Ma374-LAB 07

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Question 1.

The formula used to calculate **Call option price** is as follows:

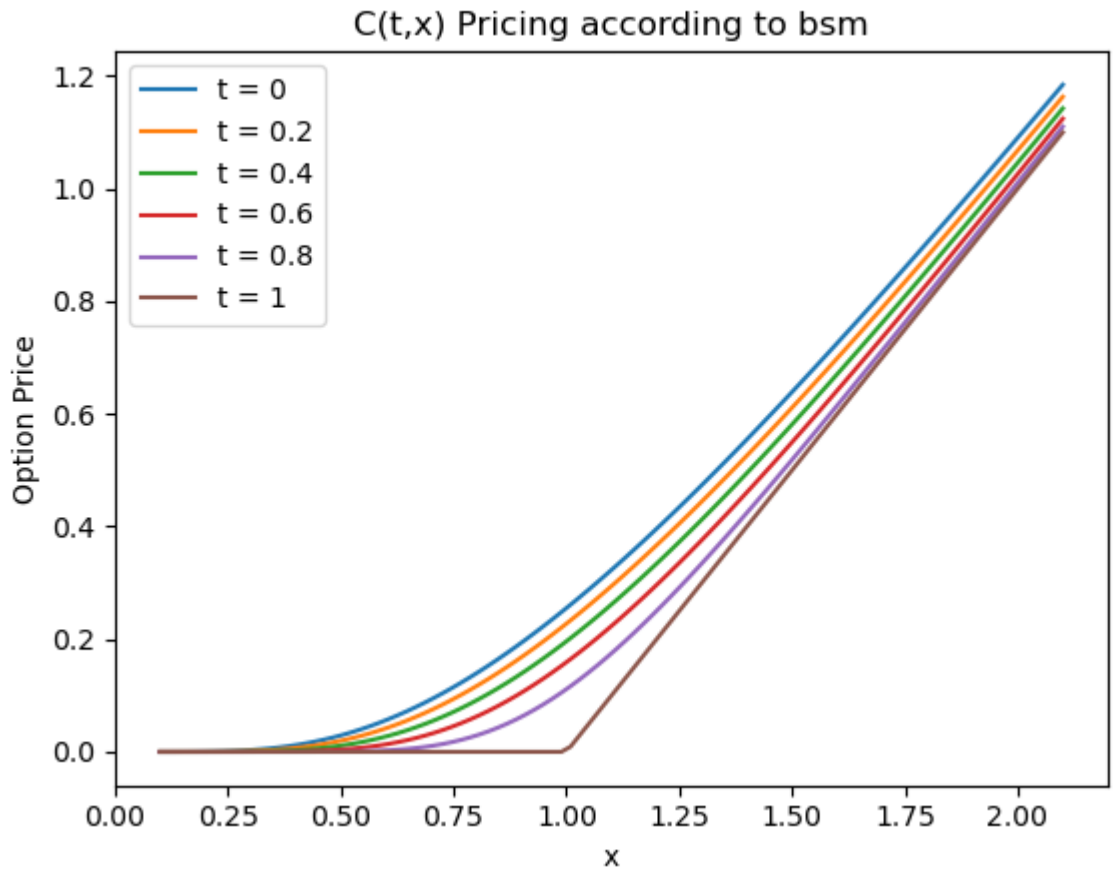
$$c(t,x) = xN(d_+(T-t,x)) - Ke^{-r(T-t)}N(d_-(T-t,x))$$

