SOCIETY OF ACTUARIES
Enterprise Risk Management – Retirement Benefits Extension

Exam ERM-R

Date: Friday, May 1, 2015
Time: 8:30 a.m. – 12:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has a total of 80 points.

   This exam consists of 9 questions, numbered 1 through 9.

   The points for each question are indicated at the beginning of the question. Questions 8 and 9 pertain to the extension readings and/or 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 ERM-R.

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. (*5 points*) You are an actuary at Myers Insurance Company, which offers a wide range of property and casualty insurance products. You have determined that the company's concentration risk limits have been breached. You have recommended to management that they explore the option of transferring some of the risk to a third party.

Management is only willing to consider reinsurance that attaches at the risk limit.

(a) (*1 point*) Explain how reinsurance could be used to address Myers' breach in risk limits.

Myers has the option of entering into one of the following two reinsurance agreements:

I. Hayden Re: Surplus reinsurance with \$60 retention and \$240 capacity
II. Tarpon Re: Excess of loss reinsurance with priority \$50 and \$100 capacity

Hayden Re has an AA credit rating, and Tarpon Re has an A- credit rating.

(b) (*0.5 points*) Compare and contrast surplus reinsurance with excess of loss reinsurance.

(c) (*1.5 points*) Calculate Myers' retained claim for each of the following scenarios. Show your work.

Myers Retained Claims Under Reinsurance Agreements

Scenario	Sum Insured	Size of Claim	Retained Claim Agreement I	Retained Claim Agreement II
A	\$100	\$20		
B	\$300	\$200		

You have determined that entering into either one of these agreements will bring Myers back within its concentration risk limits.

(d) (*2 points*) Outline the considerations that would factor into making a recommendation between the two reinsurance options.

2. (*8 points*) Calusa Insurance Solutions is a large multi-line insurance company that offers life, health, property and casualty, and pension products. Calusa is undergoing changes within each insurance division, and management is concerned with the risks resulting from these changes.

(a) (*2 points*) Calusa's Life Insurance division specializes in term life insurance. Currently all of Calusa's term products use the same underwriting process. The underwriting process is very thorough, requiring a full medical examination.

Calusa is considering the addition of a "simplified issue" term product. The simplified issue product would only require an applicant to answer a few questions regarding medical history, with no verification of the answers required. If an applicant answers the questions in an acceptable manner, the policy is issued. All approved applicants of the same age and gender receive the same premium rates.

(i) Describe the main risk that would be introduced by the simplified underwriting product.

(ii) Propose strategies to manage the risk identified.

(b) (*2 points*) Calusa's Pension division offers a pension product to small and mid-size companies with defined benefit pension plans. The current pension product provides guaranteed immediate annuities to pension plan participants at their retirement, with level monthly payments for life. Calusa is considering the addition of a new pension product with a Cost of Living Adjustment (COLA) feature.

(i) Describe the main risk that would be introduced by the COLA feature.

(ii) Propose strategies to manage the risk identified.

(c) (*2 points*) Calusa's Property and Casualty (P&C) division has recently experienced employee turnover in the claims department, resulting in experienced employees being replaced by new hires. In addition, Calusa hires temporary employees to assist with data entry during high volume periods.

(i) Describe the main risk associated with Calusa's personnel practices.

(ii) Propose strategies to manage the risk identified.

2. Continued

(d) (*2 points*) Calusa's Health division is in the process of implementing a new internet-based claims administration system. The new system would result in Calusa data being hosted on third party servers and allow Calusa employees to access this data remotely.

(i) Describe a significant risk associated with the new claims administration system.

(ii) Propose strategies to manage the risk identified.

3. (*12 points*) In 2012, Dr. Dan opened an animal hospital in a small but growing town near a medium-sized city. Dr. Dan is the hospital's only veterinarian and is not paid a salary. He started the business with a bank loan and is not competent with cash management of the business. The hospital has not yet earned a profit but is expected to become profitable in 2015. Dr. Dan expects he could sell the hospital for an amount equal to its outstanding debt.

