

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

**AS381: Actuarial Contingencies I - Term 141 (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:**

1. Bowers N., Gerber, H., Hickman, J., Jones, D. & Nesbitt, C. (1997 or later printing) *Actuarial Mathematics*, 2nd edition. Society of Actuaries Publishing.
2. Texas BAII Plus Calculator or Texas BAII 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:** UT: 2.00pm -3.00pm and 4.20pm -4.50pm, R: 10.30am-11.55am 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, homework and Term Paper Report	(2%+5%+10%)
Exam 1 (Chapters 1, 2, & 3) <b>Monday (Oct 20 – week 6) , 5.30 pm (venue TBA)</b>	20%
Exam 2 (Chapters 4 & 5) <b>Wednesday (Nov 12 - week 9), 5:30 pm (venue TBA)</b>	20%
Exam 3 (Chapters 6 & 7) <b>Wednesday (Dec 3 - week 12), 5:30 pm (venue TBA)</b>	18%
Final Exam (Comprehensive) <b>Monday January 5, 2015 7pm (venue TBA)</b>	25%

**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) May change in 2014 due to OE

**a) Post-2011 Outcomes (incorporates most of pre-2011 Outcomes) with SOA weights**

SOA Learning Outcomes		weight	Course
1.	Describe the <b>common decrements</b> and their application to insurances and annuities.	0-5%	AS381
2.	Models <b>used to model decrements</b> used in insurances and annuities. a. Calculate <b>single, joint, marginal and conditional probabilities</b> , as applicable and <b>moments</b> for the time-to-decrement, age-at-decrement and cause-of-decrement random variables based on <b>single decrement</b> on single life models, <b>multiple decrements</b> on single life models and single decrement on <b>multiple lives</b> models. b. Calculate the <b>probability</b> of being in a particular state and transitioning between states based on continuous-time Markov chain models, discrete approximations of continuous-time Markov chain models and discrete-time Markov chain models.	10-20%	AS381 & AS482
3.	Calculate <b>present values</b> and <b>accumulated values</b> using non-stochastic interest rate models	0-5%	AS381
4.	Models <b>used to model cash flows of traditional life</b> insurances and annuities. a. Calculate <b>single, joint, marginal and conditional probabilities</b> , as applicable and <b>moments</b> of the present-value-of-benefits and present-value-of-premium random variables based on <b>single decrement</b> on single life models, <b>multiple decrements</b> on single life models and single decrement on <b>multiple lives</b> models. b. Calculate present values of cash flows. c. Calculate present values of cash flows by redefining the present-value-of-benefit and present-value-of-premium random variables to Markov chain models	15-25%	AS381 & AS482
5.	Describe how <b>reserves are used as an accounting entry</b> to allocate income over the life of a contract.	0-5%	AS381
6.	Benefit reserves for traditional life insurances and annuities. a. Calculate <b>moments</b> of the loss-at-issue random and <b>future-loss random</b> variables based on <b>single decrement</b> on single life models and <b>multiple decrements</b> on single life models. b. State the <b>equivalence principle</b> . c. Calculate benefit reserves and premium based on <b>single decrement</b> on single life models and <b>multiple decrements</b> on single life models. d. Calculate benefit reserves and premium using a Markov chain model with specified cash flows.	15-25%	AS381 & AS482
7.	Models used to <b>model cash flows</b> for non-interest sensitive insurances other than traditional life insurances and annuities a. Calculate benefit premium and benefit reserves by applying concepts presented for traditional life insurance and annuities for the loss-at-issue and future loss random variables based on <b>single decrement</b> on single life models, <b>multiple decrements</b> on single life models, and Markov chain models.	5-15%	AS381 & 482
8.	Models used to <b>model contract cash flows</b> for basic universal life insurances. a. Calculate the contract account value and contract surrender value. b. Describe differences between primary and secondary contract guarantees.	Combined weight for objectives 8 – 10	AS482
9.	Models used to <b>model cash flows</b> of basic universal life insurance a. Calculate probabilities and moments of the present-value-of-benefits, present-value-of-premiums and present-value-of-charges random variables based on <b>multiple decrements</b> on single life models. b. Calculate present values of cash flows. c. Redefine the present-value-of-benefit and present-value-of-premium random variables to Markov chain models to calculate present values of cash flows.		AS482
10.	<b>Benefit reserves for basic universal</b> life insurances a. Calculate the <b>benefit reserve</b> . b. Describe the calculation of the reserve for a secondary guarantee.	is 0-10%	AS381 & AS482
11.	Models that <b>consider expense cash flows</b> . a. Calculate an expense factor using the appropriate exposure. b. Calculate probabilities and moments of the present-value-of-expenses random variable based on single decrement on single life model and <b>multiple decrements</b> on a single life models. c. Calculate the <b>expense reserve</b> . d. Calculate a gross premium given expenses and benefits based on: the equivalence principle; and a return on gross profits basis. e. Calculate the gross premium reserve. f. Calculate the <b>asset share</b> . g. Calculate expected profit, actual profit, gain, and gain by source.	10-25%	AS482

