

King Fahd University of Petroleum and Minerals
Department of Mathematics and Statistics
AS482: Actuarial Contingencies 2 - Term 171 (3-0-3)

Course Objectives:

A continuation of Life Contingencies I. Development is based on a stochastic approach to insurance models. Major topics include benefit premiums and reserves, and multi-life and multiple-decrement models. Parallel treatment of topics based on Takaful system. Application of such area in life insurance and property.

Prerequisites: AS 381

Textbook and Package:

1. Cunningham, R.J., Herzog, T.N., & London, R.L. (2012) *Models for Quantifying Risk, 5th edition*. ACTEX Publication: Winsted, USA.
2. Texas BAI Plus Calculator or Texas BAI Professional

Reference:

1. Dickson, D.C., Hardy, M. R., & Waters, H. R. (2011) *Actuarial Mathematics for Life Contingent Risks*. Cambridge University Press: Cambridge, UK.
2. Bowers N., Gerber, H., Hickman, J., Jones, D. & Nesbitt, C. (1997 or later printing) *Actuarial Mathematics*, 2nd edition. Society of Actuaries Publishing.
3. Camilli, S.J., Duncan, I, & London, R.L. (2014) *Models for Quantifying Risk, 6th edition*. ACTEX Publication: Winsted, USA.
4. Society of Actuaries regulations for LTAM (Long Term Actuarial Models) and sample exams for MLC (Models for life Contingencies)

Instructor: Dr. Mohammad H. Omar

Office: Bldg – 5, room – 508. **Phone:** 013 - 860 2471

E-mail: omarmh@kfupm.edu.sa (Not by WebCT/Blackboard email)

Office Hours: UR (10.00-11.45am), and T (10.00-10.55am), or by appointment

Assessment

Assessment for this course will be based on attendance, homework, term report, 2 major exams and a comprehensive final exam, as follows:

Activity	Weight
Attendance and homework	(2%+5%)
Term Paper Report & Presentation (Tuesday Dec 20 - week 14, 9:00am - 9:50am)	(10%+5%)
Exam 1 (Chapters 3, 5.5, 6.5, 13 & 14 {exclude 14.5}) Wednesday (Oct 18 - week 5) , 5.30 pm (venue TBA)	23%
Exam 2 (Chapters 12, 15, & 16) Monday (Nov 20 - week 10), 5:30 pm (venue TBA)	25%
Final Exam (Comprehensive) Sunday Jan 2 7pm (as posted on registrar website)	30%

IMPORTANT NOTE on GRADES: There is no quota on the number of students who can get an A+ or other grades.

- ✓ **Attendance** on time is *very* important. Mostly, attendance will be checked within the **first five minutes** of the class. Entering the class after that, is considered as late (**2 lates= 1 Absence**) and
- ✓ **More than 10 minutes late = Absence** (regardless of any excuse).
- ✓ Only University Blue paper Official excuses will be accepted as valid excuse.

Letter grade	A+	A	B+	B	C+	C	D+	D	F	DN
Cut-off	90%	85%	80%	75%	67%	60%	55%	50%	<50%	≥ 9 absences

General Notes:

- Students are required to carry **pens, note-taking equipment** and a **calculator** to **EVERY lecture and exams**. It is strongly recommended to keep a **binder** for class-notes.
- Students are also expected to bring the book, take notes and organize their solved questions in a **binder** for easy retrieval to help them in study and review for class, exams, etc
 - It is to the student's advantage to keep a binder for storing class notes, homework, and other graded assignments. Students who are **organized** will find it **easier** to find important materials when **studying for exams**.

Home Work:

- To successfully prepare for the SOA exams, students MUST **solve problems** regularly and with discipline. The selected assigned problems are specifically designed to prepare you for major and final exams. So, it is expected that you complete these problems **step-by-step** and **with comprehension**.
 - If you happen to stumble upon a *solution manual* somewhere, remember **2 important points**. (1) Due to publishing costs and deadlines, these solutions are brief and may have mistakes and (2) in your career as an actuary and your exams and quizzes in this class, you are expected to know **every step to a problem** and to know if a solution is incorrect. Thus, the best way to solve problem is without these brief solutions.
 - **Homework is due in class on the first Sunday after completing a chapter.**
 - **No late homework will be accepted, and**
 - **Actuaries don't act like the guy in the cartoon below.**



They **manage risk**.