Dr. Dan enjoys the freedom of being his own boss but struggles with the challenges of managing a business. For example, he has had trouble collecting money his clients owe him, and he acknowledges that he does not manage his employees effectively.

Dr. Dan has hired you as a personal advisor to conduct an independent analysis of the following three strategic options:

I. Continue his current business with no change.

II. Sell his hospital and become a staff veterinarian at another animal hospital.

III. Sell his hospital and take a loan to buy a franchise of a MegaPet animal hospital in the nearby city. MegaPet is a chain of animal hospitals housed exclusively inside a national chain of large pet stores.

You are provided the following simplified financial projections in thousands:

	Option I			Option II			Option III		
Calendar Year	**2015**	**2016**	**2017**	**2015**	**2016**	**2017**	**2015**	**2016**	**2017**
Gross Revenue	190	290	388	100	104	108	250	600	900
Client accounts written off	30	35	40	0	0	0	5	10	20
Net Revenue	160	255	348	100	104	108	245	590	880
Debt service	18	18	18	0	0	0	20	25	30
Fees to MegaPet	0	0	0	0	0	0	50	100	200
Professional liability ins.	2	2	4	0	0	0	2	4	6
Salaries/wages	75	125	220	0	0	0	125	250	375
Employee benefits	0	0	10	0	0	0	19	38	56
Other Expenses	35	45	55	0	0	0	45	65	85
Total Expenses	130	190	307	0	0	0	261	482	752
Net Income	30	65	41	100	104	108	(16)	109	128

You can ignore taxes in your analysis.

3. Continued

You are also provided with the following information regarding the three options:

Option I:

- Projections provide for adding one veterinarian to staff in 2017
- Employee benefits for 2017 are for the second veterinarian only
- Salaries/wages are for support staff in 2015 – 2017 plus the second veterinarian in 2017
- Dr. Dan does not pay himself a salary but receives the hospital's net income each year

Option II:

- The net income represents the salary Dr. Dan receives as an employee

Option III:

- Projections provide for adding one veterinarian in 2016 and a second in 2017
- Dr. Dan does not receive a salary but receives the net income each year
- In addition to branding, MegaPet will:
    - Supply a state-of-the-art hospital administration computer system
    - Monitor the management reports generated by the administration system and communicate with Dr. Dan about potential problems
    - Provide standard policies and procedures that all their hospitals must follow (including requiring clients to pay for the cost of veterinary services at the time of service)
    - Supply training for all employees
    - Purchase most supplies in bulk and handle payments to suppliers
    - Require that employee benefits be made available to all hospital employees

(a) (*3 points*) Describe the following risks to Dr. Dan as they apply to Option I:

(i) Liquidity Risk

(ii) Counterparty Risk

(iii) Operational Risk

(iv) Professional Liability Risk (Legal obligations arising out of a professional's errors, negligent acts, or omissions during the course of the practice of his or her craft)

(b) (*2 points*) Explain how the risks described in (a) change if Dr. Dan elects to pursue Option II.

Question 3 continued on next page

3. Continued

(c) (*2 points*) Explain how the risks described in (a) change if Dr. Dan elects to pursue Option III.

As his advisor, you suggest that objective analysis of the risks should not be Dr. Dan's only consideration.

(d) (*2.5 points*)

(i) Explain why, in the strategic risk management field, scenario analysis is adopted as a qualitative analytical tool, rather than as a quantitative tool.

(ii) Identify three qualitative factors that could influence Dr. Dan's choice among the three options.

(e) (*2.5 points*) You do not intend to make a firm recommendation to Dr. Dan regarding his options; instead, you will offer guidance to help Dr. Dan make the decision that is best for him.

Outline the guidance you will offer Dr. Dan as he chooses among the three options.

4. (*5 points*) Cypress is a financial services company evaluating the economic performance of two of its operating units. You are provided the following:

	Unit A	**Unit B**
Net Income	26.1	30.8
Assets	1,000.0	1,100.0
Required Economic Capital	220.0	230.0
Available Economic Capital	225.0	275.0
Risk Adjustment to Net Income	9.5	13.2

Values are reported in $ millions.

