I. Course Title: M 349P Actuarial Statistical Estimates (Unique 55490)  
    M 389P Actuarial Statistical Estimates (Unique 55715)

II. Location and Time: JGB 2.102 (chalkboard)  
    Tuesdays and Thursdays 8:00 am – 9:15 am

III. Instructor: Mark M. Maxwell, PhD, ASA  
    Clinical Professor of Mathematics  
    Paul V. Montgomery Fellow of Mathematics  
    Actuarial Studies Program Director

    Office: RLM 11.168  
    Office Hours: Monday 8:30 am – 10:30 am  
    Tuesday and Thursday 12:30 pm – 2:00 pm  
    Additional hours available by appointment or by chance

    E-mail: maxwell@math.utexas.edu  
    Telephone: (512) 471-7169 – Work  
                (412) 716-5528 – Cellular

IV. Grader or Teaching Assistant: None

V. Prerequisites: M 339J or M 389J (Probability Models with Actuarial Applications)  
    and M 341 (or M340L) with a grade of ‘C-’ or better.

VI. Description of the Course: Statistical estimation procedures for random variables  
    related to quantities in actuarial models. With M 339J (Probability Models with  
    Actuarial Applications) this course covers the syllabus for the professional actuarial exam  
    on model construction - SOA Exam C / CAS Exam 4. This class may be counted toward  
    the quantitative reasoning flag requirement. In the event that the math department adopts  
    an independent inquiry flag, this class would meet that requirement. M 349J meets with  
    M 389J, the corresponding graduate-course number. Offered every fall semester only.  
    This is a 3-credit course.

VII. Course Objectives: An introduction 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 useful frequency and severity models  
    beyond those covered in SOA Exam MLC. The student will be required to understand  
    the steps involved in the modeling process and how to carry out these steps in solving  
    business problems. Students should be able to: 1) analyze data from an application in a  
    business context; 2) determine a suitable model including parameter values; and 3)  
    provide measures of confidence for decisions based upon the model. Students will be  
    introduced to a variety of tools for the calibration and evaluation of the models.
VIII. Learning Outcomes: Students will become familiar with survival, severity, frequency and aggregate models, and use statistical methods to estimate parameters of such models given sample data. Students will be able to identify steps in the modeling process, understand the underlying assumptions implicit in each family of models, recognize which assumptions are applicable in a given business application, and appropriately adjust the models for impact of insurance coverage modifications. Specifically, after taking both M 339J AND M 349P, students will be expected to perform the tasks listed below:

A. Severity Models
1. Calculate the basic distributional quantities:
   a) Moments
   b) Percentiles
   c) Generating functions
2. Describe how changes in parameters affect the distribution.
3. Recognize classes of distributions and their relationships.
4. Apply the following techniques for creating new families of distributions:
   a) Multiplication by a constant
   b) Raising to a power
   c) Exponentiation
   d) Mixing
5. Identify the applications in which each distribution is used and reasons why.
6. Apply the distribution to an application, given the parameters.
7. Calculate various measures of tail weight and interpret the results to compare the tail weights.

B. Frequency Models: For the Poisson, Mixed Poisson, Binomial, Negative Binomial, Geometric distribution and mixtures thereof:
   1. Describe how changes in parameters affect the distribution.
   2. Calculate moments.
   3. Identify the applications for which each distribution is used and reasons why.
   4. Apply the distribution to an application given the parameters.
   5. Apply the zero-truncated or zero-modified distribution to an application given the parameters.

C. Aggregate Models
2. Evaluate compound models for aggregate claims.
3. Compute aggregate claims distributions.

D. For severity, frequency and aggregate models
1. Evaluate the impacts of coverage modifications:
   a) Deductibles
   b) Limits
   c) Coinsurance
2. Calculate Loss Elimination Ratios.
3. Evaluate effects of inflation on losses.

