

Statistics 630 – Overview of Mathematical Statistics
Sections 600 & 700, Fall Term, 2021 (*tentative*)

The course is intended for graduate students in various fields who require an introduction to mathematical statistics. It covers basic probability theory, including random variables and their distributions, and the theory of statistical inference from the likelihood point of view, including maximum likelihood estimation, confidence intervals, likelihood ratio tests and Bayesian methods.

Course Information (*Some details are subject to change*)

Time and Place:	MWF 12:40pm–1:30pm Central, Blocker 457.
Question & Answer:	Mon 5:20pm–6:20pm, Central. I will be available online to answer questions – but also see below about the discussion board.
Instructor:	Daren Cline (dcline@stat.tamu.edu), Blocker 459D.
Office Hours:	MWF 10:00am–11:00am, or by appointment.
Grader:	TBD, —@stat.tamu.edu . See Canvas for the grader's office hours. <i>The grader will not accept homework from students.</i>
Canvas:	Lecture notes and homework assignments will be available in Canvas. There will also be a discussion board for questions about homework, lectures, etc. <i>I highly recommend that you make use of the discussion board.</i> Not only will it be more timely than waiting until the Q&A, the opportunity to formulate questions and to respond to others' questions is in itself a learning experience.
Textbook:	Michael J. Evans and Jeffrey S. Rosenthal, <i>Probability and Statistics: The Science of Uncertainty</i> , 2nd ed., (W.H. Freeman & Co.). <i>The text is also available online for free from the authors: PDF textbook. Also see the Course Outline below.</i>
Prerequisite:	Three semesters of calculus, including multiple integration and a basic understanding of limits. <i>This is important.</i> See below .
Computing:	The R statistical programming software. See Installing R below.
Homework:	Homework will be assigned regularly via Canvas. Section 700: solutions must be uploaded to Canvas as a single PDF document. Homework is worth 20% of the total term score. <i>Please see the homework policy below.</i>
Exams:	There will be two midterm exams worth 22.5% each and a final exam worth 35%. Section 700: exams will be proctored in Zoom and held evenings. <i>Please see the exam policy below.</i>
Exam Dates:	Exam I: Wednesday, 6 October (tentative). Exam II: Wednesday, 10 November (tentative). Final Exam: Monday, 13 December, 10:30am–12:30pm, Central. Students may not take the final exam early; so please do not even ask.
Grading scale:	A: 85%, B: 70%, C: 60%, D: 50%. (These are firm, without rounding.)
Disabilities Help:	The Americans with Disabilities Act ensures that students with disabilities have reasonable accommodation in their learning environment. If you have a disability and need help, please contact me and Disability Services in the Student Services Building, 845-1637.
Academic Integrity:	You are expected to maintain the highest integrity in your work for this class, consistent with the university rules on academic integrity . This includes not passing off anyone else's work as your own, even with their permission. Please see the homework and exam policies below for specifics.
Copyright:	All the resources we provide for this course are copyrighted and may not be copied or distributed without our express, written permission.

Course Policies

Homework Policy:

Homework assignments will be downloaded from Canvas.

Homework solutions can be handwritten or typeset but they must be legible, mathematically and notationally complete and in order. As a rule of thumb: *provide enough details so that you and your classmates can understand what you did 6 weeks later.*

Section 700: homework solutions must be in a *single PDF file* and uploaded to Canvas. You can scan your handwritten solutions or convert typewritten solutions for this (*no photos*).

You should be identified on the initial page with your PRINTED name, course and section number.

Your homework solutions must be your own work, not from outside sources, consistent with the university rules on *academic integrity*. I expect you to follow this policy scrupulously. *Your performance on the exams is much more likely to be better.*

You may use:

- Your textbook and notes from class.
- Your notes, homework, etc., from a related class that you took or are taking.
- Discussion with the instructor or grader.
- *Voluntary, mutual and cooperative* discussion with other students currently taking the class. This does not mean copying from each other. There will be an online discussion board in Canvas. Do not post complete solutions. Suggestions, descriptions and partial explanations are ok.

You may not use:

- Solutions manuals (printed or electronic) other than what comes with the textbook, if any.
- Solutions from previous classes or classes taught elsewhere.
- Solutions, notes, homework, etc., from students who took the class previously.
- Copying from students in this class, including expecting them to reveal their solutions in "discussion". That is, you may work together as indicated above as long as you prepare your own solutions.

Homework is to be submitted by *the end of class* on its due date unless I specify otherwise. *Late homework is not acceptable without a valid university-sanctioned excuse.*

Exam Policy:

Exams for distance students will be proctored with Zoom the evening of exam day. You should be identified on the initial page with your PRINTED name, course and section number.

