

ACT SCI 651: ACTUARIAL MATHEMATICS II

Spring 2016

INSTRUCTOR:

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Office Hours: M 4:00-5:00pm, Tu 2:30 –4:00pm, and by appointment

*Please include “ACT SCI 651” in the subject line of any e-mail pertaining to the class.

LECTURES: MW 1:00 - 2:15pm, 1140 Grainger Hall
MW 2:30 - 3:45pm, 1140 Grainger Hall

DISCUSSION: F 4:00 - 5:30pm, 1295 Grainger Hall
*Refer to **Discussion** in the **Course Policies** section.

PREREQUISITE:

At a minimum, students need a **grade of D or higher in ACT SCI 650: Actuarial Mathematics I** to take this course. It is strongly suggested that students with a grade of D in ACT SCI 650 not take this course, but rather retake ACT SCI 650. Students will have a very difficult time successfully completing ACT SCI 651 without a solid understanding of the ACT SCI 650 material; as ACT SCI 651 is a direct continuation of, and builds upon, ACT SCI 650.

COURSE MOTIVATION:

ACT SCI 650: Actuarial Mathematics I provided an introduction to the study of models that deal with payments to a life that are contingent on that life’s death or survival; i.e., **actuarial mathematics** or **life contingencies**. ACT SCI 650 is the first of a two-semester sequence to provide students with the foundations of pricing traditional insurance and annuity plans that not only have an interest component, but a mortality component. This course, **ACT SCI 651: Actuarial Mathematics II**, is the second course in the two-semester sequence, which further applies the pricing foundations established in ACT SCI 650 to analyses that are currently conducted by life and health actuaries in practice. For example, students will determine how much capital an insurer needs to amass in order to support the ongoing liabilities associated with a policy. As another example, students will calculate premiums for policies such as a disability income insurance, where a policyholder can be in one of three possible states at any given time (healthy, sick, or dead) and pricing needs to consider the likelihood of being in each of these states. The major applications to be considered in this course are delineated in **Overall Course Goals** within the **Course Goals** section. An important point is that each student will need to have sufficient understanding of the ACT SCI 650 course material in order to understand and apply the ACT SCI 651 course material, as the latter utilizes the former.

COURSE GOALS:

Overall Course Goals

By the end of this course, each student will be able:

- To **calculate policy values/reserves** for traditional life insurances and life annuities, and apply them in analyses such as gain-by-source and policy alterations.
- To **develop and utilize multiple state models**, and use transition intensities and/or probabilities to calculate premiums and reserves for policies associated with these models. In particular, students will become familiar with two types of multiple state models that are commonly used in actuarial practice: **multiple decrement models** and **multiple life models**.
- To **understand the difference between defined benefit and defined contribution pension plans**, and use salary scale functions to calculate an appropriate contribution rate for a defined contribution plan to meet a target level of pension income.
- To **define diversifiable risk**, and consider the impact on insurance and annuity valuation if the yield curve is not flat.
- To **understand and apply profit testing to analyze policies (set premiums, set reserves, assess profitability, etc.)**, and to understand and value modern policies such as **universal life insurance**.

The knowledge obtained in both this course and ACT SCI 650: Actuarial Mathematics I should enable students to pass either the Society of Actuaries' (SOA) Exam MLC (Models for Life Contingencies), or the Casualty Actuarial Society's (CAS) Exam LC (Models for Life Contingencies). Detailed information regarding Exam MLC, including syllabi and registration, is available at <https://www.soa.org/education/exam-req/edu-exam-m-detail.aspx>. Detailed information regarding Exam LC, including syllabi and registration, is available at <http://www.casact.org/admissions/syllabus/index.cfm?fa=LCsyllabi&parentID=332>.

Despite my best efforts, it is unlikely that I will cover each of the above topics in such depth that will encompass every conceivable type of Exam MLC problem. I will endeavor to provide each student with sufficient foundational knowledge of each topic that with some additional self-study should enable them to pass Exam MLC.

Student Specific Goals

In addition to the overall course goals, I have various specific goals for each student:

