# COURSE 6
# MORNING SESSION

## SECTION A – WRITTEN ANSWER

****BEGINNING OF EXAMINATION****
**MORNING SESSION**

**1.** *(5 points)* Your company is evaluating active and quasi-passive investment strategies for bond portfolio management.

(a) Define each quasi-passive indexation approach.

(b) Describe the advantages and disadvantages of each quasi-passive indexation approach.

(c) Explain the reasons your company would consider an active investment strategy.

(d) Describe the sector and security strategies that an active investment manager would use to select individual bonds.

**2.** *(7 points)* Your company is offering a 15-year term-certain immediate annuity with payments linked to the CPI. Policyholders can withdraw funds on demand at market values.

The universe of available investments consists of the following:

- Short-term T-bills
- Real return public bonds
- Corporate bonds
- Real estate

(a) Outline the advantages and disadvantages of each investment for backing this annuity.

(b) Recommend an investment strategy using the investments available.

(c) Describe the major components of an accumulated cash flow scenario-based model.

(d) Outline the major components of the investment policy statement for this product.

**3.** *(5 points)* You are given the following information:

| Bond | Term | Effective Duration | Effective Convexity |
|---|---|---|---|
| A | 5 | 3.1 | -41.7 |
| B | 5 | 4.5 | 23.4 |
| C | 5 | 4.2 | 21.3 |
| D | 5 | 2.7 | 64.5 |

The option and price characteristics of Bonds A, B, C and D are as follows:

- one bond is option-free with a current price above par
- one bond is option-free with a current price below par
- one bond is callable, priced at par
- one bond is putable, priced at par

(a) Determine the option and price characteristics corresponding to each of Bonds A, B, C and D. Explain your answer.

(b) Assess the limitations of duration as an interest rate risk measure.

(c) Define convexity. Compare effective convexity and modified convexity.

(d) Calculate the approximate percentage price change for Bonds A and B assuming a decrease in yield of 0.50%.

Show all work.

**4.** *(10 points)* You are given the following with respect to treasury securities as of today, May 13, 2005:

| Security | Years to Maturity | Annual Coupon Rate Paid Semi-annually | Yield-to-maturity |
|---|---|---|---|
| A | 0.5 | 0% | 3.0% |
| B | 1.0 | 0% | 3.2% |
| C | 1.5 | 6% | 3.5% |
| D | 2.0 | 5% | 3.6% |

(a) Calculate the spot rate for each maturity date.

(b) Explain how arbitrage profits could be made from coupon stripping.

(c) Calculate the one-year forward rate, one year from today.

(d) With respect to the pure expectations theory
  (i) Describe the theory
  (ii) Describe the interpretations of the theory that have been put forth by economists
  (iii) Explain the shortcomings of the theory

(e) With respect to other theories of term structure of interest rates:
  (i) Briefly describe each theory
  (ii) Using each theory, compare the one-year spot on May 13, 2006, with the one-year forward rate calculated in (c)

Show all work.

**5.** *(5 points)* You are given the following information with respect to Stock XYZ:

- price: 50
- variance: 4%
- dividend rate: 0%

The risk-free rate compounded continuously is 6%.

You are also given the following selected values from the Standard Normal Cumulative Distribution Function:

| Z | N(Z) | Z | N(Z) | Z | N(Z) |
|---|---|---|---|---|---|
| .01 | 0.5040 | .11 | 0.5438 | .21 | 0.5832 |
| .02 | 0.5080 | .12 | 0.5478 | .22 | 0.5871 |
| .03 | 0.5120 | .13 | 0.5517 | .23 | 0.5910 |
| .04 | 0.5160 | .14 | 0.5557 | .24 | 0.5948 |
| .05 | 0.5199 | .15 | 0.5596 | .25 | 0.5987 |
| .06 | 0.5239 | .16 | 0.5636 | .26 | 0.6026 |
| .07 | 0.5279 | .17 | 0.5675 | .27 | 0.6064 |
| .08 | 0.5319 | .18 | 0.5714 | .28 | 0.6103 |
| .09 | 0.5359 | .19 | 0.5753 | .29 | 0.6141 |
| .10 | 0.5398 | .20 | 0.5793 | .30 | 0.6179 |

(a) List the assumptions required for put-call parity.

(b) Use the Black-Scholes formula to calculate the price of a one-year European call option on Stock XYZ with a strike price of 52.

(c) Calculate the price of a one-year European put option on Stock XYZ with a strike price of 52.

Show all work.

