Dept of Mathematics and Statistics
King Fahd University of Petroleum & Minerals

AS482: Actuarial Contingencies II

Dr. Mohammad H. Omar
Final Exam Term 151 FORM A
Wednesday December 30 2015
8.00am-10.30am

Name_____ ID#:_____ Serial #:___

Instructions.

1. Please turn off your cell phones and place them under your chair. Any student caught with mobile phones on during the exam will be considered under the **cheating rules** of the University.
2. If you need to leave the room, please do so quietly so not to disturb others taking the test. No two person can leave the room at the same time. No extra time will be provided for the time missed outside the classroom.
3. Only materials provided by the instructor can be present on the table during the exam.
4. Do not spend too much time on any one question. If a question seems too difficult, leave it and go on.
5. Use the blank portions of each page for your work. Extra blank pages can be provided if necessary. If you use an extra page, indicate clearly what problem you are working on.
6. Only answers supported by work will be considered. Unsupported guesses will not be graded.
7. While every attempt is made to avoid defective questions, sometimes they do occur. In the rare event that you believe a question is defective, the instructor cannot give you any guidance beyond these instructions.
8. Mobile calculators, I-pad, or communicable devices are disallowed. Use regular scientific calculators or financail calculators only. Write important steps to arrive at the solution of the following problems.

The test is 150 minutes, GOOD LUCK, and you may begin now!

Question	Total Marks	Marks Obtained	Comments
1	5+5=10		
2	3+3=6		
3	3+3=6		
4	10		
5	4		
6	10		
7	8		
8	3+6+4=13		
9	4		
10	1+3=4		
Total	75		

Extra blank page

1. (4+4=8 points) Consider a *UL* contract with *secondary guarantee* provided by the *shadow fund* method. As of time t the *shadow fund* balance is 65000, the *net* single *premium* required to fully fund the guarantee is 100000, the *valuation net premium* is 150000, the applicable *surrender charge* is 5000, and the *basic reserve* is 10000.

   Calculate the **AG 38 reserve** for this contract under the following situations:

   a) There is **no** *deficiency reserve*.

   b) A *deficiency reserve* of 5000.

2. (3+3=6 points) A company offers a fixed deferred annuity product with *initial guaranteed annual interest* rate of 6% and initial *guarantee period* of five years. The *minimum guaranteed interest* rate is 4%. There is no interest bonus and no contract charges except a surrender charge. A client purchase this product on 1/1/10 with a deposit of $10000. There are no withdrawals before 12/31/15.

(a) Find the **minimum fund value** for this annuity on 12/31/15.
(b) Suppose the client decides to *surrender* the contract on 12/31/12. If the *surrender charge* is 3% of the contract value for surrender within the first five contract years, find the **cash surrender value** in 12/31/12.

3. (3+3=6 points) A deferred variable annuity contract has a *daily administrative charge* at annual rate 0.15%, and an Mortality-&-Expense (*M&E*) *charge* at annual rate 1.25%. There is only one separate account and no other charges.

(a) Assume the *annual step-up* option is available for determining the GMDB and is charged for at annual rate 0.75%. Calculate the **effective daily expense percentage** if this option is elected.

(b) Referring to (a) above, assume a *GMIB rider* is available for the purchase at annual rate 0.60% of the contract value. Calculate the **effective daily expense percentage** if both the *GMIB rider* and the *annual step-up GMDB* option are elected.

4. (10 points) Consider a \$10000 *single premium* equity indexed deferred *annuity* issued on 1/1/05, using the SP500 index and an *index period* of five years. The average monthly SP500 values are provided in the table below.

Time Period	**Minimum Guranteed Value**	**Average Monthly SP500 Value**
0	10000	1181.27
1	8964	1207.77
2	9184	1318.13
3	9409	1478.10
4	9640	1215.22
5	9876	948.52

The contract uses the *monthly average indexing* method with *annual ratcheting*, no *cap* rate, a 100% participation rate (*PR*), and 1.5% *spread* and 0% *floor*. The *minimum guaranteed interest* rate for this contract was found to be 2.45% . Determine the **indexed account values**.

