ECE 302: Probabilistic Methods in Electrical and Computer Engineering
Spring 2024
Instructor: Prof. Stanley H. Chan

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U N I V E R S I T Y

Course Information

Spring 2024
(Last Update: January 9, 2024)

Lecture Hours: TuTh 9am-10:15am, EE 129.

Instructor: Professor Stanley Chan
Email: stanchan@purdue.edu, Office Hour: By appointments only.

Head TA: Kent Gauen, gauenk@purdue.edu, Office Hour: Thursday 4:30 - 5:30pm, EE 208/209.

> **Recitation Hour**: Thursday 5:30 - 6:30pm, PHYS 202. Recitation is designed to discuss topics that are not covered in the lecture. This is optional, but highly recommended.

> **Duties**: The Head TA is responsible for all the course logistics. He has the full authority to assign grades and approve requests (late homework requests, absence due to medical issues, DRC requests). Any grade appeal decided by the Head TA will be final. The Head TA oversees GTAs and Undergraduate TAs.

Graduate TAs (GTA):

> Erfan Fakhabi, efakhabi@purdue.edu, Office Hour: Thursday 10:00am to 12:00pm. EE 208/209
> Weijian Zhang, zhan5056@purdue.edu, Office Hour: Tuesdays 10:15am - 12:15pm. MSEE 399

> **Duties**: Graduate TAs are responsible for office hours for Homework questions, Practice Me Questions, previous year's Midterm questions, previous year's Final questions. They will frequently check Piazza and answer your questions. GTAs will focus their efforts on difficult math questions; for programming issues, please reach out to UTAs. GTAs will grade your exams, together with the head TA. They will be the primary contact person for grade appeal. If the grade appeal cannot be resolved by the GTAs, the Head TA will make the final decision.

Undergraduate TAs (UTA):

> I-lo Chen, chen4449@purdue.edu, Monday 6-8pm, EE 208/209
> Cheng-Hao Chen, chen4848@purdue.edu, Tuesday 6-8pm, EE 208/209
> Abhiram Nambiar, ahnambia@purdue.edu, Wednesday 6-8pm, EE 208/209
> Will Stonebridge, jwstoneb@purdue.edu, Thursday 3:30-5:30pm, EE 208/209
> Tzu-Liang Tsai, tsai216@purdue.edu, Thursday 6-8pm, EE 208/209
> Cheng Yu Chu, chu263@purdue.edu, Friday 6-8pm, EE 208/209

> **Duties**: UTAs are responsible for hosting our daily office hours. They should be your primary point of contact for any Practice Me! homework questions. If you have any programming questions, please see the UTAs. UTAs will grade your homework. UTAs will provide feedback and discuss with you for your OhMyQuestion! submissions.

Course Website: `https://engineering.purdue.edu/ChanGroup/ECE302`
Piazza: `https://piazza.com/class/lq4oo61162kya`

Course Objectives:

ECE 302 is an introductory probability and random process course for Electrical and Computer Engineering students. Our syllabus has a strong emphasis on the theoretical foundations. ECE 302 is different from the statistics courses you took in high school. For example, you probably know about how to calculate the "mean" and "standard deviation" of some data, but have you thought about how to use the mean and standard deviation to classify objects in an image? You will learn some basic tools in statistics which will eventually allow you to work on big problems in the future.

The objective of this course is that by the end of the semester, you will have

- a solid background in probability and random processes that can help you take advanced courses;
- an ability to formulate engineering problems using a probabilistic approach;
- an ability to analyze large-scale systems using statistical methods;
- experience in using computers to solve probability problems.

Textbook:

- S. H. Chan, *Introduction to Probability for Data Science*, Michigan University Publishing, 2021. Freely available on `https://probability4datascience.com/`

Reference:

- R. V. Hogg, J. W. McKean, A. T. Craig, *Introduction to Mathematical Statistics*, 7th Ed, Pearson 2013.
- H. Stark and J. W. Woods, *Probability and Random Processes with Applications to Signal Processing*, 3rd Ed, Prentice Hall, 2002.
- D. P. Bertsekas and J. N. Tsitsiklis, *Introduction to Probability*, Athena Scientific, 2nd Ed, 2008.
- A. Leon-Garcia, *Probability, Statistics, and Random Processes for Electrical Engineering*, Prentice Hall, 3rd Ed, 2008.

