SOCIETY OF ACTUARIES
Advanced Portfolio Management

Exam APMV

MORNING SESSION

Date: Friday, May 11, 2007
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 11 questions numbered 1 through 11.

   b) The afternoon session consists of 12 questions numbered 12 through 23.

   The points for each question are indicated at the beginning of the question. Questions 1 through 3 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 APMV.

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.

475 N. Martingale Road
Schaumburg, IL 60173-2226

Printed in the U.S.A.
Exam APMV-Front Cover

****BEGINNING OF EXAMINATION ***
ADVANCED PORTFOLIO MANAGEMENT
MORNING SESSION

Questions 1 – 3 pertain to the Case Study

1. *(6 points)* LifeCo's management is concerned about the investment risk exposures of the Non-Traditional Life block.

(a) List and compare the sources of risk of callable corporate bonds and mortgage pass-through securities.

(b) Explain how the behavior of these asset classes may be affecting LifeCo's Non-Traditional Life scenario testing results.

(c) Recommend changes to the asset mix of LifeCo's Non-Traditional Life block to improve its risk profile.

Questions 1 – 3 pertain to the Case Study

2. *(6 points)* LifeCo's management is concerned that the current asset allocation in the Surplus Account is moving away from the target allocation.

(a) Describe and contrast the following rebalancing strategies to a 'Buy and Hold' strategy:

(i) Constant mix
(ii) Constant proportion

(b) Explain whether each of the three strategies identified in (a) is a linear, concave or convex function of stock returns.

(c) Recommend one strategy to address LifeCo's management concerns.

Questions 1 – 3 pertain to the Case Study

3. *(7 points)* LifeCo's management is concerned that its Mud & Poor's rating might be negatively affected by the liquidity and disintermediation risks of its institutional investment products if interest rates increase in general.

(a) Explain how the typical rating agency examines ALM and liquidity exposure for the purpose of assigning a rating.

(b) Describe how the typical rating agency assesses the key ALM and liquidity issues associated with institutional investment products.

(c) Calculate and interpret the following two tests of LifeCo's Institutional Pensions-GIC disintermediation risk. Assume that Mud & Poor's used 1/duration (in years) as a measure to approximate the annual amount of maturities, and that NAIC 1 plus NAIC 2 bonds correspond to government and public investment grade bonds.

(i) Capacity limit
(ii) Insurance quick ratio

(d) Recommend a course of action for managing LifeCo's Institutional Pensions-GIC liquidity and disintermediation risks and to avoid downward pressure on its rating.

4. *(4 points)* You are given the following information about an equity swap:

- Notional amount 10 million
- Fixed rate 6.00%
- Frequency of payment quarterly
- Initial equity index value 1,000

You are also given the following table of LIBOR rates.

Maturity (days)	LIBOR
30	3.75%
60	4.00%
90	4.25%
120	4.50%
150	4.75%
180	5.00%
210	5.25%
240	5.50%
270	5.75%
300	6.00%
330	6.25%
360	6.50%

(a) Illustrate the equity swap's cash flows, identifying all parties involved and the cash flows that are paid and received.

(b) Calculate the value of the swap on day 30 with the index at 1,020. Use simple interest and assume a 360 day year.

5. *(6 points)* A Canadian life insurer plans to perform a stochastic valuation of their GAAP liabilities associated with their $5 billion variable annuity block of business. All policies have a GMDB (Guaranteed Minimum Death Benefit) and about 50% of the block has a GMIB (Guaranteed Minimum Income Benefit). The Company is considering the following approach:

- 100 risk-neutral scenarios stochastically generated (equity and interest rate);
- Scenarios use annual time steps;
- CTE(95%) is used to determine the value of the liabilities;
- GMDB reinsurance, which covers 75% of the block, is modeled according to the terms of the treaties;
- A pilot hedging program covering $25 million of the block was ignored for simplicity;
- Modeled mortality is set at 110% of expected mortality; and
- Dynamic policyholder behavior was not modeled.

(a) Compare the stochastic valuation method to the three other valuation methods described in the CIA Research Paper: "Use of stochastic techniques for the valuation of actuarial liabilities under Canadian GAAP".

(b) Assess the approach under consideration by the Company and recommend improvements.

