

## MTH741: Statistical Inference I, Fall 2020

Instructor: Songfeng (Andy) Zheng

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Room and Time: Tue/Thur: 9:30am---10:45am, Cheek Hall 171 (Tue) & Zoom (Thur)

Office and Hours: Cheek 22M, 9:00am – 11:00am, Monday; or by appointment for a zoom meeting.

**Textbooks:** No textbook required, and lecture notes will be available.

**Course webpage:**

<http://people.missouristate.edu/songfengzheng/Teaching/MTH741F20.htm> will provide the download of various course materials, including the lecture notes, homework assignments, announcements, and data for exercises.

**Objectives & Prerequisites:** The course MTH 741 will lay out the basics of modern probability theory. The prerequisite is reasonable mathematical maturity, for example, students should be proficient in conducting integral, dealing infinite series, reading/writing mathematical proof. This course is required for all graduate students in statistics. After taking this course, students are expected to understand the basic of modern probability theory, familiar with difference modes of convergence in probability, and understand the famous theorems in modern probability.

**Materials to be covered (tentative):** The contents include sigma algebra, axioms of probability, Riemann-Stieltjes integral, brief review of discrete and continuous probability measures, expectation and variances, moments and moment generating functions. Convergence in probability, weak law of large numbers and variations, concentration inequalities and large deviation; Borel-Cantelli theorem, almost sure convergence, and strong law of large numbers. Glivenko-Cantelli theorem, law of iterated logarithm. Convergence in law and central limit theorem. Kolmogorov complexity and explanation of randomness.

**Grading Policy and Studying Suggestions:**

Homework: 25%      In-class Tests: 30%      Final Exam: 45%

Grading policy: A (>90%) B (80 --- 89%) C (70 --- 80%) D (60 – 70%), F(<60%)

Final Exam date: Thursday, December 10, 8:45 am to 10:45 am

It is important that you read the lecture notes regularly, understand the problems worked out in the text and practice by doing the problems. Doing the homework problems is absolutely essential to get a better grade in this course. You are allowed to discuss the homework problems among yourselves or with me. However the final work handed in must be completely your own. Anyone who receives or gives an unauthorized aid on a homework or test is considered to be cheating.

No make-up test or exam will be given under ordinary conditions. The only acceptable excuse for missing a test is an extreme emergency. However, you must obtain a written explanation from a physician, etc. If you cannot take the test on the scheduled day, you must contact me before the test date.

### **Emailing format:**

Email is an important means to communication in everyday life as well as in this course. Due to the large amount of emails sent to me every day, and due to different courses I am teaching, I suggest you clearly write a subject in the email, and in the subject, clearly tell which course you are from. For example, a good email subject would be like

*Subject: MTH 741: Q about #7 in HW2*

Thus, I can quickly locate your problem and will reply quickly. Emails which don't have a clear subject may be simple ignored!

### **Course Plan:**

Due to the serious situation of COVID-19, we will choose blended form for this course. We will meet in classroom on Tuesday and will have zoom meeting (meeting ID: 724 341 372) on Thursday. If the COVID-19 situation gets worse, and if the city of Springfield gives another stay-at-home order, we will have to conduct the rest of the lectures on zoom. I will still update the course webpage even if we have online classes.

Please download and install Zoom onto your computer, phone, or tablet to be able to attend our regular class meetings and/or office hours. You can create your own meetings if you want to familiarize yourself with how it works. One math professor created very good zoom tutorial and I will send it to you. Find a way to convert a handwritten file to a PDF file, in case we will have to conduct all online lectures. This could be using a scanner, or an app on your phone, or software on your computer. Practice doing this ahead of time to avoid frustration later.

I will be posting the lecture videos (recorded via zoom) on YouTube that you can watch at your convenience. I will send you the link of the lecture video after each lecture. Feel free to supplement my videos with other videos or resources from Khan

Academy, YouTube, etc. if you prefer. If you have questions about anything, just email me, I'll try my best to help.

