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

# Exam FETE

## AFTERNOON SESSION

**Date:** Thursday, April 26, 2012
**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.** (*5 points*) The Stilton Company is a multi-line insurer operating with three main lines of business: Annuities, Life and Group Health.

| Line of Business | Reserves | Economic Capital (with diversification) | Economic Capital (stand-alone) |
|---|---|---|---|
| Annuities | $900 | $78 | $80 |
| Life | $600 | $38 | $40 |
| Group Health | $300 | $29 | $30 |

(all amounts in $million)

The total company required capital is $150 million. Actual capital held is $185 million.

The required capital of Stilton after each business unit is removed has been computed for allocation purposes. Suppose that the values thus computed yield face capital (the difference between required and economic capital) levels of $0 million, $5 million, and $7 million for Annuities, Life and Group Health, respectively.

(a) (*1 point*) Define and calculate the following for the Stilton Company:

(i) Tier 1 capital

(ii) Tier 2 capital

(iii) Tier 3 capital

(b) (*2 points*) List the advantages and disadvantages of 4 methods to allocate capital within an organization.

(c) (*2 points*) Allocate Stilton's required capital under each method.

**11.** (*5 points*) You are the CFO of a large US independent publicly traded company in a highly regulated industry. Your company typically relies on public capital market financing. Your company is controlled mainly by professional managers and they are paid a salary and have significant stock option rights. You are considering expansion and are investigating two other markets with different ownership structure models. Below are some of their key characteristics.

| | Market 1 | Market 2 |
|---|---|---|
| Domicile | Europe | Asia |
| Market Size | Few large independent | Small number of groups |
| Financing | Typically through large commercial banks | Typically through a central bank |
| Managerial Compensation | Mostly salary with some options | 100% salary |

(a) (*2 points*)

(i) Identify the ownership structure models of Market 1 and Market 2

(ii) Describe additional characteristics for Market 1 and Market 2 that are likely to be present

(b) (*1 point*) Describe the weaknesses of both Market 1 and Market 2 ownership structure models.

One of the reasons you wish to expand is to defend against hostile domestic takeovers.

(c) (*2 points*)

(i) Describe four additional ways to defend against a hostile takeover.

(ii) Explain the likely impact to shareholder wealth if you implement these defenses.

**12.** (*9 points*) Your competitor, Paneer Corp., is up for sale. The industry view is that restructuring Paneer Corp. will increase the Actuarial Appraisal Value of the company by 42. Your firm, Chhena, has provided the following information to a consultant to calculate the value of your company:

| | |
|---|---|
| Value of Inforce and Future Business | 171 |
| Cost of Required Capital | 15 |
| Initial Required Capital $RC_0$ | 20 |
| Equity | 80% |
| Debt | 20% |
| Required Return on Debt | 4% |
| Risk of company relative to the market as a whole | 1.4 |
| Return on Surplus Assets = Risk Free Return | 3% |
| Market Expected Return | 9% |
| Tax Rate | 20% |

The external consultant has calculated Actuarial Appraisal Values of key companies concerning an acquisition of Paneer Corp. in the following matrix giving values based on which company eventually acquires Paneer Corp.

Actuarial Appraisal Values

| | | Value if Paneer Corp. is Acquired by: | | |
|---|---|---|---|---|
| Appraised Company | Stand Alone Value | Akkawi | Bergkäse | Chhena |
| Akkawi | 141 | 269 | 127 | 127 |
| Bergkäse | 113 | 99 | 240 | 99 |
| Chhena | 99 | 78 | 78 | 226 |
| Paneer Corp. | 85 | 0 | 0 | 0 |

(a) (*2.5 points*) List and describe 5 Merger Types and Critical Managerial Issues.

(b) (*1 point*) Calculate the maximum price that Chhena would be willing to pay to acquire Paneer Corp.

(c) (*1.5 points*) Calculate the minimum price Chhena could pay and expect to win.

If successful in its bid for Paneer Corp., your company (Chhena) is considering entering into a reinsurance treaty that would result in an increase in value.

