M378K Syllabus

M378K/SDSM378: Introduction to Mathematical Statistics - Spring 2025 - Syllabus

COURSE-SPECIFIC INFORMATION

Welcome to M378K! I am excited to teach this class and I hope you are excited to take it.

Let's take a moment to institute the purpose of this course as I see it. I hope to establish an inquisitive and supportive environment enabling you to seek answers and grow as a mathematician. Today, statistics and data science are at a revolutionary stage and ubiquitous in our everyday life. I want you to walk out of this course having mastered the basics their theoretical underpinnings allowing you to appreciate both their strengths and limitations. Your responsibility will be to embrace the journey. My job will be to support you on your journey by designing meaningful activities, leading you through interactive lectures, and providing frequent feedback on your progress. You all bravely took the first step of enrolling in this challenging course. Stay curious and engaged and ALL of you will excel!

Here is some information and some ground rules. Read carefully and let me know if there is anything unclear **by the twelfth day of classes, i.e., January 29th, 2024**.

Basic info

Course number. M378K/SDS378 (unique: 54555/57800)

Course meets. MWF 1pm - 1:50pm in PMA 5.104

Instructor. Milica Čudina; my office is PMA 13.142 (2515 Speedway, Austin, TX 78712).

Email. It's best to use Canvas to email me; my email address is mcudina@math.utexas.edu. Please allow at least 48 hours for your email to be responded to.

Office Hours. MWF 11am-11:50am in PMA 13.142.

Course info

Course description. Sampling distributions of statistics, estimation of parameters (confidence intervals, method of moments, maximum likelihood, comparison of estimators using mean square error and efficiency, sufficient statistics), hypothesis tests, and other topics.

This is the first course in mathematical statistics and is taught from a classical viewpoint. The major topics are: estimation of parameters, including maximum likelihood estimation; sufficient statistics, and confidence intervals; testing of hypotheses; the distributions and other properties of some statistics that occur in sampling from normal populations; Bayesian statistics. The course is designed to give students some insight into the theory behind the standard statistical procedures and also to prepare continuing students for the graduate courses. Within the limits of the prerequisites, students are expected to reproduce and apply the theoretical results; they are also expected to be able to carry out some standard statistical procedures.

Learning outcomes.

- Augmenting the proficiency with various discrete and continuous distributions common in applications.
- Establishing the basics of statistical analysis needed to proceed to more involved courses later on in the curriculum.
- Deploying simulations to better understand statistical procedures.
- Assessing the quality of an estimator based on various criteria.
- Gaining insight in capabilities and limitations of statistical inference.
- Acquisition of principles of statistical inference both in terms of skills necessary to perform a simple statistical analysis and in terms of critical thinking when faced with others' conclusions (say, in the press).

Prerequisites. The formal prerequisite is the grade C- or better in M362K.

Lectures online. This class is using the *Lectures Online* recording system. This system records the audio and video material presented in class for you to review after class. Links for the recordings will appear in the *Lectures Online* tab on the Canvas page for this class. You will find this tab along the left side navigation in Canvas.

To review a recording, simply click on the Lectures Online navigation tab and follow the instructions presented to you on the page. You can learn more about how to use the Lectures Online system at http://sites.la.utexas.edu/lecturesonline/students/how-to-access-recordings/.

You can find additional information about Lectures Online at: https://sites.la.utexas.edu/lecturesonline/.

Class format and attendance. Attendance for the purposes of grading will **not** be taken. However, regular attendance is strongly recommended. In case you need to be absent, you are responsible for covering the missed material independently. Class notes will be provided on the course website. As noted above, we will be using the *Lectures Online* recording system. There will be **no** synchronous online option for this course. You are strongly encouraged to stay home if you are sick or contagious, not only to stop the spread of disease but also to promote your personal wellness. I view this class as a community of learners. We cannot learn effectively when we are ill. Please, take care of yourselves and your classmates.

