# Math 60061/70061-001: Mathematical Statistics I

Tsung-Heng Tsai

Fall 2021

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Office Hours: TR 1:00-2:00 p.m. (*online*)
Office: MSB 372

Web: tsunghengtsai.github.io/mathstat1-F21
Class Hours: TR 9:15-10:55 a.m.
Class Room: *online*

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## Course Description

This is the first course of the two-semester Mathematical Statistics sequence, which covers the essential mathematics for work in statistics, the mathematical methods for statistical inference, and the approaches for evaluating the efficacy of inferential procedures. Topics of this course include: probability distributions, sampling distributions, inequalities, limit theorems, convergence, principles of data reduction, and fundamental concepts in statistical inference.

## Prerequisites

You should have completed Math 42002 or Math 52002 with a C or better. If you are enrolled in 70061, you must have doctoral standing. Students who do not have the proper prerequisites risk being deregistered from the class. Please contact instructor if you would like to take the course, but do not satisfy the prerequisite.

## References

There is no required textbook. Course notes will be provided throughout the course. Useful references are:

1. George Casella and Roger L. Berger. *Statistical Inference*, Duxbury Press, 2002.
2. Larry Wasserman. *All of Statistics: A Concise Course in Statistical Inference*, Springer, 2004.
3. John I. Marden. *Mathematical Statistics: Old School*, CreateSpace Independent Publishing Platform, 2017.

## Course Format

The course is offered remotely during August 26, 2021 through December 12, 2021. Every week, there are recorded video lectures for classes on Tuesday and Thursday. The videos and notes will be available on Blackboard. The instructor will hold online meetings through Blackboard Collaborate Ultra at class hours (i.e., TR 9:15-10:55 a.m.), to answer questions and/or discuss extra examples. Attendance to online sessions is optional, but highly encouraged.

# Course Policy

Important policy for this course is detailed below.

## Grading

Grades will be calculated as follows:

- Homework assignments: 20%
- Midterm exam 1: 20% (Tuesday October 5)
- Midterm exam 2: 20% (Tuesday November 9)
- Final exam: 40% (Tuesday December 14)

The final letter grades will follow the usual scale: A=90-100; B=80-89; C=70-79; D=60-69; F=0-59. Plus and minus grades will be given at discretion of the instructor.

## Homework

There will be approximately 6 homework assignments that will be posted on Blackboard. Assignments must be uploaded to Blackboard as a **PDF** file. You can either type your homework solutions or write them on papers and upload the scanned version. In any case, please make sure your work is clearly presented.

Assignments are due at the beginning of class hour on the specified date. In general, **NO** late submissions will be accepted. In case of truly exceptional situations (e.g., family emergencies or illness), the instructor may make exceptions and allow late submission. The lowest homework score will be dropped at the end of the semester.

## Exams

There will be three exams: two midterm exams and one comprehensive final exam (dates mentioned above). Each exam will be posted on Blackboard at 9:15 a.m. on the exam day, and you have to upload your solutions as a **PDF** file to Blackboard by 11:59 p.m. the next day (so you have more than one and a half days to work on the exam). You can either type your solutions or write them on papers and upload the scanned version. In any case, you should make sure your work is clearly presented. Each exam will take approximately 2 hours to finish, but you can spend as much time as you want during the period. The exams are open-book, so you can consult the textbook, notes, etc. during the exam. However, **you are not allowed to discuss with other students and the submitted work must be your own**.

## Re-grades of Homeworks and Exams

All re-grading requests should be made in writing, within one week after receiving a grade. The request should state the specific question that needs to be re-graded, as well as a short explanation of why re-grading is necessary. The new grade may be lower than the original grade.

## Academic Integrity

University policy 3-01.8 deals with the problem of academic dishonesty, cheating, and plagiarism. None of these will be tolerated in this class. The sanctions provided in this policy will be used to deal with any violations. If you have any questions, please read the policy at http://www.kent.edu/policyreg/administrative-policy-regarding-student-cheating-and-plagiarism and/or ask.

