Math 456 Syllabus	Spring 2021	Laurel Langford
Advanced Probability	11:00-11:50 MWF in NH 15	laurel.langford@uwrf.edu
Section 1; Credits: 3	Final exam: 10:15-12:15 05/12/22	http://langfordmath.com/

Office hours (getting help): 1:15-3:00 in NH 207B MWF, and by appointment.

Text: you should have several textbooks for reference. We will be using most heavily the ACTEX study manual for Exam P and Introduction to Probability Models by Sheldon Ross (10th edition)

Announcements and assignments will be posted online as well as being announced in class.

Goals for this class:

- Become *proficient* with probability content assessed on the SOA P-exam, with an emphasis on content not included in Math 356. Proficient, in this context, means that you should be able to solve problems confidently, using efficient strategies, in a reasonable length of time. Because probability is more context-dependent than most math subjects, we will spend more time on analyzing context and practicing skills than you might in another math class.

Lecture and discussion: You should plan to be in class each day, ready to work and discuss probability problems. I will be lecturing on new content, but a lot of the time will be devoted to discussion solutions to assigned and in class problems. If you can't be in class, please email me, and I will stream the class time. You must be an active participant whether in class or on line to be successful.

Assignments: Homework will be assigned and collected daily. If you can't be in class, please scan your pencil and paper assignment, and email it to me.

I recommend testing out a few of the scanner apps for your cell phone to see what works best for you. I prefer to have assignments scanned for submission by an app that will compile all of the pages into a single .pdf document with a picture quality that gives both an image that is readable and a file size that is small enough to attach to an email (10 MB). You may need to experiment with available cell phone apps to find one where you can get appropriate settings.

Homework from the ACTEX study manual:

Most of the homework this semester will come from the ACTEX study manual. For these homework problems, please follow the following instructions as your default:

- On the first page, or a cover page, list the problem numbers for the assignment
- As you work through the problems, spend about 4 minutes working on the problem independently. If, after four minutes, you are not done/are stuck then look up the solutions to the problem and look for hints/strategies in the solution or read the solution and write it down.
- After you have done all of the problems, check your answers, and make sure you understand any solutions where you didn't have it correct at first.
- Back to the first page, next to the problem number,
  - Put a check mark next to the problem number if you figured it out without help,
  - Write OK next to the problem number if you had to look up the solution, but now it makes sense and you've got it
  - Put a question mark next to the problem number if you had to look up the solution, but you don't feel totally confident about it.
    - Additional options: X means you got it wrong the first time. Follow this up with OK or ?
    - T means this is a tricky problem, and you think it's worth discussing further.

Tests: I am planning to give three tests including the final exam. The final exam will be cumulative, but weighted towards the final third of the course content.

Grading: Your grade will be based primarily on your scores on homework, participation, quizzes and the final exam. Homework will count as 20% of your grade, and the quizzes and final exam will count as 80% of your grade. Your grade will be based primarily on the weighted average of your scores. Letter grades will be at least as high* as those determined by your weighted average and these percents:

A: 94-100%	A-: 90-93%	B+: 87-89%	B: 84-86%	B-: 80-83%
C+: 77-79%	C: 74-76%	C-: 70-73%	D+: 67-69%	D: 60-66%

*I will occasionally raise a grade for someone who shows a greater understanding of the content (eg. in class discussions and presentations) than is reflected in the test scores, but I never lower a grade below what is indicated by the weighted average).

This is a course in transition I will list both the previous years' content, and the expected content of the course this year. As you probably know, Dr Coffman who has taught this class in the past retired for health reasons last semester. This year we will be spending more time on the content that is assessed on the SOA P exam, since the majority of students in the class this year are intending to take the P-exam in the future. If time permits, we will include some of the Markov chain content that was previously more typical of the course.

Course Objectives

Previous years' goals:	Current year's goals
At the end of the course, students will be able to: i) classify Markov Chains and their states and classes, e.g. irreducible, periodic, aperiodic, recurrent, null recurrent, transient ii) use matrix and other methods to perform classical calculations for finite Markov Chains, e.g. mean first visit times, mean occupation times, expected duration/absoprtion times, and absorption and stationary probabilities iii) identify and analyze classical examples of Markov Chains, e.g. gambler's ruin and random walk iv) recognize the role of the Poisson process in the formulation of continuous time Markov Chains v) use differential equations and other methods to perform classical calculations for continuous time Markov Chains, e.g. transition probabilities vi) identify other common stochastic models and processes - e.g. queueing theory, renewal processes, reliability models.	At the end of this course, students will be able to: i. Choose appropriate probability models to solve contextual probability problems ii. Accurately solve both discrete and continuous probability problems, transform probability distributions, and use probability and moment generating functions.

Required Course Content

Previous years' goals:	Current year's goals:
I. Markov Chains a) Introduction b) Chapman-Kolmogorov equations c) Limiting probabilities d) Applications (gambler's ruin) e) Mean time spent in transient states f) Monte Carlo methods II. Random walk in one, two, and three dimensions III. Exponential Distribution and the Poisson Process a) Introduction b) The exponential distribution c) The Poisson process i) The Poisson process as a counting process	Topics indicated with * may be omitted 1. Discrete probability review: a. Conditional probability and independence b. Permutations and Combinations c. Complex conditional probability problems 2. Basic distributions a. Review of discrete and conditional distributions b. Mixed distributions c. Cumulative distribution functions d. *Survival functions 3. Distribution parameters a. Review of expected value and variance b. Moment generating functions c. Percentiles and median d. * Coefficient of variation

ii) Interarrival and waiting time distributions IV. Continuous-Time Markov Chains a) Introduction b) Continuous time Markov Chains c) Birth and death processes d) Transition probability functions	e. *Skewness and kurtosis f. *Chebyshev's inequality 4. Special discrete distributions a. Review of Binomial distribution b. Poisson distribution, including moments c. Geometric distribution, including moments d. Negative binomial e. Hypergeometric f. Review of multinomial g. *Discrete uniform 5. Special continuous distributions a. Review of uniform and exponential distribution b. Normal distributions c. Gamma distributions 6. Joint, marginal and conditional distributions a. Joint distributions and expected value b. Marginal distributions c. Independent and conditional distributions d. Covariance and coefficient of correlation e. Moment generating functions for joint distributions f. Bivariate normal distributions 7. Transformations of random variables a. Review of 1-variable transformations (CDF and PDF method) b. Transformations of joint distributions c. Sums, maxima and minima of independent random variables. 8. Applications to insurance and risk management. 9. *Order statistics 10. *Introduction to Markov Chains

Mode of Instruction: Face to Face
Prerequisites: Math 356.

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