1. (4 points)

Describe the key features of:

(i) Asian options

(ii) Look-back options

(iii) Interest rate collars

(iv) Interest rate corridors
2. (7 points) You are given the following:

<table>
<thead>
<tr>
<th>Effective Annual Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
</tr>
<tr>
<td>Scenario 1</td>
</tr>
<tr>
<td>Scenario 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mix of Investments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock ABC</td>
</tr>
<tr>
<td>Portfolio I</td>
</tr>
<tr>
<td>Portfolio II</td>
</tr>
<tr>
<td>Portfolio III</td>
</tr>
</tbody>
</table>

(a) Calculate the expected rate of return and the standard deviation of each portfolio.

(b) Assess portfolios I, II and III from the perspective of:

(i) A risk-neutral investor

(ii) A risk-averse investor
3. (5 points)

a) With respect to short sales of a security:

(i) Describe the process for executing a short sale.

(ii) Outline an investor’s motivation for executing such a transaction.

b) You are given the following:

<table>
<thead>
<tr>
<th>Date</th>
<th>Corporation Z Share Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2001</td>
<td>60</td>
</tr>
<tr>
<td>January 15, 2001</td>
<td>63</td>
</tr>
<tr>
<td>January 31, 2001</td>
<td>58</td>
</tr>
</tbody>
</table>

- Corporation Z paid a dividend of 1 on January 15, 2001
- The maximum price of Corporation Z shares during the month of January 2001 was 63
- On January 1, 2001, Investor A sold short 100 shares of Corporation Z
- On January 31, 2001, Investor A covered the short position
- The initial margin requirement was 50%
- The maintenance margin requirement was 40%
- There were no other transaction costs
- No interest was earned on the balance with the broker

(i) Outline the transaction on January 1, 2001.


(iii) Determine whether a margin call was necessary.


Show all work.
4. (10 points) You are given the following information about on-the-run Treasuries:

<table>
<thead>
<tr>
<th>Term (Years)</th>
<th>Annual Coupon</th>
<th>Yield to Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.00%</td>
<td>4.00%</td>
</tr>
<tr>
<td>2</td>
<td>5.25%</td>
<td>5.20%</td>
</tr>
<tr>
<td>3</td>
<td>5.50%</td>
<td>5.40%</td>
</tr>
</tbody>
</table>

You are given the following market information about bonds issued by BIG Corporation. The credit spread is relative to Treasuries with the same maturity.

<table>
<thead>
<tr>
<th>Term (Years)</th>
<th>Credit Spread</th>
<th>Annual Coupon</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.20%</td>
<td>5.00%</td>
</tr>
<tr>
<td>2</td>
<td>0.50%</td>
<td>5.50%</td>
</tr>
<tr>
<td>3</td>
<td>0.60%</td>
<td>6.00%</td>
</tr>
</tbody>
</table>

The following 1-year rates, n-years forward along the lower path calibrate a binomial interest-rate tree where the logarithm of the 1-year rate obeys a binomial distribution with \( p = \frac{1}{2} \):

<table>
<thead>
<tr>
<th></th>
<th>( n = 1 )</th>
<th>( n = 2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Coupon</td>
<td>Price of 2-yr Bond</td>
<td>( r_L )</td>
</tr>
<tr>
<td>5.50%</td>
<td>99.632</td>
<td>6.369%</td>
</tr>
<tr>
<td>5.50%</td>
<td>100.000</td>
<td>6.005%</td>
</tr>
<tr>
<td>5.50%</td>
<td>100.556</td>
<td>5.461%</td>
</tr>
</tbody>
</table>

The volatility of the 1-year rate is 13%.

Consider a five-year 6.75% annual coupon BIG Corporation bond that has three years remaining to maturity.

(a) Determine the current price of the bond using the binomial interest-rate tree model if the bond has no embedded options.

(b) Determine the current price of the call option if the bond:
   - is callable
   - has a 3.5 year non-callable deferment period
   - has a call premium of 1%

(c) Describe the features of a bond with an attached warrant.
Show all work.
5. \((6\ \text{points})\) With respect to the performance attribution of international investment managers:

(a) Describe the measurement of the following sources of abnormal returns:

(i) Currency selection

(ii) Country selection

(iii) Stock selection

(iv) Cash/bond selection

(b) You are given the following:

<table>
<thead>
<tr>
<th>EAFE Weight</th>
<th>Return on Equity Index</th>
<th>Currency Appreciation</th>
<th>Manager’s Weight</th>
<th>Manager’s Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>30%</td>
<td>10%</td>
<td>10%</td>
<td>X</td>
</tr>
<tr>
<td>Australia</td>
<td>10%</td>
<td>5%</td>
<td>-10%</td>
<td>Y</td>
</tr>
<tr>
<td>Far East</td>
<td>60%</td>
<td>15%</td>
<td>30%</td>
<td>Z</td>
</tr>
</tbody>
</table>

- The manager’s currency selection gain: \(-6.0\%\)
- The manager’s country selection gain: \(-1.5\%\)
- The manager’s stock selection gain: \(+0.8\%\)

Calculate the manager’s weights in Europe, Australia and the Far East.

Show all work.
6. (6 points) You are performing an asset adequacy test for a block of immediate annuities. There are three different asset-liability management strategies:

- Immunization
- Contingent immunization
- Dedicated portfolio

(a) Describe the three strategies.

(b) Describe the active management modeling considerations of these three strategies.

(c) Evaluate the advantages and disadvantages of the three strategies for a block of immediate annuities in a changing interest rate environment.
7. (7 points)

(a) (1 point) Describe the risks to an insurance company of using commercial mortgage-backed securities (CMBS) to support insurance liabilities.

(b) (3 points) Describe methods of mitigating risks inherent in CMBS.

(c) (3 points) You are given the following with respect to a portfolio of 10 commercial mortgage loans:
   - All are new loans of $50 million each
   - Eight loans are secured by hotels in New York
   - Two loans are secured by warehouses in Chicago
   - The average loan-to-value ratio is 95%
   - The average debt-service-coverage ratio is 1.1
   - All loans have a yield-maintenance agreement
   - All loans feature a balloon payment in five years

(i) Evaluate the credit quality of a proposed CMBS which would consist of the above commercial mortgage loan portfolio.

(ii) Recommend modifications to the commercial mortgage loan portfolio that would increase its attractiveness to the insurance company.
COURSE 6
MORNING SESSION

SECTION B – MULTIPLE CHOICE
1. The risk that remains even after extensive diversification of an investment portfolio is:

(A) Firm-specific risk

(B) Market risk

(C) Non-systematic risk

(D) Political risk

(E) Unique risk
2. You are given the following information:

   Expected annual return on a risky portfolio: 10%
   Standard deviation of annual returns on a risky portfolio: 20%
   Risk-free annual rate of return: 5.0%
   Annual borrowing rate: 7.5%

Calculate the reward-to-variability ratio of a leveraged position in the risky portfolio.