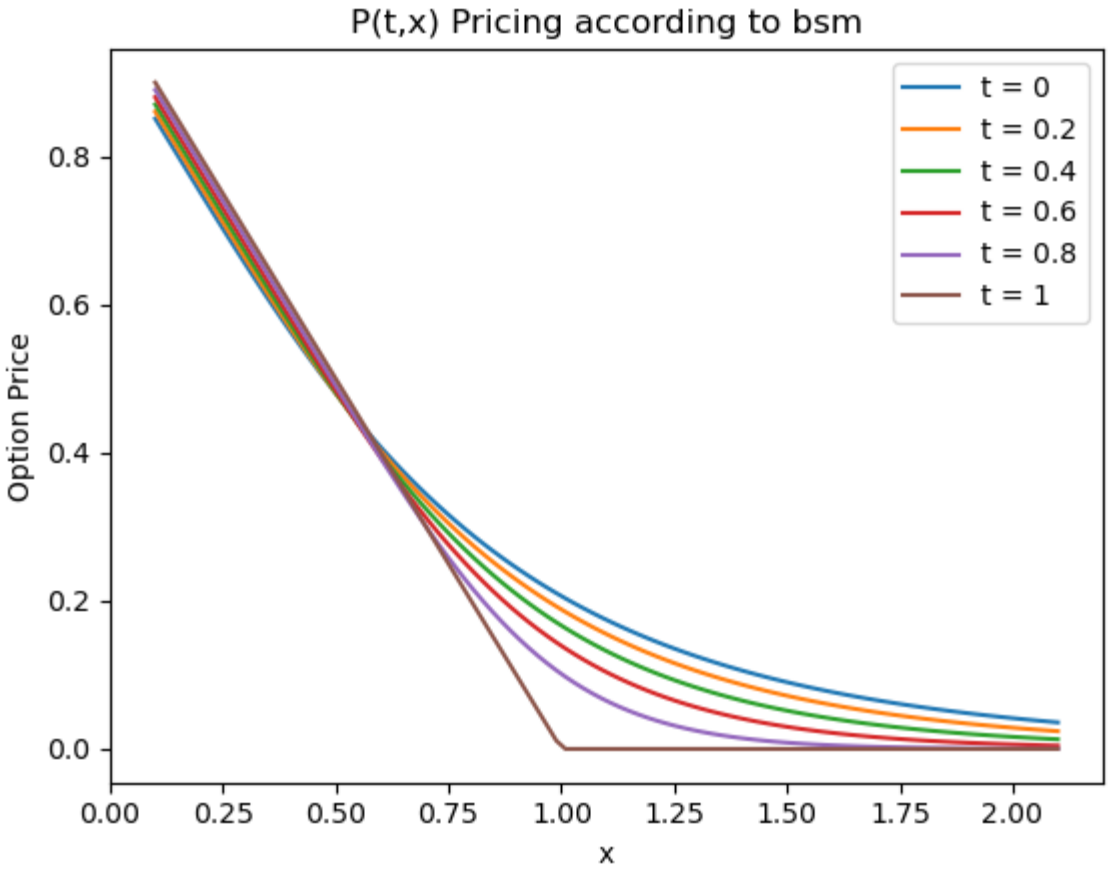
$$where\ d_\pm(T-t,x) = \frac{1}{\sigma\sqrt{T-t}}[\log(x/K) + (r \pm \frac{\sigma^2}{2})(T-t)]$$

Put option price was calculated with the put call parity as follows:

