Exam AFE

AFTERNOON SESSION

Date: Friday, November 4, 2011
Time: 1:30 p.m. – 4:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This afternoon session consists of 5 questions <u>numbered 6 through 10</u> for a total of 60 points. The points for each question are indicated at the beginning of the question. There are no questions that pertain to the Case Study in the afternoon session.

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 since 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 morning or afternoon session for Exam AFE.

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.

6. (*12 points*) The regulators of a small Eastern European country are considering U.S., Canadian and Solvency II regulatory capital regimes as possible frameworks for their jurisdiction. They intend to implement separate capital regimes for life and annuity business and for auto insurance business.

Slavic Insurance Company will be subject to these frameworks and has been invited by the regulators to provide input. Slavic sells life insurance, deferred annuities and auto insurance.

The head of Slavic's life and annuity business prefers a capital regime with the following characteristics:
- Maximization of diversification benefits among blocks of business
- Maximization of solvency reserves for a given total balance sheet requirement
- Minimization of total balance sheet requirement with respect to interest rate risk

(a) (*2 points*) Rank the level of diversification benefits allowed in each of the three capital regimes, U.S., Canadian and Solvency II, for the life and annuity business. Support your ranking.

(b) (*3 points*) For each of the following components of the total balance sheet requirement for life and annuity business:

> I.   Best estimate liability
> II. Solvency margin
> III. Interest rate risk amount

(i) Describe the component.

(ii) Compare the relative size of the component across the three capital regimes.

(c) (*3 points*) Evaluate which of the three capital regimes will be the most beneficial from the perspective of Slavic's life and annuity business head.

The head of Slavic's auto insurance business prefers a capital regime which does not assess capital charges for catastrophe and operational risks.

(d) (*3 points*) Describe the charges for the following risks under each of the three capital regimes for the auto insurance business:

(i)   Catastrophe risk
(ii) Operational risk
(iii) Interest rate risk

(e) (*1 point*) Evaluate which of the three capital regimes will be the most beneficial from the perspective of Slavic's auto insurance business head.

7. (*11 points*) You are assessing the variance of the VaR and CTE risk measures for the present value of Guaranteed Minimum Withdrawal Benefit (GMWB) liability cash flows. You have run 1,000 simulations, of which 200 show losses. You have computed a 95% confidence interval (CI) for VaR 95 using the normal approximation. You have also computed a CI for CTE 90 using the normal approximation with the sample standard deviation of the worst 10% of the simulated present values.

(a) (*1 point*) Define VaR and CTE with parameter α ($0 < \alpha < 1$) and explain how to estimate these metrics from the simulations.

(b) (*2 points*) Explain why less sampling error is expected for the CTE 90 as compared to the VaR 95.

(c) (*2 points*) Assess whether the methodology used in calculating the CI for CTE fully captures the uncertainty associated with this risk measure.

(d) (*2 points*) Using the following alternative methodology:

$$VAR(\widehat{CTE}_n) \approx \frac{VAR(X \mid X \geq VaR) + \alpha(CTE - VaR)^2}{n(1-\alpha)}$$

Determine the number of simulations needed to reduce the standard deviation of the CTE to 20% of its current level.

(e) (*2 points*) Define control variate, and explain whether using the estimated VaR as a control variate can significantly reduce the variance of the estimated CTE.

(f) (*2 points*) Define antithetic variate, and explain whether use of an antithetic variate can significantly reduce the variance of the estimated CTE.

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8. (*12 points*) Huckleberry Life is a U.S. insurance company that sells term life insurance. Huckleberry is considering acquiring Blossom Assurance, a European insurance company that sells annuities. You have been hired by Huckleberry to help evaluate this potential acquisition.

You are given the following information for Blossom:

Table 1
(in millions USD)

Market Value of Assets	1,000
Expected PV of Liability Cash Flows	900
Cost of Capital	15%

Table 2

Risk Category	**Hedgeable**	**PV of Solvency Capital Requirement (in millions USD)**	**Diversification Factors**
Market Risk	Yes	300	60%
Business Risk	?	230	70%
Credit Risk	?	20	25%
Insurance Risk	?	50	55%
Operational Risk	?	10	15%

(a) (*3 points*)

  (i) Define Market Value Margin (MVM).

