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

Exam FETE

MORNING SESSION

Date: Thursday, April 26, 2012
Time: 8:30 a.m. – 11:45 a.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has a total of 120 points. It consists of a morning session (worth 60 points) and an afternoon session (worth 60 points).

   a) The morning session consists of 9 questions underlined numbered 1 through 9.

   b) The afternoon session consists of 9 questions underlined numbered 10 through 18.

   The points for each question are indicated at the beginning of the question. Questions 1 – 2 pertain 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 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.

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.

Questions 1-2 pertain to the Case Study.
Each question should be answered independently.

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1.   (*6 points*) Wonka Life is designing a hedge program for its Equity-Linked GIC product
(case study page 34).

   (a)   (*1 point*) Identify the features of Wonka Life's Equity-Linked GIC product that
          present risk exposures that may require hedging.

   (b)   (*2 points*) Recommend which of the following approaches is more appropriate for
          hedging the Wonka Life Equity-Linked GIC block. Justify your recommendation.

          (i)   A static hedging strategy using options

          (ii)   A dynamic hedging strategy using futures

   (c)   (*1 point*) Explain why a static hedge may not work perfectly.

   (d)   (*1 point*) Explain why a dynamic hedge may not work perfectly.

   (e)   (*1 point*) Recommend enhancements to the dynamic hedging strategy to improve
          hedging effectiveness.

2. (*8 points*) You are helping Wonka set up a hedging program for its Variable Annuity GMDB.

(a) (*1 point*) Define the following risks for this VA benefit:

(i) Delta

(ii) Gamma

(iii) Vega

Wonka has provided you with the following present values from the new liability model under different scenarios and estimated the Greeks of the GMDB liability.

	S&P 500 Volatility		
S&P 500	26%	Current = 25%	24%
Increase 2%	−64	−58	−52
Increase 1%	−65	−59	−53
Current = 1100	−68	−62	−56
Decrease 1%	−72	−66	−60
Decrease 2%	−78	−71	−64

Delta	Gamma	Vega
0.318	0.008	−600.00

(b) (*1 point*) Confirm that the Greek values of the liability that Wonka gave you are reasonably correct. Show your work.

You are able to enter into an S&P 500 forward contract and/or the two options below to set up the hedging position.

	Delta	Gamma	Vega
Option A	−0.30	0.05	2.0
Option B	−0.45	0.08	1.2

You are considering two hedging strategies. The first is delta hedging.

2. **Continued**

    (c)   (*2 points*) Determine the notional amount of the forward contract and whether it is to be short or long.

Your second strategy is a full hedge of all three Greeks.

    (d)   (*2 points*) Determine the number of units of the options and the notional amount of the forward contract and whether it is to be short or long.

    (e)   (*2 points*) Demonstrate that your full hedging strategy works when the S&P 500 decreases 1% and its volatility increases 1%.

3. (*7 points*) You are an investment actuary analyzing the margin requirements for a portfolio of long and short European call options on a Custom Equity Index, the "CEI":

TABLE 1   **Call Option Portfolio**

Purchase Year	2007	2008	2009	2010	2011
Strike of Long Call	10	45	65	10	100
Strike of Short Call	35	20	60	70	10
Expiration Year	2012	2012	2012	2012	2012

You are also given the following probability distributions of CEI prices:

TABLE 2
CEI: Probability Distribution Functions of Price Under Alternate Volatility Scenarios

Volatility Scenario: Probability of Occurrence:		Decreases 20%	Unchanged 50%	Increases 30%
		Probability of CEI price at Option Expiry if		
CEI Price (S) upon Option Expiry, 2012	Option Portfolio Value: $V(S)$	Volatility Decreases	Volatility Unchanged	Volatility Increases
0	0	1%	2%	0%
5	0	1%	2%	0%
10	0	1%	5%	0%
15	5	1%	5%	0%
20	10	1%	5%	1%
25	10	3%	5%	1%
30	10	3%	5%	1%
35	10	5%	5%	1%
40	5	10%	5%	3%
45	5	10%	5%	10%
50	0	25%	10%	10%
55	0	10%	5%	10%
60	0	10%	5%	10%
65	−5	10%	5%	10%
70	$V(70)$	3%	5%	9%
75	−10	1%	5%	8%
80	$V(80)$	1%	5%	7%
85	−20	1%	5%	6%
90	−25	1%	5%	6%
95	−30	1%	5%	4%
100	$V(100)$	1%	1%	3%
Sum of Probabilities		100%	100%	100%

