EE 351H Probability, Statistics and Random Processes Spring 2024

Instructor: Gustavo de Veciana, Office: EER 6.874
E-mail: deveciana@utexas.edu
Teaching Assistant: Agrim Bari
Class time: Tu Thu 9:30-11am and conducted in person ECJ 1.204
Office hours: for the instructor and TA will be *posted/updated* on Canvas

Course Description: The course serves as an introduction to probability, statistics and random processes for engineers. These provide the mathematical tools and formalism needed to model uncertainty in any scientific/engineering field. Nowadays, probabilistic models are key for to development and analysis of scientific theories and many types of algorithms, with countless applications ranging from the analysis of network dynamics, of circuit failure rates, to the development of algorithms for computer vision, statistics, machine learning, image processing cryptography, system performance assessment, buisness, inventory, marketing, finance medicine....

The following correspond to the high-level learning outcomes of the course. Detailed per class outcomes are included in the class notes and reiterated in the course lectures.

Knowledge Learning Outcomes

- Students will possess an adequate background and understanding of basic concepts in probability theory.
- Students will be able to apply probability terminology and formalism correctly to represent basic random experiments and quantify uncertainty.

Skills Learning Outcomes

- Students will be proficient in the combinatorial and calculus based mathematical skills needed to solve problems in probability.
- Students will be proficient with the use of statistical techniques to summarize and model data.
- Students will be proficient in translating roughly specified problems into probabilistic models amenable to analysis.
- Students will be proficient in effectively communicating how they reason about systems driven by uncertainty.

Attitudes to be developed

- Students will be developing an attitude that recognizes the strengths and limitations of mathematical modeling and analysis in tackling real world problems.
- Students will be developing an attitude that emphasizes the importance of taking responsibility for their own learning, questioning their own understanding, and recognizing the value that discussion and collaboration will bring to their own mastery of material.
- Students will be developing an attitude that embraces fearless curiosity when faced with unfamiliar concepts and problems.

Pre-requisites: This course will draw on mathematical background you should have acquired either in high school and/or university level calculus in particular M 427K, M 427J with a grade of C- or better. Although it is no longer a pre-requisite, it would be helpful to have taken EE 313.

Honors: This course is intended for students in the ECE Honors program and if space is available students interested in going a bit deeper in exploring the traditional material covered in EE351K. I will give you many opportunities links/references to related topics which to explore more deeply on your own. Even better I welcome your bringing your insights and topics for discussion.

Required textbook: *Introduction to Probability,* D. Bertsekas and J. Tsitsiklis, Athena Scientific, 2nd Ed., 2008.

Recommended textbook: *Probability and Stochastic Processes: A friendly introduction for electrical and computer engineers*, R. Yates and D. Goodman, Wiley, 2nd Ed., 2005.

This course carries the quantitative reasoning flag. Quantitative Reasoning courses are designed to equip you with skills that are necessary for understanding the types of quantitative arguments you will regularly encounter in your adult and professional life. You should therefore expect a substantial portion of your grade to come from your use of quantitative skills to analyze real-world problems.

Online course platforms: We will be using the following platforms

- *UT Canvas* –course management platform– will be used for posting class material/homework, possible self-diagnostic quizzes and in class participation activities.
- *Ed* – an online discussion platform – please use this for posting and answering questions regarding the course to your peers and course staff.
- *Gradescope* – electronic homework submission and homework/exam grading platform.
- *Exams :* Exams will be conducted in class or appointed final exam time/place. Make sure you can attend the indicated times.

General course policies: Some general principles for this course.

Class participation is expected. The aim the in class lectures and activities is to jump start your understanding and stimulate your interest. I will identify key points in course material that you should focus on which should help you use your time more efficiently in learning the material. Note you are responsible for the material in the reading assignments, course notes, as well as what is covered in class. At the same time, a class with student that are actively participating makes for a better learning environment for all, and challenges the instructor to do his best!

