MA374 – Financial Engineering II

LAB 10 Report

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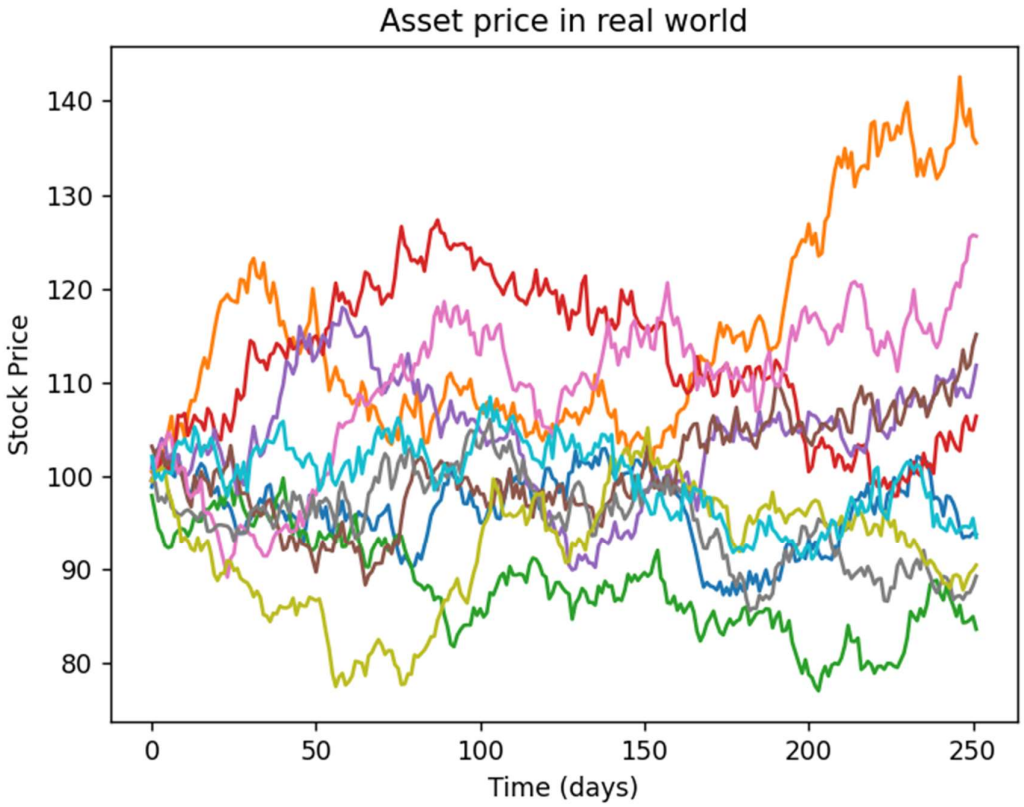
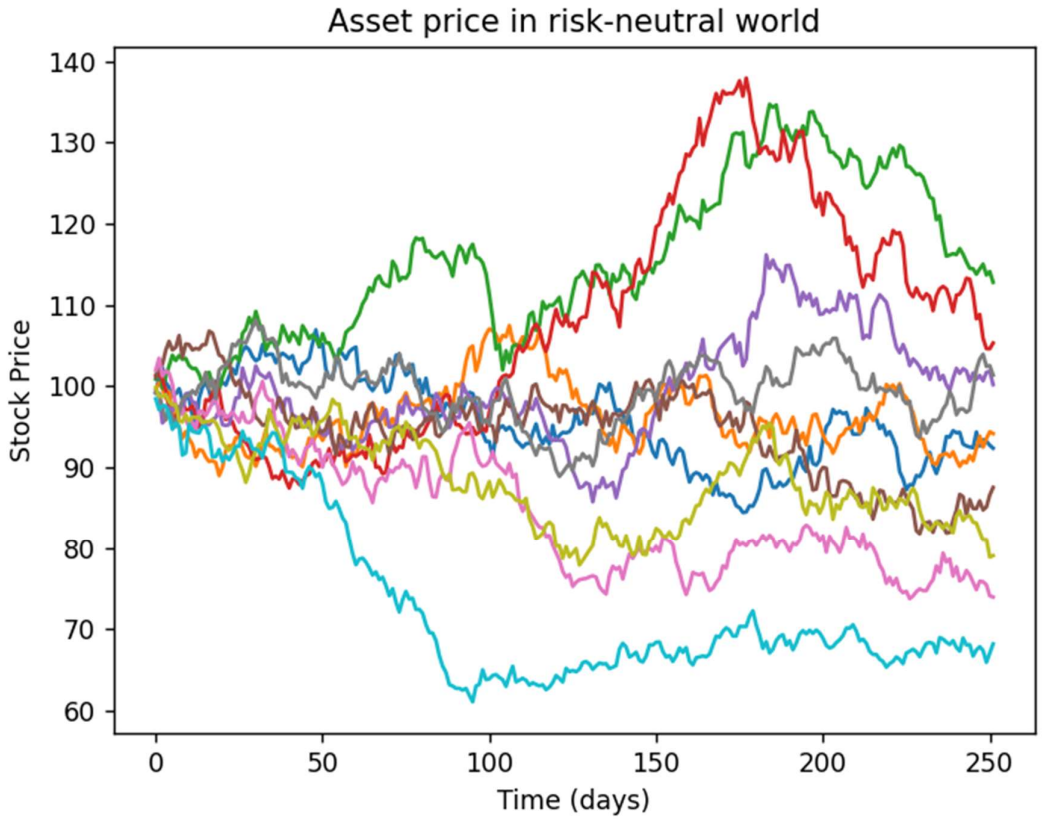
Question 1



