Risk Management and Derivatives 2026
Shanghai Jiao Tong University
Summer School 2026
Midterm Exam

Reading time: 10 minutes. **Writing time:** 120 minutes.
Total marks: 100. **Calculators are permitted.**
Instructions: Answer **all** questions. In Section A, circle the letter of the single best answer. In Section B show your working; a correct number with no method earns little credit. Section C is a short essay. Interest rates are **continuously compounded** unless stated otherwise.

Structure:

- **Section A** – Multiple choice: 20 questions, 2.5 marks each (**50 marks**).
- **Section B** – One analytical problem in five parts (**30 marks**).
- **Section C** – One short essay (**20 marks**).

Useful formulas. Hedge ratio $h^* = \rho\,\sigma_S/\sigma_F$; contracts $N^* = h^* Q_A/Q_F$; hedge effectiveness $= \rho^2$; basis $b = S - F$; conversions $R_c = m\ln(1+R_m/m)$, $R_m = m(e^{R_c/m}-1)$; $PV = CF_T\,e^{-z(T)T}$; $f(T_1,T_2) = \dfrac{z(T_2)T_2 - z(T_1)T_1}{T_2 - T_1}$; $\Delta B \approx -B\,D\,\Delta y$; duration hedge $N = \dfrac{P\,D_P}{V_F\,D_F}$; $F_0 = S_0 e^{rT}$, $F_0 = (S_0 - I)e^{rT}$, $F_0 = S_0 e^{(r-q)T}$, $F_0 = S_0 e^{(r+u-y)T}$; delivery cost of bond i = quote$_i - F \times CF_i$; SOFR futures price = 100− rate.

Section A: Multiple Choice (20 questions × 2.5 marks = 50 marks)

1. A trader is *short* a forward contract with delivery price $K = \$90$. At maturity the spot price is $S_T = \$75$. The payoff to the short position is:

(A) +\$15.

(B) −\$15.

(C) \$0.

(D) +\$75.

2. An *arbitrageur* is a market participant who:

(A) reduces an existing business exposure.

(B) takes on risk to profit from a market view.

(C) locks in a riskless profit from a price discrepancy.

(D) guarantees both sides of every cleared trade.

3. The main purpose of daily settlement (marking to market) in futures markets is that it:

(A) stops losses accumulating unpaid over the life of the contract.

(B) guarantees each trader a small profit on every trading day.

(C) removes the need for traders to post any initial margin.

(D) fixes the futures price at its level until the delivery day.

4. Two traders, neither of whom has any existing position, trade one futures contract with each other. As a result:

(A) volume rises by one; open interest is unchanged.

(B) volume and open interest each rise by one.

(C) open interest rises by one; volume is unchanged.

(D) neither volume nor open interest changes.

5. A copper producer will sell its output in three months and fears a price fall. Its hedge is:

(A) a long futures position.

(B) a larger inventory of copper.

(C) a short futures position.

(D) no position, since producers gain from high prices.

6. A hedger is *short* futures against a future sale of the asset. Between opening and closing the hedge, the basis $b = S - F$ strengthens unexpectedly. The hedger's effective sale price is:

(A) lower than expected.

(B) exactly the initial futures price.

(C) unchanged from the initial spot price.

(D) higher than expected.

7. The maximum possible loss for the *buyer* of an option is:

(A) the premium paid.

(B) the strike price.

(C) unlimited.

(D) the spot price at expiry.

8. A continuously compounded rate of 5% is equivalent to an annually compounded rate of:

(A) 5.13%.

(B) 5.00%.

(C) 4.88%.

(D) 5.25%.

9. *Bootstrapping* a zero curve means:

(A) averaging the quoted yields across all the traded bonds.

(B) forecasting the path of future central bank rate decisions.

(C) solving for zero rates one maturity at a time from bond prices.

(D) fitting a straight line through two observed bond yields.

10. A forward rate agreement (FRA) struck at today's forward rate:

(A) costs the present value of the notional to enter.

(B) costs nothing to enter.

(C) requires physical delivery of a bond.

(D) locks the borrower's credit spread as well.

11. A bond portfolio is worth \$200 million with duration 4. If all yields *fall* by 50 basis points, the portfolio approximately:

(A) loses \$4 million.

(B) gains \$2 million.

(C) gains \$4 million.

(D) loses \$2 million.

12. A share pays no dividends and trades at $S_0 = \$50$; the one-year rate is 2%. The one-year forward price is:

(A) \$51.01.

(B) \$50.00.

(C) \$49.01.

(D) \$52.04.

13. The same share as in Question 12 will instead pay a \$2 dividend in six months (present value \$1.98). The one-year forward price becomes:

(A) \$51.01.

(B) \$53.05.

(C) \$50.02.

(D) \$48.99.

