AS251 – Mathematics of Financial Derivatives
Dept. of Mathematics, KFUPM
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T252 – Major 1
Name. . . . . ID:

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Instructions

1. Please turn off your cell phones and place them under your chair. Any student caught with mobile phones on during the exam will be considered under the cheating rules of the University.

2. If you need to leave the room, please do so quietly so not to disturb others taking the test. No two person can leave the room at the same time. No extra exam time will be provided for the time spent outside the room.

3. Only materials provided by the instructor can be present on the table during the exam.

4. Do not spend too much time on any one question. If a question seems too difficult, leave it and go on.

5. Use the blank portions of each page for your work. Extra blank pages can be provided if necessary. If you use an extra page, indicate clearly what problem you are working on.

6. Only answers supported by work will be considered. Unsupported guesses will not be graded.

7. While every attempt is made to avoid defective questions, sometimes they do occur. In the rare event that you believe a question is defective, the instructor cannot give you any guidance beyond these instructions.

8. Mobile calculators, I-pad, or communicable devices are disallowed. Use regular scientific calculators, financial calculators, or SOA-approved calculators only. Write important steps to arrive at the solution of the exam problems.

9. Important: Questions in Part A worth 1 point each, while Questions in Part B worth 2 points each (1 point for correct option, 1 point for correct working).

The test is 120 minutes, GOOD LUCK, and you may begin now.

Part A: Multiple Choice Questions (1 point each)

1. Which statement correctly describes a **call option**?

   (A) The right to sell an asset at a fixed price
   (B) The obligation to buy an asset at a fixed price
   (C) The right, but not the obligation, to buy an asset at a fixed price
   (D) The obligation to sell an asset at a fixed price
   (E) A contract that guarantees a profit

2. An investor buys a **put option** mainly because they expect:

   (A) The asset price to rise sharply
   (B) The asset price to remain constant
   (C) The asset price to fall
   (D) Interest rates to increase
   (E) Volatility to disappear

3. Which of the following parties has an **obligation**, not a right?

   (A) Buyer of a call option
   (B) Buyer of a put option
   (C) Writer (seller) of a call option
   (D) Holder of a European option
   (E) Holder of an American option

4. Determine which of the following statements is NOT a typical reason for why derivative securities are used to manage financial risk.

   (A) Derivatives are used as a means of hedging.
   (B) Derivatives are used to reduce the likelihood of bankruptcy.
   (C) Derivatives are used to reduce transaction costs.
   (D) Derivatives are used to satisfy regulatory, tax, and accounting constraints.
   (E) Derivatives are used as a form of insurance.

5. Which of the following best describes using short selling to lock in the value of an asset you already own and protect against a potential price decline?

   (A) Speculation
   (B) Arbitrage
   (C) Financing
   (D) Hedging
   (E) Leverage

6. The current price of a stock index is 1100 and the 6-month forward price is 1160. Assume the price of the stock index in 6 months will be 1210.

   Which of the following is true regarding forward positions in the stock index?

   (A) Long position gains 50
   (B) Long position gains 60
   (C) Long position gains 110
   (D) Short position gains 60
   (E) Short position gains 110

7. The dividend yield on a stock and the interest rate used to discount the stock's cash flows are both continuously compounded. The dividend yield is less than the interest rate, but both are positive.

   The following table shows four methods to buy the stock and the total payment needed for each method. The payment amounts are as of the time of payment and have not been discounted to the present date.

METHOD	**TOTAL PAYMENT**
Outright purchase	A
Forward contract	B
Prepaid forward contract	C
Fully leveraged purchase	D

   Determine which of the following is the correct ranking, from smallest to largest, for the amount of payment needed to acquire the stock.

   (A) $C < A < D < B$
   (B) $A < C < D < B$
   (C) $D < C < A < B$
   (D) $C < A < B < D$
   (E) $A < C < B < D$

8. Determine which of the following positions has the same cash flows as a short stock position.

   (A) Long forward and long zero-coupon bond
   (B) Long forward and short forward
   (C) Long forward and short zero-coupon bond
   (D) Long zero-coupon bond and short forward
   (E) Short forward and short zero-coupon bond

9. Determine which of the following positions has the same cash flow as a long zero-coupon bond position.

   (A) Long stock and long forward
   (B) Long stock and short forward
   (C) Short stock and long forward
   (D) Short stock and short forward
   (E) Long forward and short forward

10. An investor purchased Option A and Option B for a certain stock today, with strike prices 70 and 80, respectively. Both options are European one-year put options.