E. Risk Measures
1. Calculate VaR, and TVaR and explain their use and limitations.

**F. Construction of Empirical Models**
1. Estimate failure time and loss distributions using:
   a) Kaplan-Meier estimator, including approximations for large data sets
   b) Nelson-Áalen estimator
   c) Kernel density estimators
2. Estimate the variance of estimators and confidence intervals for failure time and loss distributions.
3. Apply the following concepts in estimating failure time and loss distribution:
   a) Unbiasedness
   b) Consistency
   c) Mean squared error

**G. Construction and Selection of Parametric Models**
1. Estimate the parameters of failure time and loss distributions using:
   a) Maximum likelihood
   b) Method of moments
   c) Percentile matching
   d) Bayesian procedures
2. Estimate the parameters of failure time and loss distributions with censored and/or truncated data using maximum likelihood.
3. Estimate the variance of estimators and the confidence intervals for the parameters and functions of parameters of failure time and loss distributions.
4. Apply the following concepts in estimating failure time and loss distributions:
   a) Unbiasedness
   b) Asymptotic unbiasedness
   c) Consistency
   d) Mean squared error
   e) Uniform minimum variance estimator
5. Determine the acceptability of a fitted model and/or compare models using:
   a) Graphical procedures
   b) Kolmogorov-Smirnov test
   c) Anderson-Darling test
   d) Chi-square goodness-of-fit test
   e) Likelihood ratio test
   f) Schwarz Bayesian Criterion

**H. Credibility**
1. Apply limited fluctuation (classical) credibility including criteria for both full and partial credibility.
2. Perform Bayesian analysis using both discrete and continuous models.
3. Apply Bühlmann and Bühlmann-Straub models and understand the relationship of these to the Bayesian model.
4. Apply conjugate priors in Bayesian analysis and in particular the Poisson-gamma model.
5. Apply empirical Bayesian methods in the nonparametric and semi-parametric cases.
I. Simulation
   1. Simulate both discrete and continuous random variables using the inversion method.
   2. Estimate the number of simulations needed to obtain an estimate with a given error and a given degree of confidence.
   3. Use simulation to determine the p-value for a hypothesis test.
   4. Use the bootstrap method to estimate the mean squared error of an estimator.
   5. Apply simulation methods within the context of actuarial models.

IX. Instructional Materials:


B. Calculator: Currently the Society of Actuaries (SOA) approves the following calculators: Texas Instruments BA-35, BA II plus, BA II plus Professional, 30X, and/or 30Xa. It is my strongest recommendation that you donate your graphing utility to charity and rely on the TI BA II plus professional calculator as your only calculator.

C. Other Study Materials: *Actex Study Manual* or the *CSM Study Manual* are available at www.actexmadriver.com. These are optional. Get with some peers and obtain as many practice problems as you are able.


E. Other Resources: Tables for Exam C/Exam 4

X. Delivery System: This is your class. The responsibility of learning the course objectives (section VI.) and attaining your learning outcomes is entirely your responsibility. I imagine the first 15 – 30 minutes of each class being devoted to reviewing assigned homework and 45 minutes of presentation on new content.

XI. Instructor Specific Course Policies:

A. Make-up work: Make-up work is a rare event. If you must miss a scheduled exam, you must make alternative accommodations with me (typically taking the exam before it is scheduled). See the penalties for late work in section XIII. F.

B. Cheating: It is bad, do not do it. Cheating during an examination will result in an exam score of zero and almost certainly in a course grade of ‘F’.

C. Class Distractions: You will make the necessary arrangements so that cell phones, pagers, watch alarms, and the like do not disturb class. This includes sending and receiving text messages during class.
D. Learning Situations Outside of Class: Following presentations in class is a good start to understanding, being able to complete problems on your own shows a higher level of awareness, and being able to explain solutions to others demonstrates exceptional insight. Therefore, you are encouraged to form study groups. I am available during class, during scheduled office hours, and by appointment. I hope that you feel comfortable receiving help from me. I look forward to helping those motivated students who have attempted their homework. Contact information is listed in section IV. It is ineffective to learn a large amount of mathematics in a short period of time. If you are having difficulty, see me immediately.

E. Extra Credit: None. Extra work is not a substitute to learning the material in a timely fashion. It is inappropriate for you to request extra credit work in this class.

F. Professionalism: Students are expected to maintain appropriate behavior in the classroom and other activities that reflect the university.

G. Course Philosophy: Expectations, execution, no excuses, no exceptions. – Tony Dungy.

XII: University Policies and Services

A. Students with Disabilities: The University of Texas at Austin provides appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at (512) 471-6259, (512) 471-4641 TTY. If you plan on using accommodations, notify me early in the semester.

B. 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 Judicial Services web site at www.utexas.edu/depts/dos/sjs/.

C. The UT Learning Center: Jester Center A332, (512) 471-3614.

D. Counseling and Mental Health Center


F. Religious Holidays: Please make arrangements with me prior to missing any coursework due to religious observances.

XIII: Grading Information

A. Definition of Letter Grades:

A  Achievement of distinction with an unusual degree of intellectual initiative. I would expect ‘A’ students to pass Exam MLC or 3L.
B Superior work. Students earning a ‘B’ could pass MLC or 3L, but I would think that they would have to prepare quite a bit more.