Pre-requisites:

(MA 26200 or MA 26600 or MA 36600) and ECE 30100 [may be taken concurrently]

ECE 302 is a mathematically challenging course in the ECE curriculum. We require all students to be *fluent* in calculus and linear algebra. If you are uncertain whether you are ready to take ECE 302, please talk to Prof Chan.

We will try to minimize the dependency of ECE 301 in the first half of the semester. However, we expect you to be prepared for the Fourier Transforms when we start to discuss about moment generating functions (MGF).

We assume that you have taken ECE 20875 Python. Our homework requires Python, but we also allow MATLAB. Of course, you are welcome to write things in C.

Grades:

- Homework: 10%. There are 12 homework assignments. We will drop the worst homework. Please submit your homework through **gradescope** by 11:59pm Eastern Time on the due day. Homework will be graded for completeness:

    - 0: You didn't submit
    - 1: You submitted, but it was partially done.
    - 2: You submitted, and it was mostly done.

- Practice Me!: 0%. These problems are given to you for practice. Please do not submit, but please do them. You will be very happy to see them some of them in the midterms.

- Oh My Question!: 20%. You will be asked to form teams to create problems. We will have more instructions below. There are two OhMyQuestion presentation days:

    - OMyQ Round 1 Finalist Presentation: Feb 13, in class.
    - OMyQ Round 2 Finalist Presentation: Apr 2, in class.

- Midterms: There are two mid-term exams in this course. The mid terms are scheduled on

    - Mid-term 1, 20%: Feb 15, in class.
    - Mid-term 2, 20%: Apr 4, in class.

    Mid-terms are closed-book, closed-note. No electronics, including calculators, cell phones, and smart watches are allowed.

- Final: 30%. The date of the final exam will be announced later. Final is closed-book, closed-note. No electronics, including calculators, cell phones, and smart watches are allowed.

Make-up Exam Policy:

We do NOT offer make-up exams except for very special occasions, e.g., serious illness (with doctor certificate) and civil service (Jury duty or military training, with proofs). Should any of these happen, please reach out to the **Head TA**. No make-up exam will be made due to travel schedule. You should not travel before the end of the final exam week (including the last Saturday). We reserve the right to decline any makeup exam request.

Re-Grade Policy:

Homework: There is no homework regrade.

Exam: If you want to request an exam regrade, please send your request to one of the **GTA** within **three days** after we return you the exams. No late re-grade requests will be entertained. When submitting your request, please write your question clearly. Our re-grade policy is that we will give you points which you deserve if the mistake is proven on our side. However, if we find new mistakes that are not spotted in the first grading, we will take your points off, regardless of where these mistakes are. If after re-grade you are still unhappy, you can appeal to the **Head TA**.

Any decision made by the Head TA will be final. Prof Chan will not override.

Academic Dishonesty:

You are in college, not high school. We respect you as adults, and we expect you behave as adults. Therefore, we ask you to be honest and ethical in the course. In that respect, any action that might give a student unfair advantage on homework or exams will be considered dishonest. Examples include, but are not limited to:

- Sharing information during exam;
- Using forbidden material or device during exam;
- Viewing and/or working on an exam before or after the official time allowed;
- Requesting a re-grade of work that has been altered;
- Copying from your friend's homework;
- Submitting works generated by ChatGPT (and any kinds of AI tools);
- Plagiarism, including copying questions from books without properly citing them.

All cases of academic dishonesty will be reported to the Office of Student Rights and Responsibilities, and will result in punishment. Possible punishments include, but are not limited to, a score of zero on work related to the cheating incident, a failing grade for the course, and, in severe cases, expulsion from the university.

Copyright of Course Material:

All ECE 302 course material, including lecture, homework, project, solutions and exams are protected by copyright law. Without Prof Chan's permission, you are not allowed to distribute through any media including online sources. Below is an excerpt from `http://www.purdue.edu/studentregulations/student_conduct/misc.html`

... Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally. Notes taken in class are, however, generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor...