6. *(8 points)* The implied volatility of options on the dividend-paying stock of Company ZYX increased during the past few months. The following table presents the current implied volatility for different strike prices of put options on the Company stock.

Strike Price	Implied Volatility
90	0.185
95	0.195
100	0.200
105	0.200
110	0.190
115	0.180

You are given the following information about a put option on Company ZYX stock:

- Stock price 100
- Term 3 months
- Risk free rate 3% (continuously compounded)
- Quarterly dividend 0.40 (next ex-dividend date is in 1 month)

(a) Calculate the price of the at-the-money European put option according to the Black-Scholes-Merton model.

(b) Explain the concept of volatility smile.

(c) Interpret the observed volatility curve.

(d) Criticize the Black-Scholes-Merton model assumptions.

(e) Recommend one alternative to the Black-Scholes-Merton pricing model for options on this stock that can reflect a more realistic behavior of stock prices.

7. *(4 points)* You are given the following statistics and assumptions:

Bond Portfolio Statistics

	Amount ($million)	Distribution	Expected Annual Default Cost (bp)
Government	58.7	5.0%	0
AAA	139.2	11.9%	2
AA	300.0	25.6%	4
A	300.0	25.6%	12
BBB	300.0	25.6%	30
BB	60.0	5.1%	100
B	10.0	0.9%	300
CCC to C	5.9	0.5%	700
D (default)	0.0	0.0%	0
Total	1,173.8	100.0%	16

Assumptions

Recovery rate	50%
Risk-free rate	5%

(a) *(3 points*) Compare and contrast the Credit Migration – CreditMetrics approach to the Contingent Claim and the Actuarial approaches.

(b) *(1 point)* Derive the market-implied credit spread of the assets.

8. *(4 points)* You are given the following information about a company:

- Market value of firm assets $1,000 million
- Market value of 1-year bond debt $300 million
- Market value of 10-year bond debt $0
- Expected asset growth rate 10%
- Annualized asset volatility 15%

You are also given the following issuer debt rating expected defaults:

Distance To Default	Expected Defaults (per 10,000 issues)	Issuer Debt Rating
1	350	B-
2	50	BB
3	20	BBB+
4	8	A
5	3	AA

Assume that the asset values follow a lognormal distribution.

(a) Determine the company's current debt rating based on the Contingent Claim-KMV approach.

(b) Calculate the maximum dollar amount of 10-year bonds the Company can issue and expect a rating of A. Assume that the total asset value remains the same.

9. *(4 points)* You are given the following discrete insurance loss distribution resulting from 1,000 scenarios generated by a stochastic model:

Present Value of Loss ($)	Number of Scenarios
0	920
100	50
200	20
1,000	9
10,000	1

(a) Calculate the 90% VaR and 90% CTE for the distribution.

(b) Define "coherent risk measure".

(c) Assess the appropriateness of VaR and CTE for this loss distribution using the coherent risk measure criteria.

10. *(6 points)* You are given the following statistics on two assets that could be used to back a liability:

Year	Asset 1	Asset 2	Liability	Return (Asset 1)	Return (Asset 2)
2001	100.0	100.0	90		
2002	110.0	108.0	95	10.0%	8.0%
2003	121.0	113.4	100	10.0%	5.0%
2004	123.4	116.8	105	2.0%	3.0%
2005	125.9	122.6	110	2.0%	5.0%
2006	132.2	128.7	115	5.0%	5.0%
Mean				5.74%	5.18%
Standard deviation				4.02%	1.79%

Assume that the risk-free rate is 4%.

(a) Calculate the Sharpe Ratio for these two assets.

(b) Describe the shortcomings of the Sharpe ratio as a measure for investment decisions in an asset-liability framework.

(c) Calculate the Risk Adjusted Change in Surplus (RACS) for these two assets.

(d) Explain how the RACS may be more effective in an asset-liability framework.

11. *(5 points)* You have been asked to construct a dedicated portfolio as a benchmark for a terminated defined benefit pension plan.

(a) Describe the process for constructing a dedicated portfolio for this pension plan.

(b) Describe the following securities and determine whether they are appropriate to include in the dedicated portfolio.