  (ii) Compare and contrast the Market Cost of Capital (MCoC) approach and the Percentile approach to calculating MVM.

8. **Continued**

(b)   (*5 points*) All applicable risks of Blossom are shown in Table 2.

   (i)   Market risk has already been classified as hedgeable.

          Classify the remaining risk categories as hedgeable or non-hedgeable.
          Justify your choice.

   (ii)   Calculate the MVM using the MCoC approach. Show your work.

   (iii) Calculate available economic capital (defined as market value of assets
          less market value of liabilities). Show your work.

(c)   (*1 point*) Provide two reasons why market risk may not always be hedgeable for
       variable annuities.

(d)   (*1 point*) Describe the levels of diversification benefits that would apply if
       Huckleberry acquired Blossom.

(e)   (*2 points*)

   (i)   Based on the information above, recommend whether Huckleberry should
          acquire Blossom at a price of 70 million USD. Justify your
          recommendation.

   (ii)   List three additional significant considerations that you would want to
          evaluate before making the acquisition decision.

9. (*14 points*) You are given the following:

Zero-Coupon Bond	1-Year Spot Yield to Maturity	2-Year Spot Yield to Maturity
Treasury (Risk-Free)	5.0%	7.0%
High Quality (HQ)	8.0%	12.0%
Low Quality (LQ)	10.5%	13.5%

(a) (*2 points*) Identify three factors that can affect the Loss Given Default (LGD) for a bond. For each factor, state whether the correlation with LGD is positive or negative.

(b) (*5 points*) Calculate the two-year cumulative probability of default for both an HQ-rated and an LQ-rated two-year, zero-coupon bond. Assume LGD is 100% and that the bonds cannot change in rating aside from defaulting.

You are given the following one-year, risk-neutral credit migration matrix:

	HQ	LQ	Default
HQ	90%	8%	2%
LQ	5%	85%	10%
Default	0%	0%	100%

Credit migration probabilities are assumed to be constant over time.

(c) (*4 points*) Calculate the credit spread of a two-year, zero-coupon LQ-rated bond assuming LGD is 100%.

(d) (*3 points*) Calculate the value of a two-year, zero-coupon LQ-rated bond assuming LGD is 40% and the par value is $100 million.

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10. (*11 points*) You are responsible for calculating internal capital requirements for Spud Annuity, which only issues Single Premium Immediate Annuity (SPIA) and Equity Indexed Annuity (EIA) products.

Spud has a static hedging program for its EIA block. Derivatives replicating the payoff structure of the index accounts are bought at the beginning of each index term.

The current internal capital requirement is a formulaic function of premiums and reserves. You are proposing new requirements based on Required Economic Capital using CTE 95. The market value of liabilities is defined as the expected PV Net Outflows.

To demonstrate the technique, you run 100 scenarios and produce the following results:

Scenario #	SPIA PV Net Outflows in $M	EIA PV Net Outflows in $M
7	340	700
12	250	1,250
29	315	650
38	375	900
54	275	1,100
55	320	850
64	225	675
79	330	1,350
89	230	925
100	290	800

SPIA:
- For each of the other 90 scenarios, the PV Net Outflows is below $200M.
- The average of the PV Net Outflows for the other 90 scenarios is $75M.

EIA:
- For each of the other 90 scenarios, the PV Net Outflows is below $500M.
- The average of the PV Net Outflows for the other 90 scenarios is $250M.

(a)   (*3 points*) For each product, SPIA and EIA, describe the exposure to the following risks:

   (i)   Pricing Risk

   (ii)   Market Risk

   (iii) Operational Risk

10. Continued

(b)   (*2 points*) Describe three potential deficiencies of a formulaic internal capital requirement.

(c)   (*3 points*) Calculate the Required Economic Capital for each of the two products, SPIA and EIA, separately. Show your work.

(d)   (*3 points*)

   (i)   Explain why a diversification benefit might exist from combining SPIA and EIA.

   (ii)   Calculate the diversification benefit from combining SPIA and EIA in the Required Economic Capital calculation. Show your work.

END OF EXAMINATION
Afternoon Session

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