

ACT 247: Introductory Life Contingencies (Summer 2021)

Instructor Information:

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High level description

Probability theory applied to survival and to costs and risks of life assurances, life annuities, and pensions; analysis of survival distributions; international actuarial notation

Course outcomes:

By the end of the course, you will be able to:

- Understand the key elements behind the mathematics of pricing key life insurance products: sequences and series, probability theory, and time value at money
- Recognize life contingency notation and comfortably apply it
- Understand the concept behind and apply life contingency tables
- Understand and apply parametric survival models for long-term insurance coverages
- Understand the key features of life insurance and apply mathematical relationships to price them
- Understand the key features of life annuities and apply mathematical relationships to price them

Textbook: S. Broverman, Actuarial Science Coursebook for ACT247H + ACT238H 2019-20 Edition

Course tentative outline:

(1) Week 1: Introduction

- a. Introduction
- b. Life insurance products (high level)
- c. ABCs (Section 1):
 - i. Key geometric series
 - ii. Key integrals
 - iii. Probability theory
 1. Intro
 2. Single variable functions
 3. Multiple variable functions
 4. Conditional probability
 5. Independence
 6. Mixture distributions
 7. Distribution functions

- iv. Time value of money
- d. Modelling survival & mortality (Sections 2 & 3):
 - i. Survival probability in the context of life and death
 - ii. Time until death
 - iii. Force of mortality
 - 1. Of a newborn
 - 2. Of a person aged x

(2) Weeks 2 & 3: Life tables & parametric survival models

- a. Life tables (Section 4)
- b. Mean and variance survival metrics (Section 5):
 - i. Complete lifetime expectation, T_x
 - ii. n -year term expectation of life for x , $T_{x:n}$
 - iii. Median and mode lifetime of T_x
 - iv. Curtate expectation of life for x , K_x
 - v. n -year curtate expectation of life for x , $K_{x:n}$
 - vi. Variance of lifetime
 - vii. Variance of curtate lifetime
- c. Parametric survival models (Section 6)
- d. Fractional age assumptions (Section 7)
- e. Select and ultimate mortality (Section 8)

(3) Weeks 4 & 5: Life insurance products

- a. Introduction (Sections 9, 10, 11, 12, & 13):
 - i. Premise
 - ii. Metrics (single policy)
 - iii. Metrics (multiple policies)
 - iv. Useful recursive expressions (APVs)
 - v. Useful continuous/yearly interchanging formula under UDD assumption
- b. Constant paying benefits (Sections 9, 10, 11, & 12):
 - i. n -year term insurance
 - ii. Whole life insurance
 - iii. n -year pure endowment
 - iv. n -year endowment insurance
 - v. Special n -year endowment insurance
 - vi. n -year deferred insurance
 - vii. n -year deferred j year term insurance
- c. Varying paying benefits (Sections 11, & 12):
 - i. Geometrically increasing benefit
 - ii. Whole life increasing insurance
 - iii. n -year term increasing insurance
 - iv. n -year term decreasing insurance

- v. Other continuous varying benefit products
- d. Simplifications when assuming distributions (Section 13):
 - i. Uniform
 - ii. Exponential
 - iii. Normal approximation
- e. Mathematical relationships between insurance products (Section 13):
 - i. Simple, direct relationships
 - ii. Recursive relationships
 - iii. Discrete and continuous insurance relationships assuming UDD
 - iv. Discrete and fractional (whole life insurance only)
 - v. Covariances

(4) Week 6: Annuity insurance products

- a. Introduction (Sections 14, 15, 16, & 17)
- b. Discrete life annuities (Section 14 & 15)
 - i. Whole life annuity due
 - ii. n -year temporary life annuity-due
 - iii. n -year deferred life annuity-due
 - iv. Simplifications under known probability distributions
- c. Continuous life annuities (Section 16)
 - i. Continuous whole life annuities
 - ii. Continuous n -year temporary life annuity
 - iii. Continuous n -year deferred whole life annuity
- d. Mathematical relationships between life annuities (Section 17)
 - i. Recursive relationships
 - ii. Life annuities with m -thly payments
 - iii. Varying life annuities
 - iv. Modified mortality risk & structured settlements

Course Grading:

- 1) Assignments (30%):
 - a. Assignment 1: 15% (due 2021-07-16Fri 11:59PM – covers W1)
 - b. Assignment 2: 15% (due 2021-07-30Fri 11:59PM – covers W1-W3)
 - c. Assignment 3: 15% (due 2021-08-13Fri 11:59PM – covers W1-W5)
- 2) Open book tests (75%):
 - a. Midterm 1: 20% (on 2021-07-29Thu 07:00PM to 09:00PM – covers W1-W3)
 - b. Midterm 2: 20% (on 2021-08-12Thu 07:00PM to 09:00PM – covers W1-W5)
 - c. Final: 20% (on 2021-08-19Thu 07:00PM to 10:00PM – covers W1-W6)

You can earn up to 105 points. Grade is capped at 100 points.

Academic integrity: Because this course is 100% online, it is more difficult to enforce a fair environment that assesses individual performance. Thus, more scrutiny on the teacher's end will be exercised to ensure that individual-based assessments are based on the individual's efforts. Moreover, anyone caught cheating (e.g., copying assignments, solving individual-based assessment problems in groups) will be met with the strictest penalties provided by UT's guidelines.

Canadian Institute of Actuaries (CIA)'s University Accreditation Program (UAP)

ACT247 is an accredited course under the UAP program. You may apply for a credit for Exam LTAM if you achieve the minimum grades for the following three courses: ACT247, ACT348, ACT455. The minimum grade required for ACT247 is 70. For detailed information on UAP, please visit the following webpage:

https://www.cia-ica.ca/membership/university-accreditation-program-home/accredited-universities/accredited-university-detail?pav_universityid=06f6b138-61e5-e511-80b9-00155d111030

Note: CIA will grant credits to students for SOA/CAS examinations based on the achievement of the minimum Grade towards Associateship (ACIA) and Fellowship (FCIA) in CIA. At the time of this agreement, CIA credits are recognized by the following actuarial organizations towards their respective designations:

Casualty Actuarial Society (CAS): ACAS, FCAS

UK Institute and Faculty of Actuaries (IFoA): FIA, AIA

Institute of Actuaries of Australia (IAA): AIAA, FIAA

Actuarial Society of South Africa (ASSA): AMASSA, FASSA

American Academy of Actuaries (AAA): MAAA

CIA does not guarantee that credits granted to students under the CIA UAP will be recognized by any other actuarial organizations towards their actuarial designations.

Textbook purchase information:

You may purchase the coursebook on the UofT Bookstore website.

Navigate to the **Digital Course Materials** section on the University of Toronto Bookstore Website at https://uoftbookstore.com/textbooks/access_codes.asp?

From here, scroll down the list and select your course, which appears as:

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