$$c(t,x) - p(t,x) = x - Ke^{-r(T-t)}$$

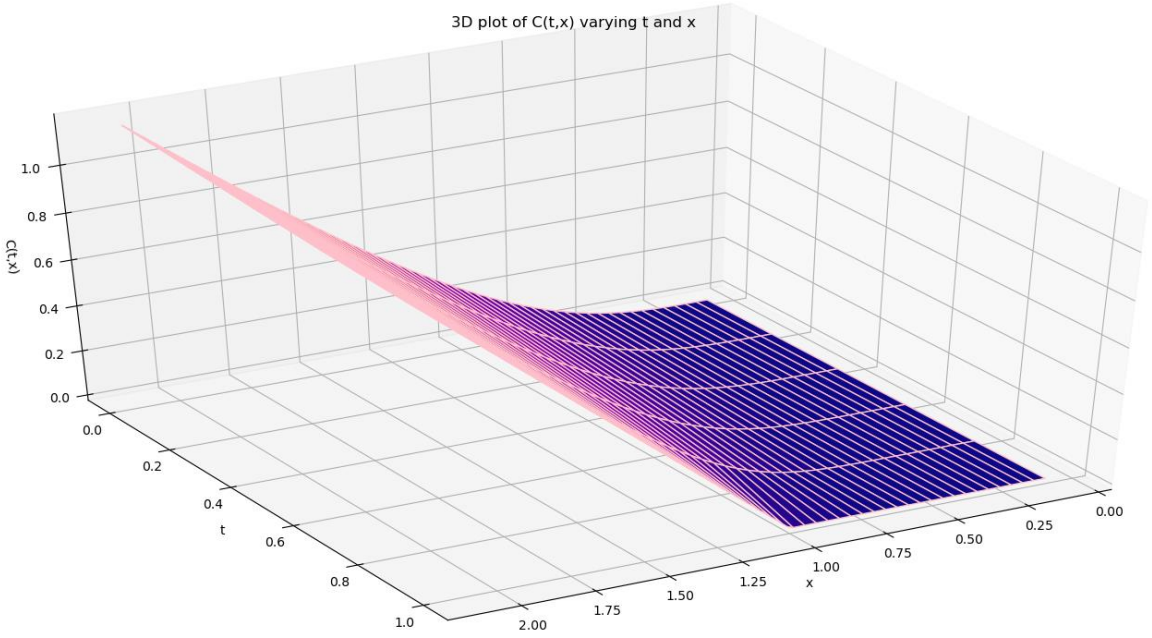
Question 2. The plots of **Call Option** Prices and **Put Option** Prices are as follows:

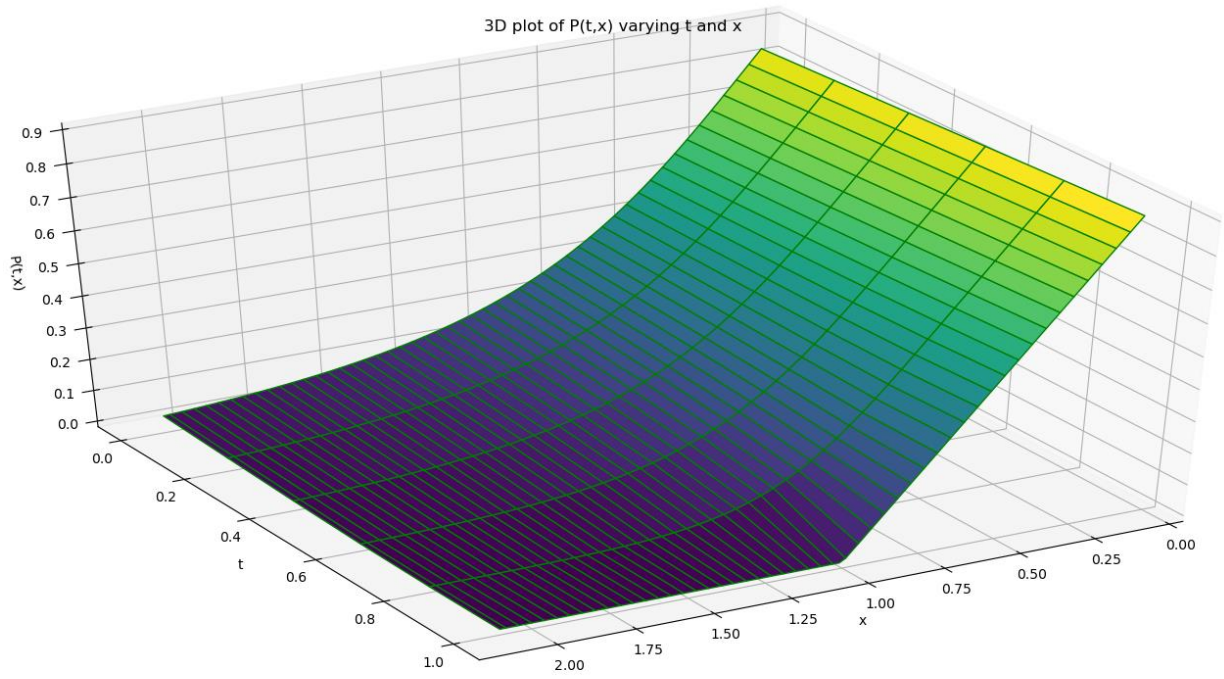




- As expected, the call option price increases with increase in stock price, and the put option price decreases with increase in stock price.