(A) 0.100
(B) 0.125
(C) 0.167
(D) 0.250
(E) 0.500
3. An arbitrage free securities market model consists of a bank account and one security. The security price today is 100. The security price one year from now will be either 104 or 107. Determine which of the following can be the bank account interest rate.

(A) 0%
(B) 3%
(C) 5%
(D) 8%
(E) 10%
4. You are given the following information concerning a contingent immunization strategy:

- Initial portfolio value: 10,000,000
- Minimum target return: 4.0%
- Number of years in investment horizon at inception: 10
- Immunized yield available at inception: 8.0%

Calculate the difference \( x \) between the initial portfolio value and the required assets for immunization at inception.

(A) \( x \leq 2,000,000 \)
(B) \( 2,000,000 < x \leq 3,000,000 \)
(C) \( 3,000,000 < x \leq 4,000,000 \)
(D) \( 4,000,000 < x \leq 5,000,000 \)
(E) \( x > 5,000,000 \)
5. You are given the following information for Stock ABC:

<table>
<thead>
<tr>
<th>Limit-Buy Orders</th>
<th>Limit-Sell Orders</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Price</strong></td>
<td><strong>Number of Shares</strong></td>
</tr>
<tr>
<td>49.75</td>
<td>500</td>
</tr>
<tr>
<td>49.50</td>
<td>800</td>
</tr>
<tr>
<td>49.25</td>
<td>500</td>
</tr>
</tbody>
</table>

A market-buy order for 150 shares of Stock ABC is placed.

The spread between the bid price and the ask price is zero for this transaction.

Calculate the price at which the market-buy order will be filled.

(A) 49.75
(B) 50.25
(C) 50.67
(D) 50.88
(E) 51.50
6. You are given the following information about a securities exchange:

<table>
<thead>
<tr>
<th></th>
<th>Day I</th>
<th>Day II</th>
<th>Day III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issues traded</td>
<td>3,401</td>
<td>5,587</td>
<td>9,034</td>
</tr>
<tr>
<td>Advances</td>
<td>1,373</td>
<td>2,048</td>
<td>5,609</td>
</tr>
<tr>
<td>Declines</td>
<td>1,476</td>
<td>2,358</td>
<td>5,906</td>
</tr>
<tr>
<td>Advance volume (000)</td>
<td>241,061</td>
<td>524,897</td>
<td>678,095</td>
</tr>
<tr>
<td>Decline volume (000)</td>
<td>312,272</td>
<td>489,655</td>
<td>668,901</td>
</tr>
<tr>
<td>Total volume (000)</td>
<td>587,215</td>
<td>1,018,629</td>
<td>1,353,333</td>
</tr>
</tbody>
</table>

Using the trin statistic, rank days I, II, III from most bearish to least bearish.

(A) I > II > III
(B) I > III > II
(C) II > I > III
(D) II > III > I
(E) III > II > I
7. You are given the following information:

- An option market satisfies the condition for put-call parity
- The current underlying security price is 100
- A call option with a strike price of 105 and maturity one year from now has a current price of 4
- A put option with a strike price of 105 and maturity one year from now has a current price of 6

Determine the short-term risk-free interest rate.

(A) 2.9%
(B) 3.9%
(C) 5.9%
(D) 6.9%
(E) 15.4%
8-14. Each of questions 8 through 14 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:

<table>
<thead>
<tr>
<th>Lettered Item</th>
<th>Is Related to Numbered Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) X</td>
<td>I and II only</td>
</tr>
<tr>
<td>(B) X</td>
<td>II and III only</td>
</tr>
<tr>
<td>(C) Y</td>
<td>I and II only</td>
</tr>
<tr>
<td>(D) Y</td>
<td>I and III only</td>
</tr>
<tr>
<td>(E) The correct answer is not given by (A), (B), (C) or (D).</td>
<td></td>
</tr>
</tbody>
</table>

8. X. Macaulay/modified duration matching

I. Cannot put a value on existing interest rate exposure.

Y. Cash flow matching

II. Works well only for small, parallel movements in interest rates.

III. Matching is rarely perfect because the yield cost is too high due to restrictions on asset selection.

9. X. Common stocks

I. Volatility of return is often uncorrelated to interest rate volatility.

Y. Bond futures

II. Useful for correcting asset-liability mismatch positions.

III. Are generally not appropriate to support new money liability cash flows.
10. X. Limit order                I. Sidecar
    Y. Circuit breaker            II. Stop loss
        III. Collar

11. X. Seasoned new issue        I. Best efforts underwriting arrangement more common.
    Y. Initial public offering (IPO)    II. Commonly underpriced.
        III. Shelf registration applies.

12. X. Variance/covariance approach to optimization
    Y. Worst case approach to optimization
        I. Useful for evaluating risk for bond portfolios.
        II. Useful for evaluating risk for equity portfolios.
        III. Uses linear programming optimization.
8-14. Each of questions 8 through 14 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:

<table>
<thead>
<tr>
<th>Lettered Item</th>
<th>Is Related to Numbered Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) X</td>
<td>I and II only</td>
</tr>
<tr>
<td>(B) X</td>
<td>II and III only</td>
</tr>
<tr>
<td>(C) Y</td>
<td>I and II only</td>
</tr>
<tr>
<td>(D) Y</td>
<td>I and III only</td>
</tr>
<tr>
<td>(E)</td>
<td>The correct answer is not given by (A), (B), (C) or (D).</td>
</tr>
</tbody>
</table>

13. X. Option-pricing model

I. Requires the study of an assumed asset cash flow.

Y. Actuarial simulation model

II. Considers one side of the balance sheet at a time.

III. Produces market value results.

14. X. Asian option

I. The payoff of this option is based on the average price of the underlying asset during the life of the option.

Y. Look-back option

II. A high-water mark option is an example of this option.

III. This option is popular in the US in the foreign currency and interest rate options market place.
15-21. 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.

**ASSERTION** | **REASON**
---|---
15. The transaction costs on futures contracts consist of a bid-ask spread only. | BECAUSE Futures contracts are traded on exchanges.

16. A non-convertible bond will often require a yield-to-maturity greater than that offered by a convertible bond. | BECAUSE A convertible bond is often subordinated debt.

17. Mortgages are desirable instruments for dedicated portfolios. | BECAUSE The Macaulay duration of mortgages accurately reflects the change in market price for a given change in the interest rates.
18. **ASSERTION**
   A callable bond generally has positive convexity.

   **REASON**
   BECAUSE An increase in interest rate volatility increases the value of an embedded call option.

19. **ASSERTION**
   An increase in interest rate volatility increases the value of a callable bond.

   **REASON**
   BECAUSE An increase in interest rate volatility increases the value of an embedded call option.

20. **ASSERTION**
   For a participating life insurance policy, a dividend scale guarantee of level dividend over 10 years is a major investment risk exposure.

   **REASON**
   BECAUSE Dividend scale guarantees are put options granted to the purchaser of a life insurance policy.

21. **ASSERTION**
   According to the Dow Theory, tertiary stock price trends are more important than intermediate trends.

