

SOCIETY OF ACTUARIES

EXAM FM FINANCIAL MATHEMATICS

**EXAM FM SAMPLE QUESTIONS**

Financial Economics

June 2014 changes

Questions 1-30 are from the prior version of this document. They have been edited to conform more closely to current question writing style, but are unchanged in content.

Question 31 is the former Question 58 from the interest theory question set.

Questions 32- 34 are new.

Some of the questions in this study note are taken from past SOA/CAS examinations.

These questions are representative of the types of questions that might be asked of candidates sitting for the Financial Mathematics (FM) Exam. These questions are intended to represent the depth of understanding required of candidates. The distribution of questions by topic is not intended to represent the distribution of questions on future exams.

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1.

Determine which statement about zero-cost purchased collars is FALSE

- (A) A zero-width, zero-cost collar can be created by setting both the put and call strike prices at the forward price.
- (B) There are an infinite number of zero-cost collars.
- (C) The put option can be at-the-money.
- (D) The call option can be at-the-money.
- (E) The strike price on the put option must be at or below the forward price.

2.

You are given the following:

- The current price to buy one share of XYZ stock is 500.
- The stock does not pay dividends.
- The annual risk-free interest rate, compounded continuously, is 6%.
- A European call option on one share of XYZ stock with a strike price of  $K$  that expires in one year costs 66.59.
- A European put option on one share of XYZ stock with a strike price of  $K$  that expires in one year costs 18.64.

Using put-call parity, calculate the strike price,  $K$ .

- (A) 449
- (B) 452
- (C) 480
- (D) 559
- (E) 582

3.

Happy Jalapenos, LLC has an exclusive contract to supply jalapeno peppers to the organizers of the annual jalapeno eating contest. The contract states that the contest organizers will take delivery of 10,000 jalapenos in one year at the market price. It will cost Happy Jalapenos 1,000 to provide 10,000 jalapenos and today's market price is 0.12 for one jalapeno. The continuously compounded annual risk-free interest rate is 6%.

Happy Jalapenos has decided to hedge as follows:

Buy 10,000 0.12-strike put options for 84.30 and sell 10,000 0.14-strike call options for 74.80. Both options are one-year European.

Happy Jalapenos believes the market price in one year will be somewhere between 0.10 and 0.15 per jalapeno.

Determine which of the following intervals represents the range of possible profit one year from now for Happy Jalapenos.

- (A) -200 to 100
- (B) -110 to 190
- (C) -100 to 200
- (D) 190 to 390
- (E) 200 to 400

4.

Zero-coupon risk-free bonds are available with the following maturities and annual effective yield rates:

Maturity (years)	Yield Rate
1	0.060
2	0.065
3	0.070

Susan needs to buy corn for producing ethanol. She wants to purchase 10,000 bushels one year from now, 15,000 bushels two years from now, and 20,000 bushels three years from now. The current forward prices, per bushel, are 3.89, 4.11, and 4.16 for one, two, and three years respectively.

Susan wants to enter into a commodity swap to lock in these prices.

Determine which of the following sequences of payments at times one, two, and three will NOT be acceptable to Susan and to the corn supplier.

- (A) 38,900; 61,650; 83,200
- (B) 39,083; 61,650; 82,039
- (C) 40,777; 61,166; 81,554
- (D) 41,892; 62,340; 78,997
- (E) 60,184; 60,184; 60,184

5.

The PS index has the following characteristics:

- One share of the PS index currently sells for 1,000.
- The PS index does not pay dividends.

Sam wants to lock in the ability to buy this index in one year for a price of 1,025. He can do this by buying or selling European put and call options with a strike price of 1,025.

The annual effective risk-free interest rate is 5%.

Determine which of the following gives the hedging strategy that will achieve Sam's objective and also gives the cost today of establishing this position.

- (A) Buy the put and sell the call, receive 23.81
- (B) Buy the put and sell the call, spend 23.81
- (C) Buy the put and sell the call, no cost
- (D) Buy the call and sell the put, receive 23.81
- (E) Buy the call and sell the put, spend 23.81

6.

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)  $P > 105$

7.