**b) Specific to Pre-2011 MLC Outcomes**

1. Calculate considerations (premiums) for life insurances and annuities,
  - a. using percentiles.
2. Calculate liabilities, analyzing the present-value-of-future-loss random variables:
  - a. using the prospective method; b. using the retrospective method; c. using special formulas.
3. Using recursion, calculate expected values (reserves) and variances of present-value of future-loss random variables for general fully-discrete life insurances written on a single life.

### Syllabus (Tentative)

Week	Sections	Topics	Notes
1 (Aug 31-Sept 4)	Some 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, Approx for the Distribution of the Sum	Sept 3: Last day for late registration & for adding courses
2 (Sept 7-11)	Ch 3	<b>Survival Distribution and Life Tables.</b> Probability at the age of death. Life Tables & Characteristics. Fractional Ages. Some analytical Law of Mortality.	
3 (Sept 14-18)	Ch 4	<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 (Sept 21-25)	Ch 4	<b>Life Insurance (continued).</b> Relationship between models. Differential Equations for Insurance payable at the moment of death.	Sept 23: National Day Holiday
<b>Eid Al-Adha Vacation: Sept 26-Oct 11, 2014</b>			
5 (Oct 12-16)	Ch 5	<b>Life Annuities.</b> Continuous and Discrete Life Annuities. Life Annuities with $m$ -thly payments.	<b>Declare your Term paper topic: Sunday Oct 19</b>
6 (Oct 19-23)	Ch 5  Ch 6	<b>Life Annuities.</b> Apportionable Annuities-Due and Complete Annuities-Immediate. <b>Benefit premiums</b> Fully continuous and Discrete Premiums.	<b>(2 wks):</b> Midterm grade reports starts
<b>Monday, Oct 20 – 1st Major Exam (chapters 1, 2, &amp; 3)</b>			
7 (Oct 26-30)	Ch 6	<b>Benefit premiums (continued)</b> True $m$ -thly payment premiums. Apportionable premiums.	
8 (Nov 2-6)	Ch 6  Ch 7	<b>Benefit premiums (continued)</b> Accumulation-Type Benefits. <b>Benefit Reserves</b> Fully continuous and Fully Discrete Benefit Reserves	
9 (Nov 9-13)	Ch 7	<b>Benefit Reserves (continued).</b> Other Formulas for fully continuous Benefit reserves. Semicontinuous Benefit Reserves.	
<b>Wednesday, Nov 12 – 2nd Major Exam (chapters 4 &amp; 5)</b>			
10 (Nov 16-20)	Ch 7	<b>Benefit Reserves (continued).</b> True $m$ -thly benefit Reserves. Benefit Reserves on Apportionable or Discounted Continuous Basis.	
11 (Nov 23-27)	Ch 8	<b>Analysis of Benefit Reserves</b> Benefit Reserves for General Insurances. Recursion Relations for Fully Discrete Benefit Reserves.	<b>Sat Nov 23:</b> Term Paper Report due to instructor.
12 (Nov 30-Dec 4)	Ch 8	<b>Analysis of Benefit Reserves</b> Benefit Reserves for General Insurances. B. Reserves at Fractional durations. Risk Allocation to Insurance Years.	
<b>Wednesday, Dec 3- 3rd Major Exam (chapters 6 &amp; 7)</b>			
13 (Dec 7-11)	Ch 8	<b>Analysis of Benefit Reserves (continued).</b> Differential Equations for Fully continuous Reserves	
14 (Dec 14-18)	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.	
15 (Dec 21-25)	Assigned reading	<b>Practical issues in calculation of reserves.</b> IBNR and IBNER	
16 (Dec 28)	Review	<b>Review</b>	Dec 28: Normal Tuesday
<b>Final Exam (Comprehensive): Monday Jan 5, 2015 7pm</b>			

