BUSI 4512 Derivatives
Fall 2011
Midterm Exam
(Time allowed: 2 hours)

There are 20 (twenty) multiple choice questions and 3 (three) long problems. Answer the multiple choice questions in Scantron forms, write the answers to the longer problems in the exam booklet.

Section 1: Multiple Choice Questions (50 marks; 2.5 marks per question)

1. What is the *duration* of a 2-year 10% bond paying interest semiannually and selling to yield 10% per annum compounded continuously.
   A) 2.00 years
   B) 1.90 years
   C) 1.86 years
   D) 1.72 years

2. The price of a three-year zero coupon government bond is 85.16. The price of a similar four-year bond is 79.81. The one-year implied forward rate (annually compounded) from year 3 to year 4 is closest to:
   A) 4.4%
   B) 5.5%
   C) 5.8%
   D) 6.7%

3. Consider a forward rate agreement (FRA) with the same maturity and compounding frequency as a Eurodollar futures contract. The FRA has a LIBOR underlying. Which of the following statements is true about the relationship between the forward rate and the futures rate:
   A) They should be exactly the same.
   B) The forward rate is normally higher than the futures rate.
   C) The forward rate is normally lower than the futures rate.
   D) They have no fixed relationship.

4. It is June 2 and a fund manager with $10 million invested in government bonds is concerned that interest rates will be highly volatile over the next three months. The manager decides to use the September Treasury bond futures contract to hedge the value of the portfolio. The current futures price is 95.0625. Each contract is for the delivery of USD 100,000 face value of bonds. The duration of the manager's bond portfolio in three months will be 7.8 years. The cheapest-to-deliver bond in the Treasury bond futures contract is expected to have duration of 8.4 years at maturity of the contract. At the maturity of the Treasury bond futures contract, the duration of the underlying benchmark Treasury bond is 9 years. What position should the fund manager undertake to mitigate his interest rate risk exposure?

   A) Short 94 contracts
   B) Short 98 contracts
   C) Long 98 contracts
   D) Long 113 contracts

5. On March 13, 2008, William Tell, a fund manager for the Rossini fund, takes a short position in the March Treasury bond (T-bond) futures contract. He plans to deliver the cheapest-to-deliver Treasury bond with a coupon of 4.5% payable semiannually on May 15 and November 15, a conversion factor of 1.3256, and a face value of USD 100,000. The delivery date is Friday, March 15. The settlement price for the cheapest-to-deliver Treasury bond on March 13 is 68-02. The invoice price is closest to:
   A) $90,118.87
   B) $91,727.79
   C) $92,367.75
   D) $95,619.47

6. You are a manager of USD 40 million equity portfolio considering locking up the profit from the recent rally. The S&P 500 index and its futures with the multiplier of 250 are trading at 950 and 1010, respectively. Instead of selling off his holdings, you want to hedge the portfolio market exposure over the remaining three months. The correlation between your portfolio and the S&P 500 index futures is 0.445 and the volatilities of the equity fund and the futures are 0.51 and 0.24 per year, respectively, what position should you take to achieve his objective?:
   A) Buy 33 futures
   B) Buy 150 futures
   C) Sell 150 futures
   D) Sell 159 futures

7. You have a short T-bond interest rate futures position. The bonds presented in the table are eligible for delivery. The futures price is 103-17 and the maturity date of the contract is September 1. The bonds pay their coupon amount semiannually on June 30 and December 31. The yield curve is upward sloping. What is the cheapest-to-deliver bond?

