

**University of Texas, Austin Course Syllabus**  
**Department of Mathematics**  
**M339J (53400): Probability Models with Actuarial Applications**  
**Spring 2019**

**I. Course Title:** M 339J Probability Models with Actuarial Applications (Unique 53400)

**II. Location, Days, and Time:** CPE 2.220  
MWF 1:00pm - 1:50pm

**III. Faculty:** Alisa Havens Walch, MA, FCAS  
Assistant Professor of Instruction  
Assistant Director of Actuarial Studies  
CAS Exams: 1-9, C1, C2, COP, VE, VF, VS

**Office:** RLM 13.148

**Office Hours:** MWF 10:30am – 11:15am and MW 3:45pm-4:30pm

Additional hours available by appointment, if you cannot make the scheduled office hours. Appointments may be held in Canvas conferences.

**Note: Students are expected to bring their class notes and textbook with them to office hours. (I may not help you if you don't have your notes with you.)**

**E-mail:** [ahavens@math.utexas.edu](mailto:ahavens@math.utexas.edu) (best way to communicate)

**Note: Include course # (M339J) in the subject line.**

**Telephone:** (512) 232-6189 – UT (voice mail not set up)

**IV. Prerequisites:** M 362K (Probability) with a grade of 'C-' or better, and at least one of M 358K (Applied Statistics) or M 378K (Mathematical Statistics) with a grade of 'C-' or better.

**V. Description of the Course:** Introductory actuarial models for property and casualty insurance. With M 349P (Actuarial Statistical Estimates), this course covers the syllabus for the professional actuarial exam on model construction - SOA Exam STAM (no CAS equivalent).

In addition, 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.

**VI. Course Objectives:** An intro. to modeling and important actuarial methods useful in modeling. A thorough knowledge of calculus, probability, and mathematical statistics is assumed. Students will be introduced to a variety of frequency, severity, and aggregate models that are useful for short-term actuarial applications. Students will learn how to analyze data in a business context, determine a suitable model including parameter values, provide measures of confidence, and estimate losses using credibility procedures. Students will be introduced to a variety of tools to calibrate and evaluate models.

**VII. Learning Outcomes:** After taking both M 339J and M 349P, students will be expected to perform the tasks listed below:

**A. Severity Models**

1. Calculate moments, percentiles, and generating functions.
2. Describe how changes in parameters affect the distribution.
3. Recognize classes of distributions, including extreme value distributions, and their relationships.
4. Create new distributions by multiplication by a constant, raising to a power, exponentiation, and mixing.
5. Identify the applications to which each distribution may apply and explain why.
6. Apply the distribution to an application, given the parameters.
7. Compare two distributions based on various characteristics of their tails, including moments, ratios of moments, limiting tail behavior, hazard rate function, and mean excess function.

**B. Frequency Models**

For the Poisson, mixed Poisson, binomial, negative binomial, geometric distributions, and mixtures thereof:

1. Calculate moments and generating functions.
2. Describe how changes in parameters affect the distribution.
3. Recognize classes of distributions and their relationships.
4. Identify the applications to which each distribution may apply and explain why.
4. Apply the distribution to an application, given the parameters.
5. Derive and perform calculations with the zero-truncated and zero-modified versions of these distributions.

**C. Aggregate Models**

1. Define collective and individual risk models and calculate their expectation and variance.
2. Use the normal distribution to approximate the aggregate distribution.
3. Use the recursive formula to calculate the values of the collective risk models with discrete distributions of severities.
4. Calculate the expected aggregate payments in the presence of an aggregate deductible.
5. Evaluate the effect of the coverage modifications on the expected aggregate payments.
6. Perform the exact calculation of aggregate loss distribution in case of the normal distribution of severities, exponential and gamma (Erlang) distribution of severities, and a compound model with negative binomial frequency and exponential distribution of severities.

**D. Coverage Modifications**

For frequency, severity, and aggregate models:

1. Evaluate the effect of coverage modifications, in particular, deductibles, limits, and coinsurance.
2. Calculate loss elimination ratios and increased limits factors.
3. Evaluate the effects of inflation on losses.

