

**KING FAHD UNIVERSITY OF PETROLEUM & MINERALS**  
**DEPARTMENT OF MATHEMATICS & STATISTICS**  
**DHAHRAN, SAUDI ARABIA**

**AS381: Actuarial Contingencies I - Term 161 (3-0-3)**

**Course Objectives:**

This course is an introduction to life insurance mathematics based on a stochastic approach. Major topics include life insurance, annuities, benefit premiums, and net reserves. Parallel treatment of topics based on Takaful system may also be addressed. Students are assumed to be proficient in Multivariable calculus. A required course for Actuarial Science majors.

**Prerequisites:** AS 201 and STAT 301

**Textbook and Package:**

- Bowers N., Gerber, H., Hickman, J., Jones, D. & Nesbitt, C. (1997 or later printing) *Actuarial Mathematics*, 2nd edition. Society of Actuaries Publishing.
- Texas BAII Plus Calculator or Texas BAI Professional

**Reference:**

Dickson, D.C., Hardy, M. R., & Waters, H. R. (2011) *Actuarial Mathematics for Life Contingent Risks*. Cambridge University Press: Cambridge, UK.

MLC exam syllabus on SOA site.

**Instructor:** Dr. Mohammad H. Omar

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**Office Hours:** UTR (12.30pm-1.45pm), and R (10.05-10.50am), or by appointment.

**Assessment**

Assessment for this course will be based on attendance, homework, term report, 3 major exams and a comprehensive final exam, as in the following:

Activity	Weight
Attendance and homework	(2%+5%)
Term Paper Report + poster presentations	(10%+5%)
Exam 1 (Chapters 1, 2, & 3) <b>Wednesday (Oct 19– week 5), 6.00 pm (venue TBA)</b>	23%
Exam 2 (Chapters 4 & 5) <b>Wednesday (Nov 30 - week 10), 6:00 pm (venue TBA)</b>	25%
Final Exam (Comprehensive) <b>Thursday Jan 19 8am (venue TBA)</b>	30%

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

- ✓ **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).

Letter grade	A+	A	B+	B	C+	C	D+	D	F	DN
Cut-off	90%	85%	80%	75%	70%	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**.
- 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.
- **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 the next 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.

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

<b>SOA Learning Objectives and Learning Outcomes (Fall 2016)</b>		<b>weight</b>	<b>Course</b>
1.	<p>Topic: Models for single and multiple lives</p> <p><b>Learning Objectives</b> The Candidate will understand key concepts concerning tabular or parametric survival models and <b>single</b> or <b>multiple-life</b> states.</p> <p><b>Learning Outcomes</b> 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 <b>appropriate approximation</b> methods such as <b>uniform distribution of deaths, constant force, Woolhouse, and Euler.</b></p>	10-20%	<p>Both AS381 &amp; AS482 Both  AS482  Both  AS482 Both</p>
2.	<p>Topic: Present Value Random Variables</p> <p><b>Learning Objectives</b> 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><b>Learning Outcomes</b> 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 <b>appropriate approximation</b> methods such as <b>uniform distribution of deaths, constant force, Woolhouse, and Euler</b></p>	10-20%	<p>Both  AS381 Both AS381</p>
3.	<p>Topic: Premium Calculation</p> <p><b>Learning Objectives</b> 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><b>Learning Outcomes</b> 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 <b>appropriate approximation</b> methods such as <b>uniform distribution of deaths, constant force, Woolhouse, and Euler.</b></p>	20-35%	<p>Both  AS381  Both AS381 AS482 AS482 Both</p>
4.	<p>Topic: Reserves</p> <p><b>Learning Objectives</b> The Candidate will understand reserves for insurances and annuities for models mentioned in the Learning Outcomes of Learning Objectives 1 and 3.</p> <p><b>Learning Outcomes</b> 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 <b>appropriate approximation</b> methods such as <b>uniform distribution of deaths, constant force, Woolhouse, and Euler.</b></p>	20-35%	<p>Both  Both AS482 AS381  AS482 AS482 AS482  AS482 Both Both</p>
5.	<p>Topic: Pension Plans and Retirement Benefits</p> <p><b>Learning Objectives</b> The Candidate will understand how the models from previous Learning Objectives apply to pension plans and retirement benefits.</p> <p><b>Learning Outcomes</b> 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> <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>	10-20%	<p>AS482  AS482  AS482</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.	AS482
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	AS482
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.	AS482
f. Apply to calculations involving these defined benefit pension plans appropriate approximation methods such as uniform distribution of deaths, constant force, Woolhouse, and Euler.	AS482