    Determine which statement is true about the moneyness of these options, based on a particular stock price.

    (A) If Option A is in-the-money, then Option B is in-the-money.
    (B) If Option A is at-the-money, then Option B is out-of-the-money.
    (C) If Option A is in-the-money, then Option B is out-of-the-money.
    (D) If Option A is out-of-the-money, then Option B is in-the-money.
    (E) If Option A is out-of-the-money, then Option B is out-of-the-money.

Part B: Multiple Choice Questions (2 points each)

11. If the bid price on a stock is 29.75 and the ask price is 30.25, how much would you pay for 100 shares?

    (A) \$2,975
    (B) \$3,000
    (C) \$3,025
    (D) \$3,050
    (E) \$3,075

12. A yen-denominated forward agreement provides for the delivery of \$100 at the end of 3 months. The continuously compounded risk-free rate for dollars is 5%, and the continuously compounded risk-free rate for yen is 2%. The current exchange rate is 110¥/\$. Calculate the forward price in yen for this agreement.

    (A) 10,918 ¥
    (B) 11,000 ¥
    (C) 11,078 ¥
    (D) 11,150 ¥
    (E) 11,225 ¥

13. The following relates to one share of XYZ stock: - The current price is 100. - The forward price for delivery in one year is 105. - P is the expected price in one year.

    Determine which of the following statements about P is TRUE.

    (A) $P < 100$
    (B) $P = 100$
    (C) $100 < P < 105$
    (D) $P = 105$
    (E) $P > 105$

14. A jeweler buys gold, which is the primary input needed for her products. One ounce of gold can be used to produce one unit of jewelry. The cost of all other inputs is negligible. She is able to sell each unit of jewelry for 700 plus 20% of the market price of gold in one year. In one year, the actual price of gold will be in one of three possible states, corresponding to the following probability table:

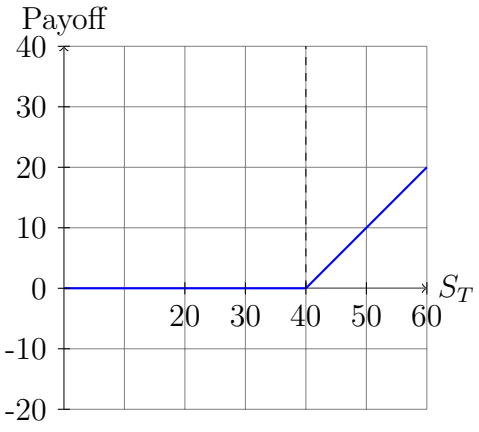
Market Price of Gold in one year	Probability
750 per ounce	0.2
850 per ounce	0.5
950 per ounce	0.3

The jeweler is considering using forward contracts to lock in 1-year gold prices, in which case she would charge the customer (one year from now) 700 plus 20% of the forward price. The 1-year forward price for gold is 850 per ounce.

Calculate the increase in the expected 1-year profit, per unit of jewelry sold, that results from buying forward the 1-year price of gold.

(A) 0
(B) 8
(C) 12
(D) 20
(E) 32

15. The following graph shows the payoff diagram for a call option with strike price 40:



Which of the following best describes the payoff when the price at maturity = 50?

(A) -10
(B) 0
(C) 10
(D) 20
(E) 40

16. For a stock: (i) The stock's price is 40. (ii) A stock pays continuous dividends at a rate of 4%. (iii) The continuously compounded risk-free rate is 10%.

    Party A buys 10,000 180-day futures contracts from Party B. Each contract allows purchase of 1 share of stock. After 1 day, the price of the stock increases to 42. Calculate the amount paid by party B to party A after 1 day.

    (A) \$10,265
    (B) \$15,430
    (C) \$20,530
    (D) \$25,615
    (E) \$30,750

17. An investor buys 100 futures contracts. The price of the futures contract is 2300. The initial margin is 10% and the maintenance margin is 80% of the initial margin. 5% annual effective interest is paid on the margin account.

    The futures price changes to 2350 on day 1 and 2200 on day 2. Calculate the size of the margin call on day 2.

    (A) \$5,000
    (B) \$7,500
    (C) \$9,993
    (D) \$12,500
    (E) \$15,000

18. An investor purchases a 6-month call option on a stock with strike price 50. The investor pays 3.35 as premium. At the end of 6 months, the price of the stock is 60. The risk-free annual effective interest rate is 5%.