## **E. Risk Measures**

1. Calculate Value-at-Risk and Tail-Value-at-Risk.
2. Explain the desirable properties of a risk measure and determine whether a given risk has these properties.

## **F. Construction and Selection of Parametric Models**

1. Estimate the parameters for severity, frequency, and aggregate distributions using Maximum Likelihood Estimation for:
  - a) complete, individual data
  - b) complete, grouped data
  - c) truncated or censored data
2. Estimate the variance of the estimators and construct confidence intervals.
3. Use the delta method to estimate the variance of the maximum likelihood estimator of a function of the parameter(s).
4. Estimate the parameters for severity, frequency, and aggregate distributions using Bayesian Estimation.
5. Perform model selection using:
  - a) Hypothesis tests, including Chi-square goodness-of-fit, Kolmogorov-Smirnov, and Likelihood ratio (LRT) tests
  - b) Score-based approaches, including Schwarz Bayesian Criterion (SBC)/Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC).

## **G. Credibility**

1. Apply and critique limited fluctuation (classical) credibility.
2. Explain and apply Bayesian credibility.
3. Apply conjugate priors in Bayesian credibility.
4. Apply Bühlmann and Bühlmann-Straub models and understand their relationship to Bayesian models.
5. Explain and apply empirical Bayesian methods in the nonparametric and semiparametric cases.

## **H. Insurance and Reinsurance Coverages**

1. Describe different types of short-term insurance coverage including auto, homeowners, liability, health, disability, and dental.
2. Describe the types of policy limits and coverage modifications for short-term insurance.
3. Describe the operation of basic forms of proportional and excess loss reinsurance.
4. Derive the distribution of claim amounts paid by the insurer and reinsurer under various forms of reinsurance.

## **I. Pricing and Reserving for Short-Term Insurance Coverages**

1. Explain the role of rating factors and exposure.
2. Describe the different forms of experience rating.
3. Describe and apply techniques for estimating unpaid losses from a run-off triangle, using the following methods:
  - a. chain ladder
  - b. average cost per claim
  - c. Bornhuetter Ferguson
4. Describe the underlying statistical models for the methods in (3).
5. Calculate premiums using the pure premium and loss ratio methods.

## VIII. Instructional Materials:

### A. Texts:

- 1 - *Loss Models: From Data to Decisions*, (Fourth Edition), 2012, by Klugman, S.A., Panjer, H.H. and Willmot, G.E., ISBN 978-1-118-31532-3.

*For the most part, these sections will be covered in the order seen here.*

Chapter 2 (2.1-2.2)

Chapter 3 (3.1-3.5)

Chapter 4 (4.1-4.2)

Chapter 5 (5.1-5.4)

Chapter 6 (6.1-6.6)

Chapter 8 (8.1-8.6)

Chapter 9 (9.1-9.8, excluding 9.6.1)

Chapter 10 (10.3)

Chapter 13 (13.1-13.4)

Chapter 14 (14.1-14.4, 14.6)

**B. Calculator:** Currently the Society of Actuaries (SOA) approves the following calculators: Texas Instruments BA-35, BA II Plus, BA II Plus Professional, TI-30Xa, TI-30X II, and/or TI-30XS MultiView. My favorite calculator for this exam/class is the **TI-30XS Multiview**. Calculators not listed above are **not** permitted to be used on exams in this class! **You should bring your calculator to class every day.**

**C. Coil Page:** Coil is a website made for classmates and educators to collaborate and stay organized. You can create study groups, get your questions answered, and request tutoring. The most active and helpful students can earn a scholarship!

<https://utaustin.coilapp.com/view-groups-details/5c47a39844a0583f60e4401c>

### Other Study Materials:

#### Study Manuals/Online Seminars

Many study manuals are available for this exam. A list of distributors can be found at <http://www.soa.org/education/exam-req/resources/edu-txt-manuals.aspx>. A study manual is optional and not necessary for this course but can be very useful if taking Exam STAM.

#### Sample Questions and Solutions

The SOA has put together a list of sample questions and solutions for Exam STAM. They are posted on Canvas. In addition, the University of Wisconsin-Madison has put together video solutions for the sample questions (link below to videos).