(i) Credit default swaps
(ii) Collateralized debt obligations
(iii) Convertible bonds

****END OF EXAMINATION****
MORNING SESSION

SOCIETY OF ACTUARIES
Advanced Portfolio Management

Exam APMV

AFTERNOON SESSION

Date: Friday, May 11, 2007
Time: 1:30 p.m. – 4:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This afternoon session consists of 12 questions numbered 12 through 23 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 APMV.

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.

475 N. Martingale Road
Schaumburg, IL 60173-2226

Printed in the U.S.A.
Exam APMV-Front Cover

****BEGINNING OF EXAMINATION****
ADVANCED PORTFOLIO MANAGEMENT
AFTERNOON SESSION
Beginning with Question 12

12. *(3 points)* The following table presents the current allocation of a pension portfolio:

Asset Class	Allocation
Investment Grade Corporate Bonds	30%
U.S. Large Cap Equities	70%

You are considering allocating a portion of the portfolio to hedge funds.

(a) Contrast the investment constraints faced by hedge fund managers versus conventional investment managers.

(b) Describe two ways to implement a hedge fund allocation.

(c) Explain how hurdle rates can be used to justify a reallocation of assets to hedge funds.

13. *(4 points)* The following table of European put option values was created using the explicit finite difference method.

Stock Price	Time to Maturity (in months)			
	3	2	1	0
20	0.0000	0.0000	0.0000	0.0000
15	0.0094	0.0049	0.0017	0.0000
10	0.1734	0.1178	0.0601	0.0000
5	4.9040		4.9673	5.0000
0	10.0000	10.0000	10.0000	10.0000

The details of the put option are:

- Strike Price $10
- Annual volatility 30%
- Risk free rate 5% (continuously compounded)
- Annual dividend rate 2% (continuously compounded)

(a) *(3 points)* Calculate the missing cell value using the explicit finite difference method.

(b) *(1 point)* Describe the Crank-Nicolson method and compare it to the explicit finite difference method.

14. *(6 points)* Company ZYZ uses the following stochastic interest rate model:

$$dr = a(b - r)\,dt + \sigma\,dZ, \quad a > 0$$

(a) Interpret the stochastic differential equation and each parameter included in the formula.

(b) Assess the ability of the model to replicate market prices of interest-rate derivatives.

(c) Recommend and describe one alternative model that would be better at replicating market prices of interest rate derivatives.

(d) Explain whether or not the alternative model can be used to estimate the market probability that long-term interest rates will exceed 8.0% within five years.

15. *(6 points*) You are given the following information about a guaranteed minimum accumulation benefit (GMAB) contract:

- Guarantee:
  - 10-year terms between rollover dates
  - Three years to next rollover
  - Maximum of two further rollovers
  - Guarantee paid on death or maturity
  - Initial guarantee is 120% of starting market value
- Annual volatility of the underlying segregated fund = 25%.
- Risk-free rate = 5% (continuously compounded)
- Management charge = 3% effective per year
- ${}_3p_{50}^{(\tau)} = 0.77708$, ${}_{13}p_{50}^{(\tau)} = 0.32088$, ${}_{23}p_{50}^{(\tau)} = 0.11428$
- The following table gives European put option prices with an initial share price S_0=1, strike price K and time to expiration T for a stock with 3% annual effective dividend yield, using the Black-Scholes-Merton methodology:

S_0 /K	1		1/1.2	
T	3	10	3	10
Price	0.1274	0.1470	0.2335	0.2204

(a) *(4 points)* Calculate the cost of the GMAB survival benefit hedge for a policyholder aged 50, per $100 of fund at valuation, using the Black-Scholes-Merton methodology.

(b) *(2 points)* Describe the process of dynamic hedging of the GMAB survival benefit.

16. *(6 points)* You are given a lognormal model (LN) and a regime-switching lognormal (RSLN-2) model for an equity index with the following monthly parameters:

Model	Parameters
LN	μ=0.0077, σ=0.0457
RSLN-2	Regime 1: μ_1= 0.0127; σ_1= 0.0348; p_{12}=0.0398 Regime 2: μ_2= -0.0161; σ_2= 0.0748; p_{21}=0.1896

(a) Calculate the probability that the return for 2 months is negative for each model, i.e. that the 2-month value of the index S_2 is lower that the starting value S_0.

(b) Compare the density function of the 5-year accumulated total return of the index under each model.