The evolution of the asset price in real world is governed by following differential equation:

$$dS = \mu S dt + \sigma S dW(t)$$



The evolution of the asset price in the risk-neutral world is governed by following differential equation: $dS = rSdt + \sigma SdW*(t)$ where, W* is a Brownian motion under risk-neutral probability.

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************** For K = 90 **************
Asian call option price                 = 12.398703854351378
Variance in Asian call option price     = 125.09315793689079

Asian put option price                  = 0.7548329318973247
Variance in Asian put option price      = 5.605878781056578


************** For K = 105 **************
Asian call option price                 = 3.2368733823789984
Variance in Asian call option price     = 37.92430282907894

Asian put option price                  = 6.078131124292315
Variance in Asian put option price      = 50.28793382533291


************** For K = 110 **************
Asian call option price                 = 2.206181436031252
Variance in Asian call option price     = 30.476117804767206

Asian put option price                  = 9.032743937275171
Variance in Asian put option price      = 69.88066248199358
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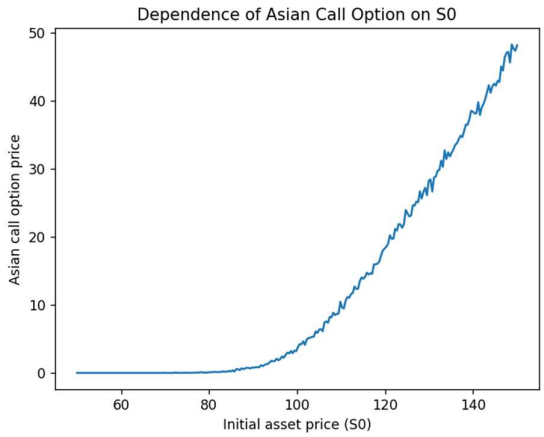
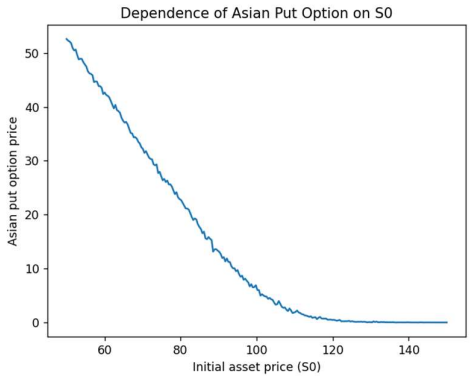
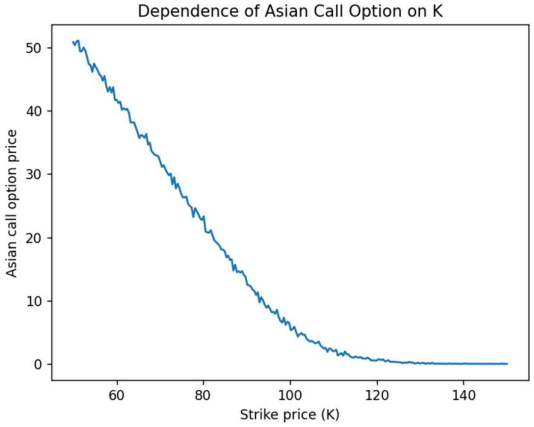
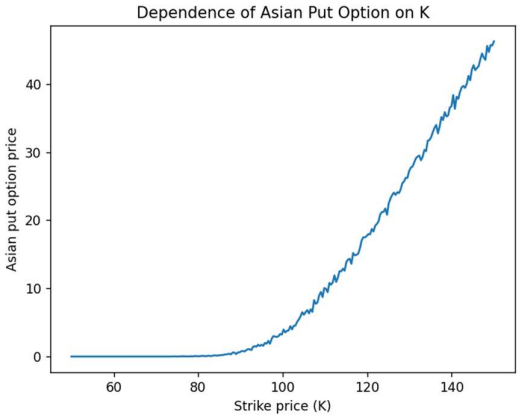
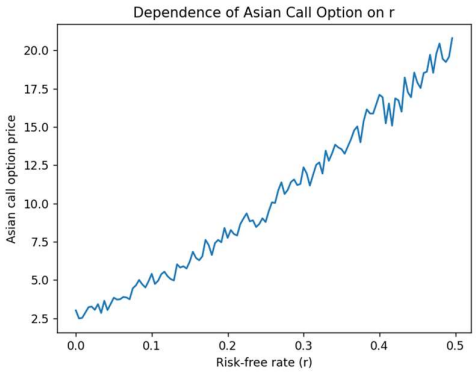
Sensitivity Analysis