3. **Continued**

You are also given the following information:

- $r = 1$

- All options expire on the same day in 2012

- Current CEI Price $= 50$

- Current Value of Option Portfolio $= V(50) = 0$

- Assumptions under SPAN (a market risk pricing method developed by the CME) given the current CEI price:

    o   The futures price under SPAN is represented by the CEI price

    o   The "specified range" for moves of the futures price is defined either by the move from 50 to 20 or by the move from 50 to 80

    o   "Extreme" moves of the futures price are defined as moves from 50 to either 0 or 100

- Under SEC margin requirements, minimum margin call spreads are constructed from pairing long and short calls with strikes nearest to each other, not necessarily by pairing calls from the same issue year.

(a)   (*5 points*) Calculate margin requirements for the option portfolio under each of the following approaches:

(i)   The SEC method

(ii)   The SPAN method

(b)   (*2 points*) Outline the disadvantages of:

(i)   The SEC method

(ii)   Using VaR

4. (*8 points*) Manchego Corp. has $200 of non-convertible debt and 100 existing shares. Future earnings have an expected present value of either $0, $500 or $1000, each with a 1/3 probability. The CFO is considering acquiring another firm, Chevre Company, for $300 with a present value of future earnings of $500.

The CFO has asked you to investigate the following forms of financing for the acquisition:

> (i)   Nonconvertible debt
>
> (ii)   Convertible debt at 0.25 shares per dollar issued
>
> (iii)   Reverse convertible debt at 1.0 shares per dollar issued

(a)   (*1 point*) Analyze possible reasons for using convertible debt and reverse convertible debt instead of nonconvertible debt.

(b)   (*1 point*) Calculate the value of equity prior to any acquisitions.

(c)   (*4 points*) Calculate the value of the firm and the value of the equity after the acquisition, under each form of financing. Assume no bankruptcy costs.

(d)   (*2 points*) Explain in words whether Manchego Corp. should pursue the Chevre acquisition.

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5. (*9 points*) You are the CFO for Peyniri Dairy Products, Limited. The Company has decided to add a new product line to seek increased profitability. Financing of this new product line requires $10 million. You are asked to recommend the best way of financing this expansion.

You are provided with the following information:

- The profitability of the new product line depends on the cost of wholesale milk which could either remain level or increase for the next year.

- The value of the new product line is 30 million if the cost of milk remains level.

- The value of the new product line is 7 million if the cost of milk increases.

- The Risk-free rate is 3%.

- Cost of Equity Capital is 7%.

- Cost of Debt Capital is 5%.

(a) (*2 points*) Outline the advantages and disadvantages of financing the new product line through each of the following methods:

(i) Equity

(ii) Hybrid debt

(iii) Private debt

(b) (*2 points*) Calculate the value to Peyniri of the new product line under each of the following expansion scenarios using the risk-neutral probability approach. Show your work.

(i) Fund using 100% common stock

(ii) Fund using 60% common stock and 40% private debt financing

(iii) Fund using 100% private debt financing

5. **Continued**

You plan to use a 1-year European call option to hedge the price of milk. The price of milk M is assumed to follow the following process: $dM = \mu M dt + \sigma M dW_t$, where μ, σ are positive constants and W_t follows a Wiener process.

- The convenience yield is 0.

- The initial price of milk is $2 per pound and σ is 15% per annum.

- Estimated milk needed is 1 million pounds.

You may assume that a semi-annual up step can be approximated by $\exp(\sigma\sqrt{t})$.

(c) (*3 points*) Calculate the price of the 1-year vanilla European call option.