## **Miscellaneous Notes:**

**Mask and Face Covering Policy** In accord with the [MSU Mask and Face Covering policy](#), [Greene County Health Department](#) and the [Springfield City Ordinance](#), masks or face coverings must be worn at all times during a traditional (seated) class. This measure is being implemented to reduce COVID-19 related health risks for everyone engaged in the educational process. Masks or face coverings must be worn over the nose and mouth, in accordance with the [Centers for Disease Control and Prevention \(CDC\) guidelines](#). Face shields are not considered masks or face coverings for purposes of this requirement. Students who cannot wear a mask or face covering due to a disability must contact the [Disability Resource Center \(DRC\)](#) to initiate the interactive accommodation process. In the absence of an approved accommodation, a student's refusal to wear a mask or face covering will be considered a classroom disruption, consistent with [Op3.04-11 Class Disruption](#), and may result in the student being administratively dropped from the class section.

**Attendance policy:** The University expects instructors to be reasonable in accommodating students whose absence from class resulted from: (1) participation in University-sanctioned activities and programs; (2) personal illness; or (3) family and/or other compelling circumstances. Instructors have the right to request documentation verifying the basis of any absences resulting from the above factors. Please see The University's attendance policy can be found in the *2010-2011 Undergraduate Catalog* at [www.missouristate.edu/registrar/attendan.html](http://www.missouristate.edu/registrar/attendan.html).

**Academic dishonesty:** Missouri State University is a community of scholars committed to developing educated persons who accept the responsibility to practice personal and academic integrity. You are responsible for knowing and following the university's academic integrity policy plus additional more-specific policies for each class. The university policy, formally known as the "Student Academic Integrity Policies and Procedures" is available online at Academic Integrity Policies and Procedures (Students) and also at the Reserves Desk in Meyer Library. Any student participating in any form of academic dishonesty will be subject to sanctions as described in this policy.

**Nondiscrimination:** Missouri State University is an equal opportunity/affirmative action institution, and maintains a grievance procedure available to any person who believes he or she has been discriminated against. At all times, it is your right to address inquiries or concerns about possible discrimination to the Office for Institutional Equity and Compliance, Park Central Office Building, 117 Park Central Square, Suite 111, 417-836-4252. Other types of concerns (i.e., concerns of an academic nature) should be discussed directly with your instructor and can also

be brought to the attention of your instructor's Department Head. Please visit the OIEC website.

**Disability accommodation:** If you are a student with a disability and anticipate barriers related to this course, it is important to request accommodations and establish an accommodation plan with the University. Please contact the Disability Resource Center (DRC) at the Disability Resource Center website, Meyer Library, Suite 111, 417-836-4192, to initiate the process to establish your accommodation plan. The DRC will work with you to establish your accommodation plan, or it may refer you to other appropriate resources based on the nature of your disability. In order to prepare an accommodation plan, the University usually requires that students provide documentation relating to their disability. Please be prepared to provide such documentation if requested. Once a University accommodation plan is established, you may notify the class instructor of approved accommodations. If you wish to utilize your accommodation plan, it is suggested that you do so in a timely manner, preferably within the first two weeks of class. Early notification to the instructor allows for full benefit of the accommodations identified in the plan. Instructors will not receive the accommodation plan until you provide that plan, and are not required to apply accommodations retroactively.

**Cell phone policy:** As a member of the learning community, each student has a responsibility to other students who are members of the community. When cell phones or pagers ring and students respond in class or leave class to respond, it disrupts the class. Therefore, the Office of the Provost prohibits the use by students of cell phones, pagers, PDAs, or similar communication devices during scheduled classes. All such devices must be turned off or put in a silent (vibrate) mode and ordinarily should not be taken out during class. Given the fact that these same communication devices are an integral part of the University's emergency notification system, an exception to this policy would occur when numerous devices activate simultaneously. When this occurs, students may consult their devices to determine if a university emergency exists. If that is not the case, the devices should be immediately returned to silent mode and put away. Other exceptions to this policy may be granted at the discretion of the instructor.

**Emergency response:** At the first class meeting, students should become familiar with a basic emergency response plan through a dialogue with the instructor that includes a review and awareness of exits specific to the classroom and the location of evacuation centers for the building. All instructors are provided this information specific to their classroom and/or lab assignments in an e-mail prior to the beginning of the fall semester from the Office of the Provost and University Safety. Students with disabilities impacting mobility should discuss the approved accommodations for emergency situations and additional options when applicable with the instructor. For more information, visit University Safety.

