COURSE 6
MORNING SESSION

SECTION A – WRITTEN ANSWER

****BEGINNING OF COURSE 6****
MORNING SESSION

1. *(5 points)* You are given the following information:

Stock	Price at Beginning of Period	Price at End of Period	Number of Shares Outstanding
I	10	15	100
II	9	10	125
III	15	15	200

(a) Describe and compare:
- (i) Price-weighted index
- (ii) Market-value-weighted index
- (iii) Equally-weighted index

(b) Calculate the percentage change over the period for:
- (i) Price-weighted index
- (ii) Market-value-weighted index
- (iii) Equally-weighted index

(c) Calculate the end of period price for Stock III that results in an equivalent percentage increase in the price-weighted index and the market-value-weighted index.

Show all work.

2. *(6 points)* An investor has the following securities available for investment:

	Expected Annual Return	Standard Deviation of Annual Return
Stock I	9%	13%
Stock II	12%	20%
T-bills	5%	0%

The covariance between the two risky assets is 0.93%.

Construct the optimal portfolio using the three available assets, assuming:

(i) an investor's degree of risk aversion is 4

(ii) an investor's degree of risk aversion is 2

Show all work.

3. *(10 points)* You are given the following information:

- all options have nine months to expiry
- all options have a strike price of 49
- current stock price is 50
- volatility is 30%
- risk-free rate is 5% per annum

Using the binomial option pricing model and a three-month step, calculate the cost of

(i) a European put;

(ii) an American put;

(iii) a European call.

Show all work.

4. *(5 points)*

(a) Describe the obligations of the trustee of a pension fund.

(b) Describe the key considerations in selecting an appropriate pension funding method.

5. *(6 points)* You are given the following financial data for Company ABC:

- capital and surplus: 800,000
- total company assets:

Bond	Book Value	C1 Factor
AAA	2,000,000	0.3%
BB	5,000,000	4%
B	3,000,000	12%

- other required capital components:

Risk	Base	Required Capital Factor
C2	150,000,000	0.1%
C3	4,000,000	1%
C4	500,000	2%

- required capital components for whole life block:

Risk	Base	Required Capital Factor
C1	8,000,000	6%
C2	100,000,000	0.1%
C3	3,000,000	1%
C4	400,000	2%

- ceding allowance for a reinsurance treaty is 3% of assets transferred
- C1 required capital factor for assets ceded to reinsurer is 0.5%
- required capital formula: $C4 + \sqrt{C2^2 + (C1 + C3)^2}$
- Risk Based Capital ratio = Available capital ÷ Required capital

(a) Describe the weaknesses of using the required capital formula when comparing two companies that have healthy Risk Based Capital ratios.

(b) Evaluate the impact on required capital if you entered into a 50% coinsurance agreement for the whole life business.

(c) Evaluate the impact on required capital of upgrading all assets to a minimum rating of BB.

(d) Recommend which capital management action the company should use.

Show all work.

6. *(5 points)* You are given the following information about three stocks in a multiple stock universe using the single-index model:

	Beta	Mean Excess Return	Standard Deviation
Stock I	1.25	12%	40%
Stock II	0.75	5%	25%
Stock III	1.75	12%	40%
Market	1.00	8%	20%

The risk-free rate is 6% per year.

(a) Explain why the single-index model is an effective tool for portfolio optimization.

(b) Determine the value of the items in the input list required for the development of a Markowitz efficient frontier.

(c) Calculate the expected return and standard deviation for a portfolio consisting of equal proportions of Stock I, Stock II, and Stock III.

Show all work.

7. *(8 points)* You are given the following information for company XYZ:

- it only sells deferred annuities with rates guaranteed to age 65
- its target market is young professionals under the age of 30
- policy surrenders are paid at the greater of book value and market value
- products are credited with new money interest rates, which are currently at historical lows
- currently the liabilities are supported by fixed income securities

XYZ is considering investing up to 50% of assets supporting the liabilities in equity investments.

XYZ has implemented an annual process to monitor duration mismatch between assets and liabilities.

Analyze XYZ's interest rate risk management practices and, if appropriate, recommend changes to current practices to help minimize this risk.

COURSE 6
MORNING SESSION

SECTION B – MULTIPLE CHOICE

1. You are given the following characteristics of a zero-coupon bond:

- term to maturity: 5 years
- yield: 8% on a semi-annual basis

Calculate the original-issue discount.

