SOCIETY OF ACTUARIES
Exam FETE
Financial Economic Theory and Engineering Exam (Finance/ERM/Investment)

Exam FETE

AFTERNOON SESSION

Date: Thursday, November 3, 2011
Time: 1:30 p.m. – 4:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This afternoon session consists of 9 questions numbered 10 through 18 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 FETE.

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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Exam FETE-Front Cover

****BEGINNING OF EXAMINATION****
AFTERNOON SESSION
Beginning with Question 10

10. (*8 points*) Manitowoc Life Insurance Company (Man Co.) has one large block of accumulation-oriented flexible premium UL policies, and another large block of VUL policies. They have calculated the economic capital for the VUL block, and would like to calculate the economic capital for the UL block.

For this purpose, EC is defined as "the amount of capital needed to cover misestimation of mean, deterioration of the mean, and statistical fluctuations."

For the UL block the company intends to use the EC calculation in order to adjust the current amount of capital. The current amount of capital is used to cover misestimation of the mean loss due to the most significant risks, which are interest rate risk, mortality risk, and lapse risk.

For the UL block, the EC will be set at the 98th percentile of the loss distribution of the three most significant risks.

Three separate Monte Carlo simulations were used to quantify the 98th percentile and mean losses for the UL product's three risks:

Risk Type	Mean Loss	98th Percentile Loss
Interest rate	200,000	300,000
Mortality	12,000	40,000
Lapse	40,000	55,000

Manitowoc is employing a traditional approximation to determine the covariance adjustment among the three risks.

For the UL block, Manitowoc currently holds total balance sheet liabilities of 295,000 which includes capital to cover the misestimation of the total mean of the three risks. The total actuarial liability on the balance sheet is 270,000. They would like to adjust the amount of existing capital to reflect the EC.

(a) (*3 points*)

(i) Calculate the *unadjusted* EC before covariance.

(ii) Calculate the *unadjusted* EC after covariance.

(iii) Calculate the *adjusted* EC after covariance.

10. Continued

Manitowoc has already calculated the EC for the VUL block to be $70,000, and would like to incorporate the economic capital result into the pricing of a similar VUL product. It was determined that the inforce VUL EC is based 80% on interest rate risk, 20% on mortality risk.

The following grid describes the actual figures for the inforce VUL block, as well as the projected figures for the VUL product under development.

Inforce VUL or VUL Pricing Model	Year	Net Amount at Risk	Statutory Liabilities	After-Tax Profits Before Distributable Earnings	$tPx(d)$	$tPx(q)$
Inforce	0	110,000	252,000	22,000	0.005	0.000
Pricing Model	1	30,000	105,000	-5,000	0.015	0.000
Pricing Model	2	20,000	110,000	+12,000	0.020	0.000
Pricing Model	3	15,000	115,000	+10,000	0.030	0.000

The pricing model has following assumptions:

Interest rate on EC	8%
Pricing hurdle rate	15%
Tax rate	35%

You are told to use a linear approximation based on the EC results of the inforce VUL block to calculate a set of factors in order to project the EC for the priced VUL product. Using these projected EC values and discounting at the hurdle rate:

(b) (*5 points*) Calculate the PV of annual distributable earnings under:

(i) The *indirect* approach

(ii) The *direct* approach

11. (*8 points*) Sturgeon Bay Bank (SBB) has been selling a "reverse mortgage" product for several years. The product is aimed at homeowners without a mortgage who want to receive an enhanced pension in return for giving up some of the value of their property upon death.

The terms of the product are as follows:

- The bank lends the homeowners a fixed sum.
- Interest and fees are accumulated at a variable rate which resets quarterly until repayment.
- Homeowners live rent free in the property until death, when the property is sold and the loan is repaid from the proceeds. If the sale proceeds exceed the loan, then the difference passes to the homeowners' estate. Otherwise, the bank waives the shortfall.

A government institution provides insurance against the risk that the eventual repayment amount is less than the loan balance at that time. The premium, which is added to the loan balance, is an initial fee of 2% of the loan value and an annual fee of 0.5% of the outstanding loan balance. Based on projected cash flows, Sturgeon Bay Bank issues fixed rate GIC's of 1, 3 and 5-year maturities.