**Religious Accommodation:** The University may provide a reasonable accommodation based on a person's sincerely held religious belief. In making this determination, the University reviews a variety of factors, including whether the accommodation would create an undue hardship. The accommodation request imposes responsibilities and obligations on both the individual requesting the accommodation and the University. Students who expect to miss classes, examinations, or other assignments as a consequence of their sincerely held religious belief shall be provided with a reasonable alternative opportunity to complete such academic responsibilities. It is the obligation of students to provide faculty with reasonable notice of the dates of religious observances on which they will be absent by submitting a Request for Religious Accommodation Form to the instructor by the end of the third week of a full semester course or the end of the second week of a half semester course.

**Mental Health & Stress Management:** As a student you may experience a range of personal issues that can impede learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. Learn Visit the [Missouri State University Counseling Center website](#) to learn more about free and confidential services available to assist you.

**Title IX:** Missouri State University has a Title IX policy that guides our response to instances of sexual violence. Sexual Violence includes: Rape, Sexual Assault, Sexual Misconduct, Sexual Discrimination, Domestic Violence, Dating Violence, Stalking, Sexual Harassment and Pregnancy issues. The Title IX policy can be located on the [MSU Title IX website](#). This website is also a good resource for any questions or issues involving Title IX and contains contact information for the MSU Title IX Office and staff. Read an [overview of the Title IX office](#).

If an MSU student discloses a Title IX related issue to a MSU faculty or staff member who is deemed to be a "Responsible Employee" under the policy, that faculty or staff member is required to report such disclosure to the Title IX Coordinator. A responsible employee includes any employee who has the authority to take action to redress sexual violence; who has been given the duty of reporting incidents of sexual violence or any other misconduct by students to the Title IX Coordinator or other appropriate school designee; or whom a student could reasonably believe has the authority or duty to take action. Taylor Health employees and MSU Counseling Center Clinicians are not considered to be Responsible Employees under the policy, and therefore, are not required to report Title IX issues to the Title IX Coordinator.

**Chosen Name Policy:** A student may choose a name other than their legal name to identify themselves at Missouri State University. A chosen name is different than the student's legal name. Refer to the [Chosen Name policy](#) for more information.

Students can provide their chosen first and middle names in the *Profile* tab of [My Missouri State](#).

***Disclaimer & Fair Use Statement:*** This course may contain copyrighted material, the use of which may not have been specifically authorized by the copyright owner. This material is available in an effort to explain issues relevant to [insert topic of course] or to illustrate the use and benefits of an educational tool. The material contained in this course is distributed without profit for research and educational purposes. Only small portions of the original work are being used and those could not be used easily to duplicate the original work. This should constitute a 'fair use' of any such copyrighted material (referenced and provided for in section 107 of the US Copyright Law).

If you wish to use any copyrighted material from this course for purposes of your own that go beyond 'fair use', you must obtain expressed permission from the copyright owner.

### **Changes to this syllabus:**

The instructor reserves the right to make changes to this syllabus, and the changes will be announced in class and on the course webpage.

# Tentative Topics Covered in Fall 2020

- Week 1: Sigma algebra, Axioms of probability, and the basic properties of probability derived from the axioms.
- Week 2: Continuous property of probability measure. Random variable as a measurable function in the probability space. Examples of random variables.
- Week 3: Discrete and continuous random variables. Riemann-Stieltjes integral. Expectation and variance of random variable.
- Week 4: Joint distribution of random variables. Covariance between random variables. Cauchy-Schwarz inequality. Matrix form for covariance of two linear combinations. Variance-covariance matrix and property.
- Week 5: Independence. Moments and moment generating function. Properties of moment generating function.
- Week 6: Markov's inequality, Chebyshev's inequality, convergence in probability. Weak law of large numbers, the variations and proofs, examples.
- Week 7: convex functions and Jensen's inequalities. Applications of Jensen's inequality. The idea of Chernoff's bound, and the application to Bernoulli random variables.
- Week 8: Hoeffding's inequality and Bernstein's inequality, and their proofs.
- Week 9: Large deviation functions, and brief introduction to large deviation theory.
- Week 10: Almost sure convergence and Borel-Cantelli lemmas.
- Week 11: Kolmogorov's inequality, strong law of large numbers, and its proof.
- Week 12: Glivenko-Cantelli theorem, and its proof.
- Week 13: Levy's inequality and proof. Law of iterated logarithm, and its proof for normal random variables.
- Week 14: Convergence in distribution, properties and examples. Central limit theorem and its proof using moment generating function.
- Week 15: Basic information theory. Kolmogorov complexity and the explanation of randomness.