Bonds	Bond Price	Conversion Factor	Coupon rate, %
A	102-14	0.98	4
B	106-19	1.03	5
C	98-12	0.95	3

   A) Bond A
   B) Bond B
   C) Bond C
   D) All of them

8. What is the price of a 6-month forward on a coupon bond that pays a 5% coupon semi-annually, has a face value of $1,000, and sells at par. A coupon is to be paid in three months and the continuously compounded risk-free rate is 4%?
   A) $994.95
   B) $1005.50
   C) $980.05
   D) $1050.50

9. A 6-month futures contract on an equity index is currently priced at 1,276. The underlying index stocks are valued at 1,250 and pay dividends at a continuously compounded rate of 1.70%. The continuously compounded risk-free rate is 5%. The potential arbitrage profit is closest to:
   A) $5.20

B) $8.32
C) $16.58
D) $26.00

10. An investor enters into a short position in a gold futures contract. The initial margin on this contract is $3,000; the maintenance margin is $2,250. The contract price is $993.60 and each contract is for 100 ounces. If the price drops to $991.00 at the end of the first day and to $985.00 at the end of the second day, how many dollars will investor have to add to his margin account at the end of the second day to satisfy margin requirements:
    A) $0
    B) $260
    C) $600
    D) $860

11. An equity portfolio is worth $100 million with the benchmark of the S&P/TSX index. The index futures are currently selling at 10,000 and the corresponding portfolio beta is 1.2. The futures multiplier for S&P/TSX is 10. Which of the following is the closest to the number of futures contracts needed to *double* the portfolio beta
    A) 1,168
    B) 1,100
    C) 600
    D) 1,200

12. What is the continuously compounded rate of return on investment that has a value today of $86.50, and will have a future value of $100 in one year:
    A) 13.62%
    B) 14.50%
    C) 15.61%
    D) 16.38%

13. Assume the cash price on a 90-day T-bill is quoted as 98.75. The discount rate is closest to:
    A) 1.25%
    B) 2.50%
    C) 6%
    D) 5%

14. Consider a forward contract on a stock market index. Identify the *false* statement. Everything else being constant,
    A) The forward price depends directly on the level of the stock market index
    B) The forward price will fall if underlying stocks increase the level of dividend payments over the life of the contract
    C) The forward price will rise if time to maturity is increased
    D) The forward price will fall if the interest rate is raised

15. An investor owns $5 million of ABC Corp. 10% bonds paying coupons semi-annually. The duration of the ABC bond is 5.25 years. The yield-to-maturity on the bond is 10% (semi-annually compounded). By how many dollars the value of the portfolio will change if the interest rates increase by 1%:
    A) Increases by $262,500

B) Decreases by $262,500
C) Decreases by $250,000
D) Decreases by $50,000

16. A 3-month forward rate 4 years from now is 1.50%. The standard deviation of the change in the short-term interest in one year is 1.20%. What is the 3-month futures rate 4 years from now?
    A) 1.32%
    B) 1.38%
    C) 1.69%
    D) 1.62%

17. It is May 5, 2010. The quoted price of a government bond with a 12% semi-annual coupon and $10,000 that matures on July 27, 2014 is 110-7. What is bond cash price?
    A) $11,053.12
    B) $11,377.98
    C) $10,000.00
    D) $110,70.00

18. To initiate an arbitrage trade if the futures contract is underpriced, the trader should:
    A) borrow at the risk-free rate, short the asset, and sell the futures.
    B) short the asset, invest at the risk-free rate, and buy the futures.
    C) borrow at the risk-free rate, buy the asset, and sell the futures.
    D) invest at the risk-free rate, buy the asset, and sell the futures.

19. Consider the following Treasury bonds that pay coupons annually:

Bonds	Maturity	Coupon, %	Quoted Price	Yield to maturity, %
A	1 year	0	95.2381	5
B	2 years	6	100.9232	5.5
C	3 years	7	102.6730	6

Given the observed bond prices, the 2-year spot rate and the 3-year spot rate (annually compounded) are:

	2-year rate	3-year rate
A)	5.51%	5.92%
B)	5.46%	5.92%
C)	5.51%	6.05%
D)	5.46%	6.05%

20. Former US Treasury Secretary Robert Rubin decided to stop issuing 30-year Treasury bonds in 2001 and to replace them by borrowing more with shorter maturity Treasury bills and notes. Which of the following statements concerning this decision is most accurate?