(A) 31.9%

(B) 32.4%

(C) 46.3%

(D) 53.7%

(E) 67.6%

2. You are given the following information about a trading day on the New York Stock Exchange (NYSE):

- advances: 2,000
- declines: 1,500
- advancing volume: 300,000
- declining volume: 600,000

Calculate the trin statistic and indicate if the NYSE is considered bearish or bullish for that given day.

(A) 0.38, bearish

(B) 0.38, bullish

(C) 2.00, bullish

(D) 2.67, bearish

(E) 2.67, bullish

3. You are given the following information as of January 1, 2002:

- stock price: 67
- call option price: 2
- call option strike price: 72
- call option expiry: January 1, 2003
- rate of return on a one-year T-bill: 4% annual effective

Stock Price on January 1, 2003	Probability
76	0.60
64	0.40

Calculate the risk premium for the call option.

(A) 0.05

(B) 0.16

(C) 0.32

(D) 0.40

(E) 0.46

4. You are given the following information for a portfolio consisting of three stocks:

	Weight (W_i)	Beta (b_i)	Standard Deviation (s_i)
Stock I	20%	1.2	11%
Stock II	40%	0.9	14%
Stock III	40%	1.0	20%

The standard deviation of the deviation of the common factor from its expected value (s_F) is 15%.

Using a single factor arbitrage pricing model, calculate the nonsystematic risk standard deviation for this portfolio.

(A) 10.0%

(B) 15.0%

(C) 15.8%

(D) 16.2%

(E) 18.0%

5. You are given the following information for a 15-year callable bond:

- annual coupon rate: 9% payable semi-annually
- price: 95.32
- effective duration: 3.17
- convexity measure (C): (67.31)

$$C = \frac{V_+ + V_- - 2V_0}{2V_0(\Delta y)^2}$$

Calculate the price of the bond after a 50 basis point increase in interest rates.

(A) 93.65

(B) 93.97

(C) 95.32

(D) 96.67

(E) 96.99

6. You are given the following information with respect to a single-period securities model:

$$S(0) = \begin{bmatrix} 10 & P & 10 \end{bmatrix}$$

$$S(1) = \begin{bmatrix} 11 & 33 & 0 \\ 11 & 0 & 0 \\ 11 & 0 & 22 \end{bmatrix}$$

Determine the value of P which makes the model arbitrage-free.

(A) 14

(B) 15

(C) 16

(D) 17

(E) 18

7-16. Each of questions 7 through 16 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).

7.

X. Asian call options

Y. Lookback call options

I. Payoffs depend on the average price of the underlying asset during the life of the option.

II. Guarantees the purchase of the asset at the lowest price during the life of the option.

III. Can use averages for the exercise price.

8.

X. Cliquet option

Y. Quanto option

I. Guaranteed exchange-rate contracts.

II. A series of standard call options that pays the annual increase in the underlying assets.

III. The strike resets at the beginning of each year.

9.

X.	Interest rate corridor	I. The purchase of a cap at one strike rate and the sale of a floor at a lower strike rate.
Y.	Interest rate collar	II. The purchase of a cap at one strike rate and the sale of another cap at a higher strike rate.
		III. Sometimes described as swapping into a bond.

10.

X.	Zero-coupon convertible bond	I. Sacrifice yield
Y.	Putable convertible bond	II. Greater credit risk
		III. Lower premium

11.

X.	Modified duration	I. Allows for changing cash flows as interest rates change.
Y.	Effective duration	II. Does not allow for changing cash flows as interest rates change.
		III. Not an appropriate measure for callable bonds.

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(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).

12.

X. Decreasing yield rates

Y. Higher coupon rate

I. Increases the effective maturity of a callable bond.

II. Increases the effective maturity of a putable bond.

III. Increases the effective duration of a non-callable bond.

13.

X. Prepayment risk modeling

Y. Low-discrepancy method

I. The principles of arbitrage cannot be relied on to ensure that the valuation will be correct.

II. Arc tangent functions are commonly used.

III. Takes into account path dependencies in the cash flows.

14.

X. Parallel shift interest rate generators

Y. Non-parallel shift interest rate generators

I. Based on lognormal or Markov chain processes.

II. Used for New York 7 scenarios.

III. Works well with classical immunization theory.

15.

X. Contingent immunization

Y. Combination matching

I. Reduces the risk associated with nonparallel shifts of a sloped yield curve.

II. Liquidity needs are provided for in the initial cash flow matched period.

III. A blend of active management with immunization.

16.

X. Risk Based Capital planning

Y. Liquidity planning

I. Reduce outstanding short-term debt.

II. Portfolio diversification.

III. Public perception management.

17-25. These questions 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.

17.