A non-dividend paying stock currently sells for 100. One year from now the stock sells for 110. The annual risk-free rate, compounded continuously, is 6%. A trader purchases the stock in the following manner:

- The trader pays 100 today
- The trader takes possession of the stock in one year

Determine which of the following describes this arrangement.

- (A) Outright purchase
- (B) Fully leveraged purchase
- (C) Prepaid forward contract
- (D) Forward contract
- (E) This arrangement is not possible due to arbitrage opportunities

8.

Joe believes that the volatility of a stock is higher than indicated by market prices for options on that stock. He wants to speculate on that belief by buying or selling at-the-money options.

Determine which of the following strategies would achieve Joe's goal.

- (A) Buy a strangle
- (B) Buy a straddle
- (C) Sell a straddle
- (D) Buy a butterfly spread
- (E) Sell a butterfly spread

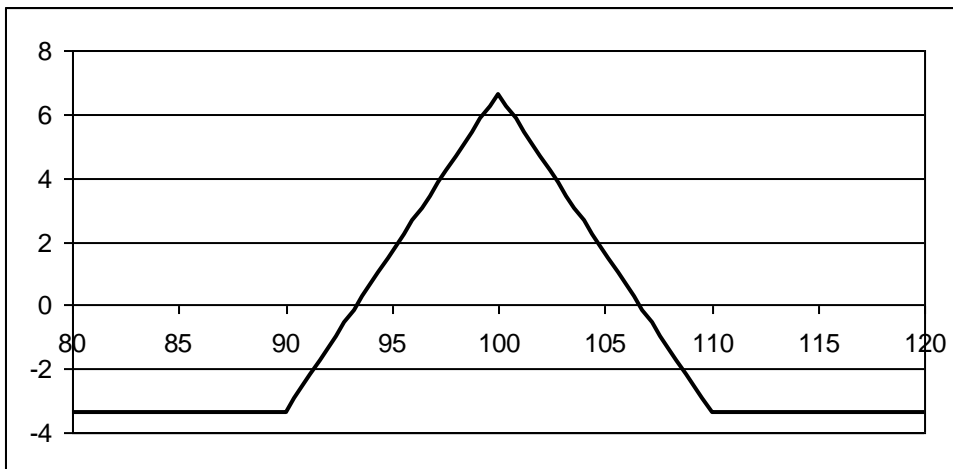
9.

Stock ABC has the following characteristics:

- The current price to buy one share is 100.
- The stock does not pay dividends.
- European options on one share expiring in one year have the following prices:

Strike Price	Call option price	Put option price
90	14.63	0.24
100	6.80	1.93
110	2.17	6.81

A butterfly spread on this stock has the following profit diagram.



The annual risk-free interest rate compounded continuously is 5%.

Determine which of the following will NOT produce this profit diagram.

- (A) Buy a 90 put, buy a 110 put, sell two 100 puts
- (B) Buy a 90 call, buy a 110 call, sell two 100 calls
- (C) Buy a 90 put, sell a 100 put, sell a 100 call, buy a 110 call
- (D) Buy one share of the stock, buy a 90 call, buy a 110 put, sell two 100 puts
- (E) Buy one share of the stock, buy a 90 put, buy a 110 call, sell two 100 calls.

10.

Stock XYZ has a current price of 100. The forward price for delivery of this stock in 1 year is 110.

Unless otherwise indicated, the stock pays no dividends and the annual effective risk-free interest rate is 10%.

Determine which of the following statements is FALSE.

- (A) The time-1 profit diagram and the time-1 payoff diagram for long positions in this forward contract are identical.
- (B) The time-1 profit for a long position in this forward contract is exactly opposite to the time-1 profit for the corresponding short forward position.
- (C) There is no comparative advantage to investing in the stock versus investing in the forward contract.
- (D) If the 10% interest rate was continuously compounded instead of annual effective, then it would be more beneficial to invest in the stock, rather than the forward contract.
- (E) If there was a dividend of 3.00 paid 6 months from now, then it would be more beneficial to invest in the stock, rather than the forward contract.



11.

Stock XYZ has the following characteristics:

- The current price is 40.
- The price of a 35-strike 1-year European call option is 9.12.
- The price of a 40-strike 1-year European call option is 6.22.
- The price of a 45-strike 1-year European call option is 4.08.