14. A long forward position was entered some time ago at delivery price K. Today the forward price for the same maturity is F. The current value of the position is:

(A) always zero.

(B) $(K - F)$ discounted to today.

(C) $S_0 - K$.

(D) $(F - K)\, e^{-rT}$.

15. The dollar interest rate is 4.5% and the yuan interest rate is 2%. In yuan terms, the one-year forward dollar trades:

(A) at a premium to spot.

(B) at a discount to spot.

(C) exactly at spot.

(D) wherever the market forecasts.

16. In April 2020 a crude oil futures contract settled at a *negative* price while the next month's contract stayed positive. The episode showed that:

(A) the cost-of-carry pricing relation had simply failed.

(B) the exchange had published an erroneous settlement price.

(C) with storage full, the carry arbitrage could not run.

(D) crude oil had permanently lost its economic value.

17. In a Treasury bond futures delivery, the invoice amount the long pays the short is:

(A) $F \times CF$ minus accrued interest.

(B) F plus accrued interest.

(C) the quoted bond price times CF.

(D) $F \times CF$ plus accrued interest.

18. The futures price is $F = 95$. Bond P is quoted at 101.00 with conversion factor 1.06; bond Q at 93.00 with conversion factor 0.97. The cheapest to deliver is:

(A) bond Q, at a cost of 0.85.

(B) bond P, at a cost of 0.85.

(C) bond Q, at a cost of 0.30.

(D) bond P, at a cost of 0.30.

19. A fund manager wants to hedge a long government bond portfolio (value P, duration D_P) using bond futures (contract value V_F, duration D_F). The hedge is:

(A) long futures, $N = P\,D_P/(V_F\,D_F)$ contracts.

(B) short futures, $N = P\,D_P/(V_F\,D_F)$ contracts.

(C) short futures, $N = V_F\,D_F/(P\,D_P)$ contracts.

(D) long futures, $N = P/V_F$ contracts.

20. In March 2020, funds running the Treasury cash-futures basis trade suffered forced unwinds even though the trade holds government bonds and is close to duration-neutral. The episode showed that:

(A) government bonds carry more default risk than markets assume.

(B) leveraged positions can be forced to unwind when margins tighten.

(C) the basis trade is riskless once its duration is hedged.

(D) futures prices always track the cash bonds exactly, at all times.

Section B: Analytical Problem (30 marks)

An airline will buy **500,000 barrels** of jet fuel in three months and hedges with crude-oil futures; each contract covers **1,000 barrels**. Current crude futures price: $F_1 = \$85$ per barrel. From monthly price-change data: $\sigma_S = 2$ (jet-fuel spot changes), $\sigma_F = 3$ (crude-futures changes), $\rho = 0.9$. Margin per contract: initial \$6,000, maintenance \$4,500.

(a) **[6 marks]** Compute the minimum-variance hedge ratio h^* and the number of contracts N^*. Should the airline be long or short, and why?

(b) **[6 marks]** What fraction of the variance of the fuel cost does this hedge remove, and what is the remaining risk called?

(c) **[6 marks]** On the first day of the hedge the crude futures price *falls* by \$2, to \$83. For one contract, compute the variation-margin flow and the margin balance at the end of the day. Does a margin call occur, and if so, how much cash must the airline post in total across all contracts?

(d) **[6 marks]** Three months later the airline buys its fuel and closes the hedge. Crude futures have risen from \$85 to \$95, and jet fuel spot is \$97 per barrel. Compute the total futures profit, the airline's net fuel bill, and the effective price paid per barrel.

(e) **[6 marks]** To finance the fuel purchase, the airline plans to borrow for six months starting in three months. The three-month zero rate is 4.2% and the nine-month zero rate is 4.8%, both continuously compounded. Compute the forward rate for the period between month three and month nine, and name the contract the airline could enter today to lock in this borrowing rate.

Section C: Essay (20 marks)

Read the scenario and write a short essay of **about half a page** (roughly 5 to 8 sentences). Marks are for clear economic reasoning, not length.

A fuel-supply company signs contracts to deliver fuel to customers at fixed prices for the next ten years. To hedge this long-term commitment it buys short-dated fuel futures, rolling them into the next month as each contract expires. The direction is right: if fuel prices rise, the futures gain what the customer contracts lose. Two years in, fuel prices fall steadily instead. The futures positions bleed cash through daily settlement month after month, while the offsetting gains on the customer contracts will arrive only over the coming decade. Facing mounting margin payments, the parent company loses patience and closes the entire position near the bottom of the market, at a loss of more than a billion dollars.

Question [20 marks]. The hedge had the right direction, yet the outcome was a disaster. Using the tools of this course, explain what was wrong with the hedge's design, why falling prices caused a cash crisis even though the firm's overall economic position was sound, and what lesson this holds for how hedging programmes should be built.