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Math 419A   Actuarial Mathematics I

Fall 2012

Bouillon 106, 12:00 – 12:50 P.M., (M, W, F)

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Office hours: M-F 9-10; and by appointments

Prerequisite: Math 411A and permission.

Text: 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).

LEARNING OUTCOMES – LIFE CONTINGENCIES (Math419A,B,C)

1) Describe the common decrements and their application to insurances and annuities. (0-5%)
2) Models used to model decrements used in insurances and annuities. (10-20%) a. Calculate single, joint, marginal and conditional probabilities, as applicable and moments for the time-to-decrement, age-at-decrement and cause-of-decrement random variables based on single decrement on single life models, multiple decrements on single life models and single decrement on multiple lives models.
      b. Calculate the probability of being in a particular state and transitioning between states based on continuous-time Markov chain models, discrete approximations of continuous-time Markov chain models and discrete-time Markov chain models.

3) Calculate present values and accumulated values using non-stochastic interest rate models. (0-5%)
4) Models used to model cash flows of traditional life insurances and annuities. (15-25%) a. Calculate single, joint, marginal and conditional probabilities, as applicable and moments of the present-value-of-benefits and present-value-of-premium random variables based on single decrement on single life models, multiple decrements on single life models and single decrement on multiple lives models.
      b. Calculate present values of cash flows.
      c. Calculate present values of cash flows by redefining the present-value-of-benefit and present-value-of-premium random variables to Markov chain models.

5) Describe how reserves are used as an accounting entry to allocate income over the life of a contract. (0-5%)
6) Benefit reserves for traditional life insurances and annuities. (15-25%) a. Calculate moments of the loss-at-issue random and future-loss random variables based on single decrement on single life models and multiple decrements on single life models.
      b. State the equivalence principle.

      c. Calculate benefit reserves and premium based on single decrement on single life models and multiple decrements on single life models.

      d. Calculate benefit reserves and premium using a Markov chain model with specified cash flows.

7) Models used to model cash flows for non-interest sensitive insurances other than traditional life insurances and annuities. (5-15%) a. Calculate benefit premium and benefit reserves by applying concepts presented for traditional life insurance and annuities for the loss-at-issue and future loss random variables based on single decrement on single life models, multiple decrements on single life models, and Markov chain models.

8) Models used to model contract cash flows for basic universal life insurances. (Combined weighting for objectives 8 – 10 is 0-10%) a. Calculate the contract account value and contract surrender value.

      b. Describe differences between primary and secondary contract guarantees.

9) Models used to model cash flows of basic universal life insurance. a. Calculate probabilities and moments of the present-value-of-benefits, present-value-of-premiums and present-value-of-charges random variables based on multiple decrements on single life models.

      b. Calculate present values of cash flows.

      c. Redefine the present-value-of-benefit and present-value-of-premium random variables to Markov chain models to calculate present values of cash flows.

10) Benefit reserves for basic universal life insurances.

      a. Calculate the benefit reserve.

      b. Describe the calculation of the reserve for a secondary guarantee.

11) Models that consider expense cash flows. (10-25%) a. Calculate an expense factor using the appropriate exposure.

      b. Calculate probabilities and moments of the present-value-of-expenses random variable based on single decrement on single life model and multiple decrements on a single life models.

      c. Calculate the expense reserve.

      d. Calculate a gross premium given expenses and benefits based on: the equivalence principle; and a return on gross profits basis.

      e. Calculate the gross premium reserve.

      f. Calculate the asset share.

Course outlines:

Topic	Days

I.   Survival Distributions and Life Tables   9

    1. The Survival Function

    2. Time-until-Death for a Person Age *x*

    3. Curtate-Future-Lifetimes

    4. Force of Mortality

5. Life Tables
6. The Deterministic Survivorship Group
7. Assumptions for Fractional Ages
8. Some Analytical Laws of Mortality
9. Select and Ultimate Tables

II. Life Insurance   6
1. Insurance Payable at the Moment of Death
    -Level Benefit
    -Endowment
    -Deferred
    -Varying Benefit
2. Insurance Payable at the End of the Year of Death
3. Relationships between Insurance Payable at the
    Moment of Death and the End of the Year of Death
4. Differential Equations for Insurances Payable at the
    Moment of Death

III. Life Annuities   5
1. Continuous Life Annuities
2. Discrete Life Annuities
3. Life Annuities with m-thly Payments

IV. Benefit Premiums   8
1. Continuous Premiums
2. Discrete Premiums
3. m-thly Payments Premiums

TESTING   3

TOTAL   31

Class format: Mixture of lectures and in-class problem solving. Students present their solutions of the assigned problems and answer any question raised by the instructor and other students.

Grading policy:
- Assignments   (150 points)
- Three Tests   (300 points)
- Final exam   (100 points)

Tentative Schedule (Any change will be announced in class.)
<u>Week</u>   <u>Reading Assignment</u>

0. 9/19-9/21   Lecture 1, 2 Probability Review, Future Lifetime of Individual Age *x*

1. 9/24-9/28   Lecture 3, 4 Life Tables, Fractional Ages

2. 10/01-10/5   Chapter 5, 6 Review

3. 10/8-10/12   **Test 1**
                                       (Survival Distributions and Life Tables)
                                       Lecture 5 Life Insurance

4. 10/15-10/19   Lecture 6, 7 Varying Benefit Insurance, Insurance Payable at the Moment and EOY of Death

5. 10/22-10/26   Chapter 7 Review

6. 10/29-11/02   **Test 2 (Life Insurance)**
                                       Lecture 9 (Omit Lecture 8) Life Annuities

7. 11/5-11/9   Lecture 10, 11 Discrete Life Annuities, Monthly Payments

8. 11/12-11/16   Chapter 8 Review, **Test 3 (Life Annuities)**

9. 11/19- 11/23   Lecture 14 (Omit Lecture 12, 13) Net Premiums
                                       THANKSGIVING!!

10. 1/26-11/30   Lecture 15, 16 Fully Discrete Premiums, Annual Premiums, Immediate Payments of Benefits

11. 12/03-12/7   **Final Exam (Chapter 5,6,7,8)**

The **Final Exam** date will be according to the university schedule.