COURSE DESCRIPTION
CS481/IE410 ADVANCED TOPICS IN STOCHASTIC PROCESSES
Fall 2024 In Person: MW 3PM-3:50PM, MW 4PM-4:50PM 1310 DCL

Instructor: Sheldon H. Jacobson, Siebel Center 3224
Office Hours: Mondays, immediately after class in 1310DCL.
Teaching Assistants (TAs): Eric Shen
Office Hours: Thursdays 11:00 AM - 12:50 PM (1127 Siebel Center)
Course Email: ie410.cs481@gmail.com
Text: "Introduction to Probability Models" by Sheldon M. Ross (any edition)
Canvas: Course material will be available on the course canvas web site http://canvas.illinois.edu

Course Objective: This course is a rigorous introduction to and survey of stochastic models, with applications in engineering & computer systems. Students should complete this course with the ability to identify problems addressed using stochastic models, as well as to use such models to solve/gain insights into such problems.

Prerequisites:
Must: Introduction to Probability and Statistics, or equivalent (e.g., IE300, CS361, Stat400)
Useful: A working knowledge of any computer programming language (C, C++, C Sharp, Java, Python).
Useful: Introduction to Operations Research, or equivalent (IE310)
NOTE: You must have the prerequisites (or equivalent, for graduate students) to take the course.

Important Advice: If you earned a B in any of these courses, you will need to thoroughly review the material in these courses, since all the material in these courses will be assumed to be known.
If you earned a B- or lower in any of these courses, you may find this course extremely challenging and will not be prepared to succeed in this course. You may wish to take the course in the future, once you are better prepared for the material. My advice is not to take the course at this time.

ISE Undergraduates: The ISE department has created IE370 (Stochastic Processes and its Applications), a watered-down version of this course. It is offered in the spring semester and will satisfy the IE410 requirement for your program of study. The topics covered are similar; the primary difference is the level of depth covered. Since IE410 is delivered at the graduate level, if you are planning to go to graduate school in CS or Engineering, this course will be a good choice for you.

General Topics: Background: Review of Probability, Conditional Probability
Poisson Processes and the Exponential Distribution
Markov Chains (Discrete, Continuous, MDPs), Birth and Death Processes
Renewal Theory

Exams: There will be two exams (the first exam will be September 30 and the second exam will be December 4.) There will be no final exam during the final exam period. Each exam will be weighted 40% towards your final grade (see description of Exam 2 multiplier in Assignments section below). Exam #1 will cover chapters 1-3. Exam #2 will cover Chapters 4-7. **Exams will only be given at the designated times. There are no opportunities for makeup exams or remedial exams if you miss an exam or fail the course.**

If you feel that you deserve additional credit on your exam, write an explanation for why you deserve more points, how many additional points you deserve, and return the explanation, with your exam, to the course email address given above within 48 hours of when the exam is first returned. Note that if you hand your exam back to be regraded, the entire exam may be regraded, including the questions that you specifically asked to be regraded. **Exams should not be altered or written on once returned to you**.

If you miss both exams, you will earn a failing grade in the course. If you miss one exam, the exam you took will contribute 40% to your final grade. The remaining 60% will be allocated based on the smaller of a) bottom 5% percentile (rounded down) grade among all students (graduate or undergraduate handled separately, based on what you are) that was earned on the exam you missed, including students who missed the exam, b) 10% of the percentile (rounded down, graduate or undergraduate, based on what you are) that you earned on the exam that you took applied to the missed exam.

Assignments: Assignment questions will be posted on canvas. Assignment problems will improve your understanding of the course material. You are encouraged to work on these assignment questions in small groups. Solutions to the assignments will be posted on canvas and/or reviewed during problem sessions.

To get credit for each chapter assignment, you must submit a sentence in the assignment text box on Canvas indicating that you attempted the problems. **Do not submit or upload the assignment, since they are not graded**. Your sentence submissions are accepted only during the designated time periods (between 3:00:00PM CT on the first day and ending at 2:59:59PM CT on the last day). Early or late submissions cannot be accepted, under any circumstances and for any reason. **The time windows for sentence submissions are:** 8/28-9/5 (Chapter 1), 9/6-9/13 (Chapter 2), 9/14-9/20 (Chapter 3), 9/21-10/9 (Chapter 4), 10/10-10/21 (Chapter 5), 10/22-11/11 (Chapter 6), 11/12-11/18 (Chapter 7).