### Syllabus (Tentative)

Week	Sections	Topics	Notes
1 (Sep 18-21)	Selected sections of Ch 1 and 2	<b>Brief Introduction to Life Insurance Economics</b> , Insurance & Utility Theory. Elements of Insurance. Optimal Insurance. <b>Individual Risk Models for a Short Term</b> Models for individual claim random variables	Sept 21: Last day for late reg & for adding courses Sept 22: Natl Day Holiday.
2 (Sep 25-29)	Ch 2 (2.4 & 2.5) Ch 3	<b>Individual Risk Models for a Short Term (continued)</b> Approx for the Distribution of the Sum. Application to insurance. <b>Survival Distribution and Life Tables</b> . Probability at the age of death. Life Tables & Characteristics. Fractional Ages.	
3 (Oct 2-6)	Ch 3 Ch 4	<b>Survival Distribution and Life Tables (continued)</b> Some analytical Law of Mortality. <b>Life Insurance</b> Insurance models for payment at the moment of death. Models with payment at the end of the year of death. Relationship between models.	
4 (Oct 9-13)	Ch 4	<b>Life Insurance (continued)</b> . Differential Equations for Insurance payable at the moment of death.	<b>Declare your Term paper topic: Sun Oct 9</b>
5 (Oct 16-20)	Ch 5	<b>Life Annuities</b> . Continuous and Discrete Life Annuities. Life Annuities with $m$ -thly payments.	
<b>Wednesday (Oct 19– week 5) , 6.00 pm – 1st Major Exam (chapters 1, 2, &amp; 3)</b>			
6 (Oct. 23-27)	Ch 5	<b>Life Annuities</b> . Apportionable Annuities-Due and Complete Annuities-Immediate.	<b>(2 wks):</b> Midterm grade reports starts
7 (Oct. 30 – Nov 3)	Ch 6	<b>Benefit premiums (continued)</b> Fully continuous and Discrete Premiums. True $m$ -thly payment premiums.	
8 (Nov 6-10)	Ch 6	<b>Benefit premiums (continued)</b> Apportionable premiums. Accumulation-Type Benefits.	
<b>Nov 13-17 Mid Term Break</b>			
9 (Nov 20-24)	Ch 7	<b>Benefit Reserves (continued)</b> . Fully continuous Benefit Reserves. Fully Discrete Benefit Reserves. Other Formulas for fully continuous Benefit reserves. Semicontinuous Benefit Reserves.	
<b>Wednesday (Nov 30 - week 10), 6:00 pm – 2nd Major Exam (chapters 4 &amp; 5)</b>			
10 (Nov 27- Dec 1)	Ch 7	<b>Benefit Reserves (continued)</b> . True $m$ -thly benefit Reserves. Benefit Reserves on Apportionable or Discounted Continuous Basis.	
11 (Dec 4 - 8)	Ch 8	<b>Analysis of Benefit Reserves</b> Benefit Reserves for General Insurances. Recursion Relations for Fully Discrete Benefit Reserves.	
12 (Dec 11 - 15)	Ch 8	<b>Analysis of Benefit Reserves</b> Benefit Reserves for General Insurances. Ben. Reserves at Fractional durations. Risk Allocation to Insurance Years.	<b>Sun Dec 11:</b> Term Paper Report due to instructor.
13 (Dec 18 - 22)	Ch 8	<b>Analysis of Benefit Reserves (continued)</b> . Differential Equations for Fully continuous Reserves	
14 (Dec 25 - 29)	Assigned reading	<b>Concept of Mutual Insurance and Introduction to Takaful</b> . What is Takaful? How is it different from conventional insurance? Current models for Takaful. Relationship/contrast with conventional insurance models.	
<b>Thursday (Dec 29 - week 14), 11:00am - 12:30pm - Poster Presentations</b>			
15 (Jan 1-5 & 8)	Assigned reading	<b>Practical issues in calculation of reserves</b> . IBNR and IBNER	
<b>Final Exam (Comprehensive): Thursday Jan 19 8am</b>			