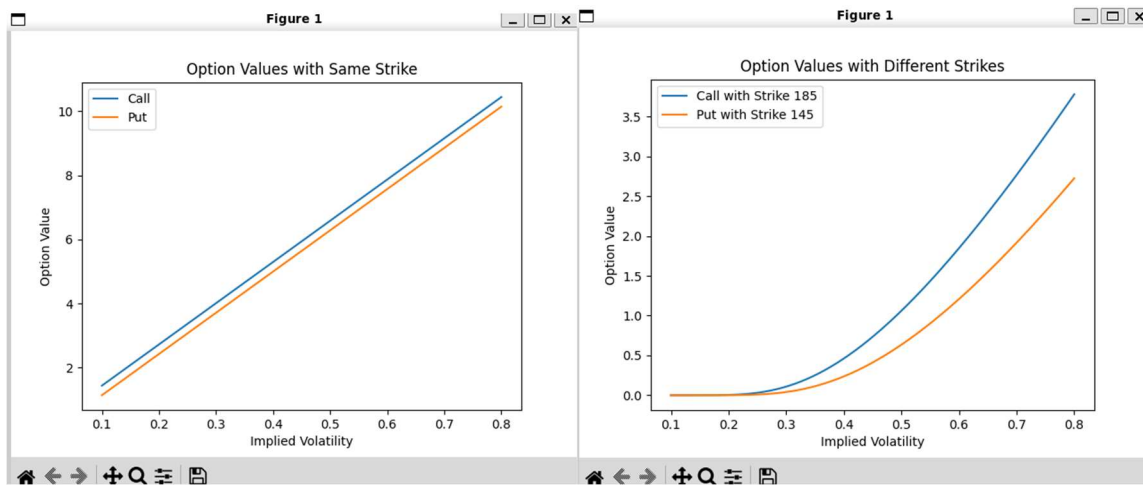


### Prob1.

After calculating the time to maturity based on the given value, I get the time to maturity is 0.0384. After that I checked put call parity with derived results with an absolute tolerance of 0.1 which return no problem. Then, since we don't know the strike price of call and put, I classify them into 2 situations, one is that put and call have the same strike price and another is put and call have different strike price and plot the above diagram. From the graph of both situations, I can find that the value of put and call options have the same trend, with the implied volatility increased, their value increased. The graph with same strike price shows a linear relationship and the graph with non-linear shows a non-linear relationship. From supply and demand side, when the demand of the stock goes up, and supply of the stock is limited or goes down, the expectation of the stock will go up, implied volatility will go up and thus the price will go up. Similarly, if the demand goes down but supply is too much, the expectation of the stock will go down, implied volatility will go down and thus the price will go down.



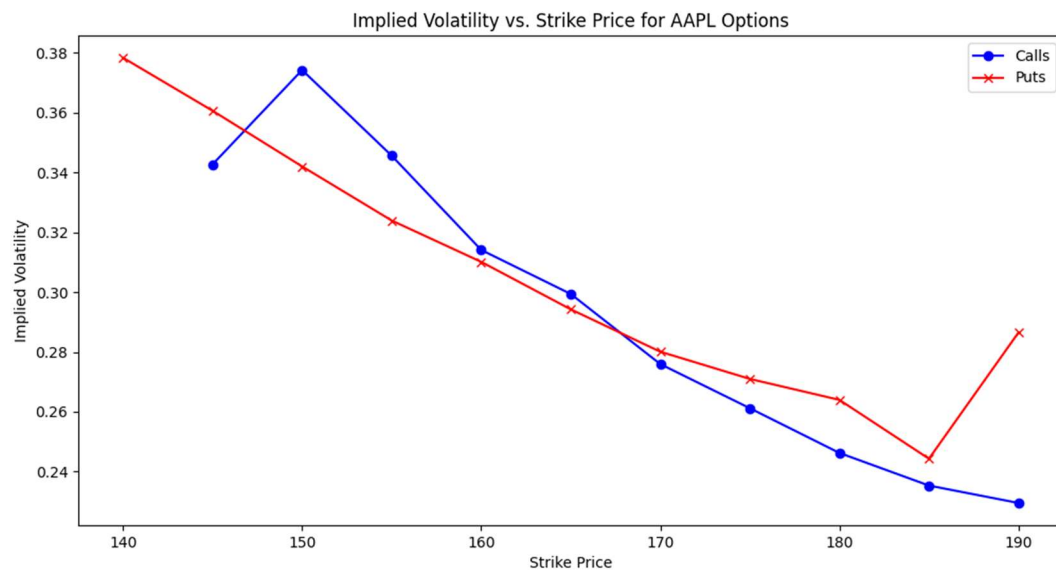
### Prob 2.