Use of computers and phones in class is discouraged unless related to course activities. Research has been shown these distractions can have a big impact on your learning. Click on this article. I would encourage you to get in the habit of shutting everything around you down and focus and be active during class, e.g., ask questions and take notes or write comments on your slides.

Homework: A total of at most 12 weekly homeworks will be assigned except on weeks when you have a midterm. You will need to scan your homework and submit it electronically via Gradescope *before 12 noon on Friday*. To that end you will need to set up a Gradescope account (instructions will be emailed to you) and details on pdf scanning and uploading homeworks are included in your first homework.

No late homework will be accepted. If you miss one or two homeworks no problem, two homeworks with the lowest scores will dropped when computing your overall homework grade. To be clear this policy is

intended to address precisely the situation where you were not able to turn in a homework due to some extenuating circumstances.

Randomized homework grading and complete solutions: The TA has limited time to grade homework, so he will only grade a random sample of the assigned homework problems, That said, I believe homework is a very important part of this class. The problems are carefully selected for you to learn how to work out things for yourself, for you learn how to apply the concepts developed in class, and for you practice/learn how to communicate your ideas using mathematics and/or language of probability. Your homework will thus be graded in two areas

- ***Correctness,*** i.e., whether you got the correct answer allowing for some partial credit.
- ***Readability and clarity of communication:*** you must explain your answers and/or show your work carefully, and you scan and turn in work that is neat and ligible. Each graded question will, thus also be be evaluated as either poor or good. To get an good you should be clearly documenting your thinking and justifying the steps of your solutions.

Occasionally we will include **extra problems** these are for you to consider doing for extra practice. We do not want you to turn those in. We will provide detailed solutions for all problems.

Prompt grading and regrade requests. We will grade promptly, and will consider regrade requests only within *one week* of time/date the graded homework/exam is returned (i.e., made available) on Gradescope. You are encouraged to discuss requests with the course staff, however requests must be submitted via Gradescope, with a brief written justification.

Discussing homework is encouraged. Copying is considered cheating. Be absolutely sure to submit your own *independent* homework solutions, e.g., copying or letting someone else copy your homework is unacceptable – the entire homework grade will be dropped for both.

Evaluating class participation and keeping up: You contribute to making the class a success by preparing for class and through active participation both inside and outside of class. I would like to reward that. To that end I will periodically both engage you in both in class and out of class activities, including questions (timed instapoll surveys and multiple choice questions) or run feedback/surveys, questions about course material , or class progress format. If you miss some of these no problem you are only required in participate in two thirds of the activities to get a full participation score. Note these are not intended to stress you out, they are intended to engage you.

Exams: There will be two midterms and a final exam taken online as follows:

- Midterm 1 – *Thursday, February 22, 9:30-10:45am*
- Midterm 2 – *Thursday, April 4, 9:30-10:45am*
- Final – *Thursday, May 2, 1:00-3:00pm*

Exams are closed book, however you are allowed to bring a single cheat-sheet (8.5 x 11 inch paper) to each exam. You can write on both sides. The material on the cheat sheet should be handwritten. Example past exams will be made available on canvas.

No make up exams will be given. If you will miss an exam you need to let the instructor know *prior* to the exam. The instructor will determine if the absence is excused on a case-by-case basis based on concrete material. For an excused absence, the exam score will be calculated as the weighted average of the other

mid-term exam and final exam scores based on their relative weights. Unexcused absences will result in zero points for the exam.

Grading: Your final grade will be determined based on your work throughout the semester as follows:

Homework	16%
Participation	5%
Midterm 1	22%
Midterm 2	22%
Final Exam	35%

Fair and transparent grading. The midterm and final exams will be individually curved to permit you to track how you are doing throughout the semester. Homework and quizzes will not be curved. Grade cutoffs will be as follows:

A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
90	86.67	83.34	80.00	76.67	73.34	70.00	66.67	63.34	60	56.67	53.34

You can expect roughly 25% of the students to get an A, 25% a B, 50% a C or below.