   **REASON**
   BECAUSE According to the Dow Theory, intermediate stock price trends are caused by short term deviations of prices.
22-23. Use the following information for questions 22 and 23.

The following two securities have the same current price of 1000 as a Treasury bond maturing one year from now with 6% annual coupons and a face amount of 1000.

(i) A European call option on 10,000 shares of stock in Company ABC at a strike price of 10 with maturity one year from now, and a probability $p_1$ of maturing for 10.50. Otherwise, the stock price would be 10 or less.

(ii) A one-year forward on 2500 bushels of wheat that will enable purchase at 30 per bushel at that date. Analysts expect that the price of wheat will be at 37 with probability $p_2$ or at 31 with probability $p_1$. Otherwise, the price of wheat will be at 28.

22. Calculate the value of $p_1$.

(A) 0.196

(B) 0.199

(C) 0.212

(D) 0.228

(E) 0.247
22-23. Use the following information for questions 22 and 23.

The following two securities have the same current price of 1000 as a Treasury bond maturing one year from now with 6% annual coupons and a face amount of 1000.

(i) A European call option on 10,000 shares of stock in Company ABC at a strike price of 10 with maturity one year from now, and a probability \( p_1 \) of maturing for 10.50. Otherwise, the stock price would be 10 or less.

(ii) A one-year forward on 2500 bushels of wheat that will enable purchase at 30 per bushel at that date. Analysts expect that the price of wheat will be at 37 with probability \( p_2 \) or at 31 with probability \( p_1 \). Otherwise, the price of wheat will be at 28.

23. Calculate the value of \( p_2 \).

(A) 0.196

(B) 0.199

(C) 0.212

(D) 0.228

(E) 0.247
24. You are given the following information with respect to a callable bond:

<table>
<thead>
<tr>
<th>Time</th>
<th>Expected Cash Flows at a 7% Annual Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8.00</td>
</tr>
<tr>
<td>2</td>
<td>7.90</td>
</tr>
<tr>
<td>3</td>
<td>107.80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual Yield</th>
<th>Bond Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>6%</td>
<td>104.33</td>
</tr>
<tr>
<td>7%</td>
<td>102.37</td>
</tr>
<tr>
<td>8%</td>
<td>99.76</td>
</tr>
</tbody>
</table>

The current yield is 7%.

Calculate the ratio of the modified duration to the effective duration of this bond.

(A) 0.80
(B) 0.86
(C) 1.00
(D) 1.16
(E) 1.25
25. The current price of a bond is 100. The derivative of the price with respect to the yield to maturity is –700. The yield to maturity is 8%.

Calculate the Macaulay Duration.

(A) 7.00
(B) 7.49
(C) 7.56
(D) 7.69
(E) 8.00
26. You are given the following multiplicative binomial branching model where the value of the short rate one year from now is either:

\[ r_1^u = r_0 (1 + \gamma) \quad \text{or} \quad r_1^d = \frac{r_0}{1 + \gamma}, \quad \text{with equal probability} \]

- Volatility is 25%
- The current value of the short rate is 4%

Calculate the value of a 2-year interest rate floor with a 3.5% strike level and a notional amount of 100.

(A) 0.217
(B) 0.219
(C) 0.363
(D) 0.859
(E) 0.876
27. You are given the following data:

<table>
<thead>
<tr>
<th>Stock</th>
<th>Expected Annual Return</th>
<th>Standard Deviation of Annual Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock I</td>
<td>10%</td>
<td>25%</td>
</tr>
<tr>
<td>Stock II</td>
<td>35%</td>
<td>60%</td>
</tr>
</tbody>
</table>

- The correlation coefficient between Stock I and Stock II is –0.2
- The T-bill annual yield is 5%

Calculate the difference between the weights of Stock I and Stock II in the optimal risky portfolio consisting of only these two stocks.

(A) 0.14
(B) 0.31
(C) 0.43
(D) 0.77
(E) 0.80
28. You are given the following with respect to a T-bill:

- Bank discount yield based on the ask price: 5.7%
- Bank discount yield based on the bid price: 5.8%
- Remaining term to maturity: 60 days

Calculate the difference between the asked bond equivalent yield and the bid bond equivalent yield.

(A) 0.1000%
(B) 0.1005%
(C) 0.1014%
(D) 0.1019%
(E) 0.1034%
29. You are given the following:

<table>
<thead>
<tr>
<th></th>
<th>Stock I</th>
<th>Stock II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Share Price</td>
<td>Share Price</td>
</tr>
<tr>
<td>Beginning of period</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>End of period</td>
<td>40</td>
<td>30</td>
</tr>
</tbody>
</table>

- A price-weighted index (PWI) is constructed using only Stock I and Stock II
- Stock II was split 2 for 1 during the period

Determine the value of PWI at the end of the period.

(A) 35.0
(B) 46.4
(C) 50.0
(D) 53.8
(E) 91.0
30. With respect to multi-period immunization, a portfolio of liabilities has a dispersion of 7. Determine the dispersion of the assets best suited to immunize these liabilities, if all other aspects of the portfolio are equally suitable.

(A) 0
(B) 6
(C) 7
(D) 8
(E) 30
<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>E</td>
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<td>16</td>
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<td>17</td>
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<td>18</td>
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<td>19</td>
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<td>20</td>
<td>C</td>
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<td>21</td>
<td>D</td>
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<td>25</td>
<td>C</td>
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<td>26</td>
<td>C</td>
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<td>27</td>
<td>A</td>
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<td>28</td>
<td>E</td>
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<tr>
<td>29</td>
<td>C &amp; D</td>
<td></td>
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<tr>
<td>30</td>
<td>D</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
8. (4 points) Describe the passive buy-and-hold and the quasi-passive indexation portfolio management strategies used for fixed-income investments.

9. (6 points) You are given the following information:

Projected liability cash flows:

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>123</td>
<td>214</td>
<td>25</td>
<td>275</td>
</tr>
</tbody>
</table>

Available assets for investment:

- 2 year bond with annual coupon of 5%
- 3 year bond with annual coupon of 8%
- 5 year bond with annual coupon of 10%

Face amount of each bond: 100
Current market yield curve: 7% for all durations

Calculate the initial cost to cash flow match the projected liability cash flows utilizing the assets listed above.
10. (5 points)

(a) Describe the features of collared floating rate securities.

(b) Describe price volatility characteristics of collared floaters and compare them to those of the collared inverse floaters.

(c) Describe the risk to an investor of investing in such a security.
11. (12 points) You are given the following securities:

- **60-day T-bill:**
  - Face amount: 1000

- **150-day T-bill:**
  - Current price: 975

- **Stock of ABC Corporation:**
  - Current price: 25
  - Dividend rate: 12%, 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:**
  - 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: 1000
  - Current price: 984

---

<table>
<thead>
<tr>
<th>$z$</th>
<th>–1.4</th>
<th>–0.7</th>
<th>0</th>
<th>0.7</th>
<th>1.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N(z)$</td>
<td>0.0808</td>
<td>0.242</td>
<td>0.5</td>
<td>0.758</td>
<td>0.9192</td>
</tr>
</tbody>
</table>

(a) Calculate the current market price of the put option.

