ISyE 6412 Theoretical Statistics
Fall 2026, Syllabus

Course Information

- **Instructor:** Sen Na (senna@gatech.edu)
- **Course Prefix and Number:** ISYE 6412
- **Term:** Fall 2026

Course Description

This course provides a rigorous, proof-based introduction to theoretical statistics. Topics include statistical decision theory; sufficiency, completeness, ancillarity, and exponential families; unbiased and equivariant estimation; Bayes, empirical Bayes, and minimax methods; the James–Stein phenomenon; the Neyman–Pearson framework, optimal tests, confidence intervals, and testing with nuisance parameters; and large-sample theory for maximum likelihood and M-estimators. The course also covers asymptotic efficiency, superefficiency, local asymptotic minimax theory, and likelihood-based tests. Students are expected to have completed a graduate-level course in probability or mathematical statistics and to possess strong mathematical maturity.

Course Learning Outcomes

By the end of this course, students will be able to:

1. Formulate statistical problems using decision rules, loss functions, estimators, and tests.
2. Derive and evaluate sufficient statistics, optimal estimators, and tests in parametric models.
3. Establish consistency, asymptotic normality, efficiency, and minimax properties.
4. Analyze Bayes, minimax, and asymptotic optimality properties of statistical procedures.

Required Course Materials

No single textbook purchase is required. Assigned readings and examples may be drawn from the following references:

[1] Keener, R. W. **Theoretical Statistics: Topics for a Core Course**. Springer, 2010. https://doi.org/10.1007/978-0-387-93839-4.

[2] Lehmann, E. L., and Casella, G. **Theory of Point Estimation**, 2nd ed. Springer, 1998. https://doi.org/10.1007/b98854.

[3] van der Vaart, A. W. **Asymptotic Statistics**. Cambridge University Press, 1998. https://doi.org/10.1017/CBO9780511802256.

[4] Lehmann, E. L., and Romano, J. P. **Testing Statistical Hypotheses**, 3rd ed. Springer, 2005. https://doi.org/10.1007/0-387-27605-X.

Software: Most assignments emphasize mathematical derivations and proofs. R, Python, or another suitable language may be used for occasional numerical experiments or simulations.

Grading Policy

Grades will be based on the following components:

Component	Weight
Participation	5%
Homework	25%
Midterm 1	25%
Midterm 2	35%
Scribe notes	10%

Letter grades are assigned according to the following scale:

Grade	Score
A	≥ 90
B	80–89
C	70–79
D	60–69
F	< 60

Homework. Homework will be assigned periodically and submitted electronically through Canvas. Late homework will not be accepted except in connection with approved accommodations or documented circumstances. Students may collaborate, but each student must prepare and submit an individual solution.
Exams. The course includes two in-class midterm examinations, weighted 25% and 35%, respectively. Exams are open notes and open book. Exam details will be announced on Canvas.
Scribe notes. Students will work individually or in small groups to prepare polished LaTeX notes for an assigned lecture using the course template. The notes should accurately organize the lecture material and will be made available to the class.

Attendance Policy

Regular attendance and constructive participation are expected. Students are responsible for material and announcements missed during an absence. Documented accommodations and approved absences will be honored in accordance with Georgia Tech policy.

Academic and Research Honesty/Integrity Statement

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review the Student Code of Conduct and the Academic Honor Code. Suspected violations will be referred to the Office of Student Integrity.

All submitted work must reflect the student's own understanding and effort and must properly acknowledge outside sources. AI tools may be used for brainstorming, grammar checking, and other supportive tasks, but their use must be disclosed. Students remain responsible for the validity of submitted work, and AI-generated content may not be presented as original work.

Core IMPACTS

Not applicable.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services as soon as possible to discuss your needs and obtain an accommodations letter. Please also contact the instructor to arrange implementation of approved accommodations.

Expectations of Advisors and Advisees

At Georgia Tech, we believe that it is important to foster an atmosphere of mutual respect, acknowledgment, and responsibility between faculty members and students. The Student-Faculty Expectations Agreement articulates the basic expectations that students and faculty may have of one another. Respect for knowledge, hard work, and cordial interactions will help build the environment we seek.