Sturgeon Bay Bank's CEO has asked you to explore the possibility of securitizing the repayment cash flows (longevity risk) of the reverse mortgage business.

(a) (*2 points*)

(i) Describe the option that the bank is currently writing.

(ii) Describe the underlying, strike price, and volatility implicit in the context of this particular option.

(b) (*2 points*) Analyze the risks associated with this line of business as currently managed.

(c) (*4 points*) Recommend a securitization structure,

(i) Identifying the parties to the transaction,

(ii) The role of each party, and

(iii) Diagramming all cash flows.

12. (*6 points*) You are the CFO of a Misha Mokwa Company (MiMo), a new public company and you are considering a project to upgrade your current technology.

You are given:

- MiMo has 1,000,000 shares outstanding, current share price is 50.
- MiMo's current business is valued at 40,000,000.
- The new project will cost 15,000,000.
- The new project will generate a stream of cash flows with a NPV of 20,000,000 (excluding the 15,000,000 initial cost).

Management is looking to finance the new project and is considering the following alternatives:

(i) Issue new equity

(ii) Issue new senior debt with a reduction in NPV of 30%

(iii) Issue new cumulative preferred stock with reduction in NPV of 20%

(a) (*2 points*) Describe the advantages and disadvantages of each financing alternative.

(b) (*2 points*) Calculate the impact on shareholder value for each financing alternative.

(c) (*2 points*) Recommend and justify the best funding alternative for MiMo.

13. (8 *points*) Your company is currently using a deterministic method to model the risk of its guaranteed minimum maturity benefit (GMMB). You have been assigned to review this methodology and recommend changes if necessary.

(a) (*1 point*) Describe the problems with using a deterministic method to model GMMB liabilities.

Your company has committed to switching to stochastic modeling of its GMMB liabilities and now must choose a stock return model from following list.

- Lognormal Model
- Regime-Switching Lognormal Model
- Empirical Model

(b) (*2 points*) Describe the features of the above models.

(c) (*3 points*) Assess the suitability of each model for modeling your company's GMMB liability for economic capital purposes.

Your company is choosing a source of data to calibrate the stock return model. It is considering the following sources:

- Historical stock returns since 1926
- Historical stock returns since 1956
- Current Market Prices

(d) (*2 points*) Describe the advantages and disadvantages of each data source and make a recommendation of which source to use. Support your choice.

14. (*5 points*) Two securities $S_1(t)$ and $S_2(t)$ follow the diffusion processes below under the P-measure (real world):

$$dS_1 = \mu_1 S_1(t)\,dt + \sigma_1 S_1(t)\,dW_1(t)$$

$$dS_2 = \mu_2 S_2(t)\,dt + \sigma_2 S_2(t)\,dW_2(t)$$

where $dW_j(t)$ are standard Wiener processes.

(a) (*1 point*) Modify the above processes to be risk-neutral. Define any variables you introduce.

(b) (*1 point*) Write down an expression for the market price of risk, λ.

(c) (*1 point*) Express μ_2 in terms of σ_2, and the market price of risk.

(d) (*1 point*) Explain in words the concept of a martingale.

(e) (*1 point*) Identify, with reasons, which of the following processes are martingales:

(i) The asset value at each time step in a risk-neutral process

(ii) The discounted asset value in a risk-neutral process

15. (*9 points*) The Oconto Company is going to make an important announcement in 2 months. The CFO uses a one-step binomial tree to model the expected impact of the announcement on the company's stock price.

Current Stock Price	= $25.00
Percentage increase in stock price after good news	= 30%
Percentage decrease in stock price after bad news	= 30%
Time period	= 2 months
Risk-free rate	= 4%

(a) (*1 point*) Outline the key costly and costless signaling announcements.

(b) (*2 points*) Calculate the price and delta of the 2-month call option on the stock with strike price equal to $30 using the binomial tree.

(c) (*2 points*) Solve for the Black-Scholes-Merton model's annualized implied volatility using the price from (b).

(d) (*2 points*) Calculate the Black-Scholes-Merton model's delta using the implied volatility from (c).

(e) (*2 points*) Evaluate the appropriateness of delta hedging changes in the stock price, versus using an option hedge strategy.