Here are some university resources on COVID-19.

If **students** are isolating, too sick to attend class, or experiencing another type of absence, they should:

- contact the Student Emergency Services immediately, and
- email the instructor as soon as they feel well enough to do so.

If the **instructor** is isolating, or too sick to attend class, she will do her best to change class modality to Zoom (with an alternative instructor if the situation calls for such drastic measures and if it's possible).

The class meetings consist of interactive lectures, coding demonstrations, and problem solving. In short, the course will incorporate a lot of active learning in class. Thus, if you miss class, you miss out on these learning opportunities. Please, come to class as much as possible.

Textbook. There is no required textbook. Lecture notes authored by Dr. Gordan Zitkovic are available here. The students in need of an additional source of problems (or explanation) are referred to *Mathematical Statistics with Applications* by D. Wackerly, W. Mendenhall and R. Scheaffer (7th ed) and *Mathematical Statistics with Applications in R* by K. Ramachandran and C. Tsokos (3rd ed).

Required devices. You will need access to a computer to be able to upload your homework to Canvas and to view class recordings if necessary.

Online resources.

1. **Course website**: https://mcudina.github.io/page/M378K/M378K.html. I recommend bookmarking this course site in your default browser for easy access.
2. **Canvas** will be used in this course to keep track of grades and for communication purposes. The students are responsible for the content of these announcements. The easiest way not to miss any is to turn on (i.e., not turn off) *Announcements* in their account's *Notification* menu.
3. **Ed Discussion** will be used for informal class discussion. The system is highly catered to getting you help fast and efficiently from classmates and myself. Rather than emailing questions to the instructor, I encourage you to post your questions on Ed Discussion. It is accessible via the menu on the left-hand side in Canvas.

Sharing of Course Materials is Prohibited. No materials used in this class, including, but not limited to, lecture hand-outs, videos, assessments (quizzes, exams, papers, projects, homework assignments), in-class materials, review sheets, and additional problem sets, may be shared online or with anyone outside of the class unless you have my explicit, written permission. Unauthorized sharing of materials promotes cheating. It is a violation of the University's Student Honor Code and an act of academic dishonesty. Any materials found online that are associated with you, or any suspected unauthorized sharing of materials, will be reported to Student Conduct and Academic Integrity in the Office of the Dean of Students. These reports can result in sanctions, including failure in the course.

Class Recordings. Class recordings are reserved only for students in this class for educational purposes and are protected under FERPA. The recordings should not be shared outside the class in any form. Violation of this restriction by a student could lead to Student Misconduct proceedings.

Assessment and grading

Homework assignments. Homework assignments will be available on the course website or in Canvas. You will be uploading your solutions using Canvas. Please, have your solutions in order and number the pages. Having read and understood this First-Day Handout in its entirety will count as the zeroth homework assignment. To get the credit, read this entire document with understanding by the homework deadline. Not handing in this assignment does not exempt you from abiding by this First-Day Handout. **Since life can be unpredictable, and situations may arise that impact your ability to hand in the homework in time, the lowest three homework scores will be dropped. Since the homework solutions will be posted on Canvas after the due date, no late homework assignments will be accepted. The homework assignments and their due dates will be announced as the term progresses.**

No late homework assignments are accepted except in dire circumstances at the sole discretion of the instructor.

In-term exams. There will be three in-term exams. All will be **individual** and conducted **in-person** in our classroom. The exam coverage will be shared on the course website ahead of the exam itself. If you miss an exam due to illness or other extenuating circumstances, the final exam will take the weight of the in-term exam you missed (on top of its original weight). If you miss more than one in-term exam, you are strongly encouraged to seek assistance from the Office of the Dean of Students to explore what your options are in such a dire situation.

You *should* bring a sufficient amount of paper to work on and hand-in your solutions on to the exams. You **must not** bring books, notes, manuals, anything containing solved problems to the exams. Calculators are are not outlawed but the exams will be designed in such a way that you will not need them.