They **don't let risk manage them**

- **Never round** your intermediate results to problems when doing your calculations. This will cause you to lose calculation accuracy. Your answers may then be different from the SOA exam key even when you use the right procedure.
- For every exam, so you need to bring with you **pens, pencils, a sharpener, an eraser**, and a **SOA approved calculator**.
- Students should wait until completion of course AS482 before they attempt to take the professional exam MLC.

Academic Integrity: All KFUPM policies regarding **ethics** and **academic honesty** apply to this course.

Tentative Schedule

Week	Sections	Topics	Notes
1 (Sep 17 – 21)	Ch 3 & 5.5	Review of Markov Chains (3-1/2 class).	Sept 20: Last day for late reg & for adding courses. Sept 24: Natl Day Holiday
2 (Sep 25-28)	Ch 3 & 5.5 Ch 13	Review of Markov Chains (continued). Multiple-Decrement Models. Discrete Multi-Decrement Models. Theory of Competing Risks. Continuous Multi-Decrement Models. Uniform Distribution of Decrements.	
3 (Oct 1-5)	Ch 13 Ch 14 & 6-5	Multiple-Decrement Models. (continued). Miscellaneous Examples. Multiple-Decrement Models (Applications). Actuarial Present Value. Asset Shares. Non-forfeiture Options. Multi-State Model representations, with Illustrations (14.4 & 6.5).	
4 (Oct 8-12) + Oct 7	Ch 14 & 6-5 Ch 12	Multiple-Decrement Models (Applications -continued). Defined Benefit Pension Plans. Models dependent on Multiple Survivals (Multi-life Models). Joint-Life Model. The Last Survivor model. Contingent Probability functions.	Life Tables & Characteristics. Declare your Term paper topic: Sun Oct 8
5 (Oct 15 – 19)	Ch 12 Appendix A.6	Multi-life Models (continued) Contingent Contracts Involving Multi-Life Statuses. General Random Variable Analysis. Common Shock – A model for lifetime dependency. Multi-State Model Representation (5.5 & 12.5).	(2 wks): Midterm grade reports starts
Wednesday (Oct 18– week 5) – 1st Major Exam (chapters 3, 5.5, 6.5, 13, & 14 (exclude 14.5))			
6 (Oct. 22-26)	Ch 15	Models with Variable Interest Rates Actuarial PV using Variable Interest. Deterministic Interest Rate Scenarios. Spot Interest Rates & Term Structure of Interest Rates.	
7 (Oct. 29 – Nov 2)	Ch 15	Models with Variable Interest Rates (continued). Forward Interest Rates. An Example with Simulated Rates of Return. Transferring the Interest Rate Risk.	
8 (Nov 5 – 9)	Ch 16	Universal Life Insurance Basic Aspects. Indexed Universal Life Insurance.	
9 (Nov 12 – 16)	Ch 16	Universal Life Insurance (continued) Pricing Considerations (including Pricing for Secondary Guarantees).	
10 (Nov 19 – 23)	Ch 16 Ch 14.5	Universal Life Insurance (continued) Pension Mathematics	
Monday (Nov 20 - week 10), 5:30 pm – 2nd Major Exam (chapters 12, 15 & 16)			
11 (Nov 26 – 30)	Ch 14.5	Pension Mathematics (continued)	
12 (Dec 3 – 7)	MLC Manual MLC manual	Pension Mathematics (continued) Profit Testing.	Sun Dec 3: Term Paper Report due to instructor.
13 (Dec 10 – 14)	MLC manual	Profit Testing. (continued)	
14 (Dec 17 – 21)	MLC manual & Handout	Profit Testing. (continued) New Participating Insurance	
Tuesday (Dec 20 - week 14), 9:00am - 9:50am - Poster Presentations			
15 (Dec 24 – 28)	Supplements & Review	New Participating Insurance (continued) Review	
Final Exam (Comprehensive): Sunday Jan 2 7pm			

Learning Outcomes: By completing this course, students should be able to

- Demonstrate a thorough understanding of multi-decrement models
- Apply multi-life models to real situations
- Distinguish Actuarial Models with fixed interest rates from those with variable returns

- Calculate Premiums for Pension Funding of Pension payouts
- Compare effects of various assumptions for profit testing
- Explain main features of plans under Universal life insurance and participating Insurance
- Solve SOA type MLC (LTAM) problems

Learning outcomes that are more detailed are available in the SOA MLC exam syllabus. A mapping of these detailed SOA outcomes to this AS482 course and to AS381 can be found below.