(b) Demonstrate that a market consisting of the 60-day T-bill, the put option, and the stock is arbitrage free over one period. The period is 60 days, and the stock price at the end of 60 days will be either 21, 30, or 36.

Show all work.
12. *(4 points)* Outline the contents of an investment policy in an asset/liability management context in accordance with the CIA guidance note.

13. *(4 points)* The issuer of a callable bond is considering issuing a new 10-year callable bond on July 1, 2001 to refinance its outstanding debt.

You are given the following with respect to the outstanding debt:

- Issue date: July 1, 1981
- Maturity date: July 1, 2011
- Annual coupon rate: 12%
- Call price on July 1, 2001: 110% of par value

You are also given the following with respect to the callable debt issuer:

- The tax rate is 35%
- The expenses incurred for calling the existing bond and issuing the new bond would total 0.50% of par value
- Can issue a new 10-year callable bond with an 8.5% annual coupon

(a) Explain the risks of the call provision to an investor in callable debt.

(b) Recommend whether the issuer should refinance its debt.

Show all work.
14. *(5 points)* Your company is considering various investments to support a newly issued block of 5-year, 7% GIC’s which pays a benefit only at maturity. One of these investments is a callable bond with the following features:

- **Maturity:** 10 years
- **Call Protection Period:** 3 years
- **Call Price:** 100
- **Option Adjusted Spread (OAS):** 0.50%
- **Effective duration:** 5 years
- **Current market price of the callable bond:** 104
- **Coupon:** 8% semi-annual

- The current market price of a 10-year semi-annual 8% non-callable bond is 106
- The current market price of a 3-year semi-annual 8% non-callable bond is 107

(a) Calculate the value of the embedded call option.

(b) List the elements which affect the value of the embedded call option.

(c) Describe OAS and how it is used as an indicator of relative value.

(d) Assess the suitability of the callable bond to support your company’s newly issued GIC block.

**END OF COURSE 6**
MAY 2001

COURSE 6
MORNING SESSION

FINANCE AND INVESTMENTS

SECTION A—WRITTEN ANSWER
Course 6 Model Solutions

1. (i) Asian Options
   - used for equity index products, foreign currency and interest rate options.
   - have to know type of averaging, time period of averaging, number of points to use
     (i.e. monthly, daily)
   - payoff can be: for call option, \((S_{\text{average}} - X)^+\) or \((S - S_{\text{average}})^+\)
   - payoff is normally based on the average price of the underlying asset during the life
     of the option

(ii) Look Back Options
   - pay off depends on maximum or minimum of underlying assets during holding period
   - call option payoff: \((K - S_{\text{min}})^+\) \(K\) is strike price
     - assure getting the lowest price asset possible during holding period
   - put option payoff: \((S_{\text{max}} - S)^+\)
   - higher water mark pay off: \((S_{\text{max}} - K)^+\)

(iii) Interest Rate Collars
   - buy a cap, and sell a floor at lower strike price to compensate the purchase price of a
cap
   - to limit liabilities within the two strike price
   - have protection from rising interest rate above cap strike price, giving up some gain
     potential by falling rate – if interest rate fall below floor strike price, have to pay
     (floor strike rate – Index rate ) x notional amount
   - if interest rates are within upstrike rate and floor strike rate, there will be no cash
     inflow or cash outflow
2.

(a) \[ E(r_t^2) = 0.6(4)^2 + 0.4(4)^2 = 16 \]
\[ = \sigma_t^2 = 16 - (4)^2 = 0 \]

Let \( r_t \) = return on portfolio I
\( r_{II} \) = return on portfolio II
\( r_{III} \) = return on portfolio III

So, \( E(r_t) = 17\% \)
\[ E(r_{II}) = 0.75(17) + 0.25(4) = 13.75\% \]
\[ E(r_{III}) = 0.75(17) + 0.25(a) = 15\% \]

\[ r_t^2 = (1)^2(96) = 96 \Rightarrow \sigma_t = \sqrt{96} = 9.8\% \]
\[ r_{II}^2 = (0.75)^2(96) + (0.25)^2(0) + 2(0.75)(0.25)\text{Cov}(r_{AISC}, r_t) \]
Since \( \sigma_t^2 = 0 \Rightarrow Cr - (r_{AISC}r_t) = 0 \)
So \( \sigma_{II}^2 = 54 \Rightarrow 0_{II} = \sqrt{54} = 7.35\% \)

\[ \sigma_{III}^2 = 10.751^2(96) + (0.25)^2(24) + 2(0.75)(0.25)\text{Cov}(r_{ABC}, r_{DEF}) \]
\[ \text{Cov}(r_{A}, r_{B}) = E(r_Ar_B) - C(r_A)C(r_B) \]
\[ E(r_{ABC}r_{DEF}) = 0.6(25)(5) + 0.4(5)(15) = 105 \]
\[ = \text{Cov}(r_{ABC}, r_{DEF}) = 105 - (17)(9) = -48 \]
\[ = \tau_{III}^2 = 54 + 15 - 18 = 37.5 \Rightarrow \sigma_{III} = \sqrt{37.5} = 6.12 \]

Risk Neutral Investor
- judges portfolio by expected return only
- risk is not relent it is ignored in making decisions
- will choose portfolio I since it has highest return

Risk Averse Investor
- Evaluates portfolio by taking into account both risk and return.
- Greater returns are penalized depending on how much extra risk is taken on to achieve the higher return.
- Portfolio III is most likely choice since one can achieve with the lowest risk a good return.
- Portfolio III achieves lower risk for curbing stocks. ABC and DEF which are negatively correlated.

COURSE 6: MAY 2001
(b) use utility function \[ U = E(r_p) - 0.005A \sigma_p^2 \]

(i) risk-neutral investor
   
   \( A = 0 \)
   
   looks for portfolio with brightest expected return and ignores risk

   \[ E(r_i) > E(r_{ii}) > E(r_{iii}) \]

   would choose Portfolio I

(ii) risk-averse
     
     \( A > 0 \)
     
     look for maximum return with minimum risk

     \[ E(r_i) > E(r_{ii}) > E(r_{iii}) \]

     but

     \[ r_i > r_{ii} > r_{iii} \]

     choose Portfolio III

     standard deviation of Portfolio III = \( \sigma_3 \)

     \[ = \sqrt{W_{ABC}^2 \sigma_{ABC}^2 + W_{DEF}^2 \sigma_{DEF}^2 + 2W_{ABC}W_{DEF}COV(r_{ABC}, r_{DEF})} \]