The annual effective risk-free interest rate is 8%.

Let  $S$  be the price of the stock one year from now.

All call positions being compared are long.

Determine the range for  $S$  such that the 45-strike call produce a higher profit than the 40-strike call, but a lower profit than the 35-strike call.

- (A)  $S < 38.13$
- (B)  $38.13 < S < 40.44$
- (C)  $40.44 < S < 42.31$
- (D)  $S > 42.31$
- (E) The range is empty.

12.

Consider a European put option on a stock index without dividends, with 6 months to expiration and a strike price of 1,000. Suppose that the annual nominal risk-free rate is 4% convertible semiannually, and that the put costs 74.20 today.

Calculate the price that the index must be in 6 months so that being long in the put would produce the same profit as being short in the put.

- (A) 922.83
- (B) 924.32
- (C) 1,000.00
- (D) 1,075.68
- (E) 1,077.17

13.

A trader shorts one share of a stock index for 50 and buys a 60-strike European call option on that stock that expires in 2 years for 10. Assume the annual effective risk-free interest rate is 3%.

The stock index increases to 75 after 2 years.

Calculate the profit on your combined position, and determine an alternative name for this combined position.

	<b>Profit</b>	<b>Name</b>
(A)	-22.64	Floor
(B)	-17.56	Floor
(C)	-22.64	Cap
(D)	-17.56	Cap
(E)	-22.64	“Written” Covered Call

14.

The current price of a non-dividend paying stock is 40 and the continuously compounded annual risk-free rate of return is 8%. You are given that the price of a 35-strike call option is 3.35 higher than the price of a 40-strike call option, where both options expire in 3 months.

Calculate the amount by which the price of an otherwise equivalent 40-strike put option exceeds the price of an otherwise equivalent 35-strike put option.

- (A) 1.55
- (B) 1.65
- (C) 1.75
- (D) 3.25
- (E) 3.35

15.

The current price of a non-dividend paying stock is 40 and the continuously compounded annual risk-free rate of return is 8%. You enter into a short position on 3 call options, each with 3 months to maturity, a strike price of 35, and an option premium of 6.13.

Simultaneously, you enter into a long position on 5 call options, each with 3 months to maturity, a strike price of 40, and an option premium of 2.78.

All 8 options are held until maturity.

Calculate the maximum possible profit and the maximum possible loss for the entire option portfolio.

	Maximum Profit	Maximum Loss
(A)	3.42	4.58
(B)	4.58	10.42
(C)	Unlimited	10.42
(D)	4.58	Unlimited
(E)	Unlimited	Unlimited

16.

The current price of a non-dividend paying stock is 40 and the continuously compounded annual risk-free rate of return is 8%. The following table shows call and put option premiums for three-month European of various exercise prices:

Exercise Price	Call Premium	Put Premium
35	6.13	0.44
40	2.78	1.99
45	0.97	5.08

A trader interested in speculating on volatility in the stock price is considering two investment strategies. The first is a 40-strike straddle. The second is a strangle consisting of a 35-strike put and a 45-strike call.

Determine the range of stock prices in 3 months for which the strangle outperforms the straddle.

- (A) The strangle never outperforms the straddle.
- (B)  $33.56 < S_T < 46.44$
- (C)  $35.13 < S_T < 44.87$
- (D)  $36.57 < S_T < 43.43$
- (E) The strangle always outperforms the straddle.

17.

The current price for a stock index is 1,000. The following premiums exist for various options to buy or sell the stock index six months from now:

Strike Price	Call Premium	Put Premium
950	120.41	51.78
1,000	93.81	74.20
1,050	71.80	101.21

Strategy I is to buy the 1,050-strike call and to sell the 950-strike call.

Strategy II is to buy the 1,050-strike put and to sell the 950-strike put.

Strategy III is to buy the 950-strike call, sell the 1,000-strike call, sell the 950-strike put, and buy the 1,000-strike put.

Assume that the price of the stock index in 6 months will be between 950 and 1,050.

Determine which, if any, of the three strategies will have greater payoffs in six months for lower prices of the stock index than for relatively higher prices.