Emergency Procedure:

Purdue University is a very safe campus and there is a low probability that a serious incident will occur here at Purdue. However, just as we receive a "safety briefing" each time we get on an aircraft, we want to emphasize our emergency procedures for evacuation and shelter in place incidents. Our preparedness will be critical *if* an unexpected event occurs.

Purdue prepares for natural disasters or human-caused incidents with the ultimate goal of maintaining a safe and secure campus, but in the end, emergency preparedness is your personal responsibility. Let's quickly review the following procedures:

- To report an emergency, call 911. To obtain updates regarding an ongoing emergency, sign up for Purdue Alert text messages, view `www.purdue.edu/ea`.
- There are nearly 300 Emergency Telephones outdoors across campus and in parking garages that connect directly to the PUPD. If you feel threatened or need help, push the button and you will be connected immediately.

- If we hear a fire alarm during class we will immediately suspend class, evacuate the building, and proceed outdoors. Do not use the elevator.

- If we are notified during class of a Shelter in Place requirement for a tornado warning, we will suspend class and shelter in [the basement].

- If we are notified during class of a Shelter in Place requirement for a hazardous materials release, or a civil disturbance, including a shooting or other use of weapons, we will suspend class and shelter in the classroom, shutting the door and turning off the lights.

- Please review the Emergency Preparedness website for additional information. `http://www.purdue.edu/ehps/emergency_preparedness/index.html`

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. In such an event, information will be provided through the course website and through emails.

Syllabus:

The following outline is a tentative schedule of the topics that we will cover in this course. Please refer to the course website for the finalized version.

Week	Date	Topics	Instructor	Recitation	Your Work
1	Jan 9 (Tu)	Review	Stanley	HW Kent	HW 1
1	Jan 11 (Th)	Probability	Stanley		
2	Jan 16 (Tu)	Set theory, axioms	Stanley	HW Kent	HW 2
2	Jan 18 (Th)	Conditional prob	Stanley		
3	Jan 23 (Tu)	Bayes theorem	Kent	HW Kent	HW 3
3	Jan 25 (Th)	Total probability	Kent		
4	Jan 30 (Tu)	PMF, CDF	Stanley	HW Erfan	HW 4
4	Feb 1 (Th)	Expectation, variance	Prof. Comer		
5	Feb 6 (Tu)	Bernoulli, Bino., Geo.	Stanley	HW Erfan	HW 5
5	Feb 8 (Th)	Poisson	Stanley	Review Weijian	OMyQ Oral+Submit
6	Feb 13 (Tu)	Oh My Question!	Stanley	Review Kent	
6	Feb 15 (Th)	Midterm 1	Kent		
7	Feb 20 (Tu)	PDF, CDF	Stanley	HW Kent	HW 6
7	Feb 22 (Th)	CDF, Uniform	Stanley		
8	Feb 27 (Tu)	Exponential, Gaussian	Stanley	HW Kent	HW 7
8	Feb 29 (Th)	Function of RV	Stanley		
9	Mar 5 (Tu)	Linear regression	Stanley	HW Kent	HW 8
9	Mar 7 (Th)	Overfitting	Stanley		
	Mar 12 (Tu)	Spring Break			
	Mar 14 (Th)	Spring Break			
10	Mar 19 (Tu)	Bias-Var	Stanley	HW Kent	HW 9
10	Mar 21 (Th)	Regularization	Stanley		
11	Mar 26 (Tu)	Joint, conditional	Stanley	HW Erfan	HW 10
11	Mar 28 (Th)	Cond. expectation	Stanley	Review Kent	OMyQ Oral+Submit
12	Apr 2 (Tu)	Oh My Question!	Stanley	Review Kent	
12	Apr 4 (Th)	Midterm 2	Kent		
13	Apr 9 (Tu)	Sum of RV	Stanley	HW Kent	HW 11
13	Apr 11 (Th)	Charac. function	Stanley		
14	Apr 16 (Tu)	Radnom Vector	Stanley	HW Kent	HW 12
14	Apr 18 (Th)	ML Estimation	Stanley		
15	Apr 23 (Tu)	MAP Estimation	Stanley	Review Erfan	
15	Apr 25 (Th)	Conclusion	Stanley	Review Kent	