ASSERTION		REASON
Commercial mortgage-backed securities have higher prepayment risks than residential mortgage-backed securities.	BECAUSE	Commercial mortgage-backed securities are often balloon loans.

18.

ASSERTION		REASON
A portfolio consisting of negatively correlated assets offers better risk-return opportunities than individual component securities on their own.	BECAUSE	The standard deviation of a portfolio is less than the weighted average of the standard deviations of its component securities.

19.

ASSERTION		REASON
Under CAPM, the standard deviation of the return of a security is the critical element in calculating the price of that security.	BECAUSE	Under CAPM, all investors are assumed to be rational mean-variance optimizers.

20.

ASSERTION		REASON
For a callable bond, the difference between effective and modified durations decreases as interest rates increase.	BECAUSE	The probability of a callable bond being called decreases as interest rates increase.

21.

ASSERTION		REASON
Convertible bonds offer upside equity potential with downside protection.	BECAUSE	Convertible bonds have a lower yield relative to non-convertible bonds.

22.

ASSERTION		REASON
Generally, a valuation model with two or more factors is implemented by simulation.	BECAUSE	Simulation permits the inclusion of path dependency in the cash flows of the instrument.

17-25. These questions 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.

23.

ASSERTION		REASON
Option exposures can be managed by matching expected asset and liability cash flows.	BECAUSE	The asset and liability cash flow matching technique determines a dollar value for the interest rate exposures that exist.

24.

ASSERTION		REASON
Option-based portfolio insurance strategies are time variant.	BECAUSE	With respect to option-based portfolio insurance strategies, the optimal mix of risky and riskless positions depends on the time left before the horizon is reached.

25.

ASSERTION		REASON
The Multiple Asset Performance strategy is equivalent to purchasing an option that allows the buyer to choose the asset to call or buy at a guaranteed price.	BECAUSE	A Multiple Asset Performance option valuation-based approach does not require asset return forecasts.

26. You are given the following information with respect to a callable bond:

- par amount: 1,000
- term to maturity: 3 years
- annual coupon rate: 6% payable annually
- value of embedded call option: 20

Term	Annual Spot Interest Rates
1	7%
2	8%
3	9%

Calculate the value of the bond.

(A) 906

(B) 926

(C) 930

(D) 950

(E) 1,000

27. You are given the following information with respect to a non-callable bond:

- par amount: 1,000
- term to maturity: 4 years
- annual coupon rate: 8% payable annually

Time	1-Year Annual Forward Interest Rates	
	Scenario X	Scenario Y
0	7%	7%
1	7%	6%
2	8%	7%
3	10%	5%

Each interest rate scenario has an equal probability of occurring.

Calculate the value of the bond.

(A) 1,000.00

(B) 1,018.40

(C) 1,022.80

(D) 1,030.39

(E) 1,031.07

28. You are given the following information with respect to a multiplicative binomial branching model:

- the short rate one year from now will be either:
  $r_{t+1}^{u} = r_t \times (1 + gamma)$, or
  $r_{t+1}^{d} = r_t \div (1 + gamma)$, with equal probability

- volatility: 20%
- current short term interest rate: 6%
- notional amount of a 2-year interest rate collar: 100

Calculate the value of a 2-year interest rate collar with strike levels of 5% and 8%.

(A) 0.141

(B) 0.187

(C) 0.328

(D) 0.348

(E) 0.368

29. You are given the following information:

- expected market return: 12%
- standard deviation of market return: 10%
- risk-free rate: 4%
- utility function of the investor: $U_M = E(R_M) - \frac{s(R_M)^2}{5}$

Calculate the optimal percentage the investor would invest in the market.

(A) 10%

(B) 20%

(C) 30%

(D) 40%

(E) 50%

30. You are given the following information:

- immunization target: 9.0%
- minimum return acceptable to the fund sponsor: 6.0%
- worst case return for an actively managed portfolio: 2.5%

Calculate the minimum proportion of the initial portfolio (X) that should be actively managed.

(A) $X < 40\%$

(B) $40\% \le X < 45\%$

(C) $45\% \le X < 50\%$

(D) $50\% \le X < 55\%$

(E) $55\% \le X < 60\%$

****END OF COURSE 6****
MORNING SESSION

COURSE 6
AFTERNOON SESSION

****BEGINNING OF COURSE 6****
AFTERNOON SESSION
Beginning with question 8

8. *(4 points)* Describe the risks associated with investing in fixed income securities.

