NJIT New Jersey's Science & Technology University

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF MATHEMATICAL SCIENCES

MATH 665-102: Statistical Inference
Spring 2020 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: Review of sampling distributions. Data reduction principles: sufficiency and likelihood. Theory and methods of point estimation and hypothesis testing, interval estimation, nonparametric tests, introduction to linear models.

Number of Credits: 3

Prerequisites: MATH 662 or departmental approval.

Course-Section and Instructors

Course-Section	Instructor
Math 665-102	Professor S. Dhar

Office Hours for All Math Instructors: Spring 2020 Office Hours and Emails

Required Textbooks:

Title	*Introduction to Mathematical Statistics*
Author	Hogg, McKean, and Craig
Edition	8th
Publisher	Pearson
ISBN #	978-0134686998

University-wide Withdrawal Date:The last day to withdraw with a **W** is **Monday, April 6, 2020**. It will be strictly enforced.

COURSE GOALS

Course Objectives and Description: This course will focus on mathematical methods for statistical inference. Topics include: review of sampling distributions. Data reduction principles: sufficiency and likelihood. Theory and methods: point estimation and hypothesis testing, interval estimation, nonparametric tests, introduction to

linear models. Problem solving is emphasized. At least one birds-eye-view of the topic will be given. Methods material will be discussed, proofs given at the course level and few examples/problems of the topic covered will be demonstrated. Software will be used as a tool to motivate the subject matter.

Course Outcomes: On successful completion, students will be able to demonstrate understanding of the following topics:

- Read mathematical statistics methods.
- Do mathematical statistics problem solving.
- Gain ideas to do statistical computations.
- Use a data reduction method.
- Perform estimation techniques to capture information and develop analysis of data.
- Be conscientious of choosing the best method for problem solving.
- Consistency and asymptotic normality
- Delta method
- Maximum likelihood estimation
- Sufficiency
- Minimum variance unbiased estimation
- Hypothesis tests; uniformly most powerful tests; likelihood ratio tests

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	10%
Final Exam	10%
Midterm Exam I	25%
Midterm Exam II	25%
Final Exam	30%

Grading Scale: Your final letter grade will be **BASED ON A CURVE** that ensures at least few A's. Practice problems, HW and Quiz assignments are posted on Math 665 course Canvas page. Homework is generally due within a week unless announced otherwise by the instructor. Solutions to the assignments will be handed out in class and discussed. Late homework cannot be accepted, since the solutions are already handed out.

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.

Advice on how to read/ approach the materials: Always read the material covered in class again on your own immediately within the week. Reading means understanding each sentence in the class notes and textbook and then solving problems on them effectively on your own. Next, be able to solve most of the remaining related problems on your own.

Reference Materials:

- *Probability and Statistical Inference*, by Nitis Mukhopadhyay, 2000, Marcel and Dekker, Inc. ISBN: 0-824703790
- *Introduction to the Theory of Statistics*, by Mood, Graybill and Boes, Third edition.
- *Probability and Statistics*, by Morris H. DeGroot and Mark J. Schervish, Third Edition

- *A Course in Mathematical Statistics*, by George G. Roussas, Second Edition. (Has certain solutions to both odd and even problems)
- *Fundamentals of Probability*, by Saeed Ghahramani, Second Edition, Prentice Hall

Calculator: Bring a scientific basic calculator to all the lectures and exams. However, you are not allowed to bring calculators that have graphic display/ storage capacity (only simple calculators are allowed) in exams and quizzes.

Laptops: computers and other communication devices should remain closed during lecture time, exams and quizzes. Unless, accessing textbook/notes online.

Grading: Any complaints regarding grading have to be presented immediately after receiving the graded test or exam in-class.

Looking into your neighbors work: during exams and keeping eyes hidden using hats, caps, etc., from the proctor but not from the neighbors work during exams is not allowed.

Wandering in and out of the classroom is not allowed.

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

Midterm Exam I	February 25, 2020
Midterm Exam II	April 7, 2020
Final Exam Period	May 8 - 14, 2020

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: Disability Support Services (DSS) 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 Disability Support 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 Disability Support 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 Disability Support Services (DSS) website at:

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

Important Dates (See: Spring 2020 Academic Calendar, Registrar)

Date	Day	Event
January 21, 2020	T	First Day of Classes
January 31, 2020	F	Last Day to Add/Drop Classes

March 15 - 22, 2020	Su-Su	Spring Recess: No Classes/ University Open
April 6, 2020	M	Last Day to Withdraw
April 10, 2020	F	Good Friday - University Closed
May 5, 2020	T	Friday Classes Meet - Last Day of Classes
May 6 & 7, 2020	W & R	Reading Days
May 8 - 14, 2020	F - R	Final Exam Period

Course Outline

Week	Date	Topic
1	1/21	Chapter 5: CONSISTENCY AND LIMITING DISTRIBUTIONS. Convergence; central limit theorem; delta method; moment generating functions, including technique for proving distribution convergence.
2	1/28	Chapter 4: SOME ELEMENTARY STATISTICAL INFERENCES. Sampling and Statistics, Point and Interval Estimation.
3	2/4	Chapter 4: SOME ELEMENTARY STATISTICAL INFERENCES. Hypothesis Testing, Fundamental Concepts and Principles of Testing (Classification of Hypotheses, Test Functions, Critical Regions, Size and Power, p-value).
4	2/11	Chapter 6: MAXIMUM LIKELIHOOD METHODS. Rao-Cramer lower bound and efficiency, plug-in estimators, method of moments Sufficiency, Minimal Sufficiency, Completeness.
5	2/18	Chapter 6: MAXIMUM LIKELIHOOD METHODS. Maximum likelihood tests, multi-parameter case: estimation and testing
6	2/25	**MIDTERM I**
7	3/3	Chapter 7: SUFFICIENCY. Sufficient statistic and properties: Rao Blackwell, completeness and uniqueness.
8	3/10	Chapter 7: SUFFICIENCY. Minimum variance unbiased estimators, exponential family, functions of a parameter.
9	3/24	Chapter 8: OPTIMAL TESTS OF HYPOTHESES. Most powerful tests; Neyman-Pearson lemma.
10	3/31	Chapter 8: OPTIMAL TESTS OF HYPOTHESES. Uniformly most powerful tests; likelihood ratio tests; monotone likelihood ratio.
11	4/7	**MIDTERM II**
12	4/14	Chapter 9: INFERENCE ABOUT NORMAL LINEAR MODELS. Quadratic forms, ANOVA.
13	4/21	Chapter 9: INFERENCE ABOUT NORMAL LINEAR MODELS. Multiple Comparisons, A Regression Problem, Tests for Independence.
14	4/28	***REVIEW***

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: Student is absent (please give proof of extenuating circumstance). 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. If this person were not a member of the class, valuable class-time would be saved.

1: Student is present and not disruptive. Tries to respond when called on but does not offer much. 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. If this person were not a member of the class, the quality of discussion would not be changed.

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. If this person were not a member of the class, the quality of discussion would be diminished.

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. If this person were not a member of the class, the quality of discussion would be diminished markedly.

The average score out of the maximum of 4 is used to calculate the class participation score.