The credit you earn will be in the form of a multiplier for your second exam. Each assignment sentence submitted during the designated time period represents a multiplier of 0.08. Therefore, if you submitted N assignment sentences during the designated time period, your multiplier for the second exam will be 1+0.08*N. This means that a perfect 40% for the second exam will be rescaled to 40%*(1+0.08*N). **Note that this multiplier credit only applies to students who sit for and submit the second exam for grading.** To be fair to all the students in the class, there will be no exception to missing the cutoff date and time for assignment credit, under any circumstances. This includes health, family, or personal issues, forgetting to submit the assignment, problems with canvas, a power outage, a weather event, a national disaster (natural or man-made), or any other reason. Students do so at their own risk when waiting until the last minute to submit. Only submissions received on canvas are valid.

Final Grades: Final grades are determined based on breakpoints

Undergraduate students:

84.0% to 100% = A range, 72.0% to 83.99999% = B range,
65.0% to 71.99999% = C range, 60% to 64.99999% = D range.

Graduate students:

84.0% to 100% = A range, 72.0% to 83.99999% = B range, 65.0% to 71.99999% = C range.

A final total score below 60% will earn a failing grade in the course for undergraduate students, and below 65% will earn a failing grade in the course for graduate students.

Classes Times: In-person lectures may be as much as 100 minutes. Problem sessions will be held during lecture times throughout the semester.

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Graduate students (4 credits) versus undergraduate students (3 credits): Graduate students may have additional questions on one or both of their exams.

DRES Students: Please email me no later than 3PM CT, September 9 to discuss your situation. If I do not hear from you by this date, you will have opted out of any accommodation.

Participation and Engagement: Learning is a two-way exchange of information. I will frequently ask questions during in-person lectures, so it is in your best interest to be prepared.

Class Attendance: You are not required to attend lectures. Experience has shown that students who stay engaged also perform better in the course. Also, stay tuned-in to the canvas course page for announcements.

Cell Phones: As a courtesy to others, during in-person lectures, please put your cell phone on silent mode or off during all classes, to limit disruptions that affect other students.

General Comments:
- My lectures and the course material may not always match the book and its presentation. There are a number of concepts covered in the book that I will not cover, and vice versa. Therefore, although you are not required to attend the in-person or virtual lectures (i.e., no attendance is taken), it is in your best interest to stay engaged, since you will be responsible for all the material covered in the modules.
- If you are having problems with the course, discuss the situation with me as soon as possible. It is typically very difficult to find a solution in mid-November, while feasible plans of attack may be identified in mid-September.
- A review session will be held before each exam, which will provide an overview of the material that you will be tested on, as well as give you an opportunity to see the types of questions you can expect on the exam. No sample exams will be available.
- The best way to prepare for exams is to work a large number of problems, including the problems assigned for your assignments, and to understand the material being presented in the lectures (in particular, listen to what I emphasize). I encourage you to work extra problems in the book that I have not assigned, since the only way to truly understand the material is by working problems. Working only the problems assigned will not be sufficient for you to gain an understanding of the material presented in the course. All such problems represent sample exam questions.
- If the pace of a lecture is too fast / slow, let me know. I am not always aware of it, no matter how obvious it may be to you.
- Probability is an area where you may feel that you understand the course material, yet not be able to solve problems. Solving problems requires a great deal of practice. Your assignments provide you with some of this practice. However, you should also attempt to solve problems not assigned. Working problems out of any probability/stochastic processes book in the library or from the web is encouraged. Use my / the teaching assistants' office hours to get help with those problems that you have difficulty.
- Some of the material presented will be rather abstract. However, most of it also has real practical value. If I forget to mention it, ask where or how the material can be applied.
- Safety is everyone's concern. Visit http://police.illinois.edu/emergency-preparedness/run-hide-fight/

TOPICS TO BE COVERED (see detailed week by week topics and modules)
Course Outline: Chapters 1-7 of text (in whole or part)

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Introduction to Probability (1 weeks, Chapter 1)
- Sample Spaces, Events, Probability and Conditional Probability, Independence and Bayes Formula

Random Variables (1.5 weeks, Chapter 2)
- Discrete and Continuous, Expectation and Variance
- Jointly Distributed Random Variables, Moment Generating Functions, Limit Theorems

Conditional Probability and Conditional Expectation (1 week, Chapter 3)
- Discrete and Continuous
- Computing Expectations and Probabilities by Conditioning

Discrete Time Markov Chains (2 weeks, Chapter 4)
- Introduction and Definitions
- Chapman Kolmogorov Equations, Classification of States and Limiting Probabilities
- Branching Processes and Markov Decision Processes

The Exponential Distribution and Poisson Processes (1.5 weeks, Chapter 5)
- Exponential Distribution, Poisson Processes and Generalizations of Poisson Processes

Continuous Time Markov Chains (1.5 weeks, Chapter 6)
- Introduction/ Definitions, Birth & Death Processes, Queueing models, Chapman Kolmogorov Differential Equations, Limiting Probabilities

Renewal theory (1 week, Chapter 7)