After calculating the volatility for each option, I can plot the graph below of put and call option with such trend. The result of implied volatility is shown:

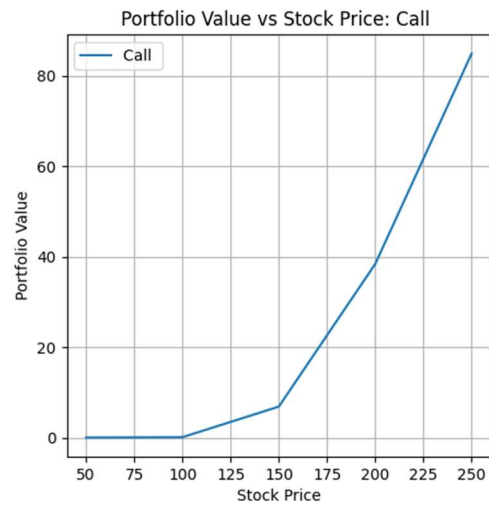
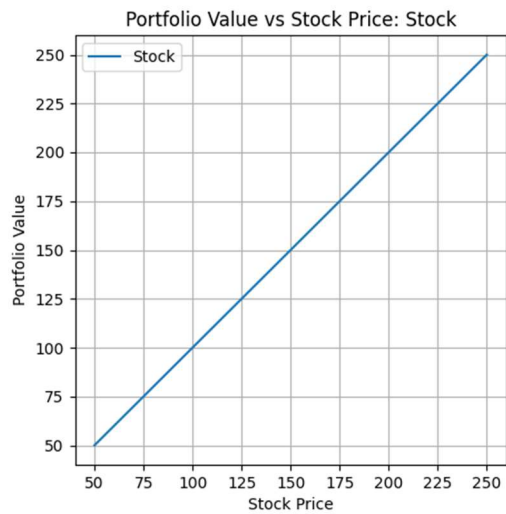
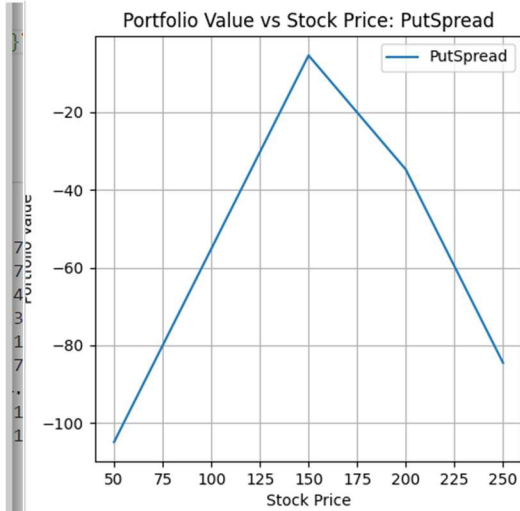
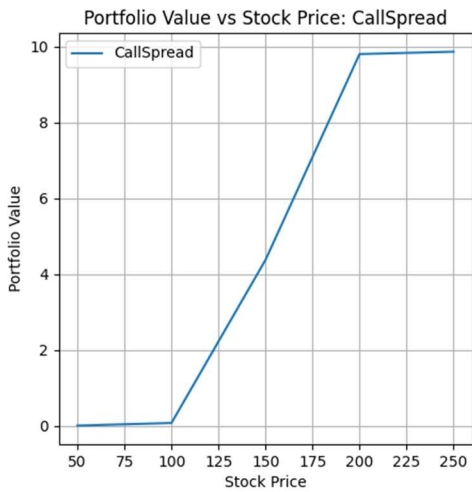
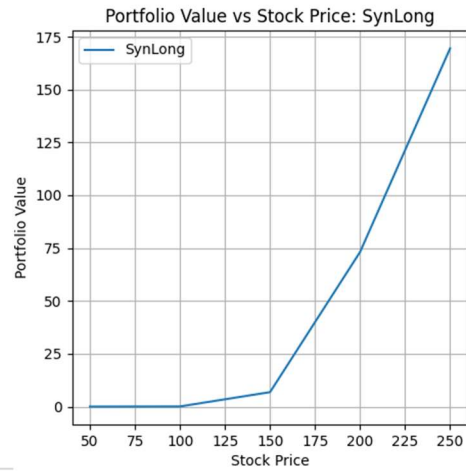
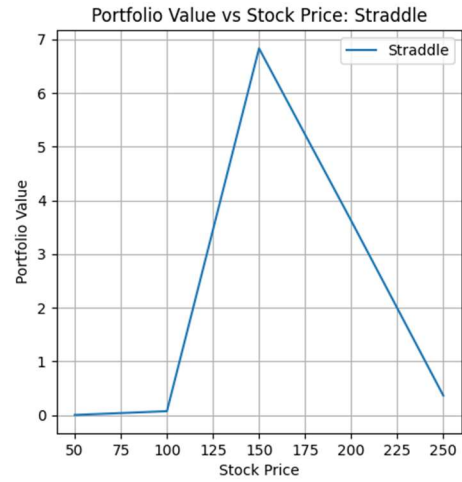
Time, weeks, not 100 days