(a) (*2 points*) Calculate the following measures of return for each unit:

(i) ROA

(ii) ROE

(iii) RAROC

(iv) RORAC

(v) RARORAC

Show your work.

(b) (*1 point*) Explain the benefits of using risk-adjusted return measures as compared to traditional measures.

(c) (*2 points*) The CFO of Cypress concludes from your calculations that unit B is underperforming based on the RAROC measure.

(i) Explain why the CFO may be most focused on the RAROC measure.

(ii) Provide arguments to counter the CFO's conclusion that unit B is underperforming.

5. (*10 points*) Acme Corporation, a high tech firm, and Elliott, Inc., a traditional manufacturer of high-end furniture, each has outstanding zero coupon debt of $100 million maturing in three years. This is the only debt outstanding for each company.

You intend to use the Merton model to evaluate the debt.

The companies currently have the following characteristics:

	Assets	**Expected Growth Rate**	**Volatility**
Acme	$175M	0.12	0.36
Elliott	$250M	0.04	0.29

(a) (*2.5 points*)

(i) Explain how the payoffs to Acme's bondholders and stockholders can be viewed in terms of puts and calls.

(ii) Graph the payoffs to Acme's stockholders as a function of the potential asset values at the end of year three. Label your graph.

(iii) Graph the payoffs to Acme's bondholders as a function of the potential asset values at the end of year three. Label your graph.

(b) (*2 points*) Show that the probability of default at the end of year three using the Merton model is:

(i) 12.2% for Acme

(ii) 3.5% for Elliott.

(c) (*0.5 points*) First, assume that there is no dependence between the two companies.

Calculate the probability that both companies will default at the end of year three. Show your work.

5. Continued

(d) (*5 points*) Next, assume that the asset values at time 3 of the two companies are linked by a Clayton Copula with parameter $\alpha = 2$.

The Clayton Copula has a generalized function:

$$C_{\alpha}\left(F\left(x_1\right), F\left(x_2\right), \ldots, F\left(x_N\right)\right) = \left[\sum_{n=1}^{N}\left(F\left(x_n\right)\right)^{-\alpha} - N + 1\right]^{-\frac{1}{\alpha}}$$

(i) Show that the probability that both companies will default at the end of year three using the Clayton Copula is 3.4%.

(ii) Explain why the maximum possible value for the probability that both companies will default at the end of year three is 3.5%.

(iii) State with reasons whether the Clayton Copula with parameter $\alpha = 2$ is an appropriate model for the joint probability functions for the two distributions in this case.

6. (*11 points*) Gaia Insurance is a life insurer that has historically sold life insurance and annuity contracts. Gaia has been measuring its economic capital for this business using a parametric VaR of its profits and losses (P&L). VaR is measured using a quarterly horizon with a 95% confidence level. The profits are assumed to be normally distributed with a quarterly mean profit of $5 million and a standard deviation of $8 million.

You have been asked to review alternative calculation methods for VaR.

The following table provides the worst ten ordered quarterly losses for Gaia over the last 100 quarters:

Losses ($millions)	13.5	11.3	10.1	9.0	8.2	7.4	6.8	6.2	5.7	5.3

(a) (*1.5 points*) Calculate the following risk metrics for Gaia's life and annuity block at a 95% confidence level over a quarterly horizon:

(i) Parametric VaR

(ii) Empirical VaR

Show your work.

(b) (*2 points*) You recall the following standard error formulas:

$$SE(\hat{q}) = \sqrt{\frac{c(1-c)}{Tf(q)^2}}$$

$$SE(\hat{\sigma}) = \sigma\sqrt{\frac{1}{2T}}$$

Calculate a 95% confidence interval for each of the following risk metrics with respect to a sample of 100 observations that have an underlying Normal distribution:

(i) 95% Parametric VaR

(ii) 95% Empirical VaR

Show your work.

