Instructions

- **Due date: Tuesday, February 8th before 9:00am**.
- Please submit using the assignment submission links on Canvas. Do not email me your solutions. If you wish to hand write solutions please take a clear photo and upload this file onto Canvas.
- There will be ten problem sets – the schedule is laid out in the syllabus. Each will be graded out of 15 points.
- These are group problem sets. You may choose different groups for each problem set if you desire. **No more than 3 students per group. You should make only one submission per group. Clearly indicate the group members on your submission.**
- You are expected to follow the University's Student Code of Academic Integrity. The relevant section may be found at https://studentcode.illinois.edu/article1/part4/1-402/.

Questions

Question 1 (10 points)

Data Suppose it is September 1st, 2020. The stock price of Meta Platforms (previously Facebook, FB) on 09/01/2020 was \$296.43. The option prices were quoted as of 12:00 pm EDT 09/01/2020. The options all would expire on September 18th, 2020.
To find the future value of $\$A$, use LIBOR rates and simple compounding: $FV(A) = A(1+rT)$, Assume r is 0.50% (0.005), and use Actual/360 day count convention to find time to maturity, T, in years. Data on option prices is given in the attached spreadsheet `PS2_Q1_data.xlsx`.

Explain and show on a diagram the **profit** at maturity from the following combinations of positions. Show the profit from each option or stock AND the profit from the combined position on one graph. Label carefully all turning points and profit levels in the positions.
You should have TWO graphs each for parts (a), (b), and (c), one for the combination given you and one for the equivalent strategy.
Recall: each option contract is also on 100 shares, but you can treat them as an option on a single share, except in parts (a) and (d). In parts (a) and (d), you can treat 100 shares as a single share if you wish. Use the bid-ask midpoints as the option price until part (e).

(a) Short one stock (a roundtrip), short a 285 put, and long a 300 call. Then try to find an equivalent strategy with other options and stock positions (bends at same prices, same slopes on all sections, **but levels may be different**).

(b) Sell one 290 call and sell one 295 put. Then try to find an equivalent strategy with other options and stock positions.

(c) Long one stock (round trip), short a call at 285, and long a call at 295. Then try to find an equivalent strategy with other options and stock positions.

(d) Can you find an arbitrage? If you succeed in finding a sure way to make money, your profit should be entirely above the x-axis. Is there another arbitrage, one which has a higher profit? Find **the best arbitrage** you can, and draw a profit at maturity diagram. Be careful to document exactly what position in which options you choose.

Note: You are constrained to positions that involve buying or selling only one of each option series (that is, you can buy or sell a 285 call and a 285 put, a 290 call and a 290 put, etc., but you cannot buy, for instance, two 295 calls). If required, you can buy or sell more than one stock (or round trip).

(e) Looking more closely at the option price data, you will observe that you should not use the midpoints but use the bid-ask prices. Is your best strategy in part (e) still an arbitrage opportunity if you use the correct prices (either bid/ask) for the options and stock?

Question 2 (5 points)

Morgan Stanley issued Buffered PLUS Contracts on the S&P 500 Index denominated in USD (full details are here) that matured on 27 Feb 2023 and has payoffs based on the value of the S&P 500 on 27 Feb 2023.[1] These notes were marketed and priced on 26 Aug 2020, on which date the S&P 500 index closed at 3,478.73. The contract payoff at maturity of 27 Feb 2023 is as follows

Scenario	**Payoff**
The final underlier level (February 27) is *greater than or equal to* 107.625% of the initial underlier level.	$\$1,152.50$
The final index value (February 27) is *greater than* the initial index value but less than 107.625% of the initial underlier level.	$\$1,000 +$ leveraged upside payment
The final index value (February 27) is *less than or equal to* the initial index value but has decreased from the initial index value by an amount *less than or equal to* 10%.	$\$1,000$
If the final index value (February 27) is *less than* the initial index value and has decreased from the initial index value by an amount *greater than* 10%.	$\$1,000 \times$ index performance factor $+ \$100$

where

$$\textbf{leveraged upside payment} = \$1,000 \times 2 \times (\text{final index value} - \text{initial index value})/\text{initial index value},$$

$$\textbf{index performance factor} = \text{final index value}/\text{initial index value}.$$

[1] Actually, the maturity is on March 2nd, but this makes things a little more confusing, so let's assume that the maturity date is the same as the day where the final index level is recorded.

(a) Draw the payoff diagram for the Buffered PLUS with the possible values of the S&P 500 (not the return) on February 27, 2023 the x-axis and payoff, based upon an investment of \$1000, on the y-axis.

(b) Find a portfolio of zero-coupon bonds and European options that can replicate the payoff of the plan, based on an investment of \$1000.

Hint: To get the number of options to enter into, you will need to know the slope of the lines in part (a). These could be slightly strange numbers, you may also need a bond.)

(c) What information would you liked to have had in order to determine the value of the Buffered PLUS on August 26, 2020? (e.g., what option prices, what interest rates, stock prices etc.) Based on some brief research do you think that this information would be available?

Note: Do not try to value this product at this point. We will do this in Problem Set 10.