

The University of Iowa
College of Liberal Arts and Sciences
Department of Statistics and Actuarial Science
Course Outline for ACTS:4280 Life Contingencies II Fall Semester 2022
MWF 1:30 to 2:20 pm 14 SH

Instructor: Dr. E.S.W. Shiu Office: 362 SH Phone: 319 335 2580 E-mail: elias-shiu@uiowa.edu

Office Hours: 1:45 to 3:15 pm on Tuesdays and 10:30 am to 12 noon on Thursdays; or by appointment.

Department: Statistics & Actuarial Science, 241 SH

Phone: 319 335 2082

D.E.O.: Dr. Kung-Sik Chan Phone: 319 335 0712

E-mail: kung-sik-chan@uiowa.edu

Prerequisites: C+ or better in ACTS:4180. Calculus, linear algebra, and probability are used extensively in this course.

The textbook is *Actuarial Mathematics for Life Contingent Risks*, 3rd ed (2020), by D.C.M. Dickson, M.R. Hardy, and H.R. Waters, Cambridge University Press. The goal of the course is to cover its Chapters 8, 9, 10, 11, 13, 14, 17, and Sections 7.2.4, 15.2, 18.6.

Below are some useful references.

- *Actuarial Mathematics*, 2nd edition, by N. L. Bowers, Jr., H. U. Gerber, J. C. Hickman (U Iowa MS 1952, PhD 1961), D. A. Jones (U Iowa MS 1956, PhD 1959), and C. J. Nesbitt, SOA 1997.
- *Solutions Manual for Actuarial Mathematics for Life Contingent Risks*, 3rd edition, by D. C. M. Dickson, M. R. Hardy, and H. R. Waters, Cambridge University Press.
- *Models for Quantifying Risk*, 6th edition, by S.J. Camilli, I. Duncan, and R. L. London, ACTEX Publications, and its *Solutions Manual*.
- *Fundamental of Actuarial Mathematics*, 3rd edition, by S. D. Promislow, Wiley.
- *Stochastic Models in Life Insurance* by Michael Koller (a book published by Springer for the European Actuarial Academy). Using a campus connection, you can download the entire book for free <http://link.springer.com/book/10.1007/978-3-642-28439-7>

For the midterm and final exams, you are to use a calculator approved by the SOA.

Tentatively, your numerical grade will be calculated using the formula,

$$\text{HW/Projects } 10\% + \text{Midterm Test } 35\% + \text{Final Exam } 55\%,$$

and translated to a letter grade for your UI transcript as follows:

Undergraduates F[0, 40); D-[40, 45); D[45, 50); D+[50, 55); C-[55, 60); C[60, 65); C+[65, 70); B-[70, 75); B[75, 80); B+[80, 85); A-[85, 90); A[90, 95); A+[95, 100]

Graduate students F[0, 46); D-[46, 50.5); D[50.5, 55); D+[55, 59.5); C-[59.5, 64); C[64, 68.5); C+[68.5, 73); B-[73, 77.5); B[77.5, 82); B+[82, 86.5); A-[86.5, 91); A[91, 95.5); A+[95.5, 100]

The formula for SOA's UEC score is: HW/Projects 20% + Final Exam 80%. To get ALTAM credit from the SOA, you need to achieve 85% or better.

The **final** examination, to be held during the week of December 12, is **cumulative** (covering material from throughout the course).

The **midterm** examination will be held on October 14, 6:30 to 8:30 pm, in 140 SH. The topics to be examined are: Multi-State Models (Chapter 8), Multiple-Decrement Models (Chapter 9), Joint Life and Last Survivor Functions (Chapter 10), and Universal Life Insurance (Chapter 14). Below are some areas where ACTS:4280 goes beyond the textbook AMLCR. Matrix theory is used extensively to strengthen the development in Chapters 8 and 10 of AMLCR: Chapman-

Kolmogorov equation ${}_t\mathbf{P}_x \times {}_s\mathbf{P}_{x+t} = {}_{t+s}\mathbf{P}_x$; Kolmogorov forward equation $\frac{d}{dt} {}_t\mathbf{P}_x = {}_t\mathbf{P}_x \mathbf{M}_{x+t}$; Euler

method for approximately solving the Kolmogorov forward equation ${}_{t+h}\mathbf{P}_x \approx {}_t\mathbf{P}_x(\mathbf{I} + h\mathbf{M}_{x+t})$.