**6.** *(6 points)* You are given the following with respect to a portfolio of bonds:

| Bond | Annual Coupon | Par | Market Value | Option Features | Years to Maturity |
|---|---|---|---|---|---|
| A | 4.50% | 100 | 100 | none | 2 |
| B | 6.00% | 100 | | callable in one year at 101 | 2 |

You are given the following with respect to a binomial lattice:

- $r_L$ : 4%
- $\sigma$ : 15%
- time interval between nodes: 1 year

(a) Calculate the one-year spot rate.

(b) Calculate the two-year spot rate.

(c) Calculate the one-year implied forward rate.

(d) Calculate the value of the option in Bond B.

Show all work.

**7.** *(4 points)* Outline the risks faced by a U.S. investor in purchasing a 10-year privately-placed U.S. corporate callable bond.

# COURSE 6
# MORNING SESSION

# SECTION B – MULTIPLE CHOICE

**1-5.** Each of questions 1 through 5 consists of two lists. In the list at the left are two items, lettered X and Y. In the list at the right are three items, numbered I, II and III. ONE of the lettered items is related in some way to EXACTLY TWO of the numbered items. Indicate the related items using the following answer code:

| | Lettered Item | Is Related to Numbered Items |
|---|---|---|
| (A) | X | I and II only |
| (B) | X | II and III only |
| (C) | Y | I and II only |
| (D) | Y | I and III only |

(E) The correct answer is not given by (A), (B), (C) or (D).

**1.**

X. Yield-to-maturity return method

Y. Total return method

I. Requires an explicit reinvestment rate assumption

II. Is commonly used for pricing and trading

III. Ignores the capital gain or loss from security sales

**2.**

X. Effective duration matching

Y. Cash flow matching

I. Very expensive to implement

II. Only works for small changes in interest rates

III. Accounts for options embedded in the assets and liabilities

**3.**

| | | | |
|---|---|---|---|
| X. | Tracking error of 68 basis points | I. | Assuming a normal distribution, there is a 68% probability that the portfolio return over the next year will be within one standard deviation of the annualized benchmark return |
| Y. | Portfolio $\beta$ of 68% | II. | The portfolio has less volatility than the benchmark |
| | | III. | Expect a 68 basis point increase in the portfolio return if there is a 100 basis point increase in the benchmark return |

**4.**

| | | | |
|---|---|---|---|
| X. | Planned amortization classes | I. | Priced at tighter spreads to the Treasury curve than sequential-pay bonds |
| Y. | Accretion-directed classes | II. | Redirect principal only |
| | | III. | Complete protection against extension of average life if interest rates rise |

**5.**

| | | | |
|---|---|---|---|
| X. | Increase in volatility | I. | Decreases the value of a putable bond |
| Y. | Decrease in volatility | II. | Increases the value of a call option |
| | | III. | For a given price, increases the option-adjusted spread for a putable bond |

**6-10.** Questions 6 through 10 consist of an assertion in the left-hand column and a reason in the right-hand column. Code your answer to each question by blackening space:

(A) If both the assertion and the reason are true statements, and the reason is a correct explanation of the assertion.

(B) If both the assertion and the reason are true statements, but the reason is NOT a correct explanation of the assertion.

(C) If the assertion is a true statement, but the reason is a false statement.

(D) If the assertion is a false statement, but the reason is a true statement.

(E) If both the assertion and the reason are false statements.

| | ASSERTION | | REASON |
|---|---|---|---|
| **6.** | Returns on the S&P 500 stock index are not affected by stock splits. | BECAUSE | Returns on market-value-weighted indices are based on holding investments in proportion to their market values. |

| | ASSERTION | | REASON |
|---|---|---|---|
| **7.** | The extended Vasicek model is able to provide an exact fit to the current term structure of interest rates. | BECAUSE | The drift term in the extended Vasicek model is time-independent. |

| | ASSERTION | | REASON |
|---|---|---|---|
| **8.** | Firm-wide stress tests are reviewed frequently but changed infrequently. | BECAUSE | Stress tests may be usefully applied to markets in which illiquid conditions produce asset price jumps and impede securities trading during times of stress. |

| | ASSERTION | | REASON |
|---|---|---|---|
| **9.** | The FHA experience method is rarely used as a prepayment model. | BECAUSE | The FHA experience method does not reflect the effect of age on pre-payments. |

| | ASSERTION | | REASON |
|---|---|---|---|
| **10.** | If a risk-free asset is available, only aggressive investors will be affected by a restriction on borrowing. | BECAUSE | A borrowing restriction drives aggressive investors to portfolios on the efficient frontier of risky assets. |

**11.** A fixed-rate bond with a market value of 20 million and a duration of 4 is separated into three bonds. Two of the bonds are floaters and the third is an inverse floater.