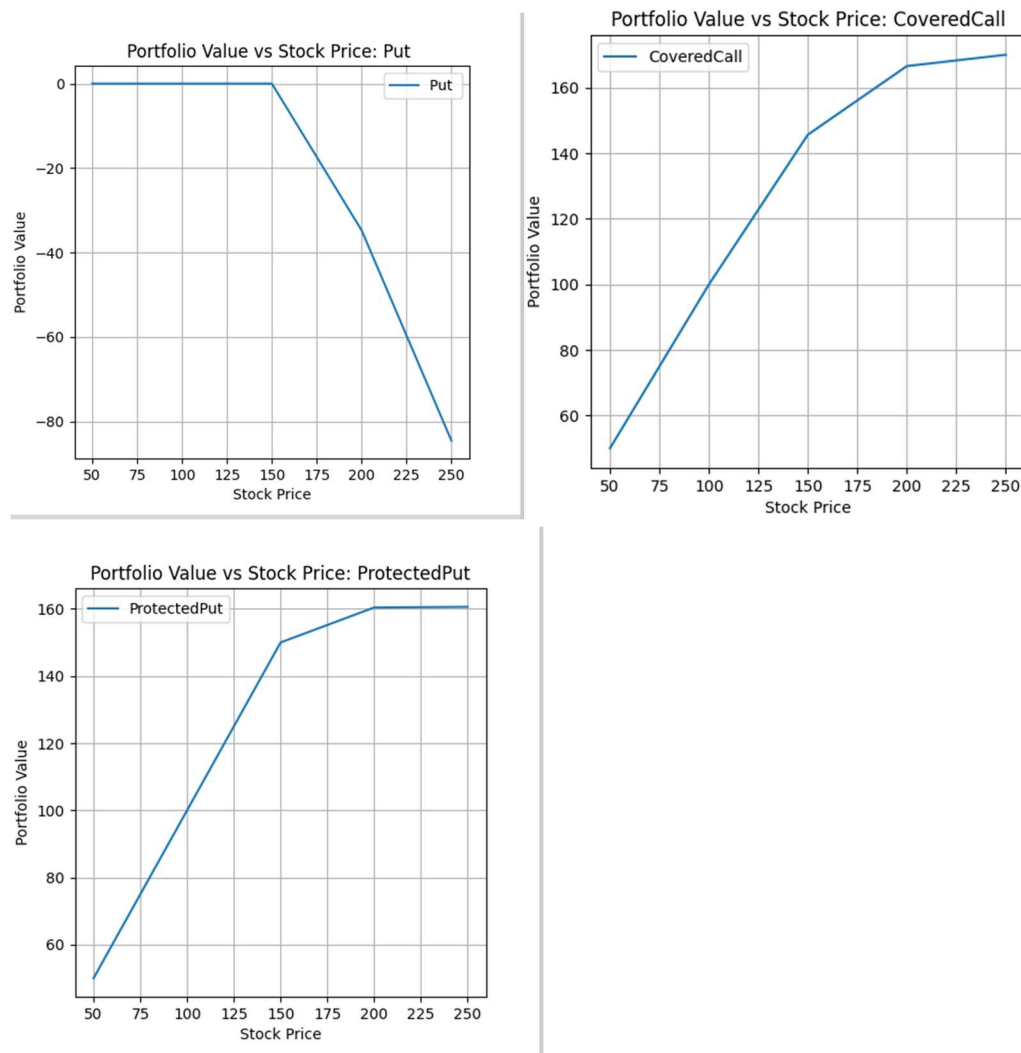
	Type	Strike	Last Price	Implied Volatility
0	Call	140	30.95	NaN
1	Call	145	26.74	0.342728
2	Call	150	22.80	0.374270
3	Call	155	18.40	0.345630
4	Call	160	14.15	0.314111
5	Call	165	10.55	0.299383
6	Call	170	7.21	0.275944
7	Call	175	4.63	0.261183
8	Call	180	2.67	0.246236
9	Call	185	1.40	0.235327
10	Call	190	0.69	0.229500
11	Put	140	0.61	0.378369
12	Put	145	0.92	0.360649
13	Put	150	1.36	0.342034
14	Put	155	2.00	0.323954
15	Put	160	2.99	0.310123
16	Put	165	4.32	0.294251
17	Put	170	6.16	0.280079
18	Put	175	8.68	0.270984
19	Put	180	11.83	0.263976
20	Put	185	15.30	0.244299
21	Put	190	20.16	0.286510