(c) Compare and contrast the ability of the two models to generate scenarios that are consistent with historical returns.

17. *(5 points)* An investment actuary is considering using either the exponentially weighted moving average (EWMA) model or the generalized autoregressive conditional heteroscedasticity (GARCH (1, 1)) model to estimate future stock return volatility. She collected 3 months of daily stock price data and then calibrated the parameters of both models using maximum likelihood methods. The results are as follow:

Parameters	GARCH(1,1)	Parameters	EWMA
α	0.0626	λ	0.9268
β	0.8976		
γ	0.0398		

(a) Calculate the expected GARCH(1,1) 10-day future volatility using 0.5% per day as the estimate of the current volatility and 0.8% per day as the estimate of the long term volatility.

(b) Compare and contrast the EWMA and GARCH(1,1) models.

(c) Describe limitations of using a maximum likelihood method to estimate parameters.

18. *(5 points)* You are given the following information about the rates of return on assets A and B.

Asset	Expected rate of return	Volatility	Correlation with A
A	7%	6%	1.0
B	4%	2%	-0.2

A financial institution holds a $10 million investment in asset A. In order to hedge the risk of asset A, it short sells $10 million of asset B. Assume that the returns are normally distributed.

(a) *(3 points)* Calculate the following 95% VaR and interpret the results:

(i) individual VaR for assets A and B
(ii) portfolio VaR
(iii) marginal VaR for assets A and B
(iv) component VaR for assets A and B

(b) *(1 point)* Evaluate the effectiveness of the short position in asset B as a hedge.

(c) *(1 point)* Calculate the position in asset B that would minimize the portfolio risk.

19. *(6 points)* An investment manager proposed to benchmark the performance of the assets supporting a block of life insurance products to the median asset portfolio performance of insurance companies with similar asset segments.

(a) Assess the proposed benchmark according to the properties of a valid benchmark.

(b) Assess the appropriateness of the following alternative benchmarks for this purpose:

(i) Lehman Aggregate Bond Index
(ii) Custom duration-matched benchmark using Treasury securities

(c) Describe the following performance measurement techniques

(i) Time-weighted rate of return
(ii) Dollar-weighted rate of return

(d) Recommend a benchmark and a performance measurement technique to evaluate:

(i) The performance of the investment manager
(ii) The profitability of the block of business

20. *(3 points)*

(a) Explain why future long term real equity returns might not match historical real equity returns.

(b) Explain the following "market anomalies" using behavioral finance:

(i) Inconsistent pricing of related securities within a "twin shares" structure

(ii) Long-run return reversals

21. *(8 points)* You are responsible for managing the credit exposure of the loan portfolio of a large bank, Mega Credit. Your CFO wants you to explore the opportunities to reduce the credit risk exposure and the regulatory capital of the loan portfolio.

(a) Discuss the traditional methods used by banks to mitigate part of their credit exposure and explain their relevance to managing Mega Credit's exposure.

(b) Categorize the different end-user applications of credit derivatives.

(c) Describe the different types of credit derivatives.

(d) Describe credit risk securitization and its potential use by Mega Credit.

22. *(4 points)* You are a consultant for Company XYZ which sponsors a traditional defined benefit pension plan. For the past few years the plan has suffered from low asset returns combined with a low interest rate environment.

You have been asked to provide advice to help manage the Company's pension contribution and accounting expense volatility.

(a) Explain the Company's financial risk exposure from the pension plan.

(b) Compare and contrast the following efficient frontier methodologies:

(i) Traditional
(ii) Lower Partial Moment
(iii) Surplus

(c) Recommend an efficient frontier methodology for the Company's pension plan.

23. *(4 points)* Assume *f* and *g* are two securities which depend on the same source of uncertainty. In addition, assume that the securities provide no income during the time period under consideration. The expected growth rate and volatility for *f* and *g* are (m_f, σ_f) and (m_g, σ_g) respectively.

(a) Define the following concepts:

(i) martingale
(ii) numeraire
(iii) equivalent martingale measure
(iv) forward risk neutral

(b) Describe the process $h = f/g$ using *g* as the numeraire in the forward risk neutral world with respect to *g*.

****END OF EXAMINATION****
AFTERNOON SESSION