## 12. Continued

Immediately after acquisition and entering into this treaty the following would apply:

- The treaty would result in a reduction in the value of Inforce and New Business in all years of 5%
- Excess capital would increase by 25
- $RC_0 = 25$
- $NPV_0\left(\text{return}_t * RC_{t-1}\right) = 50$

(d) (*4 points*) Calculate the Actuarial Appraisal value if acquiring Paneer Corp. and entering into the treaty and advise whether the company should proceed with the treaty.

**13.** (*6 points*) Your company wants to launch a new product with a 3 year life span. At the end of the first year, the project is expected to generate 50,000. At the end of each of the next two years, the revenue is expected to either increase by a factor of 1.25 or decrease by a factor of $1/1.25 = 0.8$. The project will also involve a significant systems build, which can either be undertaken today for 40,000 or at the end of year 2 for 47,000. Failure to complete the systems build at the end of year 2 would result in no revenues in year 3. The risk-free rate is 5%.

(a) (*1 point*) Show that the risk-neutral probability of an increase in revenue is 56%.

(b) (*4 points*) Calculate the value of this project using real options analysis and recommend whether the company should pursue the project.

(c) (*1 point*) Explain why using the NPV approach undervalues all projects.

**14.** (*7 points*) During recent months the market has shown an increased level of volatility. The investment managers are developing a variance model to explore ways to implement variance swaps in the equity portfolio.

(a) (*1 point*) Describe variance swaps and their uses.

The table below shows 3-month expiration option prices of the stock of Golka Company whose current price is 353; it pays no dividends. The risk-free interest rate is 2%.

| Strike | Call | Put |
|---|---|---|
| 345 | 20.92 | 11.20 |
| 350 | 18.00 | 13.25 |
| 355 | 15.35 | 15.58 |
| 360 | 12.90 | 18.10 |

(b) (*5 points*) Estimate the variance of Golka stock using the option quotes in the table above.

Consider a 3-month contract to receive the realized variance rate of Golka stock over the 3 months and pay a variance rate of 0.012 on a principal of $500 million.

(c) (*1 point*) Calculate the value of the variance swap.

**15.** (*9 points*) You are to dynamically hedge a short position of an at-the-money put option written on a stock under the Black-Scholes-Merton framework. The option has a strike price of $K = 100$ and a maturity of $T = 24$ months. You rebalance the hedge at the end of each month, that is, at $t = 1, 2, ..., 24$.

You are given:

- The price of the stock at time $t$ (in months) is $S_t$; $S_0 = 100$.
- The stock pays no dividend.
- The stock has a volatility of $\sigma = 30\%$ per annum.
- The risk-free interest rate is $r = 6\%$ per annum, compounded continuously.
- Transaction costs on stocks are 0.2% of the value of stock traded.
- There are no transaction costs on bonds.
- $d_1 = \dfrac{\ln\left(S_t / K\right) + \left(r + \sigma^2 / 2\right)\left(T - t/12\right)}{\sigma\sqrt{T - t/12}}$, $d_2 = d_1 - \sigma\sqrt{T - t/12}$.
- $N(.)$ denotes the standard normal distribution function.

You use simulations to evaluate the effectiveness of the hedge. In a single simulation (under the real-world probability measure), you obtain the following results:

| Time (months) $t$ | Simulated stock price (under the real-world measure) | Stock part of the hedge | Bond part of the hedge |
|---|---|---|---|
| 0 | 100 | 31.0300 | –41.8449 |
| 1 | 105 | 28.7280 | –37.9633 |
| 2 | 95 | 34.5895 | –46.8880 |

## 15. Continued

(a) (*8 points*)

(i) Verify that the stock part of the hedge at $t = 1$ is 28.7280 dollars.

(ii) Verify that the bond part of the hedge at $t = 1$ is $-37.9633$ dollars.

(iii) Calculate the hedging error (dollars of price drift) prior to rebalancing at the end of month 1.

(iv) Calculate the transaction costs from rebalancing the hedge at $t = 1$.

Suppose that the hedge is rebalanced weekly instead of monthly.

(b) (*1 point*) Describe the expected change in the aggregate hedging error and the aggregate transaction cost. Explain your answer.

**16.** (*7 points*) The investment team at the Tomar Company is interested in implementing a term structure model and has reached out to you for help.