**Syllabus (Tentative)**

<i>Week</i>	<i>Sections</i>	<b>AS381 Topics</b>	<i>Hwk</i>
<b>1</b> (Aug 31-Sept 4)	sections of Ch 1 and 2	<b>Brief Introduction to Life Insurance Economics, Individual Risk Models for a Short Term</b>	Ch 1: Q1.9, Q1.19 and Ch 2: Q2.7, and Q2.16
<b>2</b>	Ch 3	<b>Survival Distribution and Life Tables.</b>	Ch 3: Q3.20, 30, 35, and 44.
<b>3</b> (Sept 14-18)	Ch 4	<b>Life Insurance</b>	
<b>4</b>	Ch 4	<b>Life Insurance (continued).</b>	Ch 4: Q4.1, 6, 16, 24, and 35
<b>Eid Al-Adha Vacation: Sept 26-Oct 11, 2014</b>			
<b>5</b> (Oct 12-16)	Ch 5	<b>Life Annuities.</b>	
<b>6</b>	Ch 5	<b>Life Annuities.</b>	Ch 5: Q5.1, 3, 12, 22, 28, 51, and 56 <b>Declare your Term paper topic: Sat Oct 6</b>
	Ch 6	<b>Benefit premiums</b>	
<b>Monday, Oct 20 – 1st Major Exam (chapters 1, 2, &amp; 3)</b>			
<b>7</b> (Oct 26-30)	Ch 6	<b>Benefit premiums (continued)</b>	
<b>8</b> (Nov 2-6)	Ch 6	<b>Benefit premiums (continued)</b>	Ch 6 – Q6.3, Q6.4, Q6.10
	Ch 7	<b>Benefit Reserves</b>	
<b>9</b>	Ch 7	<b>Benefit Reserves (continued).</b>	
<b>Wednesday, Nov 12 – 2nd Major Exam (chapters 4 &amp; 5)</b>			
<b>10</b> (Nov 16-20)	Ch 7	<b>Benefit Reserves (continued).</b>	Ch 7 – Q7.1, Q7.23
<b>11</b>	Ch 8	<b>Analysis of Benefit Reserves</b>	
<b>12</b> (Nov 30-Dec 4)	Ch 8	<b>Analysis of Benefit Reserves</b>	<b>S Nov 24:</b> Term Paper due
<b>Wednesday, Dec 3- 3rd Major Exam (chapters 6 &amp; 7)</b>			
<b>13</b> (Dec 7-11)	Ch 8	<b>Analysis of Benefit Reserves (continued).</b>	
<b>14</b> (Dec 14-18)	assg reading	<b>Introduction to Takaful.</b>	Ch 8 – Q8.18, Q8.30
<b>15</b>	Assg reading	<b>Practical issues in calculation of reserves.</b>	IBNR (if time permits) –
<b>16</b> (Dec 28)	Review	<b>Review</b>	Dec 28: Normal Tuesday
<b>Thurs Jan 1 7pm</b>	<b>Final Exam</b>	<b>Comprehensive</b>	