## Accommodations for Students with Disabilities

Kent State University is committed to inclusive and accessible education experiences for all students. University Policy 3342-3-01.3 requires that students with disabilities be provided reasonable accommodations to ensure equal access to course content. Students with disabilities are encouraged to connect with Student Accessibility Services as early as possible to establish accommodations. If you anticipate or experience academic barriers based on a disability (including mental health, chronic medical conditions, or injuries), please let me know immediately.

Student Accessibility Services (SAS) Contact Information:

- Location: University Library, Suite 100
- Email: sas@kent.edu
- Phone: 330-672-3391; VP 330-968-0490
- Web: www.kent.edu/sas

## Registration Requirement

The official registration deadline for this course is September 1, 2021. University policy requires all students to be officially registered in each class they are attending. Students who are not officially registered for a course by published deadlines should not be attending classes and will not receive credit or a grade for the course. Each student must confirm enrollment by checking his/her class schedule (using Student Tools in FlashLine) prior to the deadline indicated. Registration errors must be corrected prior to the deadline.

## Withdrawal

The last day to drop without a grade of "W" is September 8, 2021. The last day to withdraw this course is November 3, 2021. Other important Registrar dates can be found at http://www.kent.edu/registrar/registrar-dates-term.

## Tentative Schedule

The schedule is subject to change and will be updated at the course website (https://tsunghengtsai.github.io/mathstat1-F21.html), so please check it regularly.

### Week 01, 08/23 - 08/27: Syllabus

*Class begins on August 26.*

### Week 02, 08/30 - 09/03: Probability and Random Variables

Topics:

- Axioms of probability
- Conditional probability and independence
- Random variables
- Distribution functions

### Week 03, 09/06 - 09/10: Transformations and Expectations

Topics:

- Transformations
- Expectations
- Moments and moment generating functions

### Week 04, 09/13 - 09/17: Families of Distributions

Topics:

- Useful distributions
- Exponential families
- Location and scale families

### Week 05, 09/20 - 09/24: Multiple Random Variables

Topics:

- Joint and marginal distributions
- Conditional distributions and independence
- Covariance and correlation

### Week 06, 09/27 - 10/01: Multivariate Distributions

Topics:

- Hierarchical models and mixture distributions
- Conditional expectation
- Multivariate distributions

### Week 07, 10/04 - 10/08: Midterm Exam I

*Exam due 11:59 p.m. on October 6 (handed out 9:15 a.m. on October 5)*

### Week 08, 10/11 - 10/15: Inequalities

Topics:

- Probability inequalities
- Inequalities for expectations

*Fall Break. No class on October 14*

### Week 09, 10/18 - 10/22: Properties of a Random Sample

Topics:

- Population, random samples, statistics
- Sampling distributions

### Week 10, 10/25 - 10/29: Derived Distributions and Order Statistics

Topics:

- Student's $t$ and Snedecor's $F$
- Order statistics

### Week 11, 11/01 - 11/05: Convergence

Topics:

- Types of convergence
- Law of large numbers

### Week 12, 11/08 - 11/12: Midterm Exam II

*Exam due 11:59 p.m. on November 10 (handed out 9:15 a.m. on November 9)*

*Veterans Day Observed. No class on November 11, 2021*

### Week 13, 11/15 - 11/19: Convergence in Distribution

Topics:

- Central limit theorem
- The Delta method

### Week 14, 11/22 - 11/26: Sufficiency

Topics:

- Data reduction principles
- Sufficient statistics

*Thanksgiving Break. No class on November 25, 2021*

### Week 15, 11/29 - 12/03: Sufficiency

Topics:

- Minimal sufficiency
- Completeness

### Week 16, 12/06 - 12/10: Statistical Inference

Topics:

- Point estimation
- Hypothesis testing
- Interval estimation

### Week 17, 12/13 - 12/17: Final Exam Week

*Exam due 11:59 p.m. on December 15 (handed out 9:15 a.m. on December 14)*