SOCIETY OF ACTUARIES
Life Risk Management

Exam ILALRM

Date: Friday, April 27, 2018
Time: 2:00 p.m. – 4:15 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has a total of 40 points.

   This exam consists of 4 questions, numbered 1 through 4.

   The points for each question are indicated at the beginning of the question. Question 3 pertains to the Case Study, which is enclosed inside the front cover of this exam booklet.
2. Failure to stop writing after time is called will result in the disqualification of your answers or further disciplinary action.
3. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions on the exam booklet.

Written-Answer Instructions

1. Write your candidate number at the top of each sheet. Your name must not appear.
2. Write on only one side of a sheet. Start each question on a fresh sheet. On each sheet, write the number of the question that you are answering. Do not answer more than one question on a single sheet.
3. The answer should be confined to the question as set.
4. When you are asked to calculate, show all your work including any applicable formulas.
5. When you finish, insert all your written-answer sheets into the Essay Answer Envelope. Be sure to hand in all your answer sheets because they cannot be accepted later. Seal the envelope and write your candidate number in the space provided on the outside of the envelope. Check the appropriate box to indicate Exam ILALRM.
6. Be sure your written-answer envelope is signed because if it is not, your examination will not be graded.

Tournez le cahier d’examen pour la version française.

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CASE STUDY INSTRUCTIONS

The case study will be used as a basis for some examination questions. Be sure to answer the question asked by referring to the case study. For example, when asked for advantages of a particular plan design to a company referenced in the case study, your response should be limited to that company. Other advantages should not be listed, as they are extraneous to the question and will result in no additional credit. Further, if they conflict with the applicable advantages, no credit will be given.

****BEGINNING OF EXAMINATION****

1. (*9 points*)

(a) (*1 point*) Identify the risk category for each of the following risks:

- Mortality rate experience turns out to be worse than planned for
- The Internal Revenue Service (IRS) passes a new law removing some of the tax benefits from life insurance
- Risk that a company incurs losses due to a rating agency downgrade
- Risk that reinvested cash flows will earn less than expected as a result of decreasing interest rates

(b) (*2 points*) Your company utilizes a Modern Operational Risk Management framework.

(i) Explain the difference between risk measurement and risk assessment.

(ii) Explain situations in which risk measurement or risk assessment would be more appropriate than the other.

(c) (*1 point*) You are in charge of modeling operational risk due to a tornado demolishing the company's building foundation severely enough to halt all work activity. The number of tornadoes is known to vary drastically from month to month.

Recommend a frequency distribution to use for operational risk management and justify its use.

1. Continued

(d) (*5 points*) Moody's is reviewing their assessment of ABC Life, whose risk management has the following characteristics:

1. Management has a long-standing track record of knowing its risks and how to manage risks to the desired tolerance level.
2. Risk management processes are in place to quantify risk but not all major risks have a mitigation plan.
3. Investment guidelines are in place, and there's effective collaboration between the investments area and other areas of the company.
4. ABC Life has an average life insurance policy size of 250,000 and reinsures amounts in excess of its retention of 50,000.
5. A plan is in place to hold a certain amount of cash and liquid assets to ensure liquidity at a high level of confidence.

(i) Evaluate how each characteristic contributes to Moody's opinion of ABC Life's risk management capabilities.

(ii) Recommend changes to ABC Life's risk management to improve the outcome of Moody's assessment of their capabilities.

2. (*11 points*) Your company has issued a new block of three-years term single premium immediate annuities (SPIA), with annual payment for three years or until death if earlier. You have been given the following information about the SPIA:

Issue age	x
Time 0 premium	200,000
First year expected annual payment	100,000
Annual interest rate	5%
q_x	0.0
q_{x+1}	0.1
q_{x+2}	0.1

(a) (*4 points*) Based on stress testing, the earnings sensitivity to a 250bps downward parallel shock in interest rates is -11,600.

Calculate the net earnings exposure if assets backing the liabilities are purchased based on each of the following ALM strategies:

(i) Duration matching only

(ii) Duration and convexity matching

(b) (*4 points*) The Chief Risk Officer has expressed concern about earnings sensitivity to non-parallel shifts in the interest rate curve and would like to develop a key rate duration (KRD) strategy using the following zero-coupon bond (ZCB) Index:

Term-to-maturity	**Key rate duration**
3 months	0.10
6 months	0.15
1 year	0.20
2 years	0.30
5 years	0.50
10 years	0.70

Each type of zero coupon bond contributes the same amount of interest rate sensitivity to the index.