You are given the following information with respect to the floaters:

| Floater | Market Value | Duration |
|---|---|---|
| A | 16 million | 1 |
| B | 2 million | 0.5 |

Calculate the duration of the inverse floater.

(A) 2.50

(B) 3.06

(C) 3.15

(D) 25.20

(E) 31.50

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**12.** You are given the following with respect to Stock X:

- Stock price today: 10
- Stock price one year from today: either 12 or 7
- Call option strike price: 11

The annual interest is 5%.

Calculate the no-arbitrage call option price on Stock X as of today.

(A) 0.67

(B) 0.74

(C) 1.40

(D) 1.47

(E) 3.33

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**13.** For a portfolio of investment-grade fixed-income securities, rank the following factors by their impact on the portfolio return from greatest to least.

(A) Duration management, individual bond selection, sector selection

(B) Duration management, sector selection, individual bond selection

(C) Individual bond selection, duration management, sector selection

(D) Individual bond selection, sector selection, duration management

(E) Sector selection, individual bond selection, duration management

**14.** You are given the following information with respect to a stock portfolio:

| Stock | Portfolio Proportion | $\beta$ |
|---|---|---|
| A | 75% | 1.25 |
| B | 25% | 1.45 |

The market risk premium is 4%.

Calculate the risk premium of the portfolio.

(A) 5.0%

(B) 5.2%

(C) 5.4%

(D) 5.6%

(E) 5.8%

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**15.** You are given the following with respect to a portfolio of zero-coupon bonds:

| Bond | Current Value | Maturity Value | Time to Maturity |
|---|---|---|---|
| A | 1000 | 1081.60 | 2 years |
| B | 1000 | 1215.51 | 4 years |

Calculate the yield-to-maturity for this portfolio.

(A) 4.3%

(B) 4.5%

(C) 4.7%

(D) 9.6%

(E) 10.0%

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**16-20.** Each of questions 16 through 20 consists of two lists. In the list at the left are two items, lettered X and Y. In the list at the right are three items, numbered I, II and III. ONE of the lettered items is related in some way to EXACTLY TWO of the numbered items. Indicate the related items using the following answer code:

| | Lettered Item | Is Related to Numbered Items |
|---|---|---|
| (A) | X | I and II only |
| (B) | X | II and III only |
| (C) | Y | I and II only |
| (D) | Y | I and III only |

(E) The correct answer is not given by (A), (B), (C) or (D).

**16.**

X. Bonds

Y. Common stock

I. Residual claim

II. Limited liability

III. Maturity date

**17.**

X. Combination by formula

Y. Multiple asset performance

I. Equivalent to purchasing an option

II. Assumes that the immunization target return exceeds either the minimum return or the expected worst case active return

III. Active management proportion will vary inversely with the minimal acceptable return

**18.**

X. Immunization strategy

Y. Total-return strategy

I. Transactions are a function of volatility and time

II. Explicitly considers real-world constraints such as tax effects, regulatory restrictions and GAAP accounting

III. Manager may take advantage of a perceived change in value in the market

**19.**

X. Rainbow options

Y. Barrier options

I. Knockout options

II. Based on the maximum or minimum of the values of several assets

III. Often arise as part of a structured security

**20.**

X. Spread analysis

Y. Relative return value analysis

I. Compares the total return and duration of various assets

II. Analyzes prices and yields by bond market sector

III. Uses regression to determine portfolio expectations

**21-26.** Questions 21 through 26 consist of an assertion in the left-hand column and a reason in the right-hand column. Code your answer to each question by blackening space:

(A) If both the assertion and the reason are true statements, and the reason is a correct explanation of the assertion.

(B) If both the assertion and the reason are true statements, but the reason is NOT a correct explanation of the assertion.

(C) If the assertion is a true statement, but the reason is a false statement.

(D) If the assertion is a false statement, but the reason is a true statement.