    Calculate the investor's profit.

    (A) 5.50
    (B) 6.57
    (C) 7.25
    (D) 8.15
    (E) 9.30

19. For a certain stock, Investor A purchases a 45-strike call option while Investor B purchases a 135-strike put option. Both options are European with the same expiration date. Assume that there are no transaction costs.

    If the final stock price at expiration is S, Investor A's payoff will be 12. Calculate Investor B's payoff at expiration, if the final stock price is S.

    (A) 0

    (B) 12

    (C) 36

    (D) 57

    (E) 78

20. An investor invests in a 3-month European put option with strike price 90. The premium for the option is 10.50. At the end of 3 months, the price of the underlying asset is 72.

    The continuously compounded annual risk-free interest rate is 10%.

    Calculate the profit on the put option.

    (A) 7.23

    (B) 8.45

    (C) 9.67

    (D) 10.89

    (E) 12.34

Solutions

1. **C. The right, but not the obligation, to buy an asset at a fixed price**

2. **C. The asset price to fall**

3. **C. Writer (seller) of a call option**
   Option writers have obligations; option buyers have rights.

4. **B. Derivatives are used to reduce the likelihood of bankruptcy.**
   While derivatives can help manage risk, reducing bankruptcy likelihood is not their primary or typical use.

5. **D. Hedging**
   Short selling an asset you already own is a hedging strategy to protect against price declines.

6. **A. Long position gains 50**
   Forward price = 1160, spot at maturity = 1210. Long position payoff = $1210 - 1160 = 50$.

7. **D.** $C < A < B < D$**; Exer. 15.3**
   Prepaid forward (C) <Outright purchase (A) <Forward contract (B) <Fully leveraged purchase (D) when dividend yield <interest rate.

8. **E. Short forward and short zero-coupon bond**
   Short stock = borrow cash (short bond) and agree to sell stock (short forward).

9. **B. Long stock and short forward**
   Long bond = receive cash at maturity, equivalent to selling forward and buying stock.

10. **A. If Option A is in-the-money, then Option B is in-the-money.**
    For puts with strikes 70 and 80: If stock price <70, both puts are ITM.

11. **C. $3,025**
    You pay the ask price: $100 \times 30.25 = 3,025$.

12. **A. 10,918 ¥**
    Forward price = $110 \times e^{(0.02-0.05)\times 0.25} \times 100 = 11,000 \times e^{-0.0075} \approx 10,917.81$.

13. **E.** $P > 105$**; Exer. 14.15**
    Since investors require risk premium, expected future price exceeds forward price.

14. **B. 8; Exer. 14.1**
Expected price of goold in one year is 0.2(750) + 0.5(850) +0.3(950) = 860.
Expected profit Without forward is 700 + 0.2(860) - 860 = 12
With forward: Profit = 700 + 0.2(850) - 850 = 20
Difference is 20 - 12 = 8.

15. **C. 10**
When $S_T = 50$, payoff $= 50 - 40 = 10$.

16. **C. $20,530; Example 15B**
Initial futures price: $10,000 \times 40 \times e^{(0.1-0.04)(180/365)} \approx 412,012$
New futures price: $10,000 \times 42 \times e^{(0.1-0.04)(179/365)} \approx 432,542$
Difference: $432,542 - 412,012 = 20,530$.

17. **C. $9,993; Example 15C**
Margin account on day 2 after mark-to-market: 13,006.81
Maintenance margin: $0.8 \times 23,000 = 18,400$
Margin call: $23,000 - 13,006.81 = 9,993.19$.

18. **B. 6.57; Example 16A**
Profit $= (60 - 50) - 3.35(1.05)^{0.5} = 10 - 3.35 \times 1.0247 = 10 - 3.4327 = 6.5673$.

19. **E. 78; ExER. 16.15**
Investor A's payoff: $\max(S - 45, 0) = 12 \Rightarrow S = 57$
Investor B's payoff: $\max(135 - S, 0) = \max(135 - 57, 0) = 78$.

20. **A. 7.23; ExER. 16.1**
Profit $= \max(90 - 72, 0) - 10.50e^{0.10\times0.25} = 18 - 10.50 \times 1.0253 = 18 - 10.7657 = 7.2343 \approx 7.23$.

— End of Examination —