accessibility/>

**Important Dates** (See: [Spring 2022 Academic Calendar, Registrar](#))

Date	Day	Event
January 18, 2022	Tuesday	First Day of Classes
January 22, 2022	Saturday	Saturday Classes Begin
January 24, 2022	Monday	Last Day to Add/Drop Classes
March 14, 2022	Monday	Spring Recess Begins
March 19, 2022	Saturday	Spring Recess Ends
April 4, 2022	Monday	Last Day to Withdraw
April 15, 2022	Friday	Good Friday - No Classes
April 17, 2022	Sunday	Easter Sunday - No Classes
May 3, 2022	Tuesday	Friday Classes Meet
May 3, 2022	Tuesday	Last Day of Classes
May 4 - May 5, 2022	Wednesday and Thursday	Reading Days
May 6 - May 12, 2022	Friday to Thursday	Final Exam Period

## Course Outline

Lecture	Date	Chapter	Topics
1	1/18	4.2-4.6,	Random variables and distributions
2	1/21	5.1-5.3, 6.1- 6.3	Expectations and Variance
3	1/25	7.4	Gamma Distribution
4	1/28	8.1	Joint Distribution of Two Random Variables
5	2/1	8.2-8.4	Independent Random Variables; Conditional Distributions; Transformations of Two Random Variables
6	2/4	8.4	Transformations of Two Random Variables
7	2/8	11.1; 8.4	Moment generating functions; Transformations of Two Random Variables
8	2/11	9.1-9.2	Multivariate Distributions, Order statistics
9	2/15	9.2	Order statistics
10	2/18	9.3	The Multinomial Distribution
11	2/22	9.3	The Multinomial Distribution
12	2/25	10.1	Expected Values of Sums of Random Variables
13	3/1	10.2-10.3	Covariance; Correlation
14	3/4	10.4	Conditioning on Random Variables
15	3/8	Review for Midterm Exam	
16	3/11	Chapter-Sections(above) 4.2-10.4	MARCH 12, TUESDAY, MIDTERM EXAM
L▶	3/15 & 3/18	L▶	SPRING RECESS: MARCH 14-21, 2022
17	3/22	10.5	Bivariate Normal Distribution
18	3/25	10.5	Multivariate Normal
L▶	3/29	11.2	Sums of Independent Random Variables

19	4/1	11.2	Sums of Independent Random Variables
20	4/5	12.2	Poisson Processes
21	4/8	12.2 - Instructor's lecture notes	More on Poisson Processes –non homogeneous.
22	4/12	12.3	Markov Chains
23	4/15	Good Friday	Holiday
24	4/19	12.3	Markov Chains
25	4/22	12.3	Markov Chains
26	4/26	12.3	Markov Chains (Branching Processes)
27	4/29	12.3	Markov Chains
28	5/3 (Friday Schedule)	12.3	REVIEW FOR FINAL EXAM
<b>FINAL EXAM: May 6-12, 2022</b>			

## **Grade Criteria for Class Participation (out of a maximum of 4)**

Instructor uniquely identifies class names. Then, from there onwards following gives the criteria of a participation score from zero to four, at the end of the each class:

0: Student is absent (please give proof of extenuating circumstance to receive a grade of 'E', which will make sure your grades are not affected). Student has sustained attention on laptop/electronic devices. Not participating in the class at all. She/he is disruptive and says little or nothing in class. Contributions in class reflect inadequate preparation. Ideas offered are seldom substantive, provides few if any insights, and never a constructive direction for the class. Integrative comments are absent. Absence of this student saves valuable class-time.

1: Student is present and not disruptive. Does not offer much but tries to respond when called on. Student demonstrates very infrequent involvement in class discussion. This person says little or nothing in class. Hence, there is not an adequate basis for evaluation. Absence of this student would not change the quality of class discussion.

2: Student demonstrates adequate preparation: knows basic facts, but does not show evidence of trying to interpret or analyze them. She/he offers straightforward information (e.g., straight from the textbook), without elaboration or very infrequently (perhaps once a class). Does not offer to contribute to discussion, but contributes to a moderate degree when called on. Student demonstrates sporadic involvement. Contributions in class reflect satisfactory preparation. Ideas offered are sometimes substantive, provides generally useful insights but seldom offer a new direction for the discussion. If this person were not a member of the class, the quality of discussion would be diminished somewhat.

3: Student demonstrates good preparation: knows covered course material well, has thought through implications of them. She/he offers interpretations and analysis of course material (more than just facts) to class. Student contributes well to discussion in an ongoing way: responds to other students' points, thinks through their own points, questions others in a constructive way, offers and supports suggestions that may be counter to the majority opinion. Student demonstrates consistent ongoing involvement. Contributions in class reflect thorough preparation. Ideas offered by the student are usually substantive; provide good insights, and sometimes direction for the class. Absence of this student would diminish the quality of class discussion.

4: Student demonstrates excellent preparation: has analyzed covered course material exceptionally well, relating it to readings and other material (e.g., readings, course material, etc.). She/he offers analysis, synthesis, and evaluation of covered course material, e.g., puts together pieces of the discussion to develop new approaches that take the class further. Student contributes in a very significant way to ongoing discussion: keeps analysis focused, responds very thoughtfully to other students' comments, contributes to the cooperative argument building, suggests alternative ways of approaching material and helps class analyze which approaches are appropriate, etc. She/he demonstrates ongoing very active involvement. Contributions in class reflect exceptional preparation. Ideas offered are always substantive, and provide one or more major insights as well as direction for the class. Absence of this student would diminish the quality of class discussion markedly.

*Calculate the class participation score by averaging scores each out of the maximum of four.*

*Updated by Professor S. Dhar - 1/7/2022  
Department of Mathematical Sciences Course Syllabus, Spring 2022*