(c) (*1.5 points*) Assess whether the parametric or empirical VaR is the better approach for Gaia's life and annuity block. Explain your conclusions using your analysis in (a) and (b).

6. Continued

Gaia recently acquired Kismah General, a property insurer.

You have constructed a distribution of annual P&L (in $millions) per $100 million earned premiums based on industry data that you will use to assess the risk exposure of Kismah General. The data has a mean profit of $30 million, a standard deviation of $30 million and the following annual loss tail:

Percentile	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Losses	145	111	86	82	41	21	16	13	11	8

(d) (*1 point*) Calculate the following risk metrics for Kismah General over a one-year horizon and at a 98% confidence level:

(i) Parametric VaR, assuming losses are normally distributed

(ii) Empirical VaR

Show your work.

(e) (*2 points*)

(i) Plot the losses predicted by assuming a Normal $\left(30, 30^2\right)$ distribution for the P&L of the Kismah General insurance block against the historical values at the following percentiles:

1. 90th
2. 95th
3. 99th

(ii) Interpret the results.

For the Kismah General insurance block, you also investigate the use of extreme value theory (EVT), fitting a two-parameter generalized Pareto distribution (GPD) to the tail of the historic loss data. The GPD has the following cumulative distribution function:

$$F(x) = 1 - \left(1 + \xi \frac{x-u}{\beta}\right)^{-\frac{1}{\xi}}$$

Question 6 continued on next page

6. Continued

Using a loss of $41 million as the threshold, beyond which 5% of the dataset remains, you determine that the maximum likelihood estimate of the shape parameter is 0.5 and of the scale parameter is $100.

Using the GPD for the tail losses, the estimated VaR at the cth level of confidence is:

$$\widehat{VaR} = u + \left(\hat{\beta}/\hat{\xi}\right)\left\{\left[\left(N/N_u\right)\left(1-c\right)\right]^{-\hat{\xi}} - 1\right\}$$

(f) (*1 point*) Calculate the 98$^{\text{th}}$ percent quantile estimator of VaR using your fitted Generalized Pareto model. Show your work.

(g) (*2 points*) Recommend the most appropriate method for estimating VaR from those computed in (d) and (f) to use for the Kismah General insurance block. Justify your choice with reference to specific results from your analysis.

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7. (*9 points*) You are an actuary at Bunche Mutual. Bunche's models are developed and maintained by the pricing actuaries. These models are then provided by the various pricing actuary teams to the corporate risk actuaries and converted for internal capital purposes. While the pricing actuaries have a strong sense of ownership over their models, they are not knowledgeable about the internal capital model results.

The corporate risk actuaries set capital using 90% CTE. Some of the assumptions in the Economic Capital (EC) model have not been changed since the model was developed five years ago.

You have been asked to validate the EC model based on the following three principles:

I. Model design and build need to be consistent with the model's intended purpose

II. Ensure appropriateness of established model governance

III. Validate the model components

(a) (*1.5 points*) Describe potential areas of concern with model governance (Principle II) at Bunche.

(b) (*2 points*) You are validating the model parameters for the following risks:

(i) Pandemic Risk

(ii) Operational Risk

(iii) Expense Risk

Identify an appropriate estimation method for parameterizing each of the risks listed above. Explain your response.

7. Continued

Your manager tells you that the only assumptions you need to validate are mortality and lapse.

(c) (*2.5 points*) The mortality assumption currently used in the model was provided by a consultant five years ago and has not been updated since. There have been changes to the product designs and mix of business in the last five years.

(i) Identify key considerations that should be taken into account in updating Bunche's mortality assumption.

(ii) Explain how to apply each of Principles I, II, and III to the mortality updating process.

(d) (*3 points*) Outline the process you would follow to determine if your manager's focus on validating only the mortality and lapse assumptions in the EC model is appropriate.

Questions 8 and 9 pertain to the Case Study and/or extension readings.
Each question should be answered independently.

