PRACTICE PRELIM 2

VERSION: DELTA-2

NAME:

1. Prelim 2 has *three* problems and is worth a total of XX points.
2. You may use your course notes (on the computer, iPad, etc., or paper) or other course materials, e.g., discussion problems, to formulate your solutions.
3. Do not consult with any other person regarding the prelim (except the TAs or JV), or use *any form of electronic communication* to discuss the prelim questions. Violation of this policy will result in a ZERO for the prelim.
4. Do not consult the interwebs to search for the prelim questions/solutions. Violation of this policy will result in a ZERO for the prelim.
5. Show your work and state all assumptions or simplifications.
6. Good luck!

1. (XX points) You are a Quant at Olin Financial. You have been tasked with computing the interest rate risk on U.S Treasury bond positions held by Olin; Olin holds 10 $\times$ 10-year zero-coupon STRIP products, each with a face value of 10,000 USD.

   Assumptions: (i) Olin Financial purchased the bonds at a Treasury auction on 08/18/22 with a spot rate of 2.88%; (ii) the spot rate on 10/28/22 was 4.02%; (iii) Olin Financial purchased the bonds at a fair price.

   Use the Jupyter notebook `CHEME-5660-PP2-Debt.ipynb` and any associated data sets to answer the following questions:

   a) What price did Olin Financial pay for the bonds at the Treasury auction on 08/18/22?

   b) If Olin Financial wanted to liquidate their bond position on 10/28/22, what capital gain or loss (assuming fair pricing) would they experience?

   c) Using the estimates of future spot rates computed from the Cox-Ingersoll-Ross (CIR) model, estimate the distribution of bond prices five years from now. The CIR model for the spot rate at time t, denoted by r_t, is given by:

   $$dr_r = (\theta - \alpha r_t)\, dt + \sigma\sqrt{r_t} \cdot dW_t \tag{1}$$

   where θ is the long-term spot rate, α is the mean-reversion rate, and σ is the volatility of the spot rate. For this calculation: θ = 2.11%, α = 0.90 and σ = 0.66. Use N = 25,000 sample paths.

2. (XX points) You are a Quant at Olin Financial, an up-and-coming hedge fund. You have been tasked with computing the distribution of possible future share price values for firm XYZ. Suppose the share price of firm XYZ at time t, denoted by $S(t)$, is governed by a geometric Brownian motion with the solution:

$$S(t) = S_\circ \exp\left(\left(\mu - \frac{\sigma^2}{2}\right)(t - t_\circ) + \sigma\sqrt{t - t_\circ} \cdot Z(0.1)\right) \tag{2}$$

where $S_\circ$ denotes the initial share price at $t_\circ < t$, μ denotes the rate of return parameter, $\sigma > 0$ denotes the volatility parameter and $Z\left(0, 1\right)$ denotes a standard-normal random variable.

Assumptions: (i) the implied volatility of an At the Money (ATM) 12/16 option on XYZ is 49.15%; (ii) there are 49 days to 12/16; (iii) the current share price of XYZ is 53.24 USD/share.

Use the Jupyter notebook `CHEME-5660-PP2-Equity.ipynb`, and any associated data sets, to answer the following questions:

a) Estimate the rate of return parameter μ from historical OHLC data for firm XYZ.

b) Estimate the volatility parameter σ from historical OHLC data for firm XYZ.

c) Using your estimates of the μ and σ parameters, along with (2), estimate a distribution of possible future share price values of XYZ on 12/16. Generate N = 10,000 sample paths and let $t_\circ = 0$ (now).

3. (XX points) A trader at Olin Financial, an up-and-coming hedge fund, sold a short strangle on firm XYZ with a 12/16 expiration.

   Assumptions: (i) the short put (contract 1) has a strike price of K_1 = 50.0 USD/share and an implied volatility of 50.79%; (ii) the short call (contract 2) has a strike price of K_2 = 57.50 USD/share and an implied volatility of 46.79%; (iii) there are 49 days to 12/16; (iv) the current share price of XYZ is 53.60 USD/share; (v) the risk-free rate is 4.05%.

   Use the Jupyter notebook `CHEME-5660-PP2-Options.ipynb`, and any associated data sets, to answer the following questions:

   a) Compute the premiums for the put $\mathcal{P}_1$ and call $\mathcal{P}_2$ contracts for the 12/16 short strangle on firm XYZ using the Cox, Ross, and Rubinstein (CRR) binomial lattice model.

   b) Compute the maximum profit and break-even points for the Olin Financial short strangle position on XYZ.

   c) Compute the probability for the profit at expiration for the short strangle position using the share price estimates from the `Equity` notebook.