     \( W_{ABC} \) = weight invested in stock ABC

     \( W_{DEF} \) = weight invested in stock DEF

     \( \sigma_{ABC}^2 \) = variance of stock ABC

     \( \sigma_{DEF}^2 \) = variance of stock DEF

     \[ COV[R_{ABC}, R_{DEF}] = \sum_{s=1}^{n} Pr(s) \cdot (R_{ABC} - E[R_{ABC}])[R_{DEF} - E[R_{DEF}]] \]
\[ R_{ABC} = \text{return of stock ABC} \]
\[ R_{DEF} = \text{return of stock DEF} \]
\[ E[R_{DEF}] = \text{expected return of stock DEF} \]
\[ E[R_{ABC}] = \text{expected return of stock ABC} \]
\[ = 0.6(25)\text{[5-9]} + 0.4(5)\text{[15-9]} \]
\[ \text{COV}[R_{ABC}, R_{DEF}] = -0.0048 \]
\[ \sigma_{DEF}^2 = \sqrt{0.6(5-9)^2 + 4(15-9)^2} \]
\[ = 4.9\% \quad \sigma_{DEF}^2 = 0.0024 \quad \sigma_{ABC}^2 = 0.0096 \]
\[ \sigma_3 = \sqrt{0.75^2(0.0076) + 2(0.25)(0.0048)} \]
\[ = 6.12\% \]

(a) expected return on portfolio
\[ E(r_p) = \sum_i W_i E(r_i) \]
where \( W_i \) = weight of i-th security in portfolio
\( E(r_i) \) = expected return of i-th security

variance of portfolio
\[ \sigma_p^2 = \sum_i W_i^2 r_i^2 + 2 \sum_i \sum_j W_i W_j \text{Cov}_i(r_i, r_j) \]

let \( r_{ABC} = \text{return on stock ABC}, r_{DEF} = \text{return on stock DEF} \)

\( r_T = \text{return on T-bills} \)
\[ E(r_{ABC}) = 0.6(25) + 0.4(5) = 17\% \]
\[ E(r_{DEF}) = 0.6(5) + 0.4(15) = 9\% \]
\[ E(r_T) = 0.6(4) + 0.4(4) = 4\% \]
Recall from probability,

\[ VAR(x) = E(x^2) - [E(x)]^2 \]

for random variable X

\[ E(r_{ABC}^2) = 0.6(25)^2 + 0.4(5)^2 = 385 \]

\[ \Rightarrow \sigma_{ABC}^2 = 385 - (17)^2 = 96 \]

\[ E(r_{DEF}^2) = 0.6(5)^2 + 0.4(15)^2 = 105 \]

\[ \Rightarrow \sigma_{DEF}^2 = 105 - (a)^2 = 24 \]

Expected return on any given portfolio

\[ \sum \{ Pr(s) \cdot R(s) \} \]

where \( Pr(s) \) is probability of scenario

and \( R(s) \) is return in a given scenario

Portfolio 1

\[ = .6 \times 25\% + .4 \times 5\% \]

\[ = 17\% \]

100% invested in stock ABC

Portfolio 2

\[ = .75 \times 17\% + .25 \times 4\% \]

\[ = 13.75\% \]

75% in stock DEF +25% in t-bills

Portfolio 3 = 75% invested in stock ABC

+25% in stock DEF

\[ E[R(DEF)] = .6 \times 5\% + .4 \times 15\% = 9\% \]

\[ E[Portfolio 3] = .25 \times 9\% + .75 \times 17\% = 15\% \]

Standard Deviation of Portfolio 1 = \( \sigma_1 \)
\[ \sqrt{\sum_{s=1}^{n} \{pr(s) \cdot [R(s) - E[R]] \}} \]

\[ = \sqrt{.6(25\% - 17\%)^2 + .4(5\% - 17\%)^2} \]

\( \sigma_1 = 9.8\% \)

Standard Deviation of Portfolio 2

\[ = \sigma_2 = \lambda \cdot \sigma_1 \quad \lambda = \% \text{ invested in stock ABC} \]

\[ = 75\% \times 9.8\% \]

\( \sigma = 7.35\% \)

3.

(a) Place an order with a broker

Broker borrows the security from one of the accounts he manages and sells it

Proceeds plus additional cash/collateral are kept by the broker

Enough of cash or securities owned by the investor have to be deposited to satisfy initial margin requirement

\[ \frac{\text{equity}}{\text{value of stock}} = \text{initial margin} \]

Dividends due have to be paid from the account to the owner of the stock

As stock price changes so does investor’s equity

\[ \text{equity} = \text{account value} - \text{stock value} \]

If margin \( \frac{\text{equity}}{\text{stock value}} \) falls below specified maintenance margin, investor will get a call and either will need to add cash/collateral or some securities will be bought back

Position may be closed by buying back stock and returning them to the owner.

COURSE 6: MAY 2001
• Investor sells short if he believes that price will fall (so can buy back cheaper). Short sales are allowed only after up movement in price. Investor is exposed to increase in price. May place a stop-loss order to limit its potential losses.

(b) 
• January 1 sold 100 shares for 60 a piece  
  = 6,000  
  deposited 3,000 cash with the broker  

• January 31 bought back 100 shares for 58 a piece  
  = 5,800  

returned dividends of 100  
total cost 5,900

Received 3,100 back from the broker (9,000-5,900)  
Made a profit of 100 on 3,000 investment

(c)  
\[ \left( \frac{3,100}{3,000} \right)^{12} - 1 = 48.2\% \leftarrow \text{annualized effective} \]

On January 15 investor equity decreases to:  
9,000 - 100 x 63 - 100 = 2,600  

At this point margin = \[ \frac{2,600}{6,300} = 41.3\% > 40\% \]

No margin call was necessary.
4.

a) non-call-life yield curve = on-the-run Treasury yield + credit spread

<table>
<thead>
<tr>
<th>Maturity</th>
<th>Treasury Yield</th>
<th>Credit Yield</th>
<th>Non-call-life Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.00%</td>
<td>0.20%</td>
<td>4.20%</td>
</tr>
<tr>
<td>2</td>
<td>5.20%</td>
<td>0.50%</td>
<td>5.70%</td>
</tr>
<tr>
<td>3</td>
<td>5.40%</td>
<td>0.60%</td>
<td>6.00%</td>
</tr>
</tbody>
</table>

Market Price = \( \sum CF_t / (1 + y)^t \)

Price of 2 yr. Bond = \((0.055)(100)(1.057) + [(0.055)(100) + 100] / (1.057)^3 = 99.632\)

Price of 3 yr. Bond = 100, since coupon = yield

\( r_L = 6.369\% \) and \( r_{LL} = 5.071\% \) from chart above, \( \sigma = 13 \).