5. (4 points) A single premium equity indexed deferred annuity is issued on 1/1/05. The constant maturity treasury (CMT) rate on 11/30/2004 is 4.73%. Find the **minimum guaranteed interest** rate for this contract.

6. (10 points) A variable deferred annuity contract is issued at age 88 for a deposit of 1000. The contract contains a GMDB rider, and must begin annuity payments at age 90 (so the GMDB does not apply after that age). The *GMDB fee* is charged at the beginning of the contract year, and any *death benefit* is paid at the end of the year. There are no other contract fees. Assume that $q_{88} = 0.10$, $q_{89} = 0.15$ and $i = 0$. Due to a declining equities market, the *account value* experiences a 10% decrease in value each year. Using the equivalence principle, calculate the **GMDB fee** as a percentage of the account value.

7. (8 points) You are given zero-coupon bond yields in the Table below.1

Maturity (in years)	**Annual Yield for Zero coupon Bonds**
1.0	3.0%
2.0	4.0
3.0	5.0
4.0	6.0
5.0	7.0

Find all possible forward rates for forward securities with maturities of one, two, three, and four years by complete the missing $f_{n,k}$ values in Table below. (Be sure to show at least one sample calculation)

n	$f_{n,1}$	$f_{n,2}$	$f_{n,3}$	$f_{n,4}$
1.0				8.024%
2.0	7.029%			-
3.0			-	-
4.0		-	-	-

8. (3+6+4=13 points) A person is currently *employed*, which we call State 1, at time 0. Let State 2 denote *unemployement* and State 3 denote *deceased*. The transition forces between states are as follows:

(i) $\lambda_{12}(s) = 0.20 + 0.0002s^2$
(ii) $\lambda_{13}(s) = \lambda_{23}(s) = 0.05$
(iii) $\lambda_{21}(s) = 0.80 - 0.04s$
(iv) $\lambda_{31}(s) = \lambda_{32}(s) = 0.$

a) Find the Kolmogorov **diffferential equations** for solving ${}_rp_{11}^{(0)}$ and ${}_rp_{12}^{(0)}$.

b) Using $\Delta r = \dfrac{1}{12}$, find the **approximate values** of ${}_rp_{11}^{(0)}$and ${}_rp_{12}^{(0)}$ for the **six month** period

(i.e. $r = 0, \frac{1}{12}, ..., \frac{6}{12}$) {hint: ${}_0p_{11}^{(0)} = 1$ and report your approximated values to 6 decimal places}

c) A 6-month insurance contract is issued that pays 50000 at the **end of the month** of death **only if** the insured is *unemployed* at the time of death. At a nominal interest rate of $i^{(12)} = 0.04$ and the values found in part (b), find the **APV** for this **contract**.

9. (4 points) Let Y denote the present value random variable for a contingent annuity-due with **unit** payment made during the first 15 years if **at least** one of (x) and(y) survive, but made after the first 15 years only if **exactly one** of (x) and (y) survive. Find the value of $E[Y]$, given the following values:

$\ddot{a}_x = 9.80$ $\ddot{a}_y = 11.60$ $\ddot{a}_{xy} = 7.60$ ${}_{15}|\ddot{a}_{xy} = 3.70$

10. (1+3=4 points) For a specified amount Universal Life Insurance (ULI) policy, you are given:

1) The *face amount* of the policy is \$100000
2) The *account value* on December 31, 2011 was \$15000
3) On January 1, 2012, a *premium* of \$1000 was made. No other premiums were made in 2012
4) The *expense charge* and the *cost of insurance* deducted on Jan 1, 2012 were \$100 and \$150 respectively
5) The *credited interest* rate in 2012 was 6% per annum effective
6) The *surrender charge* applicable in 2012 was \$10 per \$1000 of *face amount*.

Calculate the **cash value** of the policy on December 31, 2012.
A) \$0
B) \$14700
C) \$15700
D) \$16700
E) \$17700
Work Shown (4 points):

Hence the answer is (__)

END OF TEST PAPER