- Each student will learn to solve life contingency problems using **first principles**. In the “real world,” actuaries do not memorize hundreds of specific formulas and/or solutions to individual problems (although candidates taking preliminary SOA or CAS examinations are often led to believe the opposite, given the structure of most of those examinations). Instead, actuaries learn how those formulas and/or solutions were derived, understanding the relevant context and assumptions. With this knowledge, actuaries can attempt to solve any problem that arises, not just those they have previously encountered.
- Each student will develop their **critical thinking ability**, with an emphasis on critically analyzing and solving life contingency problems. Students should be able to define a problem, determine potential approaches that can be used to solve the problem, and then use their chosen approach to determine the solution. This will often involve translating statements in a problem to actuarial notation and terminology, and then using probability, statistics, and interest theory to arrive at a solution.
- Each student will develop their **intuition** in working life contingency problems. Can all formulas and equations utilized in the solution to a problem be interpreted in words that relate to the original problem? Does the solution to a problem seem reasonable? Furthermore, how would the solution be impacted if one or more variables in the original problem were changed? Do not underestimate the importance of intuition in actuarial work.
- Each student will learn to **ask questions** regarding the course material. I encourage students to ask questions during lecture and during office hours. This may sound cliché, but there is no such thing as a dumb question, especially in this course! Unresolved questions should be addressed as soon as possible, as understanding a particular topic requires a thorough understanding of the topics that preceded it. I encourage an interactive discussion between all students and myself. Class participation helps everyone learn.
- Each student will **build a sense of camaraderie** with myself and other students. Form a study group with other students in the course! There is no need for any student to trudge through the material on their own when others are available to assist them and provide support (both problem solving and moral). I will endeavor to be enthusiastic in my teaching and open to back-and-forth discussion both inside and outside of the classroom.

COURSE WEBSITE: <http://courses.bus.wisc.edu/>

*Refer to **Course Website** in the **Course Policies** section.

REQUIRED READINGS:

- (1) Dickson, Hardy, and Waters (2013), *Actuarial Mathematics for Life Contingent Risks, Second Edition*, Cambridge: Cambridge University Press

- Chapter 7: Policy Values
- Chapter 8: Multiple State Models
- Chapter 9: Joint Life and Last Survivor Benefits
- Chapter 10: Pension Mathematics
- Chapter 11: Yield Curves and Non-Diversifiable Risk
- Chapter 12: Emerging Costs for Traditional Life Insurance
- Chapter 13: Participating and Universal Life Insurance

This text is on reserve in the Business Library.

- (2) Johnson, Paul H. Jr. (January 2014), *SOA Exam MLC & CAS Exam LC Study Supplement*

- Section 9: Reserves I
- Section 10: Reserves II
- Section 11: Multiple State Models
- Section 12: Multiple Decrements I
- Section 13: Multiple Decrements II
- Section 14: Multiple Lives I
- Section 15: Multiple Lives II
- Section 16: Other Topics

This text is available on the Course Website.

ASSIGNMENTS AND GRADING:

Each student's grade will be based on two midterm exams, a final exam, and a series of homework assignments. Detailed information regarding exams and homework assignments is provided in the **Course Policies** section. Each student can earn a maximum of 300 points in this course, allocated as follows:

Midterm 1:	75 points / 25% of course grade
Midterm 2:	75 points / 25% of course grade
Final Exam:	90 points / 30% of course grade
Homework:	60 points / 20% of course grade

The following scale gives the lowest overall course grade that each student can earn for a given course percentage:

[93, 100] = A, [89, 93) = AB, [80, 89) = B, [75, 80) = BC, [65, 75) = C, [55, 65) = D, [0, 55) = F

COURSE POLICIES:

- **Lectures:** Each student should regularly and attentively attend the lecture section in which they are registered. For each lecture, I will provide a theoretical motivation for the topic to be discussed, as well as practical uses and applications. Then, the class and I will work several lecture examples in an **interactive problem solving session**. I will not just provide students with solutions to lecture examples, but rather I will guide students through defining the problem, determining potential approaches that can be used to solve the problem, and then using the chosen approach to determine the solution. Many of these problems will have recently appeared on Exam MLC or Exam LC.
- **Lecture Attendance:** I encourage each student to attend class and to arrive on time (preferably early). If you will be arriving late to lecture, please let me know ahead of time. Some of the material covered and many of the examples discussed will only be presented during lecture. The course content can be fairly theoretical; past experience has shown that students that regularly attend and **participate** in lecture perform the best in this course, as they learn the process of solving life contingency problems. Also, lecture attendance will enable students to get to know each other better, and build relationships that will be useful in, among other things, successfully completing homework assignments and passing exams.
- **Discussion:** I do not plan to regularly utilize the Friday discussion section until April, with the exception of Midterm 1 (refer to **Midterms** section). **I intend to use each Friday discussion section during April, and students are expected to attend these sessions – lectures will be held and Midterm 2 will be administered.** If I need to cancel Monday or Wednesday lecture, I may hold a make-up lecture during discussion. I encourage students to feel free to use the discussion section, on days when nothing is scheduled, to get to know each other better by working on the homework assignments together – the room is reserved, feel free to make use of it for course related work. If students are having difficulty learning a particular topic, or wish to learn more about a topic that is not covered in depth during lecture, I may hold an optional lecture during a discussion section.
- **Course Website:** Each student is expected to view all content that is posted on the course website, and regularly check the course website for newly uploaded content. There are various resources on this website that are essential for successful completion of this course – some of which will not be distributed via hardcopies to students (in particular, homework assignments)! Standard handouts, such as this syllabus and Exam MLC handouts, are posted on the website. Additional resources include **videos pertaining to course topics (which students are expected to watch)** as well a link to the TEL website (a collection of “web-based tools to help budding actuaries solve actuarial examination questions”). Homework assignments will be posted on the course website, and must be electronically submitted to me via this website (refer to the **Homework** section in **Course Policies**).
- **Calculators:** Use only **SOA approved calculators** in this course: the battery or solar-powered Texas Instruments BA-35 model calculator, the BA II Plus, the BA II Plus Professional, the TI-30Xa or TI-30X II (IIS solar or IIB battery), or TI-30X MultiView (XS Solar or XB Battery). As a practical matter, students should learn to efficiently use approved calculators in this course as preparation for using them on any SOA examination.

