

Faculty of Science Course Syllabus
Department of Mathematics and Statistics
Actuarial Models II — ACSC/STAT 3703
WINTER 2024

Instructor(s):	Toby Kenney	tkenney@mathstat.dal.ca
Lectures:	MW: 10:05-11:25	
Course Brightspace Page	https://dal.brightspace.com/d2l/home/311744	
Laboratories:	None	
Tutorials:	None	

Course Description

This class introduces a number of insurance concepts, and types of short-term insurance. It then introduces basic ratemaking and reserving techniques. It then builds on the material in STAT 3360 to provide a wider range of probability distributions and techniques for handling them. It also covers methods to modify existing distributions to better reflect given situations, with particular examples being truncation and censorship, such as arise from deductibles and policy limits in insurance. It also introduces basic techniques for studying aggregate loss models, and credibility theory. The examples in this course are mostly drawn from insurance contexts, but the techniques taught are general and can apply in many other situations.

Course Prerequisites

STAT 3360

Course Objectives/Learning Outcomes

- Understand and apply the concepts of utility functions as it relates to the insurance market.
- Describe various common short-term insurance coverages, and common features of these policies.
- Understand how reinsurance contracts work, and calculate expected payments and other quantities for a simple reinsurance contract.
- Adjust the premium rate for a typical short-term insurance policy based on past data including data with rate changes.
- Adjust the premium rate for a short-term insurance policy to account for expected inflation.

- Apply various methods for estimating loss reserves, including the loss ratio method, the chain ladder method and the Bornhuetter-Fergusson method.
- Understand and apply various functions and quantities used to describe continuous and discrete distributions, such as density function, distribution function, hazard rate, moments, percentiles, moment generating functions, probability generating functions.
- Understand the qualitative difference between heavy-tailed and light-tailed distributions and apply a variety of methods to compare the tail weight of different distributions.
- Apply semi-parametric and non-parametric methods to estimate a distribution from data.
- Understand and apply the relations between distributions from the transformed beta family, the transformed gamma family, and the inverse transformed gamma family.
- Calculate distributional quantities for transformations and mixtures of distributions.
- Compute probabilities for distributions from the $(a, b, 1)$ class.
- Calculate the effect of deductibles and policy limits on distributional quantities.
- Compute the moments of Aggregate losses on a portfolio of insurance contracts using a compound model.
- Compute the moments of aggregate claims using an individual risk model.
- Use aggregate loss models to estimate expected payments on a stop-loss reinsurance contract.
- Apply classical credibility theory, in cases with both full and partial credibility.

Course Materials

Textbook:

Loss Models: From Data to Decisions (Fifth Edition)
by S. A. Klugman, H. J. Panjer and G. E. Wilmot
published by Wiley, 2019

Additional reading:

Introduction to Ratemaking and Loss Reserving for Property and Casualty Insurance (Fourth Edition), 2015, by Brown and Lennox
Society of Actuaries, *SHORT-TERM ACTUARIAL MATHEMATICS STUDY NOTES* Available from the SoA website.

Course Brightspace Page:

<https://dal.brightspace.com/d21/home/311744>

Course Assessment

Component	Weight (% of final grade)	Date
Midterm Exam	30	15th February
Final Exam	55	TBA
Assignments	15	Assignment 1 — Wednesday 24th January Assignment 2 — Wednesday 31st January Assignment 3 — Wednesday 7th February Assignment 4 — Monday 12th February Assignment 5 — Wednesday 14th March Assignment 6 — Wednesday 21st March Assignment 7 — Wednesday 28th March Assignment 8 — Wednesday 4th April

Other Course Requirements

Conversion of numerical grades to Final Letter Grades follows the

Dalhousie Common Grade Scale

A+	(90–100)	B+	(77–79)	C+	(65–69)	D	(50–54)
A	(85–89)	B	(73–76)	C	(60–64)	D	< 50
A-	(80–84)	B-	(70–72)	C-	(55–59)	D	(50–54)

Delivery of Material

The course will be delivered in-person. Homeworks will be submitted in-class, or online via Brightspace. Exams will be in-person.

Course Policies

Late assignments will receive a grade of zero, as solutions are posted online immediately after the due date. Assignments submitted online should be in pdf or jpeg format. The overall assignment mark is made up from the best 7 out of 8 assignments. Students unable to take the final exam should, wherever possible, notify the instructor prior to the start of the exam, and submit the Student Declaration of Absence. All reasonable efforts to provide a make-up exam will be made. Assignments are to be individual work.