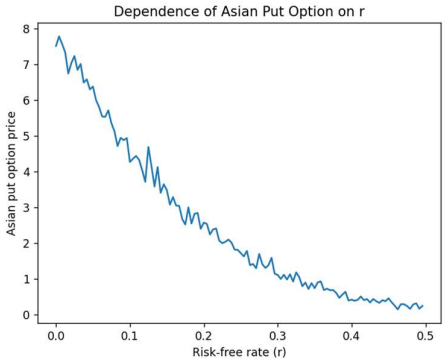


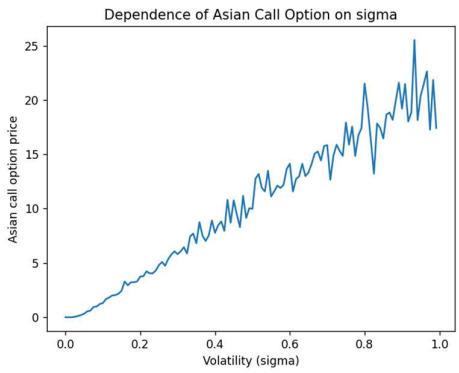


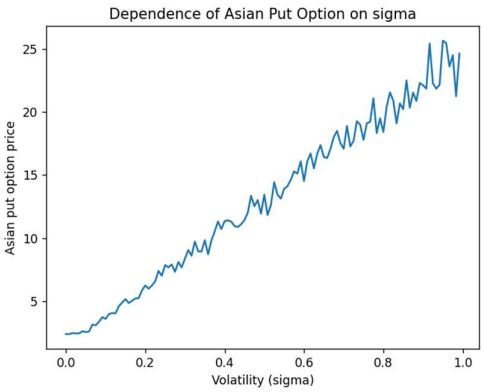












Observation –

1. If the initial asset price, S0, increases, the price of the call option will increase while that of the put option will decrease.
2. If the strike price, K, increases, the price of the call option will decrease while that of the put option will increase.
3. If the risk-free interest rate, r, increases, the price of the call option will increase while that of the put option will decrease.
4. If the volatility increases, both the price of the call and put options will increase.

Question 2

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************** For K = 90 **************
Asian call option price                 = 12.817718690521003
Variance in Asian call option price     = 88.36277065787613

Asian put option price                  = 0.7433955394607833
Variance in Asian put option price      = 5.173140920500949


