

# AMS 412: Mathematical Statistics

Spring 2023

## Course Information:

Instructor: Kai Li  
Office: Harriman Hall 132  
Class: Tue, Thu 6:30-7:50pm, Melville Lbry. E4320  
Email: [kai.li@stonybrook.edu](mailto:kai.li@stonybrook.edu)  
Office Hours: Tue, Thu 4:00-5:30pm (in person) or by appointment (online via Zoom)  
Course Page: Brightspace (<https://it.stonybrook.edu/services/brightspace>)

Graduate Teaching Assistant: Ziji Zhang  
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Office Hours: Wed, Fri 3:00-4:00pm (online via Zoom) or by appointment (online via Zoom)

**Course Description:** Estimation, confidence intervals, Neyman-Pearson lemma, likelihood ratio test, hypothesis testing, chi-square test, regression, analysis of variance, nonparametric methods. This course is the second part in a series of two courses (AMS 310/311 - AMS 412) which cover the fundamentals of mathematical statistics and statistical inference. AMS 412 focuses on the statistical inference part and covers topics such as decision theory, point estimation, interval estimation, hypothesis testing, regression, ANOVA, and nonparametric tests.

**Prerequisite:** AMS 311

**Textbook:** *John E. Freund's Mathematical Statistics with Applications* by Irwin Miller and Marylees Miller, 8th edition, 2012, Pearson

**Topics to be Covered:** Chapters 10, 11, 12, 13, 14, 15, and 16 from *John E. Freund's Mathematical Statistics with Applications*

**Homework:** Assignments will be given weekly, posted on Brightspace, to be turned in via Brightspace, as a single pdf file, and must be legibly composed. No late homework will be accepted and will be due at the beginning of class on the due date. If you want to correct your submission (before the deadline), you may upload a revision. Only your last submission will be graded. There will be approximately 11 homework sets, equally weighted. The lowest two homework scores will be dropped before computing your average.

You may discuss homework problems with other students taking the course and with the instructor and teaching assistant. The work that you turn in should always be your own write-up, and you should show that you personally understand everything that you write. You are not to view other student writeups or use them (or use internet resources) while writing your own solution. Please make certain that your writing is neat and clear (if handwritten), and that you have expressed your reasoning.

**Exam:** There will be three in-person exams. Midterm 1 will be during class, tentatively scheduled for Tuesday, February 28. Midterm 2 will be during class, tentatively scheduled for Thursday, April 6, and is noncumulative. The final will be held during the University-assigned date/time, on Wednesday, May 9, 5:30-8:00pm, and is cumulative, but will emphasize more on the recent

material; unless otherwise announced, the location will be our regular classroom (Melville Lbry. E4320). All exams are closed books and closed notes. All necessary formulas, theorems, and statistical values will be provided on the exams. You can use a nongraphing calculator, but no computer or communication devices (e.g. Apple Watch, calculator with a CAS, etc.) are allowed.

**Grading Policy:** Your total average score will be calculated based on 15% homework, 25% midterm 1, 25% midterm 2, and 35% final.

**Learning Outcomes:** By the end of this course, students should successfully be able to:

- Calculate and evaluate point estimators.
- Formulate, construct and interpret confidence intervals about parameters in a statistical model.
- Formulate statistical hypotheses, construct appropriate hypotheses tests and interpret results.
- Formulate linear regression models, fit these models and interpret the results.
- Formulate one-way ANOVA models, fit these models and interpret the results.
- Construct distribution-free hypotheses testing procedures.

**Student Accessibility Support Center Statement:** If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, Stony Brook Union Suite 107, (631) 632-6748, or at [sasc@stonybrook.edu](mailto:sasc@stonybrook.edu). They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

**Academic Integrity Statement:** Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Professions, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at [http://www.stonybrook.edu/commcms/academic\\_integrity/index.html](http://www.stonybrook.edu/commcms/academic_integrity/index.html)

**Critical Incident Management:** Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Student Conduct and Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.

### Tentative Course Schedule

| Week | Date      | Chapter | Topic  | Notes         |
|------|-----------|---------|--|---------------|
| 1    | Tue. 1/24 | Ch10    | Introduction, Unbiasedness   |               |
|      | Thu. 1/26 | Ch10    | Efficiency   | HW1 due 2/2   |
| 2    | Tue. 1/31 | Ch10    | Consistency  |               |
|      | Thu. 2/2  | Ch10    | Sufficiency  | HW2 due 2/9   |
| 3    | Tue. 2/7  | Ch10    | Robustness, Method of Moments                                      |               |
|      | Thu. 2/9  | Ch10    | Method of Maximum Likelihood                                       | HW3 due 2/16  |
| 4    | Tue. 2/14 | Ch11    | Introduction, Estimation of Means                                  |               |
|      | Thu. 2/16 | Ch11    | Estimation of Differences Between Means                            | HW4 due 2/23  |
|      |           |         | Estimation of Proportions,   |               |
| 5    | Tue. 2/21 | Ch11    | Differences Between Proportions,                                   |               |
|      |           |         | Variances and the Ratio of Two Variances                           |               |
|      | Thu. 2/23 | Ch12    | Introduction,  |               |
|      |           |         | Testing a Statistical Hypothesis                                   |               |
| 6    | Tue. 2/28 |         | Midterm 1  |               |
|      | Thu. 3/2  | Ch12    | Neyman-Pearson Lemma   | HW5 due 3/9   |
| 7    | Tue. 3/7  | Ch12    | Power Function of a Test   |               |
|      | Thu. 3/9  | Ch12    | Likelihood Ratio Tests   | HW6 due 3/21  |
| 8    | Tue. 3/14 |         | No Class (Spring Break)  |               |
|      | Thu. 3/16 |         | No Class (Spring Break)  |               |
| 9    | Tue. 3/21 | Ch13    | Introduction, Tests Concerning Means and Differences Between Means | HW7 due 3/28  |
|      | Thu. 3/23 | Ch13    | Tests Concerning Variances and Proportions                         |               |
| 10   | Tue. 3/28 | Ch13    | Tests Concerning Differences Among $k$ Proportions                 | HW8 due 4/4   |
|      | Thu. 3/30 | Ch13    | The Analysis of an $r \times c$ Table                              |               |
|      |           |         | Goodness of Fit  |               |
| 11   | Tue. 4/4  | Ch14    | Introduction, Linear Regression                                    |               |
|      | Thu. 4/6  |         | Midterm 2  |               |
| 12   | Tue. 4/11 | Ch14    | Method of Least Squares  | HW9 due 4/20  |
|      | Thu. 4/13 | Ch14    | Normal Regression Analysis   |               |
| 13   | Tue. 4/18 | Ch14    | Normal Correlation Analysis  |               |
|      | Thu. 4/20 | Ch15    | Introduction, One-Way Designs                                      | HW10 due 4/27 |
| 14   | Tue. 4/25 | Ch15    | One-Way Designs  |               |
|      | Thu. 4/27 | Ch16    | Introduction, The Sign Test  | HW11 due 5/4  |
|      |           |         | The Signed-Rank Test   |               |
|      |           |         | Rank-Sum Tests: The $U$ Test                                       |               |
| 15   | Tue. 5/2  | Ch16    | Rank-Sum Tests: The $H$ Test                                       |               |
|      |           |         | The Rank Correlation Coefficient                                   |               |
|      | Thu. 5/4  | Ch16    | Review   |               |
| 16   | Tue. 5/9  |         | Final  | 5:30-8:00pm   |