

# Models for Life Contingencies Exam

Spring 2016

## Important Exam Information:

[Exam Registration](#)

Candidates may register online or with an application.

[Introductory Study Note](#)

The Introductory Study Note has a complete listing of all study notes as well as errata and other important information.

[Past Exams](#)

Past Exams from 2000 - present are available on the SOA website.

[Updates](#)

Candidates should be sure to check the Updates page on the exam home page periodically for additional corrections or notices.

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**1. Topic: Models for single and multiple lives (10-20%)**

**Learning Objectives**

The Candidate will understand key concepts concerning tabular or parametric survival models and single or multiple-life states.

**Learning Outcomes**

The Candidate will be able to:

- a) Explain and interpret the effects of transitioning between states, the survival models and their interactions. Calculate and interpret standard probability functions including survival and mortality probabilities, force of mortality, and complete and curtate expectation of life.
- b) For models dealing with multiple lives and/or multiple states, explain the random variables associated with the model; calculate and interpret marginal and conditional probabilities, and moments.
- c) Using the factors mentioned in Learning Outcomes 1a and 1b, construct and interpret survival models for cohorts consisting of non-homogeneous populations, for example, smokers and non-smokers or ultimate-and-select groups.
- d) Describe the behavior of continuous-time and discrete-time Markov chain models, identify possible transitions between states, and calculate and interpret the probability of being in a particular state and transitioning between states.
- e) Apply to calculations involving these models appropriate approximation methods such as uniform distribution of deaths, constant force, Woolhouse, and Euler.

**2. Topic: Present Value Random Variables (10-20%)**

**Learning Objectives**

The Candidate will be able to perform calculations on the present value random variables associated with benefits and expenses for any of the models mentioned in the Learning Outcomes of Learning Objective 1.

**Learning Outcomes**

The Candidate will be able to:

- a) Calculate and interpret probabilities, means, percentiles and higher moments.
- b) Calculate and interpret the effect of changes in underlying assumptions such as mortality and interest.
- c) Apply to calculations involving these random variables appropriate approximation methods such as uniform distribution of deaths, constant force, Woolhouse, and Euler.

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**3. Topic: Premium Calculation (20-35%)**

**Learning Objectives**

The Candidate will be able to both calculate with and explain premium-calculation methodologies such as the equivalence principle, the portfolio-premium principle, and premiums determined by specified profit objectives.

**Learning Outcomes**

The Candidate will be able to:

- a) Calculate and interpret probabilities, means, percentiles and higher moments of random variables associated with these premiums, including loss-at-issue random variables.
- b) Using any of the models mentioned in the Learning Outcomes of Learning Objective 1, calculate and interpret the effect of changes in policy design and underlying assumptions such as changes in mortality, benefits, expenses, interest and dividends.
- c) Perform the calculations mentioned in Learning Outcomes 3a and 3b for contracts associated with specified contingent cash flows including
  - o Non-interest-sensitive insurances;
  - o Annuities;
  - o Universal life insurances; and
  - o Participating insurances.
- d) Apply to calculations involving these premiums appropriate approximation methods such as uniform distribution of deaths, constant force, Woolhouse, and Euler

**4. Topic: Reserves (20-35%)**

**Learning Objectives**

The Candidate will understand reserves for insurances and annuities for models mentioned in the Learning Outcomes of Learning Objectives 1 and 3.

**Learning Outcomes**

The Candidate will be able to:

- a) Calculate and interpret any of (i) several reserve types including benefits reserves, gross premium reserves, expense reserves or any of (ii) several reserve methods such as Full Preliminary Term (FPT) or modified reserves.
- b) Calculate and interpret probabilities, means, percentiles and higher moments of random variables associated with these reserves, including future-loss random variables.
- c) Calculate and interpret asset shares, expected profit, actual profit, gain, gain by source and period, internal rate of return and other common profit measures.

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- d) Calculate and interpret the effect of policy modifications.
- e) Calculate and interpret contract account values, contract surrender values and profit measures on universal life insurance contracts.
- f) Compare and contrast non-interest-sensitive and participating insurances with universal life insurances.
- g) Calculate and interpret the effect of changes in policy design and underlying assumptions such as changes in mortality, benefits, expenses, interest and dividends.
- h) Apply to calculations involving these reserves appropriate approximation methods such as uniform distribution of deaths, constant force, Woolhouse, and Euler.

**5. Topic: Pension Plans and Retirement Benefits (10-20%)**

**Learning Objectives**

The Candidate will understand how the models from previous Learning Objectives apply to pension plans and retirement benefits.

**Learning Outcomes**

The Candidate will be able to:

- a) Describe and compare defined contribution and defined benefit pension plans including final salary and career average earning plans.
- b) Identify and interpret the common states and decrements for pension plans, and the parametric and tabular models, including Markov chain models, associated with these decrements.
- c) Apply the models mentioned in learning outcome 5b to defined benefit pension plans and calculate and interpret replacement ratios, benefits, and their expected values with adjustments such as the early retirement reduction factor.
- d) Calculate and interpret the actuarial accrued liability and the normal cost for defined benefit plans under projected unit credit (PUC) and traditional unit credit (TUC) funding.
- e) Calculate and interpret the effect of changes in underlying assumptions such as mortality, other decrements and interest on the quantities mentioned in learning outcomes 5c and 5d.
- f) Apply to calculations involving these defined benefit pension plans appropriate approximation methods such as uniform distribution of deaths, constant force, Woolhouse, and Euler.

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**Resources**

- *Actuarial Mathematics for Life Contingent Risks, 2<sup>nd</sup> Edition*, 2013, Dickson, D., Hardy, M., Waters, H., Cambridge University Press, ISBN: 978-1-110704-407-4. Exercises are considered part of the required readings.
  - Chapters 1-9
  - Chapter 10
  - Chapter 11 (Except Section 11.5)
  - Chapters 12-13
- [Notation and Terminology Note](#)
- [Exam MLC Tables](#)

Note, the text and the Notation and Terminology Note will not be available with the examination booklet. A copy of the Tables will be available.