Math 419C   Actuarial Mathematics III
Spring 2013
Bouillon 102 M. W. F. 11:00 – 11:50

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Office hours: M,W 1-1:50; T, R 11-11:50; and by appointments. Schedule on
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Prerequisite: Math 419A,B and permission.

Two texts required:
 1. Cunningham, R.J., Herzog, T.N., and London, R.L. (2011) *Models for Quantifying Risks*, Fourth Edition. Winsted, CT: ACTEX Publications, Inc. Chapters 3, 5-15 (excluding Sections 11.6 and 15.5), 16 (Section 16.1 only). This text will be used as the main source of class lectures and assigned homework problems.

 2. ACTEX MLC Study manual, Fall 2012 Edition by Johnny Li and Andrew Ng. The text supplements lectures with organized formulas, summaries, reviews, and practice problems and sample exams.

Course objectives: After taking the math 419 course sequence, students will be able to apply mathematical principles to traditional insurance and annuities products. Students will be able to use methods of pricing and evaluating risk for these products. Students will be able to demonstrate **life contingency** and **risk theory** and apply the theory to insurance products and business. For math 419C, students will be able to demonstrate the multiple decrement models and collective risks models as well as apply them to reserving and assessing risks.

Course Conduct: You are expected to attend each class. Homework will be due every Friday after the class. Homework questions are expected over the week before the due time. So Begin the Work Early! If you expect to do well in this course, you must do the homework independently. Limited time will be available during class to discuss the homework problems and your instructor is available during office hours and by appointment. Seeking help timely is important to succeed in our quarter setting. Your questions relevant to the previous lecture are most welcomed in class. Questions relevant to earlier material are welcome during office hours. This is a highly challenging course demanding diligence and continual work on problems. Expect to spend hours of concentration on the text reading and problem attempting before each new lecture/Q&A.

Students with Disabilities: If you require accommodation based on a documented disability, have emergency medical information to share, or need special arrangements in case of emergency evacuation, please discuss the situation with me as soon as possible.

Course Prerequisites: Actuarial Mathematics (II) is a formal prerequisite for this course. You must <u>know</u> the basic notations, concept, and rules for survival functions, mortality tables, mathematical survival models, life insurance and annuity contracts, contract premiums, loss variables, and benefit reserves, under both continuous and discrete survival time variable schemes. You must also <u>know</u> the formulas for their interdependent relationships and some proofs by using your pre-requisite in probability theory and calculus. These skills are crucial. You must be able to manipulate algebraic expressions, powers, logarithms, derivatives, and integrals. You should be able to solve linear, quadratic, exponential, logarithmic and trigonometric equations. In addition to the exams, you will complete a SOURCE project independently or within a team. Your working knowledge of Excel spreadsheets is assumed and continues developing. It is possible to arrange a workshop on Friday afternoons to learn from other SOURCE projects.

Learner Outcomes: Upon successful completion of this course, the student will master the following actuarial exam requirements under multiple decrements models:
- the concept and calculation of benefit premiums;
- how benefit reserves can be evaluated for a variety of products and assumptions;
- the concept of modified benefit reserves and its applications;
- the practice to incorporate expenses and general financial liabilities;
- analytical methods for constructing reserve valuations;
- the various interpretations of the universal life insurance;
- the implementation procedures for insurance and annuity pricing through spreadsheet applications.

Grading: Your course grade will be determined by the following:

1. Two 100-point in-class exams. You can drop the lower exam score. So these exams will count for up to 100 points.
2. Weekly homework worth up to 60 points.
3. A complete SOUIRCE project worth up to 100 points.
4. A final exam covering the last chapter worth up to 100 points.

A perfect score on both of the above categories would result in a total of 360 points. Your course grade will be determined by the percentage p of these points you earn, according the following scale.

A 100-93%   **A-** 92.9-90%
B+ 89.9-87%   **B** 86.9-83%   **B-** 82.9-80%
C+ 79.9-77%   **C** 76.9-73%   **C-** 72.9-70%
D+ 69.9-67%   **D** 66.9-63%   **D-** 62.9-60%
F 59.9% and below

Note: No makeup exams will be given. If you miss an exam, it will be the one you drop. You **must** take the final exam to pass the course. It is highly unlikely to curve the grade regardless how the entire class is doing, either too well or too poor. I would like to hold consistent standards across classes.

Course outlines:

Topic	Days
	(One day is one-hour)

I. Multiple Life Functions   6
  1. Joint Distributions of Future Lifetimes
  2. The Joint − Life Status
  3. The Last − Survivor Status
  4. More Probabilities and Expectations
  5. Insurance and Annuity Benefits
       a. -Survival Statuses
       b. -Special Two-Life Annuities
       c. -Reversionary Annuities

  6. Evaluation—Special Mortality Assumptions
       a. -Gompertz and Makeham Laws
       b. -Uniform Distribution
       c. 2. Dependent Lifetime Models-Common Shock

II. Multiple Decrement Models (Theory)   10

  1. Two Random Variables
  2. Random Survivorship Group
  3. Deterministic Survivorship Group
  4. Associated Single Decrement Tables
      -Basic Relationships
      -Constant Force Assumption for Multiple Decrements
      -Uniform Distribution Assumption for Multiple Decrements
  5. Construction of a Multiple Decrement Table