Binomial model: \( r_H = r_L e^{2\sigma}, r_{HL} = r_{LL} e^{2\sigma}, r_{HH} = r_{LL} e^{4\sigma} \)

\( r_H = 6.369\% e^{2(0.13)} = 8.260\% \)

\( r_{HL} = 5.071\% e^{2(0.13)} = 6.577\% \)

\( r_{HH} = 5.071\% e^{4(0.13)} = 8.530\% \)

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>V0</td>
<td>6.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>8.26%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.20%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

V1
6.75
8.53%
100
6.75

V2
6.75
6.58%
100
6.75

V3
6.75
V4
6.75
V5
5.07%
100
6.75

6-10-01 Replacement Page
V3 = 106.75/1.0853 = 98.36 
V4 = 106.75/1.06577 = 100.162 
V5 = 106.75/1.05071 = 101.598 
V1 = 0.5 \times (V3 + 6.75 + V4 + 6.75)/1.0826 
= 0.5 \times (98.36 + 6.75 + 100.162 + 6.75)/1.0826 
= 97.923 
V2 = 0.5 \times (V4 + 6.75 + V5 + 6.75)/1.06369 
= 0.5 \times (100.162 + 6.75 + 101.598 + 6.75)/1.06369 
= 101.185 
V0 = 0.5 \times (V1 + 6.75 + V2 + 6.75)/1.042 
= 0.5 \times (97.923 + 6.75 + 101.185 + 6.75)/1.042 
= 102.019 

b) 
V5b = 100 + 1% call premium = 101 
V4 < 101, therefore not called. 
V4b = V4 and V1b = V1 (not callable in any event) 
V2b = 0.5 \times (V4b + 6.75 + V5b + 6.75)/1.06369 
= 0.5 \times (100.162 + 6.75 + 101 + 6.75)/1.06369 
= 100.904 
V0b = 0.5 \times (V1b + 6.75 + V2b + 6.75)/1.042 
= 0.5 \times (97.923 + 6.75 + 100.904 + 6.75)/1.042 
= 101.844 

Value of call option = Value of optionless bond – Value of callable bond 
= 102.019 – 101.844 
= 0.135 

c) 
A bond with an attached warrant is a convertible bond. 
Non-convertible bonds require a higher yield to maturity than 
convertibles; convertible bonds allow lower interest cost for issuer. 
Convertible bonds often allow less restrictive covenants (debt agreements) 
for issuer. 
There is capital structure uncertainty with convertibles. 
Convertibles are typically subordinated debt issues; convertible debt 
holder is exposed to the risk of expropriation that comes with the issuance 
of new debt. 
Convertibles offer downside protection that bonds can offer during bad 
economic times, while allowing one to share in the upside potential of 
common stock. 
Convertible bonds are attractive for investors whose ability to take equity 
risk is constrained.
5.
(a)

(i) Currency Selection:
- this is the extra return from currency appreciation on manager’s portfolio over that of the EAFE by weighting the amount of investment in the three territories differently than that by EAFE

i.e. \[ \text{gain}_{\text{curr}} = \sum_{i=1}^{3} \text{return on equity index}_i \times (\text{Manager weight}_i - \text{EAFE weight}_i) \]

where
\[ \begin{align*}
  i &= 1 = \text{Europe} \\
  i &= 2 = \text{Australia} \\
  i &= 3 = \text{Far East}
\end{align*} \]

(ii) Country selection:
- This is the extra return gained in each territory (country) by weighting the amount of investment in the 3 territories differently than that by EAFE.

i.e. \[ \text{gain}_{\text{curr}} = \sum_{i=1}^{3} \text{return on equity index}_i \times (\text{Manager weight}_i - \text{EAFE weight}_i) \]

(iii) Stock selection:
- This is the extra return by picking stocks differently in each territory than that represented by the index

i.e.
\[ \text{gain}_{\text{stock}} = \sum_{i=1}^{3} \text{Manager's weight}_i \times (\text{Manager's return}_i - \text{Equity Index Return}_i) \]

(iv) Cash/Bond Selection:
- This is the extra return by allocating different portions into cash/bond

\[ \begin{align*}
\text{sub } x &= 0.4, z = 0.4 \text{ to 1} \\
\text{then } 0.4 - y + 3(0.4) &= 1.4 \\
y &= 0.2
\end{align*} \]

\[ \therefore \text{weight in Europe} = 40\% \]
\[ \text{weight in Australia} = 20\% \]
\[ \text{weight in Far East} = 40\% \]
6.

(a)

(i) Immunization – technique of maintaining a positive surplus as interest rates change
   - match effective duration of assets and liabilities
   - convexity of assets greater than convexity of liabilities

(ii) Contingent Immunization
   - actively manage the assets as long as the immunizable safety net is not violated.
   - shift to immunization immediately if safety reached

(iii) Dedicated Portfolio
   - expected asset and liability cash flows are matched
   - must specify reinvestment rate

(b)

(i) Immunization
   - durations change at different rates over time
   - durations change due to interest rate moves
   - asset and liabilities present values change

(ii) Contingent Immunization
   - must have a plan in place for immunization if safety net violated
   - monitor return closely to immunize promptly

(iii) Dedicated Portfolio
   - little room for active management since the cash flows must be matched
   - asset quality, and asset cash flow uncertainty is a consideration
   - liability cash flows are well defined

(c)

(i) Immunization
   - cheaper than dedication
   - use effective duration for interest sensitive cash flows
   - only good for small changes in interest rates
   - only good for parallel yield curve shifts
   - need to rebalance constantly

(ii) Contingent Immunization
   - may not reach safety return due time to shift portfolio to immunization
   - management makes portfolio decisions to get a bigger spread
   - formula can be used to determine active portion

(iii) Dedicated Portfolio
   - costs more due to lower returns and conservative reinvestment rate used
   - embedded options should not be used
   - protects from reinvestment and interest risk
   - impossible to match cash flows exactly
7.
(a) Credit Risk
Risk that loans within the CMBS are in default
Prepayment risk when loans payoff early
Extension risk as loans do not always pay off as scheduled

(b) Obtain loans that have debt service coverage ratios which are favorable (ie high)
Obtain loans that have loan-to-value ratio which are favorable (ie low)
Select expert loan servicers (improve probability of collecting monies due)
Diversify by using loans in different areas and different property types (ie apartment, office, retail etc.)
Attack repayment risk by using the following mechanisms:
  - prepayment lockout – borrower contractually prohibited from prepaying loan during lockout period
  - yield maintenance – borrower “makes whole” lender based upon present value of cash flows
  - defeasance – Treasuries replace building as collateral
Attack extension risk problems with the following mechanisms:
  - Internal tail provision – required borrower to provide evidence that effort to refinance is underway prior to balloon date
  - external tail provision – maturity of CMBS is set longer than maturity of underlying loans to allow delays in refinancing

(c)
(i) 10 is a small number of loans not very diversify
Diversify geographically or by industry type
High LTV – higher levered
Low DSCR
Balloon loans create possibility of not being able to refinance loans and going into delinquency and/or default