- (A) None
- (B) I and II only
- (C) I and III only
- (D) II and III only
- (E) The correct answer is not given by (A), (B), (C), or (D)

18.

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:

<u>Market Price of Gold in one year</u>	<u>Probability</u>
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

19.

A producer of gold has expenses of 800 per ounce of gold produced. Assume that the cost of all other production-related expenses is negligible and that the producer will be able to sell all gold produced at the market price. In one year, the market price of gold will be one of three possible prices, corresponding to the following probability table:

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

The producer hedges the price of gold by buying a 1-year put option with an exercise price of 900 per ounce. The option costs 100 per ounce now, and the continuously compounded annual risk-free interest rate is 6%.

Calculate the expected 1-year profit per ounce of gold produced.

- (A) 0.00
- (B) 3.17
- (C) 6.33
- (D) 8.82
- (E) 11.74

20.

The current price of a stock is 200, and the continuously compounded annual risk-free interest rate is 4%. A dividend will be paid every quarter for the next 3 years, with the first dividend occurring 3 months from now. The amount of the first dividend is 1.50, but each subsequent dividend will be 1% higher than the one previously paid.

Calculate the fair price of a 3-year forward contract on this stock.

- (A) 200
- (B) 205
- (C) 210
- (D) 215
- (E) 220

21.

A market maker in stock index forward contracts observes a 6-month forward price of 112 on the index. The index spot price is 110 and the continuously compounded annual dividend yield on the index is 2%.

The continuously compounded risk-free interest rate is 5%.

Describe actions the market maker could take to exploit an arbitrage opportunity and calculate the resulting profit (per index unit).

- (A) Buy observed forward, sell synthetic forward, Profit = 0.34
- (B) Buy observed forward, sell synthetic forward, Profit = 0.78
- (C) Buy observed forward, sell synthetic forward, Profit = 1.35
- (D) Sell observed forward, buy synthetic forward, Profit = 0.78
- (E) Sell observed forward, buy synthetic forward, Profit = 0.34

22.

A farmer expects to sell 50 tons of pork bellies at the end of each of the next 3 years. Pork bellies forward price for delivery in 1 year is 1600 per ton. For delivery in 2 years, the forward price is 1700 per ton. Also, for delivery in 3 years, the forward price is 1800 per ton. Suppose that interest rates are determined from the following table:

Years to Maturity	Zero-Coupon Bond Yield
1	5.00%
2	5.50%
3	6.00%

The farmer uses a commodity swap to hedge the price for selling pork bellies.

Calculate the level amount he will receive each year (i.e., the swap price) for 50 tons.

- (A) 84,600
- (B) 84,800
- (C) 85,000
- (D) 85,200
- (E) 85,400



23.

You are given the following spot rates:

<u>Years to Maturity</u>	1	2	3	4	5
<u>Spot Rate</u>	4.00%	4.50%	5.25%	6.25%	7.50%

You enter into a 5-year interest rate swap (with a notional amount of 100,000) to pay a fixed rate and to receive a floating rate based on future 1-year LIBOR rates. If the swap has annual payments, what is the fixed rate you should pay?

- (A) 5.20%
- (B) 5.70%
- (C) 6.20%
- (D) 6.70%
- (E) 7.20%

24.

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.

25.

Determine which of the following statements concerning risk sharing, in the context of financial risk management, is LEAST accurate.

- (A) In an insurance market, individuals that do not incur losses have shared risk with individuals that do incur losses.
- (B) Insurance companies can share risk by ceding some of the excess risk from large claims to reinsurers.
- (C) Reinsurance companies can further share risk by investing in catastrophe bonds.
- (D) Risk sharing reduces diversifiable risk, more so than reducing non-diversifiable risk.
- (E) Ideally, any risk-sharing mechanism should benefit all parties sharing the risk.

26.

Determine which, if any, of the following positions has or have an unlimited loss potential from adverse price movement in the underlying asset, regardless of the initial premium received.

- I. Short 1 forward contract
  - II. Short 1 call option
  - III. Short 1 put option
- 
- (A) None
  - (B) I and II only
  - (C) I and III only
  - (D) II and III only
  - (E) The correct answer is not given by (A), (B), (C), or (D)

27.

Determine which of the following positions benefit from falling prices in the underlying asset.