The Pre-Final Grade. The pre-final grade is composed as follows:

Assignment	Percentage of final grade
Homework	22%
In-term exams	78% (26% each)

If you are satisfied with your course grade (see table below) based on your pre-final performance, you can opt out of the final exam by contacting me. If you missed any of the in-term exams, you are required to take the final exam. If you do not opt out of the final exam, your final-exam score **will** be incorporated in the calculation of the final score in the course as described below.

The Final Exam. The final exam is going to be comprehensive. That means that any material covered in class or assigned as reading can (and probably will) appear. The comprehensive final exam will take place in our regular classroom on **Monday, May 5, 1:00 pm-3:00 pm**.

Final grade. The final grade is composed as follows:

Assignment	Percentage of final grade
Homework	16%
In-term exams	54% (18% each)
The final exam	30%

There is *no curve* in this class and the letter grades are assigned according to the following table:

A	A-	B+	B	B-	C+	C	C-	D+	D	D-
94-100	90-94	86 - 90	82 - 86	78 - 82	74 - 78	70 - 74	65 - 70	60 - 65	55 - 60	50 - 55

GENERAL, UNIVERSITY- or STATE-MANDATED INFORMATION

Drop dates. The procedure/consequences are different, depending on whether you drop before or after the 4th day of classes (01/16), and then, before or after the *main drop (Q-drop) date* (04/16). (See https://ugs.utexas.edu/vick/academic/adddrop for details)

Students with Disabilities. The University of Texas at Austin provides upon request appropriate academic accommodations for qualified students with disabilities. If you have a documented disability and you need specific support as a result of your disability, please let me know as soon as possible, but definitely within the first 3 weeks of class. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 (TTY), 1-866-329- 3986 (video phone) or go to http://ddce.utexas.edu/disability/

Counseling and mental health. Counseling and other mental-health services are available from **Counseling and Mental Health Center**, Student Services Bldg (SSB), 5th Floor. (hours: M–F 8am–5pm. phone: 512 471 3515, web: http://www.cmhc.utexas.edu)

Religious holy days. Religious holy days sometimes conflict with class and examination schedules. Sections 51.911 and 51.925 of the Texas Education Code relate to absences by students and instructors for observance of religious holy days.

Section 51.911 states that a student who misses an examination, work assignment, or other project due to the observance of a religious holy day must be given an opportunity to complete the work missed within a reasonable time after the absence, provided that they have properly notified each instructor.

It is the policy of The University of Texas at Austin that the student must notify each instructor at least fourteen days prior to the classes scheduled on dates he or she will be absent to observe a religious holy day. For religious holidays that fall within the first two weeks of the semester, the notice should be given on the first day of the semester. The student may not be penalized for these excused absences but the instructor may appropriately respond if the student fails to complete satisfactorily the missed assignment or examination within a reasonable time after the excused absence.

Title IX Reporting/SB 212. Texas *Senate Bill 212* requires all employees of Texas universities, including faculty, report any information to the Title IX Office regarding sexual harassment, sexual assault, dating violence and stalking that is disclosed to them. Your instructor in a **mandatory reporter**. By law, your instructor must be fired if she does not report. Our Student Ombuds is confidential. Additionally, if you wish to speak with someone who can provide support **without** making an official report to the university, contact a confidential case manager by emailing advocate@austin.utexas.edu. Case managers can also provide support, resources, and accommodations for pregnant, nursing, and parenting students.

For more information about reporting options and resources, please visit: https://titleix.utexas.edu, contact the Title IX Office via email at titleix@austin.utexas.edu, or call 512-471-0419.

Sanger Learning Center. All students are welcome to take advantage of Sanger Center's classes and workshops, private learning specialist appointments, peer academic coaching, and tutoring for more than 70 courses in 15 different subject areas. For more information, please visit http://www.utexas.edu/ugs/slc or call 512-471-3614 (JES A332).