************** For K = 105 **************
Asian call option price                 = 3.7698252703008537
Variance in Asian call option price     = 36.011173042991395

Asian put option price                  = 5.8237537454243995
Variance in Asian put option price      = 36.313330912943464


************** For K = 110 **************
Asian call option price                 = 1.9426900963218094
Variance in Asian call option price     = 19.55746417990524

Asian put option price                  = 9.34148521026259
Variance in Asian put option price      = 56.69548351817069
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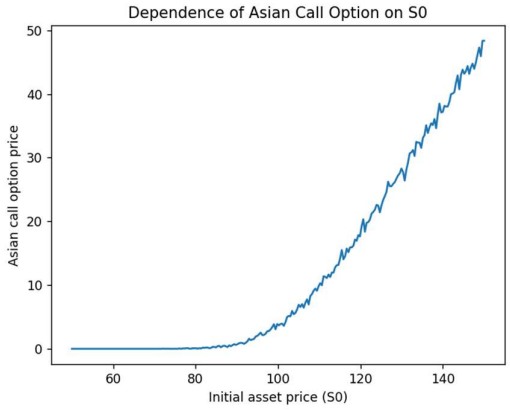
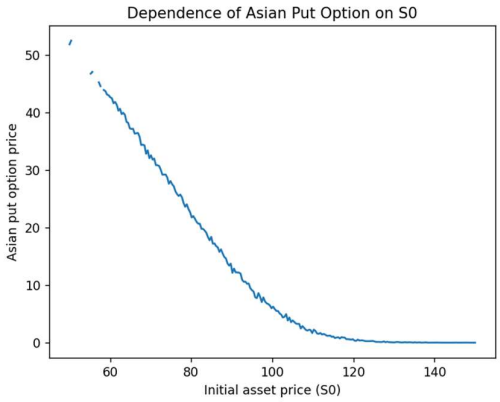
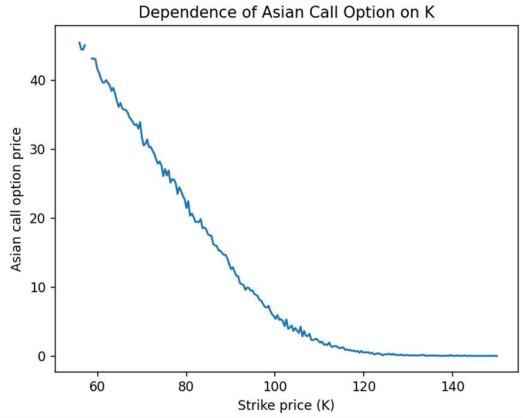
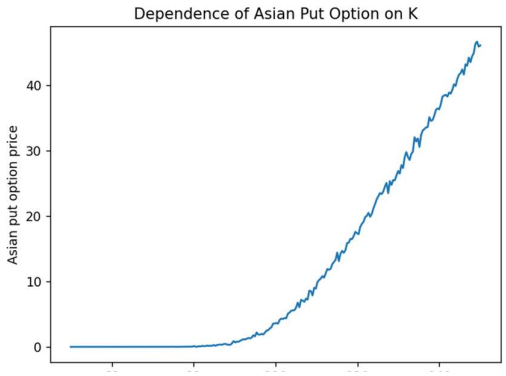
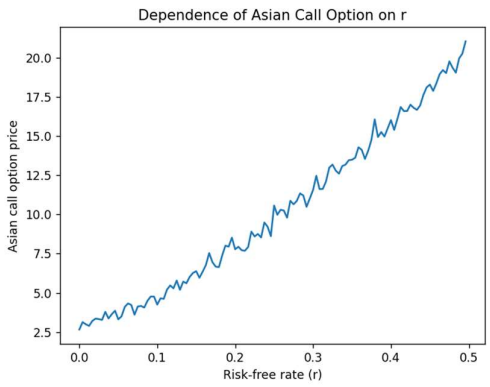
The price of both call and put options obtained using both with and without variance reduction, are comparable. The variance is reduced though.

