

# INTRODUCTION TO LIFE CONTINGENCIES

## MA499 (Fall 2018)

**Professor Jin Ma**

Office: KAP 250

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### Course Description

This course aims to introduce basic technical tools in an important aspect of modern actuarial sciences: life insurance. The topics to be covered include basics of life insurance (whole life and term), life annuities (continuous, discrete, annually and monthly), premium calculations; and will also cover some more advanced topics such as multiple state models and multiple life models under a Markovian framework, which are very similar to the credit risk issues in quantitative finance. If time permits, I will also cover some aspects of finance-related insurance problems such as universal life insurance and equity-linked insurance models. The course will provide basic computational skills for standard insurance products based only on elementary calculus, and will also seek a certain level of mathematical rigor on the concepts.

This course is suitable for upper level undergraduate students who are interested in an actuarial career, and will be particularly helpful to those who are preparing for the SOA (Society of Actuaries) Exam MLC (Models for Life Contingencies). The course is also useful for Master/Ph.D level graduate students who are interested in expanding their skill sets to include knowledge of mathematical methods in handling uncertainties of default and/or longevity risks. The students are expected to have a solid background in calculus and (calculus based) probability theory. Some knowledge of differential equations will be helpful.

#### Textbook:

- [1] (Required) David C.M. Dickson, Mary R. Hardy, and Howard R. Waters, *Actuarial Mathematics for Life Contingent Risks* (Second Edition), Cambridge University Press (2013).
- [2] (Optional) Newton L. Bowers, Jr, Hans U. Gerber, James C. Hickman, Donald A. Jones, and Cecil J. Nesbitt, *Actuarial Mathematics* (Second Edition), The Society of Actuaries (1997).

**Subjects to be presented:**

- *Introduction to life insurance and survival models* (3 weeks)
  - Week 1: Basic concepts in life insurance, Future lifetime random variable, force of mortality (§2.1-2.6)
  - Week 2: Life tables and survival models (§3.1-3.5)
  - Week 3: Select and ultimate survival models (§3.7-3.10)
- *Insurance Benefits* (3 weeks)
  - Week 4: Whole life insurance (continuous and discrete cases) (§4.1-4.4)
  - Week 5: Term life insurance, pure endowment (§4.4, 4.5)
  - Week 6: Endowment insurance and Variable insurance (§4.4, 4.6)
- *Annuities* (3 weeks)
  - Week 7: Life Annuities (discrete case) (§5.1-5.4)
  - Week 8: Annuities payable continuously and 1/mthly (§5.5, 5.6)
  - Week 9: Other life annuities (§5.7-5.11)
- *Premium calculation* (2 weeks)
  - Week 10: Present value of future loss random variable (§6.1-6.4)
  - Week 11: The equivalence principle and profit loading (§6.5-6.8)
- *Multiple state models* (2 weeks)
  - Week 12: Alive-dead model and Thiele's differential equation (§8.1-8.7, selected materials)
  - Week 13: Multiple decrement and Markov multiple state models (§8.7-8.13, selected materials)
- *Multiple life models and Universal life insurance* (3 weeks)
  - Week 14: Joint life/last survivor benefits, independent future lifetimes (§9.1-9.5)
  - Week 15: Dependent future lifetimes, common shock model, and copula (§9.6, 9.7)
  - Week 16: (if time permits) Equity-linked insurance (§9.8-9.9)

## Grading Policy

- Homeworks 20%
- Midterms 40%
- Final (take home) Exam 40%

## Classroom Policy

The assessment of a student's performance for the course will be based on the total score of all the graded assignments, which include homeworks and exams. During the semester no letter grades (such as "A", "B", ...) will be given for any of the tests. However, a "progress report" of the whole class will be handed out periodically, usually after a midterm exam or class project, so that each student can find his/her ranking in the class. The final letter grade will depend largely on the ranking in a natural way.

While it is acceptable to work in groups for homework and/or projects, each students must turn in an individual assignment. Plagiarism (copying other people's work) will not be tolerated.

## Statement on Academic Conduct and Support Systems

### Academic Conduct:

Plagiarism - presenting someone else's ideas as your own, either verbatim or recast in your own words - is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" <https://policy.usc.edu/scampus-part-b/>. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

### Support Systems:

*Student Counseling Services (SCS)-(213) 740-7711-24/7 on call*

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

<https://engemannshc.usc.edu/counseling/>

*National Suicide Prevention Lifeline-1-800-273-8255*

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. <http://www.suicidepreventionlifeline.org>

*Relationship and Sexual Violence Prevention Services (RSVP)-(213) 740-4900-24/7 on call*

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. <https://engemannshc.usc.edu/rsvp/>

*Sexual Assault Resource Center*

For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: <http://sarc.usc.edu/>

*Office of Equity and Diversity (OED)/Title IX compliance-(213) 740-5086*

Works with faculty, staff, visitors, applicants, and students around issues of protected class. <https://equity.usc.edu/>

*Bias Assessment Response and Support*

Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response.

<https://studentaffairs.usc.edu/bias-assessment-response-support/>

*The Office of Disability Services and Programs*

Provides certification for students with disabilities and helps arrange relevant accommodations. <http://dsp.usc.edu>

*Student Support and Advocacy-(213) 821-4710*

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic.

<https://studentaffairs.usc.edu/ssa/>

*Diversity at USC*

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. <https://diversity.usc.edu/>

*USC Emergency Information*

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible,

<http://emergency.usc.edu>

*USC Department of Public Safety-213-740-4321 (UPC) and 323-442-1000 (HSC) for 24-hour emergency assistance or to report a crime*

Provides overall safety to USC community. <http://dps.usc.edu>