Important Safety Information. Here is a comprehensive list of Safety, Health and Security Resources

Occupants of buildings on The University of Texas at Austin campus are required to evacuate buildings when a fire alarm is activated. Alarm activation or announcement requires exiting and assembling outside.

- Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building.
- Students requiring assistance in evacuation shall inform their instructor in writing during the first week of class.
- In the event of an evacuation, follow the instruction of faculty or class instructors. Do not re-enter a building unless given instructions by the following: Austin Fire Department, The University of Texas at Austin Police Department, or Fire Prevention Services office.
- Link to information regarding emergency evacuation routes and emergency procedures can be found at: http://www.utexas.edu/emergency

Academic (dis)Honesty. Students who violate University rules on academic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University. Since such dishonesty harms the individual, all students, and the integrity of the University, policies on academic dishonesty will be strictly enforced. For further information, please visit the Student Conduct and Academic Integrity website at: http://deanofstudents.utexas.edu/conduct For a more detailed document, please consult: https://catalog.utexas.edu/general-information/appendices/appendix-c/student-conduct-and-academic-integrity/ Please, pay particular attention to the section on *plagiarism.*

This syllabus is subject to change. If you have to miss class, please make sure to check in with a classmate to learn of any updates that were made in your absence. .

The SCHEDULE of CLASSES (The Sections Refer to the Pitman text)

Date	Weekday	Topic
1/13/2025	Mon	Orientation.
1/15/2025	Wed	Probability spaces. Discrete random variables.
1/17/2025	Fri	More on discrete random variables.
1/22/2025	Wed	Even more on discrete random variables.
1/24/2025	Fri	Expectation and variance.
1/27/2025	Mon	Random variables (continuous). The normal distribution.
1/29/2025	Wed	Random variables (continuous). Cumulative distribution function (CDF).
1/31/2025	Fri	More on the CDF.
2/3/2025	Mon	Even more on the CDF.
2/5/2025	Wed	Random vectors.
2/7/2025	Fri	More on random vectors.
2/10/2025	Mon	Transformations of random variables.
2/12/2025	Wed	*In-Term One*
2/14/2025	Fri	More on transformations of random variables. The χ^2-distribution.
2/17/2025	Mon	Moment generating functions.
2/19/2025	Wed	More on the moment generating functions.
2/21/2025	Fri	More on the normal distribution.
2/24/2025	Mon	De Moivre-Laplace.
2/26/2025	Wed	The Central Limit Theorem.
2/28/2025	Fri	More on limit theorems.
3/3/2025	Mon	The statistical set-up. Order statistics.
3/5/2025	Wed	Sampling distributions.
3/7/2025	Fri	Estimators. Bias.
3/10/20245	Mon	Mean squared error (MSE).
3/12/2025	Wed	*In-Term Two*
3/14/2025	Fri	More on the MSE.
3/24/2025	Mon	Confidence intervals.
3/26/2025	Wed	More on confidence intervals.
3/28/2025	Fri	Even more on confidence intervals.
3/31/2025	Mon	Approximate confidence intervals for the population proportion. Confidence intervals for the variance.
4/2/2025	Wed	Confidence intervals for the mean with the variance unknown.
4/4/2025	Fri	More on the $t-$procedures. Relative efficiency.
4/7/2025	Mon	Consistency. Maximum likelihood estimators (MLE).
4/9/2025	Wed	More on MLE.
4/11/2025	Fri	Sufficient statistics.
4/14/2025	Mon	More on sufficient statistics.
4/16/2025	Wed	Hypothesis testing. $p-$value.
4/18/2025	Fri	Tests for the mean.
4/21/2025	Mon	Hypothesis testing practice.
4/23/2025	Wed	*In-Term Three*
4/25/2025	Fri	Bayesian statistics.
4/28/2025	Mon	Bayesian statistics.