- **Electronic Devices Policy:** No text messaging, emailing, or web browsing during class. Wisconsin School of Business policy regarding electronic devices is as follows: the use of personal electronic technology (e.g. cell phone, iphone, ipod, blackberry, laptop computers, mp3 player) is not allowed during lectures or exams. All laptops should be disabled prior to lecture. **Any student who uses such technology during lecture will be asked to leave.** Any student who uses such technology during an exam is in violation of the code of academic conduct of the University of Wisconsin-Madison.
- **Academic Integrity:** Each student is subject to the University of Wisconsin's code of academic integrity, available at <http://www.students.wisc.edu/doso/academic-integrity/>. Basically, **do not cheat!** All incidences of cheating will result in a score of zero for the assignment or exam and will be officially reported to the Dean of Students. There will be no warnings, no second chances, and no opportunity to re-do the assignment or exam.
- **McBurney Students:** Please **notify me within the first two weeks of the semester** and present the McBurney visa. I will do whatever I can to reasonably accommodate the needs of any McBurney student; particularly with regard to taking exams.
- **Midterms:** **Midterm 1: Friday, February 26, 1295 Grainger Hall, 4:00-5:30pm**
 Midterm 2: Friday, April 8, 1295 Grainger Hall, 4:00-5:30pm

Students in both lecture sections will take the midterms together. Midterms are not cumulative *per se*, but the nature of the course material is such that knowledge of concepts from earlier chapters/sections is required to learn and apply concepts in later chapters/sections. I will announce the material to be covered on each midterm one week before the exam date. Both midterms are closed book, no notes; no personal "cheat sheets" of any kind are permitted.

- **Final exam: Wednesday, May 11, room TBD, 5:05-7:05pm.**

Students in both lecture sections will take the final exam together. The final exam will be cumulative. The final exam is closed book, no notes; no personal "cheat sheets" of any kind are permitted.

- **Make-up/Conflict Exams:**

With regard to make-up exams (<https://bus.wisc.edu/bba/mybiz/academics/academic-policies-procedures>): "Make-up exams may not consist of more than 10% of the total number of students enrolled. If an instructor needs to give a make-up to more than 10% of students enrolled, they must obtain the dean's written approval. The written approval needs to be submitted to the Undergraduate Academic Services office."

With regard to student conflicts (<https://bus.wisc.edu/bba/mybiz/academics/academic-policies-procedures>): "Students should attempt to avoid having more than two exams within 24 hours. If a student has more than two exams in 24 hours, the instructor may—but is not required to—offer a make-up final exam or allowable alternative. However, if a student has two exams at the same time and date, one instructor must offer a make-up final exam or allowable alternative."

Make-up/conflict exams will only be offered in cases where an unforeseen conflict or emergency prevents you from taking the regularly scheduled exam. Appropriate documentation will be required for such a case. In particular, internship/job interviews should not be scheduled during the above exam times if possible. Make-up exams will be given on a day and time of my choosing, and may be more difficult than the regularly scheduled exam.

- **Homework:** Most weeks, students will complete homework assignments which will generally involve problems from the texts in the **Readings** section. It is also possible that some homework assignments will be partially or entirely computer based assignments, which utilize Microsoft Excel. There will be a total of 12 homework assignments. The lowest two homework scores will be dropped and the remaining scores will determine each student's overall homework grade. For each homework assignment, only some of the problems will actually be graded. I will post solutions to the homework problems on the course website shortly after collecting the homework.

Homework must be electronically submitted via the course website prior to the due date and time! Homework not electronically submitted via the course website, or late homework, will not be accepted! There are a couple of files on the course website that describe how to **Make PDF files**. Each student should refer to each homework assignment for specific due dates and any special completion guidelines.

I encourage students to work in groups to learn the material necessary to complete the homework assignments, but each student should submit their own homework, and their work should ultimately be their own. Students should feel free to explore different and creative approaches in working homework problems without fear of being excessively penalized for incorrect solutions. Each student will receive constructive feedback for graded homework problems (alternative approaches that could have been considered, an indication of where their solution may have gone astray).