When all forces of transition are constant, the solution of the Kolmogorov forward equation can be expressed as ${}_t\mathbf{P} = \exp(t\mathbf{M})$; one way to evaluate the matrix exponential is the Lagrange-

Sylvester formula. For Multiple Decrement problems, you are to use the notation in Chapter 10 of *Actuarial Mathematics* by Bowers et al., not that in Chapter 9 of AMLCR, e.g., use ${}_tq_x^{(j)}$, not

${}_tP_x^{0j}$. You should know the Riemann-Stieltjes integral representation for ${}_tq_x^{(j)}$, especially for the case where the force of decrement can be unbounded, because the continuous-time Markov

chain models in AMLCR need the forces of transition to be finite. The term “Woolhouse’s formula” in Section 8.6.1 is incorrect; the approximation formulas in that section are merely

consequences of the Euler-Maclaurin formula that you have learned in ACTS:4180 last spring.

Account values in universal life insurance are similar in nature to retrospective reserves with the q values identified appropriately. For Type A UL insurance, Fackler’s accumulation formula can be quite useful.

You are expected to at least know the MLC/LTAM exam problems since 2012, the year the textbook changed from Bowers et al. to Dickson et al. The table on the next page was kindly provided by Dr. Andrew Ng. It lists questions in the past 21 MLC/LTAM exam papers from the four topics for the midterm examination. Some more practice problems can be found in

<https://www.soa.org/globalassets/assets/files/edu/edu-2014-spring-mlc-ques.pdf>

<https://www.soa.org/globalassets/assets/Files/Edu/2018/edu-spring-ltam-ques.pdf>

Multiple Choice Questions

Year \ Topic	Multiple state	Multiple decrement	Multiple life	Universal Life
2012 Spring MLC Exam	12,19,28	14, 29	6,11,16	27
2012 Fall MLC Exam	12,16,24	13	1,10,21	8, 9
2013 Spring MLC Exam	4,10,13	2, 11	5,6	14
2013 Fall MLC Exam	4,10,21		2	22, 23
2014 Spring MLC Exam	3	15	7,11	17
2014 Fall MLC Exam	3,12	2	1,6	18
2015 Spring MLC Exam	2,6		3,13	16
2015 Fall MLC Exam	3		5,6	13, 17
2016 Spring MLC Exam	1,4		6	14, 16
2016 Fall MLC Exam				7, 14
2017 Spring MLC Exam	3,4	1	9,13	14
2017 Fall MLC Exam	3	2		17
2018 Spring MLC Exam	10,18		3,8	13
2018 Fall LTAM Exam	4,9,16	3	10,14	
2019 Spring LTAM Exam	4,9,15	5	12	
2019 Fall LTAM Exam	10, 17	2, 5, 15	6	
2020 Spring LTAM Exam	9,13,20	4	7	
2020 Fall LTAM Exam	4,8,13	5, 9	1,10	
2021 Spring LTAM Exam	8,17	16	9	
2021 Fall LTAM Exam	4,12	5	8,13,16	
2022 Spring LTAM Exam	5,8	6,17	9,10,14	

Written-Answer Questions

2014 Spring MLC Exam	2		1(d)	6
2014 Fall MLC Exam	4		3	6
2015 Spring MLC Exam	1	2		6
2015 Fall MLC Exam	2	4	2	5
2016 Spring MLC Exam	1	5(b)		
2016 Fall MLC Exam	1	3		
2017 Spring MLC Exam	1			
2017 Fall MLC Exam		6	5	2
2018 Spring MLC Exam	1		2	
2018 Fall LTAM Exam	1(a)(b)			
2019 Spring LTAM Exam	2(c)(d)(e)		4	
2019 Fall LTAM Exam	2		3	
2020 Spring LTAM Exam		2	1	
2020 Fall LTAM Exam			4	
2021 Spring LTAM Exam	1(b)(c)(d)		6	
2021 Fall LTAM Exam	3		5	
2022 Spring LTAM Exam	2		4	

Below is a tentative teaching schedule.