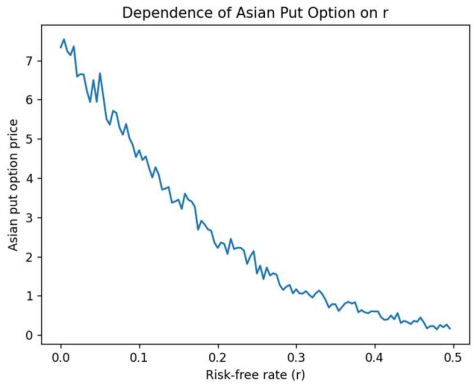

Dependence of Asian Call Option on S0
Asian call option price
Initial asset price (S0)

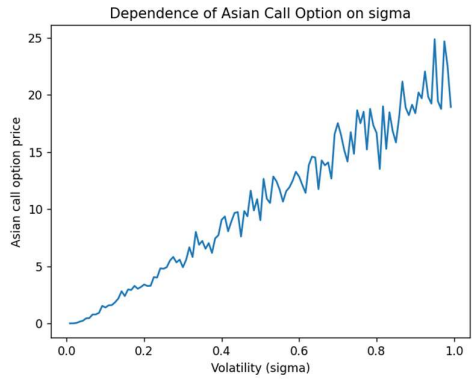

Dependence of Asian Put Option on S0
Asian put option price
Initial asset price (S0)

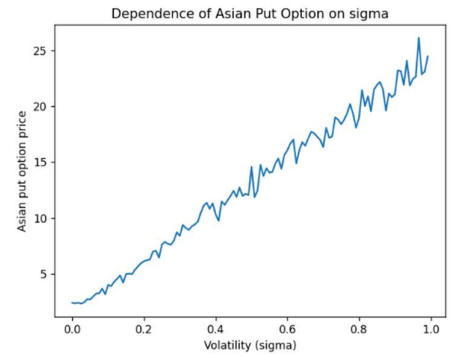

Dependence of Asian Call Option on K
Asian call option price
Strike price (K)


Dependence of Asian Put Option on K
Asian put option price


Dependence of Asian Call Option on r
Asian call option price
Risk-free rate (r)


Dependence of Asian Put Option on r
Asian put option price
Risk-free rate (r)


Dependence of Asian Call Option on sigma
Asian call option price
Volatility (sigma)


Dependence of Asian Put Option on sigma
Asian put option price
Volatility (sigma)

Observation-

1. We have demonstrated quantitatively that variance reduction is achieved, and this claim is further supported by the constructed plots.
2. Upon careful analysis, the fluctuations in the plots appear to be reduced compared to the case when variance reduction was not applied. Therefore, the scheme achieves its goal of reducing variance.
3. The nature of the plots is consistent with our expectations, as explained in the last question.