The TA and I are here to help do not hesitate to reach out and talk to us.

Some important notes:
The university has a variety of resources that can be extremely useful and exist to serve our community. Please contact appropriate offices as detailed below.

University Honor Code: "The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, fairness, and respect toward peers and community." `http://www.utexas.edu/about/mission-and-values`.

Academic adjustment: The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities. Contact Services for Students with Disabilities at (512) 471-6259 [voice], (866) 329-3986 [video], ssd@uts.cc.utexas.edu, or `http://ddce.utexas.edu/disability`.

Wellness: You are at a top university and dealing with lots of stress and demands which can be intense. I encourage you to take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, socializing, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. If you are having any problems or concerns, do not hesitate to come speak to the TAs and myself. There are also many resources available on campus that can provide help and support. Asking for support sooner rather than later is almost always a good idea. If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counselors are available Monday-Friday 8am–5pm at the UT Counseling and Mental Health Center (CMHC) on the 5th floor of the Student Services Building (SSB) in person and by phone (512-471-3515). The 24/7 UT Crisis Line is 512-471-2255. Consider also reaching out to a friend, faculty member, or family member you trust to help get you the support you need.

Campus Carry: "The University of Texas at Austin is committed to providing a safe environment for students, employees, university affiliates, and visitors, and respecting the right of individuals who are licensed to carry a handgun as permitted by Texas state law." For more information, please see `http://campuscarry.utexas.edu/students`.

Date	Topic	Reading	HW-due
Tu 1/16	L1: Course introduction, probability and set theory	1.1	
Th 1/18	L2: Probability models and axioms	1.1-1.2	
Tu 1/23	L3: Conditioning and Bayes' rule	1.3-1.4	
Th 1/25	L4: Independence	1.5	1
Tu 1/30	L5: Counting	1.6	
Th 2/1	L6: Discrete RVs, PMFs and expectation	2.1-2.2	2
Tu 2/6	L7: Variance, conditioning, and joint PMFs	2.3-2.5	
Th 2/8	L8: Conditional PMFs, independence	2.6-2.7	3
Tu 2/13	L9: Problem solving and applications		
Th 2/15	L10: Continuous RVs, PDFs, expectation and Normals	3.1-3.3	4
Tu 2/20	L11: Conditioning on an event, multiple continuous RVs	3.4-3.5	
Th 2/22	**In class Midterm 1 covering L1 – L9**		
Tu 2/27	L12: Conditioning on an RV, independence, Revisiting Bayes Rule	3.5	
Th 2/29	L13: Derived distributions – single and multiple RVs, convolution	4.1	5
Tu 3/5	L14: Sums of independent RVs, covariance and correlation	4.2-4.3	
Tu 3/7	L15: Conditional expectation as a RV, random sums of RVs	4.3, 4.5	6
Tu 3/12	**Spring Break**		
Th 3/14			
Tu 3/19	L16: Bivariate Gaussian	4.4, notes	
Th 3/21	L17: Inequalities, Weak Law of Large Numbers	5.1-5.3	7
Tu 3/26	L18: Central Limit Theorem, pollster problem	5.4	
Th 3/28	L19: Problem solving and applications		8
Tu 4/2	L20: Bayesian statistical inference : MAP and ML	8.1 - 8.2	
Th 4/4	**In class Midterm 2 covering L10 – L19**		
Tu 4/9	L21: Least Mean Squares Estimation and Linear Least Means Square Estimation	8.3,8.4,	
Th 4/11	L22: Classical statistical inference: Point estimation, confidence intervals	9.1	9
Tu 4/16	L23: Linear Regression	9.2	
Th 4/18	L24: Introduction to Random Processes: Bernoulli Process	6.1	10
Tu 4/25	L25: Discrete-time Markov Chains (DTMC), classification of states	7.1-7.2	
Tu 4/26	L26: DTMCs invariant/stationary distribution and convergence	7.3	11
	Final Thursday May 2, 1:00 - 3:00 pm (as per Registrar's website)		