III. Applications of Multiple Decrement Theory   10

  1. Actuarial Present Values and Their Numerical Evaluation
  2. Benefit Premiums and Reserves
  3. Non-Forfeiture Options
      -Cash Values
      -Reduced Paid-Up Insurance
      -Universal Life
      -Deferred Variable Annuities

4. Multi-State Model Representation
    -General Model
    -Disability Model
    -Disability Model Allowing for Recovery
    -Continuing Care retirement
5. Defined Benefit Plans

IV.   Variable Interest Rates
                                                                        2

TESTING   2

TOTAL   30

SOURCE Project: You are required to complete an independent or team spreadsheet application to investigate a real-world overarching question using life contingency models or actuarial mathematics. Making a presentation individually or contributing to a team presentation is expected for everyone in class unless your abstract is denied which will result in a low grade. A written report will be due in the last week of class.

MLC SOURCE Project Assessment Rubric

Title
A concise title describing your project is required. Your title is the first impression of the project that may draw the readers to continue reading or, on the contrary, become clueless (if too broad) or lose   interest (if too narrow).

Abstract
Your abstract should summarize the project by including the motivation and basic focus of your work, the major questions you have addressed, the technique approaches as well as the work you   have planned or completed.

Introduction
It should expand on your abstract by elaborating your work in a larger context. You should state here your big idea – your thesis – that the rest of the report will lead to. It can organize the project   report by outlining separate sections in the remaining report.

Methodology
Describe the actuarial fundamentals incorporated in your methods, equations, and ultimately, spreadsheet implementations. Actuarial symbols used need to be defined clearly and critical   concepts whenever used should be explained. Special techniques or programing used to create and advance your Excel workbook

should be specified. Life tables, mortality rates, survival models, assumptions, and quantities essential to the methodologies need to be described and related.

Deliverables and Results

This is the section in which you will give an introduction or even demonstration of your spreadsheet functionalities and capabilities. Actuarial results of your Excel workbook, analysis, and various program output. The results are often in the form of tables, graphs, figures, and screenshots of user interface. It is vital to the overall success of the entire project. This is where you tell the reader what your project has implemented and what valuable output it can deliver! Probably this will not include every policy calculation you ran, but rather only the representative and interesting ones. It would be the best if your deliverables and results were reformatted to look professional and presentable rather than what usually comes out of initial software output. For example, your graphs must be very nicely formatted, labeled, and explained.   Results of meaningful actuarial calculations and comparisons responding to the project title will go here.

Discussion and conclusion

The Discussion section is the most-read section of most papers. Here is where the reader will turn to find out both what you found, and how to interpret it. Many particular things of interest are given in this section. You may want to compare your results to results of previous studies/conjectures here, or to common sense. You will certainly want to discuss what these results mean in the context of f life contingency model and life industry or products described in the project title. If you would like to recommend that particular action be taken because of your analysis, this is a good place for this.

NOTE: For the purposes of connecting, the Results and Discussion sections do not necessarily have to be separate. You could report the results of one of your questions, and then discuss it, and then go on to the next question. This is fine!

Future research or applications

Now you can return to your thesis, summarizing the important results, and trying to put them into a future perspective on how your project work can be applied by others or used as a valuable resource. This is where people look for insight on the potential of your project in its value to other applications, variations, or educational opportunity.

References

Published/or unpublished Articles or data sources that contributed to your project.

Appendix

Techniques or information supplementing your main report but too lengthy to be included in the sections. For example, they might be the actuarial symbols, screenshots of your program, programming codes, proofs of equations, life tables, . . . ,etc. By completing the appendix material, your report and project can be validated or used by others.

Total "content of paper" points
80 points

Not a section of your report, but important in grading:
Does the paper explain all actuarial terms and equations used?
10 points
Are all figures labeled and referred to appropriately?
5 points
Is the paper well-written, with correct grammar and
clear communications/explanations?
5 points

Total "communication" points
20 points

Tentative Schedule (Any change will be announced in class.)

<u>Week</u>	<u>Reading and Homework Assignment</u>
0. 3/26-3/29	Chapter 12, Exercises: Chapter 12, #18-23 Due on the following Friday!
1. 4/1-4/5	Chapter 12 Exercises: Ch12 #24-29, 30, 31 Due on the following Friday!
2. 4/8-4/12	Chapter 12 Exercises: Chapter 12 Review Problems, Due on the following Friday!
3. 4/15-4/19	*Exam 1 (Monday)* Chapter 13 Exercises: Ch13 #1-6 Due on the following Friday!
4. 4/22-4/26	Chapter 13 Exercises: Ch13 #8-12 Due on the following Friday!
5. 4/29-5/3	Chapter 13 Exercises: Ch13 #13-18 Due on the following Friday!

6. 5/6-5/10   *Exam 2* (**Monday**)

7. 5/13-5/17 (SOURCE Day)   Chapter 14
                                         Exercises: Ch14 #1-7   Due on this Friday!

8. 5/20-5/24   Chapter 14
                                         Exercises: Ch14 #8-16   Due on this

Friday!

9. 5/27- 5/31   Chapter 14
                                         Exercises: Ch14 #17-22   Due on this

Friday!

10. 6/3-6/7   FINAL EXAM WEEK **Covering Chapter**
14 and material announced