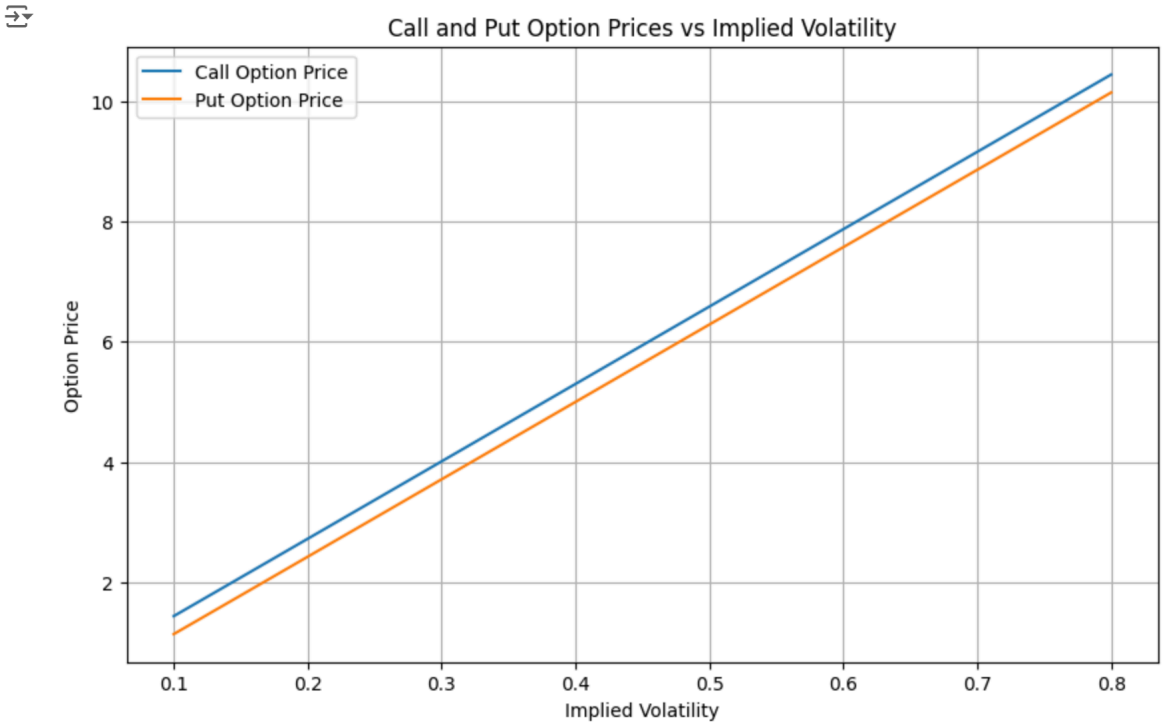
Problem 1

Discuss:
We can find from the graph that when implied volatility increases, the price of both the call and put options increases. Because higher implied volatility indicates greater uncertainty, which leads to higher option prices.

Supply and demand dynamics in the options market can also impact implied volatility. Higher demand for options increases their prices, leading to higher implied volatility. Conversely, higher supply of options decreases prices, resulting in lower implied volatility. Implied volatility thus reflects market sentiment and the balance of supply and demand in the options market.



Problem 2

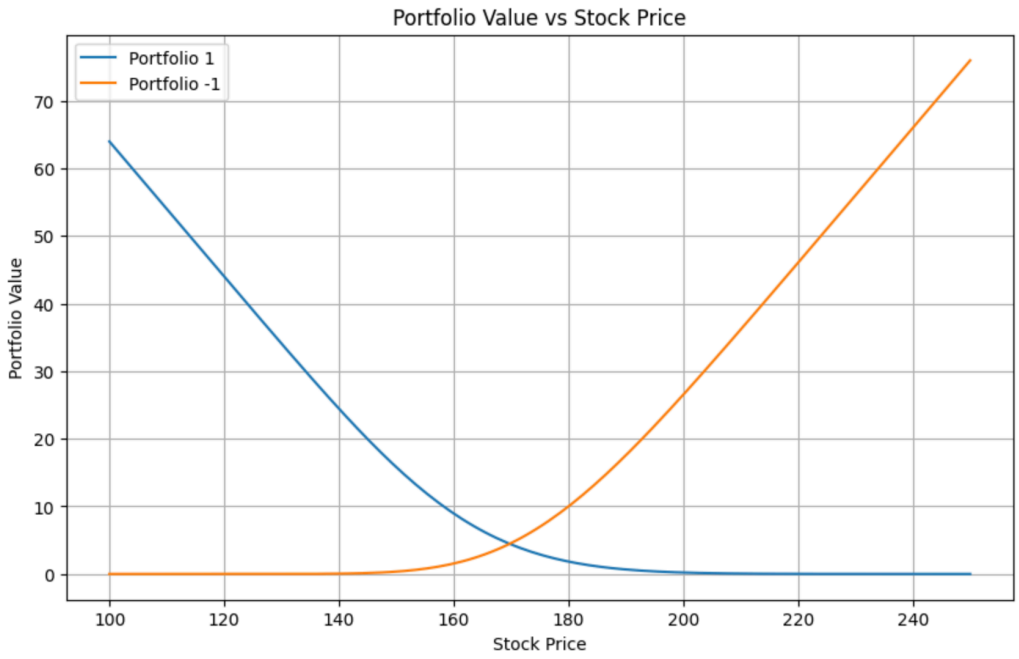
The graph shows higher implied volatility (IV) for lower strike prices in both puts and calls, with a steeper drop for calls. This shape often results from demand for downside protection (higher demand for OTM puts) and speculation (lower IVs in OTM calls). Higher demand for protective puts drives up their IV, while stable or

bullish sentiment keeps IV lower for calls as strike price increases. This reflects the market's risk and sentiment dynamics.

Problem 3

The plot shows two portfolios with values diverging as the stock price changes. The blue line (Portfolio 1) decreases as the stock price rises, resembling a put option (benefiting from lower prices). The orange line (Portfolio –1) increases with the stock price, resembling a call option (benefiting from higher prices).

According to put–call parity, if we combine a long call (orange) and a short put (blue), the result should mimic holding the stock itself, which would have a linear payoff equivalent to the stock price. The observed opposite movements in the portfolios reflect this relationship, as each portfolio is tied to the underlying's price in a way that maintains the put–call parity balance.



The plot shows simulated prices declining over the 10 days, with a few fluctuations. The close alignment of VaR and ES suggests that, in this scenario, extreme price drops beyond VaR are moderate rather than severe. These metrics highlight potential downside risk, useful for managing portfolio exposure to AAPL.

```
Mean price after 10 days: 164.83642151638338
Value at Risk (VaR) at 95% confidence: 159.50385742575483
Expected Shortfall (ES) at 95% confidence: 159.3686220197906
```