(E) If both the assertion and the reason are false statements.

| | ASSERTION | | REASON |
|---|---|---|---|
| **21.** | Discounting the scheduled stream of cash flows by the forward rates provides the market value of a callable bond. | BECAUSE | Forward rates can be used to determine the value of any stream of fixed cash flows. |

| | ASSERTION | | REASON |
|---|---|---|---|
| **22.** | As interest rates increase, the effective duration of a callable bond decreases. | BECAUSE | Effective duration recognizes the fact that yield changes may change the expected cash flows. |

| | ASSERTION | | REASON |
|---|---|---|---|
| **23.** | Value-at-risk models have limited ability to capture the risks of exceptional market events. | BECAUSE | Value-at-risk models use average historical correlations among asset prices to make statistical assessments. |

| | ASSERTION | | REASON |
|---|---|---|---|
| **24.** | FASB 87 requires both pension assets and liabilities to be marked to market. | BECAUSE | Prior to FASB 87, any under-funding of a pension plan was reported in the footnotes to the financial statements. |

| | ASSERTION | | REASON |
|---|---|---|---|
| **25.** | A callable bond has positive convexity. | BECAUSE | A callable bond may be viewed as a long position in a bond and a long position in an option. |

| | ASSERTION | | REASON |
|---|---|---|---|
| **26.** | An Arrow-Debreu security pays one unit in one state of nature and nothing in all other states. | BECAUSE | The single-period securities market model is arbitrage free if and only if there exists a state price vector. |

**27.** You are given the following:

| Country | Expected One-year Investment Return |
|---|---|
| U.S. | 4% |
| China | 6% |

The current exchange rate is 8.27 Chinese RMB per U.S. Dollar.

Calculate the no-arbitrage one-year future exchange rate.

(A) 8.11

(B) 8.29

(C) 8.43

(D) 8.60

(E) 8.77

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**28.** You are given the following for a binomial option pricing model:

- Length of interval: 4 years
- Annual volatility: 0.5
- Annual interest rate: 5.0%

Calculate the probability value $q$.

(A) 0.15

(B) 0.36

(C) 0.64

(D) 0.68

(E) 0.88

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**29.** You are given the following:

| Portfolio | Market Value | Duration |
|---|---|---|
| Assets | 100 | 5.2 |
| Liabilities | 85 | 4.4 |

Calculate the change in economic surplus if interest rates decline by 50 basis points.

(A) –1.5

(B) –0.7

(C) 0.0

(D) 0.7

(E) 1.5

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**30.** The tracking error for a portfolio is 50 basis points. Further analysis shows that the tracking error for the systematic risk is 45 basis points. Calculate the tracking error for the unsystematic risk.

(A) 2 basis points

(B) 5 basis points

(C) 14 basis points

(D) 22 basis points

(E) 25 basis points

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**31-36.** Each of questions 31 through 36 consists of two lists. In the list at the left are two items, lettered X and Y. In the list at the right are three items, numbered I, II and III. ONE of the lettered items is related in some way to EXACTLY TWO of the numbered items. Indicate the related items using the following answer code:

| | Lettered Item | Is Related to Numbered Items |
|---|---|---|
| (A) | X | I and II only |
| (B) | X | II and III only |
| (C) | Y | I and II only |
| (D) | Y | I and III only |

(E) The correct answer is not given by (A), (B), (C) or (D).

**31.**

| | | | |
|---|---|---|---|
| X. | Risk Based Capital | I. | Concentration factor adjustments |
| Y. | Minimum Continuing Capital Surplus Requirement | II. | Asset factors follow a geometric pattern as credit decreases |
| | | III. | C-0 risk |

**32.**

| | | | |
|---|---|---|---|
| X. | Freddie Mac securities | I. | Free of credit risk |
| Y. | U.S. Treasury securities | II. | In the primary market, sold through single-price auction |
| | | III. | Interest income may be subject to state and local taxation |

**33.**

X. Interest rate corridors

Y. Interest rate collars

I. Sometimes described as swapping into a bond

II. Do not involve the sale of a floor

III. Offer protection from interest rate increases at a lower cost than with the purchase of a cap

**34.**

X. Insured asset allocation

Y. Tactical asset allocation

I. Requires an investor risk tolerance function

II. Requires a prediction procedure

III. Usually assumes that expected returns, risks, and correlations remain the same

**35.**

X. Interest-only strips

Y. Principal-only strips

I. The price increases when interest rates decline

II. Benefit from slowing prepayments

III. Have positive duration

**36.**

X. CAPM

Y. Single index model

I. Systematic factors

II. Single period planners

III. Drastically reduces the necessary inputs in the Markowitz portfolio selection procedure

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

# COURSE 6
# AFTERNOON SESSION

WRITTEN ANSWER

****BEGINNING OF EXAMINATION****
**AFTERNOON SESSION**

**8.** *(4 points)* List and define the duties of an ERISA trustee. Provide a specific example of a violation of each duty.