Course Content

The planned schedule for covering the course is as follows:

Week beginning	Monday	Wednesday
8th January	Introduction and Preliminaries, IRLRPCI 1 Why insurance? , 1.3 Insurance and Utility Q.1 , 1.4 Insurable Risks	IRLRPCI 2 Types of short-term insurance coverage: 2.2 Automobile Insurance Q.2 , 2.3 Homeowner's Insurance Q.3
15th January	IRLRPCI 2 Types of short-term insurance coverage (cont.) 2.4 Tennant's Package, 2.5 Worker's Compensation, 2.6 Fire Insurance, 2.7 Marine Insurance, 2.8 Liability Insurance, 2.9 Limits to Coverage Q.4–5 IRLRPCI 5 Intermediate topics 5.3 Reinsurance Q.6	IRLRPCI 4 Ratemaking 4.1 Introduction, 4.2 Objectives of ratemaking, 4.3 Data for ratemaking, 4.4 Premium data Q.7 , 4.5 The exposure unit, 4.6 The expected effective period Q.8–9 , 4.7 Ingredients of ratemaking, 4.8 Rate changes Q.10–12
22nd January	IRLRPCI 3 Loss Reserving 3.2 How outstanding claim payments arise, 3.3 Definition of terms, 3.4 Professional considerations, 3.5 Checking the data, 3.6 Loss reserving methods	3.6.1 Expected Loss ratio method Q13 , 3.6.2 Chain Ladder method Q14 , 3.6.3 Bornhuetter-Fergusson method Q15
29th January	2 Random Variables: Q16–19, 3 Basic Distributional Quantities: 3.1 Moments Q20–22 , 3.2 Percentiles Q.23–25 , 3.3 Generating Functions and Sums of Random Variables Q26–27 ,	3.4 Tail Weight Q28–33 , 3.5 Measures of Risk Q34–40 ,
4th February	4 Characteristics of Actuarial Models: 4.2 The Role of Parameters Q41–42 , 4.3 Semiparametric and Non-Parametric Methods Q43–48 ,	Revision IRLRPCI & Chapters 2–4
12th February	Revision IRLRPCI & Chapters 2–4	MIDTERM EXAM
19th February	STUDY WEEK	
26th February	5 Continuous Distributions: 5.2 Creating New Distributions Q49–53 , 5.2.4 Mixture Distributions Q54–65 ,	5.3 Selected Distributions and their Relationships , 5.3.2 Two Parametric Families Q66 , 5.3.3 Limiting Distributions Q67–68 , 5.4 The Linear Exponential Family Q69–70 ,
5th March	6 Discrete Distributions: 6.2 The Poisson Distribution (revision) Q71–72 , 6.4 The Binomial Distribution (revision) Q73–74 , 6.3 The Negative Binomial Distribution Q75–78 ,	6.5 The (a,b,0) Class Q.79-80 , 6.6 Truncation and Modification at Zero Q81–84 ,
12th March	8 Frequency and Severity with Coverage Modifications: 8.2 Deductibles Q85 , 8.3 Loss Elimination Ratio and Inflation Q86–87 , 8.4 Policy Limits Q88 ,	8.5 Coinsurance, Deductibles and Limits Q89–90 , 9 Aggregate Loss Models: 9.1 Introduction,
19th March	9.2 Model Choices Q91 , 9.3 The Compound Model for Aggregate Claims Q92–96 ,	9.3 The Compound Model for Aggregate Claims (cont.),
26th March	9.8 The Individual Risk Model Q97-100 ,	17 Limited Fluctuation Credibility Theory : 17.3 Full Credibility Q101–103 , 17.4 Partial Credibility Q104–105 , 17.5 Problems with this approach Q106 ,
2nd April	Revision	Revision

University Policies and Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity.

Information: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

Information: https://www.dal.ca/campus_life/academic-support/accessibility.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution.

Code: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness

Statement: <http://www.dal.ca/cultureofrespect.html>

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit or e-mail the Indigenous Student Centre (1321 Edward St) (elders@dal.ca).

Information: https://www.dal.ca/campus_life/communities/indigenous.html

Important Dates in the Academic Year (including add/drop dates)

https://www.dal.ca/academics/important_dates.html

University Grading Practices

https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Student Resources and Support

Advising

General Advising https://www.dal.ca/campus_life/academic-support/advising.html

Science Program Advisors: <https://www.dal.ca/faculty/science/current-students/academic-advising.html>

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Black Students Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre/current-students.html

Academic supports

Library: <https://libraries.dal.ca/>

Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Studying for Success: https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Copyright Office: <https://libraries.dal.ca/services/copyright-office.html>

Fair Dealing Guidelines <https://libraries.dal.ca/services/copyright-office/fair-dealing.html>

Other supports and services

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html

Student Advocacy: <https://dsu.ca/dsas>

Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

Safety

Biosafety: <https://www.dal.ca/dept/safety/programs-services/biosafety.html>

Chemical Safety: <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

Radiation Safety: <https://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

Scent-Free Program: <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>