Student Learning Outcomes: (From the Society of Actuaries Exam MLC -- Changes in 2014 due to OEQ)

SOA Learning Objectives and Learning Outcomes (Fall 2016)		weight	Course
1.	<p>Topic: Models for single and multiple lives</p> <p>Learning Objectives The Candidate will understand key concepts concerning tabular or parametric survival models and single or multiple-life states.</p> <p>Learning Outcomes The Candidate will be able to:</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>e. Apply to calculations involving these models appropriate approximation methods such as uniform distribution of deaths, constant force, Woolhouse, and Euler.</p>	10-20%	Both AS381 & AS482 Both AS482 Both AS482 Both
2.	<p>Topic: Present Value Random Variables</p> <p>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.</p> <p>Learning Outcomes The Candidate will be able to:</p> <p>a. Calculate and interpret probabilities, means, percentiles and higher moments.</p> <p>b. Calculate and interpret the effect of changes in underlying assumptions such as mortality and interest.</p> <p>c. Apply to calculations involving these random variables appropriate approximation methods such as uniform distribution of deaths, constant force, Woolhouse, and Euler.</p>	10-20%	Both AS381 Both AS381
3.	<p>Topic: Premium Calculation</p> <p>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.</p> <p>Learning Outcomes The Candidate will be able to:</p> <p>a. Calculate and interpret probabilities, means, percentiles and higher moments of random variables associated with these premiums, including loss-at-issue random variables.</p> <p>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.</p> <p>c. Perform the calculations mentioned in Learning Outcomes 3a and 3b for contracts associated with specified contingent cash flows including Non-interest-sensitive insurances; Annuities; Universal life insurances; and Participating insurances.</p> <p>d. Apply to calculations involving these premiums appropriate approximation methods such as uniform distribution of deaths, constant force, Woolhouse, and Euler.</p>	20-35%	Both AS381 Both Both AS381 AS482 AS482 Both
4.	<p>Topic: Reserves</p> <p>Learning Objectives The Candidate will understand reserves for insurances and annuities for models mentioned in the Learning Outcomes of Learning Objectives 1 and 3.</p> <p>Learning Outcomes The Candidate will be able to:</p> <p>a. Calculate and interpret any of (i) several reserve types including benefits reserves, gross premium reserves, expense reserves or (ii) several reserve methods such as Full Preliminary Term (FPT) or modified reserves.</p> <p>b. Calculate and interpret probabilities, means, percentiles and higher moments of random variables associated with these reserves, including future-loss random variables.</p> <p>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.</p> <p>d. Calculate and interpret the effect of policy modifications.</p> <p>e. Calculate and interpret contract account values, contract surrender values and profit measures on universal life insurance contracts.</p> <p>f. Compare and contrast non-interest-sensitive and participating insurances with universal life insurances.</p> <p>g. Calculate and interpret the effect of changes in policy design and underlying assumptions such as changes in mortality, benefits, expenses, interest and dividends.</p> <p>h. Apply to calculations involving these reserves appropriate approximation methods such as uniform distribution of deaths, constant force, Woolhouse, and Euler.</p>	20-35%	Both Both AS482 AS381 AS482 AS482 AS482 AS482 Both Both
5.	<p>Topic: Pension Plans and Retirement Benefits</p> <p>Learning Objectives The Candidate will understand how the models from previous Learning Objectives apply to pension plans and retirement benefits.</p> <p>Learning Outcomes The Candidate will be able to:</p> <p>a. Describe and compare defined contribution and defined benefit pension plans including final salary and career average earning plans.</p>	10-20%	AS482 AS482 AS482

<p>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.</p> <p>c. Given particular participant data, plan provisions, and valuation assumptions, apply the models mentioned in learning outcome 5b to defined benefit pension plans and calculate and interpret replacement ratios, accrued benefits, and their expected values with adjustments such as the early retirement reduction factor.</p> <p>d. Given particular participant data, plan provisions, and valuation assumptions, calculate and interpret the actuarial accrued liability and the normal cost for a defined benefit plan under the projected unit credit (PUC) cost method and the traditional unit credit (TUC) cost method</p> <p>e. Calculate and interpret the effect of changes in underlying valuation assumptions such as mortality, salary increase changes, other decrements and interest on the quantities mentioned in learning outcomes 5c and 5d.</p> <p>f. Apply to calculations involving these defined benefit pension plans appropriate approximation methods such as uniform distribution of deaths, constant force, Woolhouse, and Euler.</p>		<p>AS482</p> <p>AS482</p> <p>AS482</p> <p>AS482</p>
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