NJIT New Jersey's Science & Technology University

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF MATHEMATICAL SCIENCES

MATH 345: Multivariate Distributions
Spring 2021 Graduate 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: Instruction will gear toward concepts and methods such as discrete and continuous multivariate distributions and their moments, multivariate distributions including multivariate normal and multinominal 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 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 2021 Office Hours and Emails

Required Textbooks:

Title	*Fundamentals of Probability with Stochastic Processes*
Author	Ghahramani
Edition	4th
Publisher	Pearson Prentice Hall
ISBN #	978-1498755092

University-wide Withdrawal Date:The last day to withdraw with a **W** is **Monday, April 5, 2021**. It will be strictly enforced.

COURSE GOALS

Student Learning Outcomes - On successful completion, sStudents 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.
- Gain ideas to do statistical computations.

Course Assessment: Understanding of the topics at the level at which one is able to apply the methods to do problem solving is assessed.

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:

Homework and Quizzes	15%
Class Participationa and Introduction (See rubic under Course Outline)	10%
Midterm Exams	35%
Final Exam	35%

Grading Scale: Your final letter grade will be **BASED ON A CURVE** that ensures at least few A's.

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.
• The use cell phones, beepers, or any sort of communication devices (text messaging, etc.) during classes and exams are not allowed.
• No eating allowed during the class and exams periods. You are expected to remain with the exam in Respondus the entire length of the exam time period. Wandering in and out of virtual class is not allowed.

Homework Policy: Homework is generally due within a week unless announced otherwise by the instructor. Solutions to the assignments will be handed out in Canvas and discussed as needed after the solutions by students are duly submitted. Late homework cannot be accepted, since the solutions are disclosed. Homework will count for 20% of the final grade.

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. Official announcements are made using NJIT student emails or emails provided by students to NJIT as official emails.

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. 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 will be evaluated negatively. 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.

Online Exam Policy: **Exams Instruction using Respondus Lockdown Monitor, Webcam, and Webex.**

Students have to install Lockdown Browser in order to take the exam using Lockdown Browser and will need a webcam and microphone (built in or external)

• URL for download: http://www.respondus.com/lockdown/download.php?id=264548414 (Links to an external site.)
• Locate the "LockDown Browser" shortcut on the desktop and double-click it. (For Mac users, launch "LockDown Browser" from the Applications folder.).
• Choose NJIT Canvas from the drop-down list.
• You will be brought to the NJIT Canvas login page within the LockDown Browser.
• Under "My courses," click on the course in which you would be taking the exam/quiz that requires the LockDown Browser.
• After you enter the course, find the exam or quiz and click on it.
Your NJIT ID is required for taking the Exams through Lockdown Browser and Respondus.

NOTE THAT YOU ARE REQUIRED TO STAY WITH RESPONDUS LOCK DOWN MONITOR WITH WEBCAM AND WEBEX UNTIL THE END OF EXAM. OTHER THAN YOUr BLANK PAPERS, MONITOR/PC/LAPTOP THERE SHOULD BE NOTHING ON THE TABLE ON WHICH YOU ARE TAKING EXAM. (No calculators either because a built in scientific calculator is provided via Respondus)

During this exam, you shouldn't access other resources (a tablet, notes, books, etc.) or communicate with other people. Please stay in your seat and focus on the computer screen until the exam is complete. If an interruption occurs, briefly explain what happened by speaking directly to your webcam. And, finally, remember that you cannot exit the exam until all questions are completed and submitted for grading until the allotted end of exam time. Don't wear sunglasses or hats with brims. Also, be sure to dress appropriately, as if you were in the classroom. Take the exam in a well-lit room and avoid backlighting, such as sitting with your back to a window. Hold your NJIT identification to the camera and select "Take Picture."

Students will be required to join a Webex meeting from their phone with their cameras on, and to access the exam through LockDown Browser on a Mac or Windows PC with webcam. Students must focus their phone camera on their hands and papers which give the exam solutions, and can be instructed to reposition the camera or show items of concern. Note that LockDown Browser does not work on Chromebooks, and there are significant number of technical problems with iPad use.

Download Canvas app on your phone. It will help you upload your exam work.

It is required we login to the Webex meeting using our cell phone in addition to the Respondus lock down monitor with webcam. The Webex link for classes including exam days will be provided in Announcements, Canvas. Note that your cell phone must provide authentication of yourself as an NJIT student, using your UCID and Password.

There will be a practice exam (not for grades) before the midterm exam.

Those who need practice to log in to the Webex meeting using phone can do so during office hours and also

during our class. THE PRACTICE EXAM (not for grades) USING RESPONDUS LOCK DOWN MONITOR AND WEBCAM WILL BE MADE AVAILABLE THROUGH CANVAS UNTIL THE DAY OF FINAL EXAM.
Please give your answer through Assignment (one will be created for this purpose by the instructor) in Canvas using the Assignment upload ONLY in the exams and not where the questions are described because it impossible to type math within this environment.