(i) (*1 point*) Calculate the key rate duration of the Index.

(ii) (*3 points*) Construct a portfolio of zero-coupon bonds to replicate the block of new SPIAs.

2. **Continued**

(c) (*3 points*) A return of premium (ROP) feature is being proposed for the SPIA, and would be calculated as follows:

Premium × $(3 - t) \div 6 \times (1 + iFloor)^t$, where iFloor < annual interest rate = 5%.

Assess how adding this ROP feature would impact the interest rate risk of the product.

Question 3 pertains to the case study.
Each question should be answered independently.

3. (*8 points*)

(a) (*1 point*) Define the four elements of credit risk as related to insurance companies, according to the Federal Reserve.

(b) (*7 points*) XYZ Life measures its fixed income credit risk exposure based on market value weighted average of expected probability of default of individual bond holdings. This weighted average results in an Expected Loss Score and is measured against a limit. If a block's Expected Loss Score exceeds the limit, it must improve the rating mix of its existing holdings.

Expected Loss Score limit for XYZ Life is 1.35%.

Current fixed income asset mix of XYZ Life:

Credit quality	**Actual asset mix as of Dec 31, 2016**
Aaa	2.1%
Aa	13.1%
A	64.2%
Baa	20.2%
<Baa	0.4%

- The term of the bonds is uniformly distributed across 1 – 5 years.
- The market value of the portfolio is 1.5 billion.

Expected probability of default by term and rating:

Term	**Aaa**	**Aa**	**A**	**Baa**	**<Baa**
1	0.00%	0.01%	0.03%	0.10%	0.65%
2	0.00%	0.03%	0.10%	0.30%	1.75%
3	0.00%	0.05%	0.17%	0.50%	3.00%
4	0.01%	0.10%	0.25%	0.75%	4.20%
5+	0.03%	0.12%	0.35%	1.00%	5.30%

3. Continued

Desired credit quality exposure of XYZ Life:

Credit quality	**Strategic Asset Allocation (SAA)**	**Tactical Asset Allocation (TAA)**
Aaa	0%	0 to 100%
Aa	15%	0 to 90%
A	85%	0 to 90%
Baa	0%	0 to 25%
<Baa	0%	0 to 2%

(i) (*3 points*) Determine if XYZ Life is compliant based on its credit risk management framework. Justify your answer.

(ii) (*2 points*) Assume there is a future cash flow of 500 million expected this year due to new business.

Assess how much in additional BBB-rated bonds XYZ Life can purchase while remaining compliant with its desired credit quality exposure.

(iii) (*2 points*) Assume the Expected Loss Score is currently 0.80%.

Evaluate how acquiring the SPIA block from Simple Life will impact the expected loss score.

4. (*12 points*)

(a) (2 *points*) Explain the advantages and disadvantages of the following methodologies for risk aggregation:

1. Simple Summation
2. Variance-covariance matrix
3. Copulas
4. Integrated models

(b) (*6 points*)

NYC Financial is made up of 3 legal entities: JFK, LGA, and EWR. Each legal entity is capitalized and has risk as follows:

Entity	Capital	Risk
JFK	25 million	35 million
LGA	25 million	25 million
EWR	50 million	50 million

There are two differing opinions about NYC Financial:

Opinion 1: Enterprise-wide, we do not have enough capital to support our risk.
Opinion 2: Each of the legal entities is capital sufficient.

(i) Critique the implied assumptions for risk aggregation and risk diversification in Opinion 1.

(ii) Critique the implied assumptions for capital fungibility and transferability in Opinion 2.

(iii) Describe diversifying strategies NYC Financial can use to manage the type and amount of risk in their portfolio.

4. **Continued**

(c) (*4 points*) NYC Financial has been given the following distribution of outcomes for different risks, with equal probability for each scenario:

Scenario	Risk 1	Risk 2	Risk 3
1	-2	-5	-5
2	-1	-1	-1
3	0	0	-1
4	1	2	3
5	2	4	4

NYC Financial is mostly concerned with downside risk and focuses on the 75th percentile.

Recommend which risk to assume from each pair. Justify your answer.

(i) Risk 1 and risk 2.

(ii) Risk 2 and risk 3.

(iii) Risk 1 and risk 3.

****END OF EXAMINATION****

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