<http://www.soa.org/Education/Resources/Cae/edu-soa-sponsored-study-resources.aspx>

### D. Study Notes Available from the Societies:

<https://www.soa.org/Education/Exam-Req/edu-exam-stam-detail.aspx> (This is a link to the most recent Exam STAM information.)

<https://www.soa.org/Files/Edu/2019/2019-02-exam-stam-syllabi.pdf> (This is a link to the most recent Exam STAM syllabus.)

### E. Other Resources:

#### Tables for Exam STAM

**(These should be brought to class every day.** You will use them often.)

<https://www.soa.org/Files/Edu/2019/2019-02-exam-stam-tables.pdf>

#### Actuarial Outpost

This is a very useful discussion forum for current and aspiring actuaries. There are discussions for each exam, where current and former students can ask questions and give advice. <http://www.actuarialoutpost.com/>

## IX. Instructor Specific Course Policies:

**A. Make-Up Work:** If you have a conflict with a scheduled exam or quiz, email me as soon as you can to see if an alternative accommodation can be made (typically taking the exam/quiz before it is scheduled). You must provide documentation that your absence is "legitimate" (e.g. documentation from a sponsor for a class-related trip or religious observance).

If you miss an exam for circumstances beyond your control and you do not know ahead of time that you will be missing an exam, you must provide documentation in a timely manner that your absence was "legitimate" (e.g. a note from your doctor or your lawyer). You need to expect **at most one** opportunity to complete missed work. Also, if you miss an exam for any reason, you are not eligible to be exempt from the final.

It is the student's responsibility to obtain any notes missed in class. Do not ask me to re-present class content that was missed.

**B. Cheating:** Don't do it. Cheating is taken very seriously, especially in this class, considering that if you pursue being an actuary you will be taking exams for quite a while. The actuarial societies have no tolerance for cheating, and neither do I. If a student is caught in violation of the principles of academic honesty enforced at this university, he/she is immediately reported to the higher authorities and assigned a failing grade in this course.

**C. Classroom Distractions:** The use of cell phones and laptops is not permitted in class. Please make sure that cell phones, smart watches, ipods, watch alarms, and anything else that makes noise do not disturb the class. Coming in to class late can be distracting. Please make every effort to be in class on time. Classroom distractions may affect your Classwork & Participation grade.

<https://abcnews.go.com/beta-story-container/Health/cellphones-classrooms-contribute-failing-grades-study/story?id=56837614>

**D. Extra Credit:** You should not expect any extra credit for this class. In the unlikely event that extra credit is given, it will be made available to all of the students. Asking for extra credit lowers the probability that any will be given.

**E. Professionalism:** Students are expected to maintain appropriate behavior in the classroom, in office hours, and in any activities that reflect the actuarial program and university. Students are expected to treat each other with respect. Any unprofessional behavior in the classroom may result in the student being asked to leave the classroom.

## X. University Policies and Services

**A. UT Student Honor Code:** As a student of The University of Texas at Austin, I shall abide by the core values of the University (learning, discovery, freedom, leadership, individual opportunity, and responsibility) and uphold academic integrity.

<https://www.utexas.edu/about/mission-and-values>

**B. Students with Disabilities:** The University of Texas at Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at (512) 471-6259, 471-4641 TTY.

**C. Accommodations for Religious Holy Days:** By University of Texas at Austin policy, you must notify me of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a class, an examination, a work assignment, or a project in order to observe a religious holy day, you will be given an opportunity to complete the missed work within a reasonable time after the absence.

**D. Nonacademic (family, health, etc.) Student Issues:** Students should contact the CNS non-academic counselors at (512) 471-4536 or your academic advisor.

**E. Policy on Academic Dishonesty:** Students who violate university rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failing in the course and/or dismissal from the University. For further information, visit the Student Conduct and Academic Integrity web site at <http://deanofstudents.utexas.edu/conduct/index.php>.