C Average knowledge attainment. The Bob Beaves’ 2 things.

D Unsatisfactory, but passing

F Failing

B. Assessment During the Term: From the teacher - students will receive feedback on their projects, while working in groups, during question and answer periods, during office hours, and during competency examinations. From other students - during study sessions and projects. From oneself – while working on homework problems, in-class examinations, while discussing these concepts with others, and on the comprehensive multiple-choice final examination.

C. Grade Factors: Your grade will be entirely determined by your scores earned on homework quizzes, pop quizzes, in-class examinations, and any other graded work. If you miss graded work, then you are responsible for the effect on your grade. No other factors enter into determining/assigning your grade. Some common excuses (that will result in a 25 point syllabus understanding penalty) include: (1) the student is a graduating senior, (2) the student is not a good test taker, (3) the student has a plane ticket departing prior to a scheduled exam, (4) the student will lose their scholarship, (5) the student has a job lined-up, and etcetera ad infinitum.

D. Homework Notebook: As mentioned previously, my goal is expose topics of life contingencies to University of Texas, Austin students. I trust it is our goal to demonstrate content proficiency by obtaining a passing score on SOA Exam MLC CAS Exam 3L. We consider the prompt and accurate completion of homework to be the single most important factor in student learning. It is my expectation that students study for this class (and the professional examination) as a model for future study. All students are to keep (and bring to class) a homework notebook of all assigned problems. You may choose to keep some notes, other exercises, sample examinations, projects, etcetera with the study aid.

Assigned Problems: One of your goals should be to attempt and solve all appropriate homework problems (from this text and elsewhere). If specific exercises will be collected, they will be noted in class.

Scoring Rubric: Your homework notebook may be collected and graded at random times throughout the term.

E. Final Examination: The comprehensive final examination will be designed in consultation with the actuarial faculty and knowledgeable others. Your examination will be scored and your grade assigned based upon the following rubric:

<table>
<thead>
<tr>
<th>Assigned Grade</th>
<th>Final Exam Score</th>
<th>Faculty Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>93-100</td>
<td></td>
<td>90% confident that student will pass SOA FM now</td>
</tr>
<tr>
<td>90-92</td>
<td></td>
<td>50% chance to pass FM now, can eventually pass</td>
</tr>
<tr>
<td>Score</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------</td>
<td></td>
</tr>
<tr>
<td>87-89</td>
<td>10% chance now, 75% eventual</td>
<td></td>
</tr>
<tr>
<td>83-86</td>
<td>50% chance of eventually passing</td>
<td></td>
</tr>
<tr>
<td>80-82</td>
<td>25% chance of eventually passing</td>
<td></td>
</tr>
<tr>
<td>77-79</td>
<td>10% chance of eventually passing</td>
<td></td>
</tr>
<tr>
<td>70-76</td>
<td>No chance, some understanding</td>
<td></td>
</tr>
<tr>
<td>60-69</td>
<td>Minimal understanding</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>No understanding Cheating on the final</td>
<td></td>
</tr>
</tbody>
</table>

**Uses:** Data will be kept, tracked, and compared to actual professional examination results. These results will be used to modify/improve the course, will be components in annual reports about the program, and will be included in a faculty member’s promotion dossier.

**F. Typical (Default) Point Scale and Examination Dates (TBD):**

Your syllabus and calendar =  
Plan/Goals/Roadmap/Grading Scale (due 9/2/2010) 50 points
Mid-Term Examination(s) 100 points each
Homework Quizzes 20 points each
Projects 20 points each
Final Examination (Tuesday December 14th) 200 points
In-class Presentation(s) 50 points each
Created Work 50 points

**Penalties:**

Syllabus Understanding -25 points for failure to understand this contract
Late work (not presentation) 25% if complete within one day
50% complete within a week, but after a day
100% if complete after one week

**G. Letter Grade Ranges:** The following scale will be used to assign grades at the end of the term. Be careful using this scale on any individually scored work. Some examinations are easier (most students score substantially higher) than other examinations. It is your job to maximize your total points.

- [90%–100%] A/A- range
- [80%–90%) B+/B/B- range
- [70%–80%) C+/C/C- range
- [60%–70%) D range
- [0%–60%) Failing
XIV. Homework Assignments:

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

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