(ii) Add more loans to diversify through larger number of loans, size and maturity
Diversify geographically – add more locations so localized real estate downturn will not seriously impact overall portfolio credit quality
Diversify by property type – ie add office, multi-family, industrial and retail
Add loans with lower LTV’s (e.g. <80%)
Increase DSCR multiples
Look for loans with lock-out provisions
Look for loans without balloon payments or stagger portfolio payments through time
8. **Passive Buy-and-Hold strategy**
Involves purchasing and holding a security to maturity
Cash proceeds from coupons or redemptions are reinvested in similar securities
Changes in market value (capital gains/losses) are ignored
Interest rate forecasting is ignored
Need to analyze the quality of the securities to minimize the risk of default
Assets with embedded options are less appropriate
Quasi-passive indexation strategy
Select the target bond market index
Transaction costs will cause tracking error
Three approaches
Exact Replication (difficult to do)
Sampling
Securities are selected randomly from the bonds making up the index
Probably fewer than 40 securities can closely replicate index
May not be appropriate with broader indexes
Stratified
Three steps
Segment the securities in the index into homogeneous classes (Sector, Quality, Maturity)
Select one security from each class to include in the portfolio
Manager may exercise some judgment in selecting the security from each class
Determine the amount to be held in each security selected
Use quadratic programming (Optimization) to match
Duration
Distribution of maturities
Amount held in each of the sectors of the index

9. Determine which bond combination will match liabilities, start with last years,

(i) Buy 250 face of the 5 year bond
- will provide 250 face + 25 (250 x 10%) coupon
  in year 5 for a total of $275
- will provide $25 coupon in preceding years
  → years 4 & 5 fully matched

→ remaining unmatched liabilities
year 3 = 214 - 25 = 189
year 2 = 123 - 25 = 98
year 1 = 43 - 25 = 18

(ii) Buy 175 face of the 3 year bond
- provides 175 face + 14 (175 x 8%) coupon in year 3 for a total of $189
- provides $14 coupon in years 1 & 2
  → remaining = year 3 cash flow matched
remaining unmatched liabilities
year 2 = 98 − 14 = 84
year 3 = 18 − 14 = 4

(iii) Buy 80 face of 2 year bond
- pays 80 face and 4 (80 x 5%) coupon in year 2 for a total of $84
- pays $4 coupon in year 1
→ all remaining liability cash flows matched

∴ buy $240 par of 5-year bonds
$175 par of 3-year bonds
$80 par of 2-year bonds

Price of Bonds = \( \sum\frac{CF_i}{r(1.07)^i} \)

Price of 2-year bond = \( \frac{5}{1.07} + \frac{105}{(1.07)^2} = 96.38 \)

Price of 3-year bond = \( \frac{8}{1.07} + \frac{8}{(1.07)^2} + \frac{108}{(1.07)^3} < 102.62 \)

Price of 5-year bond = \( \frac{10}{1.07} + \frac{10}{(1.07)^2} + \frac{10}{(1.07)^3} + \frac{10}{(1.07)^4} + \frac{110}{(1.07)^5} = 112.30 \)

∴ Price of matched portfolio =

\[ 250 \times \left( \frac{112.30}{100} \right) + 175 \left( \frac{102.62}{100} \right) + 80 \left( \frac{96.38}{100} \right) = 537.44 \]

10.

(a) Describe the features of collared floating rate securities

(i) A floater is a debt security whose coupon rate is reset at designated dates based on the value of some designated reference rate

Coupon Rate = Reference Rate ± Quoted Margin

A collared floater features both a cap and a floor

(ii) Features

Face amount – used to calculate the dollar value of the
Coupon payment. OR, monies received by issuer to be repaid with interest.

Reference rate – the interest rate that appears in a floater’s coupon formula and is used to determine the coupon payment on each reset date, eg, LIBOR, T-Bill yields, Prime Rates, CD Rates, Foreign Exchange rates, Commodity Prices, Equity Indices, Inflation Indices

Quoted Margin – the permanent adjustment that the issue Agrees to make to the reference rate, eg, 50 basis points

Reset frequency – how often the coupon rate is reset based On the reference rate, eg, semi-annually, quarterly, monthly or weekly. “Adjustable-rate” or “Variable-rate” is typically used to refer to floaters whose coupon rates reset not more than annually, or are based on a longer-term interest rate.

Term to maturity – the number of years until the debt will cease and the borrower or issuer will redeem the issue by paying the face amount.

Cap – a restriction on the maximum coupon rate that will be paid on any reset date

Floor – a restriction on the minimum coupon rate that will be paid on any reset date.

May contain other features, such as call/put/ prepayment/stepped spread/range note/dual index

(b) Describe the price volatility characteristics of collared floaters and compare them to those of the collared inverse floaters.

1. Factors that affect a floater’s price

   Time remaining to the next coupon reset date

   The longer the time to the next coupon reset date, the more a floater behaves like a fixed-rate security and the greater a floater’s price fluctuation.

   The shorter the time between coupon reset dates, the smaller the floater’s potential price fluctuation.
For a floater in which neither the cap nor floor is binding, and for which the market does not demand a margin different from the quoted margin, a floater that resets daily will trade at par.

**Changes in the market's required margin**

Subsequent to its initial offering, if the market required a higher/lower margin, the floater's price will decrease/increase to reflect the current margin required.

The required margin for a particular issue depends on its credit quality, its liquidity, the margin available in competitive funding markets, the presence of any embedded or put options.

**Whether or not the cap or floor is reached.**

For a floater with a cap, once the coupon specified by the coupon formula rises above the cap rate, the floater then offers a below market coupon rate and will trade at a discount. As the prevailing market rate approaches the capped rate from below or exceeds it, the more the floater will trade like a fixed-rate security with a rate equal to the capped rate.

For a floater with a floor, once the coupon specified by the coupon formula falls below the floor rate, the floater then offers an above market coupon rate and will trade a premium. As the prevailing market rate approaches the floored rate from above or falls below, the more the floater will trade like a fixed-rate security with a rate equal to the floored rate.

However, a floater's coupon resets periodically thereby reducing in sensitivity to changes in rate OR floater interest rates increase, price decreases, but coupon increases to offset price decrease => stable price.

2. Duration of Floaters

For a pure floater (with no embedded options, caps or floor)

The price behavior is similar to that of a zero-coupon
fixed-rate security with a term-to-maturity equal to the time remaining to the next coupon reset date.

Its duration will approximately be equal to the time remaining to the next coupon reset date.

Since the time remaining to the next coupon reset date for most floaters is small (less than 1 year), the duration of most floaters is also small, typically less than 1.

Two measures are employed to estimate a floater’s sensitivity to each component of the coupon formula.

Index duration is a measure of the floater’s price sensitivity to changes in the reference rate, holding the quoted margin constant.

Spread duration is a measure of the floater’s price sensitivity to changes in the quoted margin, holding the reference rate constant.

3. Price volatility of an inverse floater

Can be created by acquiring a fixed rate security (the collateral) and splitting it into a floater with X% of the collateral’s face amount, and an inverse floater with (1-X)% of the collateral’s face amount.

\[ D(\text{collateral}) = X\% \times D(\text{floater}) + (100-X\%) \times D(\text{inverse floater}) \]

Because the duration of floaters is typically small, the duration of an inverse floater will accordingly be a multiple of the collateral from which it was created OR An Inverse floater’s price volatility is higher than floater’s. OR, Inverse floaters are more risky than floaters.

