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

AS482: Actuarial Contingencies II
Dr. Mohammad H. Omar
Major 3 Exam Term 151 FORM A
Wednesday November 25 2015
3.45pm-5.05pm

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 80 minutes, GOOD LUCK, and you may begin now!

Question	Total Marks	Marks Obtained	Comments
1	6+3=9		
2	5		
3	5+6+3=14		
4	6+3=9		
5	8		
6	1+4=5		
Total	50		

Extra blank page

1. (6+3=9 points) A company sells insurance in a country where only one year bonds are available as investments to back its business. Our task is to compare the interest sensitivity of the following two products in this environment.

(i) A 5-year immediate life anuity.
(ii) A single premium 5-year term insurance contract.
The applicable failure rates are $q_x = 0.10$, $q_{x+1} = 0.15$, $q_{x+2} = 0.20$, $q_{x+3} = 0.25$, and $q_{x+4} = 0.30$.

(a) Assuming today's interest rate is 7%, **calculate the actuarial present value** for each of the three product using each of the following two interest rate scenarios:
(1) Increasing: rates rise by 1% each year, but do not exceed 11% in any year.
(2) Decreasing: rates fall by 1% each year, but do not fall below 3% in any year.
(b) Which of the product is **least interest sensitive** in this environment? Explain.

2. (5 points) Fantastic University provides a four-year scholarship for one incoming freshman who plans to major in actuarial science. Current tuition at Fantastic is \$26000 per year and tuition is expected to increase 8% per year over the next four years. The first annual tuition payment is due today. Each year we assume a 25% chance that the scholarship recipient will change majors or drop out of school where either event cancels future scholarship payments. Using the table of yields below,

Maturity (in years)	**Annual** Yield for zero-coupon Bonds
1	2%
2	4%
3	6%
4	8%

calculate the **actuarial present value** of this scholarship.

3. (5+6+3=14 points) n-year forward one year rates are given in the following table

n	0	1	2	3	4
$f_{n,1}$	4.0%	5.0%	6.0%	7.0%	8.0%

(a) Find **all** determinable **spot rates**.

(b) Find **all** available **forward rates** in blank cells in the table below.

n	$f_{n,1}$	$f_{n,2}$	$f_{n,3}$	$f_{n,4}$	$f_{n,5}$
0	0.04	z_2	z_3	z_4	z_5
1	0.05				–
2	0.06			–	–
3	0.07		–	–	–
4	0.08	–	–	–	–

(c) For taking over a client's retirement account, the client agrees to invest \$300000 of that account with your firm for three years, starting two years from now.

(1) What rate of interest can be **locked in** for the investment period?

(2) What **spot rate** transactions should be entered into today in order to lock in the yield found in part (c-1)? Include the term and principal amount of the two transactions.

4. (6+3=9 points) Consider an EIUL contract with a 11% index cap, a 2% index floor, and a 110% participation rate.

(a) Given the index closing values shown in the table below and using the annual **point-to-point indexing** method, **calculate** the **credited interest rates** by completing the table below.

Year	**Index Closing Value**	**Index Growth Rate (before participation)**	**Index Growth Rate (after participation)**	**Credited Interest Rate**
0	1000	-	-	-
1	1050		5.5%	5.5%
2	1200			
3	1100			
4	950	-13.64%	-15.00%	
5	1060	11.58%	12.74%	
6	1150			

(b) Suppose this EIUL contract uses the **monthly average indexing method** instead. Given the monthly index closing values shown in Table below, **calculate the credited interest** rate.

Month	**Index Closing Value**
0	1000
1	1020
2	1100
3	1150
4	1080
5	1040
6	960
7	1030
8	1000
9	1070
10	1150
11	1200
12	1150

5. (8 points) A Universal Life contract with face amount 100000 is issued at age x. The contract also pays the face amount as a *pure endowment* benefit upon survival to the end of five years. The contributions, mortality rates and withdrawal rates are given in the Table below:

Year	**Contribution**	$q^{(d)}_{[\mathbf{x}]+\mathbf{t}-\mathbf{1}}$	$q^{(w)}_{[\mathbf{x}]+\mathbf{t}-\mathbf{1}}$
1	20000	0.001	0.02
2	25000	0.002	0.02
3	25000	0.003	0.03
4	30000	0.004	0.04
5	20000	0.005	0.05

Assume $i = 0.05$ and that *withdrawal* occur only at the *end of the policy* year.

The contract incurs the following **expenses**:

(i) Commisions of 80% in first year and 5% in renewal years.
(ii) Sales expense of 110% of first year commission.
(iii) Acquisition expense of 50% of first year premium plus 100 per policy.
(iv) Annual maintenance expense of 0.20% of face amount plus 50 per policy.
(v) Claim settlement expense of 100 per policy.

Calculate the **actuarial present value of expenses** at policy issue.

6. (1+4=5 points) For a fully discrete 3-year term life insurance on (50) you are given:

(i) The death benefit is 5000.
(ii) An extract from a mortality table

x	50	51	52
q_x	0.005	0.006	0.007

(iii) The rate of interest is based on the yield curve at $t = 0$.
You are also given the following information based on the yield curve at $t = 0$:

t	0	1	2
Annual forward rate of interest	0.030	0.032	0.035

Calculate the **second moment** of the present value of the death benefit random variable.
A) 392,000
B) 406,000
C) 419,000
D) 432,000
E) 446,000

Work Shown (4 points):

Hence the answer is (__)

END OF TEST PAPER