**F. Counseling and Mental Health Center (CMHC):**

SSB 5th floor, (512) 471-3515, Hours: M-F 8:00am-5:00pm – offers counseling, support groups, classes, workshops, MindBody labs - <https://cmhc.utexas.edu/>

CNS Counselor: Amy Tao-Foster, (512) 471-7162, WCH 2.214

24-Hour Telephone Counseling: (512) 471-2255

Behavior Concerns Advice Line (BCAL): (512) 232-5050

CNS Support Services - <https://cns.utexas.edu/students/support>

Campus Climate Response Team: report [online](#) or call (512) 471-5017

## **XI. Grading Policies**

**A. Homeworks:** Homework assignments must be organized (solutions in order) and stapled in the top left-hand corner. They must be done carefully and written legibly on standard size paper, leaving at least ½" margins on all sides. Please, write only on the front of each sheet and leave a blank line between problems. Box or circle numerical answers where possible. Homework should be folded in half (hot-dog style) with your **Name, Course Number (M 339J - 53400), Assignment Number, and Date** on the outside. Each page should have your name and page number in the top right (Ex: Walch 1). Homework that is not prepared in this fashion may not be graded, resulting in a grade of 0 for the assignment.

Students are not allowed to use the solutions manual or other forms of solutions (such as online discussion forums) to complete or check homework before it is turned in. Instead, students are encouraged to utilize office hours, their notes, the textbook, and work together with classmates to complete homework assignments. Misuse of the solutions manual is considered a violation of the UT Honor Code.

**B. Quizzes:** Quizzes will be given throughout the semester. You should expect one quiz for every other homework assignment, unless told otherwise. No make-up quizzes will be given.

**C. Classwork and Participation:** This grade is affected by attendance, tardiness, attentiveness, preparedness, participation in class discussions, working on assigned in-class problems, attitude, compliance with the syllabus, dishonesty, cell phone use during class, unprofessional behavior, etc.

**D. In-Term Exams:** There will be three in-term exams administered during regular lecture time and will take place in the same classroom as lecture. Anybody who scores a 90% or above on all three in-term exams will not be required to take the final. The average score of all three exams will then be used as the final exam grade. Note that this does not mean a student who is not required to take the final is guaranteed an A. In order to be eligible for exemption from the final, you **must** take all three in-term exams at their scheduled times.

**E. Final Exam:** The final exam will be comprehensive, meaning any material covered in class or assigned as reading can appear.

**F. Grade Distribution and Likely Exam Dates:**

*Note: These are likely exam dates and may change.*

|   |     |
|---|-----|
| Homeworks                                 | 9%  |
| Quizzes                                   | 9%  |
| Classwork & Participation                 | 5%  |
| Exam #1 (February 22 <sup>nd</sup> )      | 18% |
| Exam #2 (April 1 <sup>st</sup> )          | 18% |
| Exam #3 (May 3 <sup>rd</sup> )            | 18% |
| Final (Wed, May 15 <sup>th</sup> , 2-5pm) | 23% |

**G. Rounding:** Rounding is not guaranteed and is at my discretion.

**H. Late Assignments:** Late homework will not be accepted.

**I. Letter Grade Ranges:**

|          |            |
|----------|------------|
| A/A-:    | [90%-100%] |
| B+/B/B-: | [80%-90%)  |
| C+/C/C-: | [70%-80%)  |
| D+/D/D-: | [60%-70%)  |
| F:       | [0%-60%)   |

**Note:** The cutoffs for +/- grades are not determined until the end of the semester.

**J. Emergency Grading Policy:** In the highly unlikely event that I am unable to administer the final due to an emergency (ex: illness, natural catastrophe, etc.), students will be given two options for calculating their total grade. The first option is to take an incomplete for the semester and take the final at a later date. The second option is to use the average of the highest two in-term exams as the final exam grade. Note: this policy does not apply to an emergency that affects only an individual student. Individual student emergencies fall under the 'Make-Up Work' policy.

**XII. Drop Dates:** The last drop date for this class is the one announced on the academic calendar for the University of Texas at Austin. See <http://registrar.utexas.edu/calendars>

**XIII. Changes:** This syllabus is subject to modification. Any changes will be announced in class.