Dates	Topics	Sections in AMLCR	Notes
8/22, 24, 26	Universal Life Insurance	Ch. 14	
8/29, 31; 9/2, 7, 9, 12	Discrete- & Continuous-time Markov chains	Sec. 8.1 to 8.5; 8.10	Matrix approach employed throughout
9/14, 16, 19, 21, 23, 26, 28, 30	State-dependent insurance & annuities	Sec. 8.6 to 8.9	
10/3, 5	Multiple Decrements	Ch 9	Reconcile AMLCR notation with that in Bowers et al. which students learned in ACTS:4180; Stieltjes integral representation
10/7, 10, 12	Joint Life	Ch 10	Reconcile with what students have learned in ACTS:4180; Sec. 10.6 is beyond Bowers et al.
10/14/2022	Midterm examination 6:30-8:30 PM		
10/17/2022	Review of Midterm exam questions		
10/19, 21, 24, 26, 28, 31	Pension Mathematics	Sec. 11.1 to 11.11	
11/2, 4, 7, 9, 11, 14	Profit Analysis	Sec. 7.2.4 & Ch. 13	
11/16, 18	Option pricing by Esscher transforms		Transactions of the SOA (1994) paper
11/28, 30; 12/2, 5	Embedded Options in insurance & annuities	Sec. 17.1 to 17.6	
12/7, 9	Estimation of transition intensities	Sec. 18.6	
12/12 to 16	Final Examination Week		

Academic Honesty and Misconduct

All students in CLAS courses are expected to abide by the [CLAS Code of Academic Honesty](#). Undergraduate academic misconduct must be reported by instructors to CLAS according to [these procedures](#). Graduate academic misconduct must be reported to the Graduate College according to Section F of the [Graduate College Manual](#).

Student Complaints

Students with a complaint about a grade or a related matter should first discuss the situation with the instructor and/or the course supervisor (if applicable), and finally with the Director or Chair of the school, department, or program offering the course.

Undergraduate students should contact [CLAS Undergraduate Programs](#) for support when the matter is not resolved at the previous level. Graduate students should contact the CLAS [Associate Dean for Graduate Education and Outreach and Engagement](#) when additional support is needed.

Drop Deadline for this Course

You may drop an individual course before the deadline; after this deadline you will need collegiate approval. You can look up the [drop deadline for this course](#) here. When you drop a course, a “W” will appear on your transcript. The mark of “W” is a neutral mark that does not affect your GPA. Directions for adding or dropping a course and other registration changes can be found on the [Registrar’s website](#). Undergraduate students can find policies on dropping and withdrawing [here](#). Graduate students should adhere to the [academic deadlines](#) and policies set by the Graduate College.

College of Liberal Arts and Sciences (CLAS) Course Policies

[Attendance and Absences](#)

University regulations require that students be allowed to make up examinations which have been missed due to illness or other unavoidable circumstances. Students with mandatory religious obligations or UI authorized activities must discuss their absences with me as soon as possible. Religious obligations must be communicated within the first three weeks of classes.

[Exam Policies](#)

Communication: UI Email

Students are responsible for all official correspondences sent to their UI email address (uiowa.edu) and must use this address for any communication with instructors or staff in the UI community.

University Policies

[Accommodations for Students with Disabilities](#)

[Basic Needs and Support for Students](#)

[Classroom Expectations](#)

[Exam Make-up Owing to Absence](#)

[Free Speech and Expression](#)

[Mental Health](#)

[Military Service Obligations](#)

[Non-discrimination](#)

[Religious Holy Days](#)

[Sexual Harassment/Misconduct and Supportive Measures](#)