**9.** *(4 points)*

(a) Compare interest rate forwards, interest rate futures, interest rate swaps, and interest rate caps and floors in terms of the following:
(i) Types of markets
(ii) Liquidity
(iii) Contract form
(iv) Transaction costs

(b) Explain how each of the following instruments can be used to manage the interest rate risk exposure of a block of fixed-rate annuities currently supported by floating-rate assets:
(i) Interest rate swaps
(ii) Interest rate caps and floors

**10.** *(8 points)* An investment house has provided an investor with the following:

| Scenario | Probability | Fund A Return | Fund B Return |
|---|---|---|---|
| 1 | 50% | 25% | 20% |
| 2 | 30% | 10% | -20% |
| 3 | 20% | -30% | 25% |

The annual T-bill return is 3%.

(a) Calculate the correlation coefficient between Fund A and Fund B using the given scenarios.

(b) Determine the optimal risky portfolio, Portfolio P. Calculate the expected return and standard deviation of Portfolio P.

(c) Calculate the slope of the Capital Allocation Line supported by T-bills and Portfolio P.

(d) The investor has the following utility function:

$$U = E(r) - 0.025\sigma^2$$

Calculate the amount the investor would invest in each of:

(i) Fund A
(ii) Fund B
(iii) T-bills

(e) Another investment house has developed a portfolio, Portfolio Q, using Fund A and Fund B. The expected return of Portfolio Q is 10% and the standard deviation is 12%. Explain if the investor should invest in Portfolio Q rather than Portfolio P.

Show all work.

**11.** *(5 points)* With respect to numerical interest rate risk management techniques,

(i) List and define the common techniques

(ii) Describe the key shortfalls of each common technique

Base your answer on the Canadian Institute of Actuaries Educational Note "Measurement of Exposure to Interest Rate Risk".

**12.** *(6 points)* Company ABC has an international fund that is benchmarked against an external index. You are given the following with respect to a benchmark portfolio and ABC's fund manager's portfolio:

| Market | Benchmark Weight | Return on Equity Index | Currency Appreciation | Fund Manager's Weight | Fund Manager's Equity Return |
|---|---|---|---|---|---|
| Asian | 40% | 10% | 20% | 35% | 12% |
| European | 25% | 5% | -10% | | 7% |
| Australian | 35% | 7% | 25% | | 20% |

(a) Describe the risks that are unique to international investments.

(b) The fund manager's portfolio return matched the return of the index. Determine the amount that the fund manager invested in the European and Australian markets.

(c) For your portfolio, calculate the individual impacts of each of the following:

(i) Currency selection

(ii) Country selection

(iii) Stock selection

Show all work.

**13.** *(5 points)* You are given the following with respect to an 8-year, 6%, sequential-pay CMO:

| Tranche | Initial Balance |
|---|---|
| 1 | 20,000 |
| 2 | 35,000 |
| 3 | 65,000 |

- The annual payment required to amortize the CMO over eight years is 19,324.31.
- The actual cash flows are as follows:

| Year | Interest Payment | Required Principal Payment | Additional Principal Payment | Outstanding Balance |
|---|---|---|---|---|
| 0 | | | | 120,000.00 |
| 1 | 7,200.00 | 12,124.31 | 1,078.76 | 106,796.93 |
| 2 | 6,407.81 | 12,916.50 | 1,877.61 | 92,002.82 |
| 3 | 5,520.17 | 13,804.14 | 2,345.96 | 75,852.72 |
| 4 | 4,551.16 | 14,773.15 | 2,443.18 | 58,636.39 |
| 5 | 3,518.18 | 15,806.13 | 2,141.51 | 40,688.75 |
| 6 | 2,441.32 | 16,882.99 | 1,190.29 | 22,615.47 |
| 7 | 1,356.92 | 17,967.39 | 185.92 | 4,462.16 |
| 8 | 267.73 | 4,462.16 | 0.00 | 0.00 |

(a) Describe the types of CMO structures.

(b) Calculate the outstanding balance for each tranche at the end of each year.

(c) Calculate the interest allocated to each tranche for each of the first three years.

Show all work.

**14.** *(4 points)*

(a) Describe the criteria for selecting an interest rate generator.

(b) Describe the characteristics of
(i) a lognormal process
(ii) a mean reversionary lognormal process

(c) Describe the steps used in the Markov chain process to generate interest rates.

**15.** *(4 points)*

(a) Describe the advantages and disadvantages of using stochastic simulation when pricing derivative securities.

(b) Describe the techniques that are available to reduce variance when using Monte Carlo simulation.

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