16. (*4 points*) Mr. Jones, the manager of the well-diversified Lake Geneva Mutual Funds, completed a factor analysis study of his funds. He found that there are two factors that affect the expected returns of his funds: changes in industrial production β_1, and unexpected inflation β_2.

His findings are summarized in the chart below:

Portfolio	Expected Return	Factor Sensitivity of Industrial Production (β_1)	Factor Sensitivity of Unanticipated Inflation (β_2)
1	20%	0.08	0.05
2	15%	0.04	0.06

The risk-free rate R_f is 5%.

(a) (*1 point*) Describe the assumptions of:

(i) Capital Asset Pricing Model (CAPM)

(ii) Arbitrage Pricing Theory (APT)

(b) (*2 points*) Derive the Arbitrage Pricing Line for this set of portfolios, using the table above.

There is another portfolio, Portfolio 3, that has $\beta_1 = 0.06$ and $\beta_2 = 0.055,$ with expected return = 16%.

(c) (*1 point*) Identify the reason an arbitrage opportunity exists here and explain how Mr. Jones can take advantage of it.

17. (6 *points*) You are given the historical values relating to a particular asset. The PVs below assume a 5% discount rate, equal to the "normal" rate of return.

Time	2 years ago	1 year ago	Today
PV future CF	170	130	65
Resale value if privately owned	160	130	70

For every time period each of the following analysts agree on the expected values in the table above, but different analysts may have had different preferences and would have paid different prices as a result.

The table below provides historical data showing each analyst's valuation of the asset at that time.

Time	2 years ago	1 year ago	Today
Analyst 1	170	130	65
Analyst 2	200	100	80
Analyst 3	170	130	70
Analyst 4	160	130	70

(a) (*2 points*) Using each analyst's asset valuations in the table above:

(i) Identify the analyst conforming most closely to the "Naïve Hypothesis" valuation approach. Justify your answer.

(ii) Identify and explain each of the other analysts' hypothesis on asset prices.

(b) (*2 points*) Describe experiments which have been conducted to provide empirical evidence which supports or repudiates each hypothesis.

Wauwatosa Investments LLC employs analysts 2 and 3, is aware of their price hypotheses, but is not aware of price quotes from analysts 1 and 4.

Wauwatosa Investments LLC also knows from analysts 2 and 3:

Cost to buy asset with analysis: 10%
Cost to buy asset with no analysis: 2%

(c) (*2 points*) Calculate the value that Wauwatosa Investments LLC believes is the equilibrium price today, under a stable mixed strategy.

18. (*6 points*) Eau Claire Life (ECL) is a publicly traded stock company. The market value of the company's assets, liabilities and equity as of 12/31/2011 are shown in Table 1 below:

Table 1: Eau Claire Life Balance Sheet as of 12/31/2011

Assets ($millions)		Liabilities and Equity ($millions)	
Cash	$100	Policy Reserve	$450
Invested Assets	$500	Zero coupon bond	$120
Total Assets	$600	Equity	$30

The zero coupon bond was issued by the company prior to year 2011 to finance its operations. It was still outstanding as of 12/31/2011. It is junior to the Policy Reserve. Its maturity value (face value) is $140 million.

Assume both the company and the market know that on the maturity date of this zero coupon bond:

- The Policy Reserve will be $480 million with probability 1.0
- The Invested Assets will be $570 million with probability 0.9 and $490 million with probability 0.1
- Cash earns 0% interest

(a) (*2 points*) Describe the major sources of conflicts between

(i) The company's managers and its stockholders

(ii) The company's stockholders and its bondholders

(b) (*3 points*) Construct Eau Claire Life's Balance Sheet (as in Table 1 above) as of 12/31/2011 if the company had paid a $20 million cash dividend to its shareholders from its $100 million cash holdings on 12/31/2011. Assume the discount rate of the zero coupon bond is unaffected by the dividend action. Show your work.

(c) (*1 point*) Calculate the wealth transfer between bondholders and shareholders assuming the $20 million cash dividend payout had occurred.

****END OF EXAMINATION****
Afternoon Session

USE THIS PAGE FOR YOUR SCRATCH WORK