    A) If the expectations theory of term structure is correct, this decision will reduce the government's borrowing cost

    B) If the liquidity theory of the term structure is correct, this decision will reduce the government's borrowing cost

C) If the liquidity theory of the term structure is correct, this decision will not change the government's borrowing cost

D) If the expectations theory of term structure is correct, this decision will increase the government's borrowing cost

Section 2: Longer Problems (50 marks)

Problem 1: (15 marks) An arbitrageur identifies two futures on individual stocks that appear to be mispriced on the market:

- 1-year futures on stock X: F_{0X} = \$34 , Spot price of stock X: $S0$X = \$30 .
- 1-year futures on stock Y: F_{0Y} = \$62 , Spot price of stock Y: $S0Y$ = \$60 .

Company X is expected to pay a \$1 dividend in 6 months and company Y is expected to pay a \$2 dividend in 6 months. The 6-month and 12-month spot interest rates are 10% (continuously compounded). Each futures contract is for the delivery of one stock.

a) Explain how the arbitrageur can make arbitrage profit by taking a position in one futures contract on stock X. Calculate the amount of arbitrage profit.

b) Explain how the arbitrageur can make arbitrage profit by taking a position in one futures contract on stock Y. Calculate the amount of arbitrage profit**.**

c) The arbitrageur can implement only one arbitrage strategy. Assume now that the arbitrageur has to pay a \$1 fee per stock that is *sold short*. The fee has to be paid when the stock is returned to its owner. Which strategy should be considered by the arbitrageur?

Problem 2: (20 marks) A fund manager has a \$50 million portfolio with beta of 0.87. The manager is concerned about the market performance over the next two months and plans to use 3-month futures contracts on S&P500 index to hedge the risk. The current index level is 1,250, one contract is on 250 times the index, the risk-free rate is 6%, and the dividend yield on the index is 3%. The current 3-month futures price is 1,259.

a) What position should the manager take to hedge exposure to the market over the next two years?

b) Calculate the effect of your strategy on the fund managers' returns if the index value in two months is 1,000. Assume that the one-month futures price is 0.25% higher than the index level at this time.

c) Calculate the same as in (b) if the index value in two months is 1,400.

Problem 3: (15 marks) It is March 10, 2011. The cheapest-to-deliver bond in a December 2010 Treasury bond futures contract is an 8% coupon bond, and delivery is expected to be made on December 31, 2011. Coupon payments on the bond are made on March 1 and September 1 each year. The term structure is flat, and the rate of interest with continuous compounding is 5% per annum. The conversion factor for the bond is 1.2191. The current quoted bond price is $137. Calculate the quoted futures price for the contract.

Useful Formulae

$$h = \rho \frac{\sigma_S}{\sigma_F}$$

$$N = h \frac{Q_A}{Q_F}$$

$$N = h \frac{V_A}{V_F}$$

$$N = \beta \frac{V_A}{V_F}$$

$$N = \frac{PD_P}{V_F D_F}$$

$$R_c = m \ln\left(1 + \frac{R_m}{m}\right)$$

$$R_m = m\left(e^{R_c/m} - 1\right)$$

$$c = \frac{(100 - 100 \times P)m}{A}$$

$$f_{T1,T2} = \frac{R_2 T_2 - R_1 T_1}{T_2 - T_1}$$

$$F_0 = S_0 e^{rT}$$

$$F_0 = (S_0 - I)e^{rT}$$

$$F_0 = S_0 e^{(r_d - r_f)T}$$

$$F_0 = S_0 e^{(r - q + u)T}$$

$$V_f = 10{,}000[100 - 0.25(100 - Q)]$$

$$\text{Forward Rate} = \text{Futures Rate} - 0.5\sigma^2 T_1 T_2$$

$$D = \sum_{i=1}^{n} t_i \left[\frac{c_i e^{-yt_i}}{B}\right]$$

$$D^* = \frac{D}{1 + y/m}$$