You must scan your handwritten solutions for this (*no photos*).

Your exam solutions must be your own work, using only resources I explicitly allow, consistent with the university rules on *academic integrity*.

Each exam will be comprehensive and cumulative.

- Please bring your own paper (blank on both sides). I ask that separate problems be on separate sheets, with the pages stapled in order.
- Bring resources (such as formula sheets) only if I explicitly allow them.
- You may use a calculator for numerical calculations only. The calculator *may not be part of, associated with or connected to any communication device*, such as a cell phone, iPod, tablet or laptop.

I will not expect you to quote theorems and results explicitly but I do expect you to demonstrate that you can make correct use of them. Specifically, you will need to:

- Show all your work. This does not necessarily mean showing every individual algebraic or calculus step – but your reasoning must be clear.
- Identify (by number, name or description) any theorems or examples you use.
- Clearly identify the solution and/or the end of a proof or derivation.

No exam may be taken early or made up, except if you provide a university excused absence with appropriate documentation.

Copies of old exams will be available for you to review. However, their content may not exactly match this semester's exams.

Course Policies (cont.)

Classroom:	<i>Please turn off all communication devices</i> (cell phones, iPods, etc.) while in the classroom. You can have a calculator for in-class work. A laptop or tablet is ok as long as you only use it to take notes or to view notes and handouts for this course. Questions are encouraged, especially to help clarify points in the lectures and homework. No question is "bad" or "dumb" if it is relevant (although I do appreciate it if you listen and avoid asking a question just answered).
Makeup Policy:	This is based on university policy. <ul style="list-style-type: none">• If you must miss an exam due to illness or other university excused absence, notify me or the Statistics Department (before, if feasible, otherwise within two working days after you return). Contact me as soon as possible to schedule a make-up exam.• An Incomplete will be given only in the event you have completed most of the course but circumstances beyond your control cause prolonged absence from class and the work cannot be made up.

Instructions for Installing R

All students will need to download and install the latest R software. R is a statistical *programming* language we will use for simulation, computing probabilities and trying out ideas. It may be obtained at the CRAN website, as described below.

1. It is recommended that you first uninstall previous versions of R, if you have any.
2. Go to <http://lib.stat.cmu.edu/R/CRAN> and click your choice of platform (Linux, MacOS X or Windows) for the precompiled binary distribution. Note the FAQs link to the left for additional information.
3. Follow the instructions for installing the *base* system software (which is all you will need).

Examples using R, that you can mimic, will be given in the lectures.

The Calculus Prerequisite

I often am asked about the required calculus for this course, especially by students who took it years ago (and haven't used it since!).

The courses listed as prerequisites are the 1st–3rd semester calculus courses at TAMU, which cover through multi-variable calculus and are pretty standard. This includes derivatives and integrals for power, logarithm and exponential functions, use of the chain rule, u-substitution and integration by parts, as well as double integrals. It also includes being able to understand and compute limits. There will be questions on exams that involve derivatives and integrals. However, I keep it fairly simple and there are many examples in the book and notes. You also will learn to recognize a few definite integrals. We mainly want you to understand the principles involved – the most important integrals have to be computed numerically anyway and are included in any decent statistical software (including R).

We also will be making extensive use of the (natural) logarithm and exponential functions, so it is a good idea to review them as well.

Many students tend to have a problem keeping the variables straight – and we usually will be dealing with several simultaneously. They integrate over "x" when it is "y" they need to integrate over, or they compute a definite integral over an interval of values of "x" and end up with something that still depends on "x". Things like that. Try to get comfortable using variables named with letters other than "x". "x" is just a name anyway; it does not affect how you do integrals or derivatives.

In addition, we will have variables with different roles: for the arguments of functions, for random variables and for parameters. While we can use notational devices to help distinguish them, it will not always be clear.

The more you endeavor to pay attention to the role of each variable, the less confusing it will be.