9. *(5 points)* You are given the following information:

	Duration	Projected Cash Flows				
		Year 1	Year 2	Year 3	Year 4	Year 5
Liabilities	4.2	210	69	445	180	1980
Assets	4.3	194	254	41	200	2200

Universe of available assets for investment:

- 90-day T-bills
- 2-year bonds with annual coupons of 5%
- 3-year bonds with annual coupons of 6%
- 5-year bonds with annual coupons of 10%

Determine the necessary asset transactions to cash flow match the projected liability cash flows.

Show all work.

10. *(8 points)* The Chief Financial Officer (CFO) of a large corporation is considering offering an innovative "collared floater" with the following features:

- value at issue: par
- par amount: 10 million
- term to maturity: 5 years
- coupon: semi-annual payment and reset, 6-month LIBOR + 0.50%
- minimum coupon: 7.5%
- maximum coupon: 12.5%

The CFO intends to use derivative instuments to convert this collared floater into synthetic fixed-rate funding. The following quotes for five-year, semi-annual settlement interest rate swaps, caps and floors on 6-month LIBOR are obtained from a market maker in derivative products:

	Bid	Ask
Swaps for LIBOR	8.65%	8.75%
Interest Rate Cap at 12.0%	0.65%	0.75%
Interest Rate Cap at 12.5%	0.50%	0.60%
Interest Rate Cap at 13.0%	0.35%	0.45%
Interest Rate Floor at 7.0%	0.80%	0.90%
Interest Rate Floor at 7.5%	0.95%	1.05%
Interest Rate Floor at 8.0%	1.10%	1.20%

(a) Determine the specific combination of transactions which result in a synthetic fixed rate of funding.

(b) Explain why this combination works.

(c) Calculate the effective (all-in) interest cost for this synthetic fixed-rate funding.

(d) Identify the situations when credit risk is a concern to the corporation in this transaction.

Show all work.

11. *(6 points)*

(a) Define a floating-rate security and describe its features.

(b) Describe the yield spread measures used to evaluate floating-rate securities.

(c) Describe the factors affecting the price of floating-rate securities.

12. *(8 points)* ABC Financial is considering two opportunities for capital investment for the upcoming fiscal year:

- a deposit-taking business earning a guaranteed return of 10% per year
- a life insurance business earning one of two possible returns:
  20%, or -20% per year.

ABC is also considering a one-year reinsurance agreement that would eliminate any loss on its life insurance business. The single premium would be paid at the beginning of the fiscal year.

(a) Compare the features of the reinsurance contract and an option contract.

(b) Calculate the reinsurance premium for the year by applying risk-neutral valuation to solve for the replicating trading strategy for the reinsurance contract.

(c) Assume that the life insurance business now has a third possible outcome of catastrophic loss, where all of the capital investment in the life insurance business is lost.

You are given the following:

- The unit Arrow-Debreu (e_1) price is its upper bound price less $\frac{1}{12}$
- $S(1)^{-1} = \begin{bmatrix} 0 & 0 & 10/11 \\ 0 & 5/4 & -5/4 \\ 1 & -3/2 & 1/2 \end{bmatrix}$

Calculate the new reinsurance premium using risk-neutral valuation.

(d) Explain how your reinsurance premium calculations would be affected if the deposit taking business earned a guaranteed return of 20% per year.

Show all work.

13. *(4 points)* You are an investment actuary managing the pension assets of a small Canadian company.

(a) Describe the key considerations in setting the Statement of Investment Policies.

(b) Describe possible investment vehicles.

14. *(5 points)* You are given the following securities:

60-day T-bill: face amount: 1,000

150-day T-bill: face amount: 1,000

Stock of ABC Corporation:
current price: 25
dividend rate: 6%, payable continuously
The amount of dividend payment is constant, regardless of changes in stock price.

European call option on the ABC stock:
current price: 1
strike price: 30
time to exercise date: 60 days
d_1 0.7

European put option on the ABC stock:
current price: 6
strike price: 30
time to exercise date: 60 days

Futures contract: underlying security: 90-day T-bill
time to delivery date: 60 days
face amount: 1,000
current price: 984

Cumulative normal distribution:

Z	– 1.4	– 0.7	0	0.7	1.4
$N(Z)$	0.0808	0.242	0.5	0.758	0.9192

Calculate the current market price of the 150-day T-bill.

Show all work.

****END OF COURSE 6****

Course 6
May 2002

Multiple-Choice Answer Key

1	B
2	D
3	C
4	A
5	A
6	A
7	E
8	B
9	D
10	B
11	B
12	B
13	A
14	B
15	C
16	D
17	D
18	A
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25	B

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