8. (*11 points*) The CEO of SLIC has become concerned about the large and volatile cash contributions which have been required to the SLIC Salaried Pension Plan ("Plan"). SLIC has hired you as a consultant to provide recommendations for reducing future contribution requirements and decreasing the surplus (deficit) volatility.

Strong equity market performance in the past year has improved the Plan's funded status. The Plan's equity manager A has suggested further increasing the equity portion of the Plan's asset mix. She argues that the increased expected returns from equities should increase the Plan's funded status and therefore decrease surplus volatility. The Plan's equity manager B has instead suggested selling equities to rebalance to the initial target.

(a) (*3 points*) Consider the following three contributors to surplus risk in the Plan:

I. Investment risk

II. Liability risk

III. Other actuarial risk

(i) Describe how each risk I through III contributes to surplus risk.

(ii) Explain how the improvement in funding status due to strong equity market performance could affect each of I through III.

(b) (*4 points*)

(i) Critique the arguments of equity managers A and B.

(ii) Recommend an appropriate change in the Plan's allocation between return-generating assets and liability-hedging assets.

(iii) Explain if and how your recommendation in (ii) would change if the reason the Plan's funded status improved were mainly due to rising discount rates.

8. Continued

(c) (*4 points*) The Plan Actuary has presented a tax arbitrage argument for investing most of the Plan assets in fixed income investments.

(i) Explain the impact of a shift in Plan assets from stocks to bonds with respect to:

1. A firm's leverage (sensitivity of firm value to economic conditions)

2. A firm's debt capacity

3. Plan benefit security

(ii) Outline how a tax arbitrage strategy between a DB Plan and a firm's capital structure would be implemented.

(iii) Assume the strategy you outlined in (ii) is implemented using $350 million of pension assets. Assume the marginal tax rate is 35% and the interest rate earned on the Plan's bonds is 4%.

Calculate the first year arbitrage profit. Show your work.

Questions 8 and 9 pertain to the Case Study and/or extension readings. Each question should be answered independently.

9. (*9 points*) Doral Manufacturing is a $75 billion firm with a $100 billion defined benefit (DB) pension liability. Doral's $75 billion in operating assets are backed by $35 billion in debt and $40 billion in equity that has an estimated beta of 2.30.

Doral's DB Plan (the "Plan") has assets of $80 billion with a 70% allocation to equity and a 30% allocation to fixed income.

You are the Plan Actuary, attending a meeting of Doral's Pension Committee. At the meeting, the new CFO expresses concern that the Plan's $20 billion funding shortfall will negatively affect the company's strategic growth plans. The CFO expects that this shortfall will lead to increased Plan contributions from Doral, depressing Doral's stock price and increasing the cost of capital.

The CFO proposes increasing the Plan's equity allocation to 100% to help close the funding gap with higher expected returns.

(a) (*2 points*) Describe the following aspects of equity risk in DB Plans:

(i) Correlation with the sponsor's finances,

(ii) Controllability by the Plan sponsor, and

(iii) Party best equipped to take the risk.

(b) (*2 points*)

(i) Explain to the new CFO how risk mismatch in Doral's DB Plan is a bigger problem than the apparent funding shortfall issue.

(ii) Provide a balance sheet analogy for Doral to illustrate your explanation.

9. Continued

(c) (*3 points*) Assume the following:

- The Plan's equity assets have a beta of 1.00
- The risk free rate is 1%
- The equity market return is 11%
- There are no taxes

(i) Estimate Doral's weighted average cost of capital (WACC) of the operating company. Show your work.

(ii) Re-estimate the WACC of the operating company on a full economic balance sheet basis incorporating the Plan's assets and liabilities. Show your work.

(iii) Explain how incorporating the Plan's assets and liabilities into Doral's WACC calculation would impact Doral's capital management strategy.

(d) (*2 points*) You recommend to the CFO that the Plan should not go to a 100% equity allocation.

(i) Calculate the impact to Doral's equity beta of a change to a 100% equity allocation. Show your work.

(ii) Explain how the results of (i) justify your recommendation.

END OF EXAMINATION

USE THIS PAGE FOR YOUR SCRATCH WORK