Effectively, the inverse floater is a leveraged position in the collateral OR Inverse Floater, interest rates decrease, price increases, but coupon increases to amplify price increase => volatile price.
Ownership of an inverse floater is equivalent to buying the collateral and funding it on a floating-rate basis, where the reference rate for the borrowing is equal to the reference rate for the inverse factor.

Other Risks (eg, Currency, Event, Sector, Regulatory, Tax)

(c) Describe the risk to an investor of investing in such a security. Cap Risk is the risk that the floater’s value will decline because the cap is reached. OR, Cap Risk is incurred if the floater’s rate is capped and the funding rate is not. OR, Cap Risk is the risk that interest above the cap rate will not be received.

Basic Risk is incurred when the floater’s reference rate is not the same as the reference rate for funding of the floater.

Price Risk, Interest Rate Risk, Option Volatility Risk
And definition

Liquidity Risk is the threat of an increase in the required margin due to a perceived deterioration in an issue’s liquidity.

Credit Risk is the risk that there will be an increase in the credit spread required by the market due to credit quality concerns. OR, Credit Risk is the risk that the issue will not be able to or default on the coupon payments.

Call/Prepayment Risk is the risk that the Investor will have to reinvest the proceeds of an early redemption at lower interest rates or margins than existed in the floater.

Floor Risk is the risk that an issuer will have to pay more than the prevailing market interest rates. It is not a risk to the investor, but it is a risk to the issuer.

Put Risk is the risk that an issuer will have to redeem the issue at prices above the prevailing market values. It is not a risk to the investor, but it is a risk to the issuer.
11.
(a) 60 day r.f. discount factor

\[
\text{Price of 150-day } T\text{-bill} = \frac{\text{Price of 60 day Future on 90 day } T\text{-bill}}{975} \approx \frac{984}{975}
\]

\[p = c + pv(k) - Se^{-\mu}
\]

\[p = 1 + \frac{975}{984}(30) - 25e^{-\frac{60}{360}}
\]

\[= 6.22
\]

(b) Arbitrage Free \iff \exists state – price vector

<table>
<thead>
<tr>
<th>T-Bill</th>
<th>Stock</th>
<th>Put</th>
</tr>
</thead>
<tbody>
<tr>
<td>975/984</td>
<td>1000</td>
<td>21.505</td>
</tr>
<tr>
<td>1000</td>
<td>25</td>
<td>30.505</td>
</tr>
<tr>
<td>1000</td>
<td>36.505</td>
<td>6.22</td>
</tr>
</tbody>
</table>

Determine solution's to:

\[\frac{975}{984} = 1000 \ y_1 + 1000 \ y_2 + 1000 \ y_3
\]

\[25 = 21.505 \ y_1 + 30.505 \ y_2 + 36.505 \ y_3
\]

\[6.22 = 9 \ y_1 + 0 \ y_2 + 0 \ y_3
\]

\[y_1 = 0.69111, y_2 = 0.134, y_3 = 0.166
\]

Solve for \(y_1, y_2, y_3\), all are >0 \(\Rightarrow\) state-price vector exists.
12.

(1) Objectives of the business
Quantitative or qualitative

(2) Description of Liabilities
Long-term or short-term, interest rate sensitivity, cash flow volatility, embedded option, impact of aggregating various liabilities type

(3) Risk Tolerance
Involve surplus change
Usually qualitative

(4) Marketability/Liquidity
Have enough cash flow for unforecasted surrenders or attractive investment opportunity
Should consider:
Termination probability
Net cash flow
Industry Outlook
Early retirement window

(5) Accounting regulatory and tax rules.
What include in income
MCCSR
Investment limits imposed by regulators
Volatility of surplus affect the plan expense

(6) Asset Mix Target
Target on: Asset Mix, Liquidity, asset/liability measure, credit rate, MECSR., police portfolio report:
long term asset mix, risk-free portfolio, basis for analyzing investment manager’s performance.

(7) Portfolio Management Constraints
Asset type, quality, style, concentration unit, asset/liability constraints, permissible assets.

(8) Performance goals and objectives
Difference between goals of fund and goals of managers
Compare certain asset shares with appropriate passive portfolio
Use attribution analysis
Monitor compliance with policy
Change management style
Compare managers to peers

(9) Procedures and Authorization
Clarify role of individuals

COURSE 6: MAY 2001 20
Standard approval limit of buying asset
Review police annually
Coordinate subsidiaries

13.

(a) Maturity uncertainty since debt can be recalled when interest rates are low.
Price risk – Price of callable bond will be directed when interest rates decrease
(negative convexity).
Reinvestment risk: When debt is called, investor will have to reinvest proceeds
at lower interest rate.
Waste of time and investment costs.

(b) If refinance tax adjusted saving on coupon of \((12 - 8.5) \times 0.65 = 2.275\%\) yr.
Expenses tax adjusted = 0.5 \(\times 0.65 = 0.325\%\)
Call premium tax adjusted: 10 \(\times 0.65 = 6.5\%\)

\[ \therefore 0.325 + 0.65 = 2.75 \times \overline{a_{10}} \]
\[ \overline{a_{10}} = 3 \]

\[ I = 31\% \]

Should Reference.

14.

(a) value of callable bond = value of straight bond – value of call option.
Value of call option = 106 -104 = 2

(b) Exercise price
Time to expiry
Level of risk-free interest rates
Current bond price
Interest rate volatility
Credit worthiness of the issuer
Features of a callable bond

(c) OAS is spread to treasury curve which equates theoretical price to market price.

The effect is similar to a parallel shift of the curve by amount of OAS

\[ \text{OAS} = \text{yield-to-maturity spread less call option yield in basis points} \]

OAS may be used to compare the investment with a similar non-callable bond
having the same effective maturity but OAS alone does not provide sufficient
information to determine whether the bond is rich or cheap.
Effective duration of GIC is close to that of the callable bond which is good because they are closely immunized but only for small changes in interest rate.

When interest rates decline a lot the value of the call option increases. The value of the bond approaches that of the non-callable 3-year bond and the duration shortens to that of the 3-year non-callable bond. The bond will likely be called subjecting the insurer to substantial reinvestment risk (will have to reinvest at lower rates) applicable to the Coupon payments and call proceeds.

When interest rates rise a lot the value of the call option decreases and the value of bond approaches that of non-callable 10-year bond. The duration lengthens. It is not likely that bond will not be called, so it may have to be sold at a loss to pay GIC outflow in year 5 (disinvestment or price risk).

The callable bond is not a suitable asset for the GIC business because there is a risk of loss whether rates increase or decrease even though the effective durations match. A more suitable investment should be found.
ANSWER KEY
MAY 2001 COURSE 6

1. B 
2. B 
3. C 
4. C 
5. C 
6. B 
7. A 
8. D 
9. E 
10. D 
11. C 
12. D 
13. B 
14. E 
15. D 
16. B 
17. E 
18. D 
19. D 
20. C 
21. D 
22. C 
23. B 
24. D 
25. C 
26. C 
27. A 
28. E 
29. C&D 
30. D 

6-10-01