The shape of the graph is quite interesting. With the strike price going up, call and put show total different behaviors. Call option begins with a increasing implied volatility until reaching the peak then goes down, but put option is different, which begins with a decreasing implied volatility until reaching the bottom and then goes up. The downward trend can be due to a demand of downside protection, which investors are concerned about some negative impact may cause stock decrease, thus they want to buy stock with lower strike price to protect their portfolio. And the transition for call and put option can be due to there are some investors who want to take more risks and get a high return, therefore there are some increasing at the begin of call and end of put.



Prob3.





I can plot these graphs based on the requirements.

For portfolio Call and put options, the money can be made only when the stock price goes up or down, they are basic options. For callspread and putspread, comparing to basic options, they have lower return. For portfolio coveredcall and portectedput, they employ a combination of stock and option, thus the portfolio values are similar to those basic options. For Synlong and stock, their patterns are very similar, but synlong tempts to maximize the return with a high risk. For portfolio straddle, the relationship between value and price is strange, the value will change always follow the price change, regardless of whether price is increased or decreased.

After simulation of AAPL 10 days returns, I get the following data:

Portfolio: Straddle

Mean: 7.50

VaR (95%): 3.39

Expected Shortfall (ES): 2.79

Portfolio: SynLong

Mean: 7.88

VaR (95%): 3.39

Expected Shortfall (ES): 2.79

Portfolio: CallSpread

Mean: 4.59

VaR (95%): 2.55

Expected Shortfall (ES): 2.16

Portfolio: PutSpread

Mean: -5.94

VaR (95%): -17.16

Expected Shortfall (ES): -20.20

Portfolio: Stock

Mean: 151.25

VaR (95%): 138.16

Expected Shortfall (ES): 135.12

Portfolio: Call

Mean: 7.69

VaR (95%): 3.39

Expected Shortfall (ES): 2.79

Portfolio: Put

Mean: -0.19

VaR (95%): -0.12

Expected Shortfall (ES): -3.73

Portfolio: CoveredCall

Mean: 146.15

VaR (95%): 136.33

Expected Shortfall (ES): 133.67

Portfolio: ProtectedPut

Mean: 150.64

VaR (95%): 138.16

Expected Shortfall (ES): 135.12

These data somehow shows a large gap between each other, but from the VaR, I think the protectedPut and stock are relatively risky because they have largest VaR value which can be really risky but with real high return.