(d) (*2 points*) Recommend a capital structure for the new product line based on your analysis in (a), (b) and (c) above. Support your position.

6. (*3 points*)

(a) (*1 point*) Identify the interest rate model $dr = a(b - r)dt + \sigma dz$ and describe the following components of the model:

    (i) dr

    (ii) $a(b - r)$

    (iii) σdz

(b) (*1 point*) Compare the model $dr = a(b - r)dt + \sigma dz$ to the following model:

$$dr = [\theta(t) - ar]dt + \sigma dz$$

For the following applications:

    (i)   Valuing and hedging interest rate derivatives

    (ii)   Modeling financial projections

(c) (*1 point*) Explain why each of the models in (b) might be appropriate for stress testing.

7. (*5 points*) You are given the following information on a stock:

Initial Price	$25
Expected Annual Return per annum	8%
Estimated Annual Volatility	20%

Assume that the log returns are normally distributed.

(a)   (*2 points*) Calculate the 95% confidence interval for the stock price in one year.

(b)   (*1 point*) Calculate the expected stock price and the standard deviation of the stock price in one year.

You are working on both of the following projects:

       (i)   Economic capital

       (ii)   Hedging

(c)   (*1 point*) Critique the assumption of log-normally distributed returns for modeling the stock for each of the two applications above.

(d)   (*1 point*) Propose alternative assumption(s) to that in (c) which would be more appropriate for modeling stock returns for each of the two projects above. Justify your proposal(s).

8. (*8 points*) You are investigating two stock price models for hedging variable annuity guarantees. The models are expressed in terms of the log-return process, $Y_t, t = 1, 2, \ldots$

For both models:

- $Y_t | (\rho_t = k) = \mu_k + \sigma_k \varepsilon_t$, where ε_t are independent $N(0,1)$ variables, $k \in \{1, 2\}$, and $t = 1, 2, 3, \ldots$

- $\mu_1 = 0.01$, $\mu_2 = -0.02$, $\sigma_1 = 0.04$, $\sigma_2 = 0.10$

For Model A:

- $\{\rho_t\}$ is a Markov regime process, with
  $$\Pr(\rho_{t+1} = 2 | \rho_t = 1) = p_{12} = 0.1, \ \Pr(\rho_{t+1} = 1 | \rho_t = 2) = p_{21} = 0.4$$

For Model B:

- $\{\rho_t\}$ is a sequence of independent random variables, with $\Pr(\rho_t = 1) = p_1 = 0.8$ and $\Pr(\rho_t = 2) = p_2 = 0.2$

(a) (*1 point*) Calculate the unconditional regime probabilities for Model A.

(b) (*3 points*) Calculate the following using Model A:

   (i)   The mean and standard deviation of Y_t

   (ii) The correlation coefficient between Y_t and $Y_{t+1}, t > 0$

(c) (*2 points*) Calculate the following using Model B:

   (i)   The mean and standard deviation of Y_t

   (ii) The correlation coefficient between Y_t and $Y_{t+1}, t > 0$

(d) (*2 points*) Outline the advantages and disadvantages of using Model A, compared with Model B, for hedging VA guarantees.

9. (*6 points*) You are thinking of new ways to enhance your personal portfolio. A friend has come to you with the idea of investing in gold and believes you can earn excess returns over the stock market. The reasons mentioned to you are:

    (i)   Gold has appreciated significantly over the past 3 years and outperformed the market.

    (ii)   Many market experts are predicting future increases.

    (iii)   Empirical studies have shown there is a strong negative correlation between gold and the stock market.

You tell him that you don't believe it is possible to earn excess returns based on this information.

    (a)   (*1 point*) Identify and describe the efficiency form of markets to which you subscribe.

    (b)   (*3 points*) Identify and describe 4 market anomalies which don't support your efficiency form.

    (c)   (*2 points*) Identify and describe 5 common errors of empirical studies.

END OF EXAMINATION
Morning Session

USE THIS PAGE FOR YOUR SCRATCH WORK