Course Outline

Topic (order varies in the lecture notes)	Textbook Section
1. Introduction to Probability	
1. Interpretation, experiments, sample space, events, set theory	1.1–1.2
2. Definition and properties of probability models	1.2–1.3
3. Finite sample spaces, counting methods, combinatorial methods	1.4
4. Conditional probability, independence, Bayes' theorem	1.5
2. Random Variables and Distributions	
1. Random variables and distributions	2.1–2.2
2. Discrete random variables, continuous random variables	2.3–2.4
3. Cumulative distribution functions	2.5
4. Functions of a random variable	2.6
5. Joint distributions, conditional distributions, independence	2.7–2.8
6. Functions of multiple random variables	2.9
7. Simulating random variables	2.10
3. Expected Values	
1. Expectation of discrete and continuous random variables	3.1–3.2
2. Variance, covariance and correlation	3.3
3. Moments, generating functions	3.4
4. Conditional expectations	3.5
5. Inequalities for probability and expectation	3.6
4. Sampling Distributions and Limit Theorems	
1. Sampling distribution of a statistic	4.1
2. Convergence in probability and the weak law of large numbers	4.2
3. Convergence in distribution and the central limit theorem	4.4
4. Monte Carlo approximations	4.5
5. Normal random samples and related distributions	4.6
5. Introduction to Statistical Inference	
1. Statistical models	5.1–5.3
2. Data collection and summary, types of statistical inference	5.4–5.5
6. Likelihood Inference	
1. Likelihood function and maximum likelihood estimation	6.1–6.2
2. Bias, variance, mean squared error	6.3.1
3. Confidence intervals, construction using pivots	6.3.2
4. Hypothesis testing and the construction of tests	6.3.3
5. Method of moments estimators, the bootstrap	6.4
6. Large sample properties of maximum likelihood estimators	6.5
7. Large sample approximate confidence intervals	6.5
8. Bootstrap confidence intervals	6.4
7. Bayesian Inference	
1. Prior and posterior distributions	7.1
2. Inferences based on the posterior distribution	7.2
8. Testing Hypotheses	
1. Neyman-Pearson approach to hypothesis testing	8.2.1–8.2.4
2. Generalized likelihood ratio tests, applications	8.2.5
3. Wald and score tests	
3. Applications of likelihood ratio tests	

Texas A&M System Mandated Statements

- **Statement On Disabilities** The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation for their disabilities. If you believe you have a disability requiring an accommodation, please contact the Office of Disabilities Services in Disability Services building at the Student Services at White Creek on the Main Campus. Their phone number is 979-845-1637. For additional information go to the website disability.tamu.edu.
- **Statement On Plagiarism** As commonly defined, plagiarism consists of passing off as one's own ideas, words, writing, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have any questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules, under the section "Scholastic Dishonesty."
- **Academic Integrity Statement** "An Aggie does not lie, cheat, or steal or tolerate those who do." The Aggie Honor Council Rules and Procedures are available at aggiehonor.tamu.edu.
- **Title IX and Statement on Limits to Confidentiality** Texas A&M University and the College of Science are committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws provide guidance for achieving such an environment. Although class materials are generally considered confidential pursuant to student record policies and laws, University employees — including instructors — cannot maintain confidentiality when it conflicts with their responsibility to report certain issues that jeopardize the health and safety of our community. As the instructor, I must report (per Texas A&M System Regulation 08.01.01) the following information to other University offices if you share it with me, even if you do not want the disclosed information to be shared: *Allegations of sexual assault, sexual discrimination, or sexual harassment when they involve TAMU students, faculty, or staff, or third parties visiting campus.* These reports may trigger contact from a campus official who will want to talk with you about the incident that you have shared. In many cases, it will be your decision whether or not you wish to speak with that individual. If you would like to talk about these events in a more confidential setting, you are encouraged to make an appointment with the Student Counseling Service (<https://scs.tamu.edu/>). Students and faculty can report non-emergency behavior that causes them to be concerned at <http://tellsomebody.tamu.edu>.
- **Statement on Mental Health and Wellness** Texas A&M University recognizes that mental health and wellness are critical factors that influence a student's academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.
- **Personal Illness and Quarantine** Students required to quarantine must participate in courses and course-related activities remotely and must not attend face-to-face course activities. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities. Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence

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(See Student Rule 7, Section 7.2.2.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student's medical provider is preferred, for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.

- **Copyright Notice** Faculty members own copyright in their educational work at Texas A&M University, as stated in the Texas A&M University System Policy for Intellectual Property Management and Commercialization (<http://policies.tamug.edu/17-01.pdf>). Students are not allowed to post or share any materials created by a faculty member unless given permission by that faculty member. This includes but is not limited to homework assignments, homework solutions, exams, exam solutions, lecture notes and any other supplemental materials. Any violation of this copyright policy could result in disciplinary actions as described in Student Rule 20.2: Procedures in Scholastic Dishonesty Cases and Student Rule 20.1.2.3.1 Texas A&M complies fully with the Digital Millennium Copyright Act ("DMCA"). Users of the Texas A&M network found to have engaged in repeated infringement of copyright are subject to termination of their network access and may be reported to the appropriate Dean or Human Resources officer for disciplinary action. Please see TAMU's Copyright Infringement Policies and Sanctions Notification for additional information ([https://security.tamug.edu/protectmyself/Copyright Infringement Policies and Sanctions Notifications.php](https://security.tamug.edu/protectmyself/Copyright%20Infringement%20Policies%20and%20Sanctions%20Notifications.php)).