Tomar wants to use this model to calculate the price of a 5-year European call option on a zero coupon bond that matures 10 years from now. Suppose that $a = 0.06$ and $b = 0.11$ for the Vasicek model. Assume:

| | |
|---|---|
| initial short rate, per annum | 3% |
| $\sigma$ | 0.04 |
| Bond Principal | 200 |
| Option Strike Price | 180 |

The following values have been provided for this particular model:

| $T$ | $A(0,T)$ | $B(0,T)$ |
|---|---|---|
| 0 | 1.0000 | 0.0000 |
| 1 | 0.9970 | 0.9706 |
| 2 | 0.9893 | 1.8847 |
| 3 | 0.9785 | 2.7455 |
| 4 | 0.9661 | 3.5562 |
| 5 | 0.9531 | 4.3197 |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | x.xxxx | y.yyyy |

(a) (*4 points*) Calculate the price of this option.

After reviewing the calculation for the European call option, the head of the ALM unit proposes that the exercise be re-done using the Hull-White Two Factor model.

(b) (*1 point*) Explain why this could be an appropriate proposal.

(c) (*2 points*) Explain how the Vasicek and the Hull-White Two Factor models can be used when:

(i) *Q* measures are used.

(ii) *P* measures are used.

**17.** (*3 points*) The Lingallin Company is using the Conditional Tail Expectation (CTE) 99.95 to calculate their economic capital requirement. They have run 10,000 scenarios using their internal model and the worst 5 outcomes are, in $ million: 80, 84, 90, 110, and 120. Your associate calculates the standard deviation of the CTE estimator (SDE) with the following formula and is going to use it to estimate the variance of CTE:

$$SDE = \sqrt{\frac{1}{k}\sum_{j=1}^{k}\frac{(x_{(j)} - CTE)^2}{(k-1)}} = 7.76$$

(a) (*1 point*) Determine whether the quantity SDE defined above is a valid estimate for the true variance of the CTE.

(b) (*2 points*) Estimate the variance of CTE 99.95 for Lingallin's capital requirement based on the approach outlined in the Manistre and Hancock paper.

**18.** (*9 points*) Asiago Corp. is a publicly traded stock company. The company's only liability is the zero coupon bond it issued in the past to finance the company's operations. Based on its business outlook the company's management announced a stock repurchase plan via a tender offer after the market close on 6/30/2012.

You are given the following information:

Table 1: Tender offer data as of 6/30/2012

| | |
|---|---|
| Share price on 6/30/2012 | $9.95 |
| Tender Offer price per share | $11.50 |
| Tender Offer shares | 10 million |
| Tender Offer period | 7/1/2012 – 7/31/2012 |

The company repurchased all 10 million shares at the tender offer price of $11.50 during the tender offer period using its available cash. There are no other transactions that affect the company's cash and other assets throughout the tender offer period except the tender offer itself.

Table 2: Balance sheet as of 6/30/2012

| Assets ($millions) | | Liabilities and Equity ($millions) | |
|---|---|---|---|
| Cash | $150 | Zero coupon bond | $285 |
| Other Assets | $350 | Equity | $215 |
| Total Assets | $500 | Total Liabilities & Equity | $500 |

You are also given the following data as of 7/31/2012:

| | |
|---|---|
| Implied volatility of the company's share price | 20.0% |
| Implied volatility of the company's Other Assets | 16.5% |
| Remaining maturity of the company's zero coupon bond | 4 years |
| Maturity value (face amount) of the company's zero coupon bond | $300 million |
| Risk-free rate (all maturities) | 0% |
| Market value of the company's Other Assets | $352 million |
| Dividend yield on the company's Other Assets | 0% |
| Cash interest rate | 0% |

(a) (3 points)

(i) Identify and describe the hypotheses related to the effect of the tender offer on the wealth of shareholders and bondholders.

(ii) Identify the hypothesis that received the strongest support from the empirical evidence.

**18.** **Continued**

(b) (*3 points*) Construct the company's balance sheet as of 7/31/2012 similar to Table 2. Show your work.

(c) (*3 points*)

(i) Demonstrate the wealth effect created or lost due to the tender offer as of 7/31/2012.

(ii) Explain where this wealth came from.

(iii) Describe in words (not numbers) the circumstances under which wealth would not be created.

(iv) Determine whether the tender offer really created wealth.

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

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