- I. Long one homeowner's insurance contract (where the falling price is due to damage covered by the insurance)
- II. Long one equity-linked CD
- III. Long one synthetic forward contract

- (A) I only
- (B) II only
- (C) III only
- (D) I, II, and III
- (E) The correct answer is not given by (A), (B), (C), or (D)

28.

Determine which of the following is NOT among a firm's rationales to hedge.

- (A) To reduce taxes through income shifting
- (B) To reduce the probability of bankruptcy or distress
- (C) To reduce the costs associated with external financing
- (D) To reduce the exposure to exchange rate risk
- (E) To reduce the debt proportion of external financing

29.

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
Fully leveraged purchase	B
Prepaid forward contract	C
Forward contract	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)  $A < C < B < D$

30.

Determine which of the following is NOT a distinguishing characteristic of futures contracts, relative to forward contracts.

- (A) Contracts are settled daily, and marked-to-market.
- (B) Contracts are more liquid, as one can offset an obligation by taking the opposite position.
- (C) Contracts are more customized to suit the buyer's needs.
- (D) Contracts are structured to minimize the effects of credit risk.
- (E) Contracts have price limits, beyond which trading may be temporarily halted.

31. (formerly Question 58 from the Interest Theory section)

You are given the following information:

- (i) The current price of stock A is 50.
- (ii) Stock A will not pay any dividends in the next year.
- (iii) The annual effective risk-free interest rate is 6%.
- (iv) Each transaction costs 1.
- (v) There are no transaction costs when the forward is settled.

Based on no arbitrage, calculate the maximum price of a one-year forward.

- (A) 49.06
- (B) 50.00
- (C) 50.88
- (D) 53.00
- (E) 55.12

32.

The S&P 500 index is currently at 1500. Judy decides to enter into 20 S&P 500 futures contracts. Each contract permits delivery of 250 units of the index exactly 3 months from now. The initial margin is 10% of the notional value, and the maintenance margin is 75% of the initial margin. Judy earns a continuously compounded return of 5% on her margin balance. The position is marked-to-market on a daily basis.

One day later, the S&P 500 index drops to 1450, which may require a margin call.

Calculate the amount of this margin call (if any).

- (A) 0 (i.e., no margin call is needed)
- (B) 24,047
- (C) 62,397
- (D) 249,897
- (E) 500,103

33.

Several years ago, John bought three separate 6-month options on the same stock.

- Option I was an American-style put with strike price 20.
- Option II was a Bermuda-style call with strike price 25, where exercise was allowed at any time following an initial 3-month period of call protection.
- Option III was a European-style put with strike price 30.

When the options were bought, the stock price was 20.

When the options expired, the stock price was 26.

The table below gives the maximum and minimum stock price during the 6 month period:

Time Period:	1 <sup>st</sup> 3 months of Option Term	2 <sup>nd</sup> 3 months of Option Term
Maximum Stock Price	24	28
Minimum Stock Price	18	22

John exercised each option at the optimal time.

Rank the three options, from highest to lowest payoff.

- (A)  $I > II > III$
- (B)  $I > III > II$
- (C)  $II > I > III$
- (D)  $III > I > II$
- (E)  $III > II > I$

34.

The two-year forward price per ton of soybeans is 4% higher than the one-year forward price per ton. The one-year spot rate is 5% and the forward rate from the end of the first year to the end of the second year is 6%.

A soybean buyer and a soybean supplier agree that the supplier will deliver 50,000 tons at the end of each of the next two years, and the buyer will pay the supplier the applicable forward price per ton.

A swap counterparty then makes a fair deal with the buyer. The buyer pays the same price per ton each year for the soybeans, in return for the counterparty paying the applicable forward prices.

Determine the type of one-year loan that occurs between the buyer and the swap counterparty in this deal.

- (A) The buyer borrows from the swap counterparty at 5% annual effective interest.
- (B) The buyer borrows from the swap counterparty at 6% annual effective interest.
- (C) The buyer lends to the swap counterparty at 4% annual effective interest.
- (D) The buyer lends to the swap counterparty at 5% annual effective interest.
- (E) The buyer lends to the swap counterparty at 6% annual effective interest.