Exams: There will be one midterm exam held in class during the semester and one comprehensive final exam. Exams are held on the following days:

Midterm Exam	March 12, 2021
Final Exam Period	May 7 - 13, 2021

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: To properly report your absence from a midterm or final exam, please review and follow the required steps under the DMS Examination Policy found here:

- http://math.njit.edu/students/policies_exam.php

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

ADDITIONAL RESOURCES

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 Chantonette Lyles, Associate Director of Office of Accessibility Resources and Services at 973-596-5417 or via email at lyles@njit.edu. The office is located in Kupfrian Hall, Room 201. A Letter of Accommodation Eligibility from the Office of Accessibility Resources and Services 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/studentsuccess/accessibility/

Important Dates (See: Spring 2021 Academic Calendar, Registrar)

Date	Day	Event
January 19, 2021	T	First Day of Classes
January 23, 2021	S	Saturday Classes Begin
January 25, 2021	M	Last Day to Add/Drop Classes
March 14 - March 21, 2021	Su - Su	Spring Recess - No Classes
April, 2, 2021	F	Good Friday - No Classes
April 5, 2021	M	Last Day to Witdraw
May 4, 2021	T	Friday Classes Meet
May 4, 2021	T	Last Day of Classes
May 5 & May 6, 2021	W & R	Reading Days
May 7 - May 13, 2021	F - R	Final Exam Period

Course Outline

Lecture	Date	Chapter	Topic
1	1/19	4.2-4.6,	Random variables and distributions
2	7.4	5.1-5.3, 6.1- 6.3	Expectations and Variance
3	1/26	7.4	Gamma Distribution
4	1/29	8.1	Joint Distribution of Two Random Variables
5	2/2	8.2-8.4	Independent Random Variables; Conditional Distributions; Transformations of Two Random Variables
6	2/5	8.4	Transformations of Two Random Variables
7	2/9	11.1; 8.4	Moment generating functions; Transformations of Two Random Variables
8	2/12	9.1-9.2	Multivariate Distributions, Order statistics
9	2/16	9.2	Order statistics
10	2/19	9.3	The Multinomial Distribution
11	2/23	9.3	The Multinomial Distribution
12	2/26	10.1	Expected Values of Sums of Random Variables
13	3/2	10.2-10.3	Covariance; Correlation
14	3/5	10.4	Conditioning on Random Variables
15	3/9	Review for Midterm Exam	
16	3/12	Chapter-Sections(above) 4.2-10.4	**MARCH 12, FRIDAY, MIDTERM EXAM**
└▶	3/16 & 3/19	└▶	**SPRING RECESS: MARCH 14-21, 2021**
17	3/23	10.5	Bivariate Normal Distribution
18	3/26	10.5	Multivariate Normal
└▶	3/30	11.2	Sums of Independent Random Variables
19	4/2	**Good Friday**	**Good Friday Holiday**
20	4/6	11.2	Sums of Independent Random Variables
21	4/9	12.2	Poisson Processes
22	4/13	12.2 - Instructor's lecture notes	More on Poisson Processes –non homogeneous.
23	4/16	12.3	Markov Chains
24	4/20	12.3	Markov Chains
25	4/23	12.3	Markov Chains
26	4/27	12.3	Markov Chains (Branching Processes)
27	4/30	12.3	Markov Chains
28	5/4(Friday	12.3	**REVIEW FOR FINAL EXAM**

	Schedule)		
	FINAL EXAM: MAY 7-13, 2021		

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

Once the student names are uniquely identified, from there onwards each student will receive a score of 0 to 4 at the end of the each class according to the following criteria:

0. Absent. Sustained attention on laptop/electronic devices. Not participating in the class at all. Disruptive. 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. If this person were not a member of the class, valuable class-time would be saved.

1. Present, not disruptive. Tries to respond when called on but does not offer much. Demonstrates very infrequent involvement in discussion. This person says little or nothing in class. Hence, there is not an adequate basis for evaluation. If this person were not a member of the class, the quality of discussion would not be changed.

2. Demonstrates adequate preparation: knows basic facts, but does not show evidence of trying to interpret or analyze them. 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. 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. Demonstrates good preparation: knows covered course material well, has thought through implications of them. Offers interpretations and analysis of course material (more than just facts) to class. 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. Demonstrates consistent ongoing involvement. Contributions in class reflect thorough preparation. Ideas offered are usually substantive, provide good insights, and sometimes direction for the class. If this person were not a member of the class, the quality of discussion would be diminished.

4. Demonstrates excellent preparation: has analyzed covered course material exceptionally well, relating it to readings and other material (e.g., readings, course material, etc.). 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. 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. 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. If this person were not a member of the class, the quality of discussion would be diminished markedly.