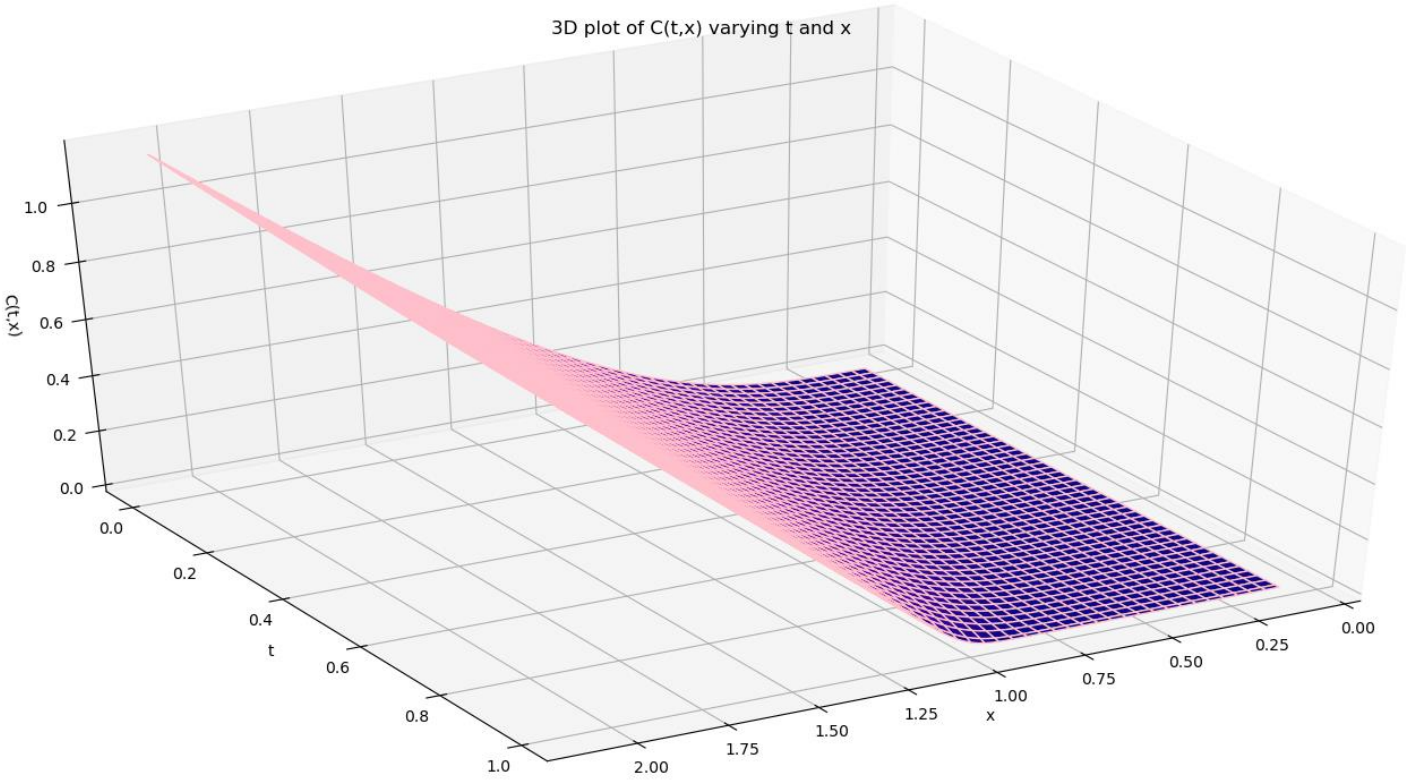
Surface Plots:

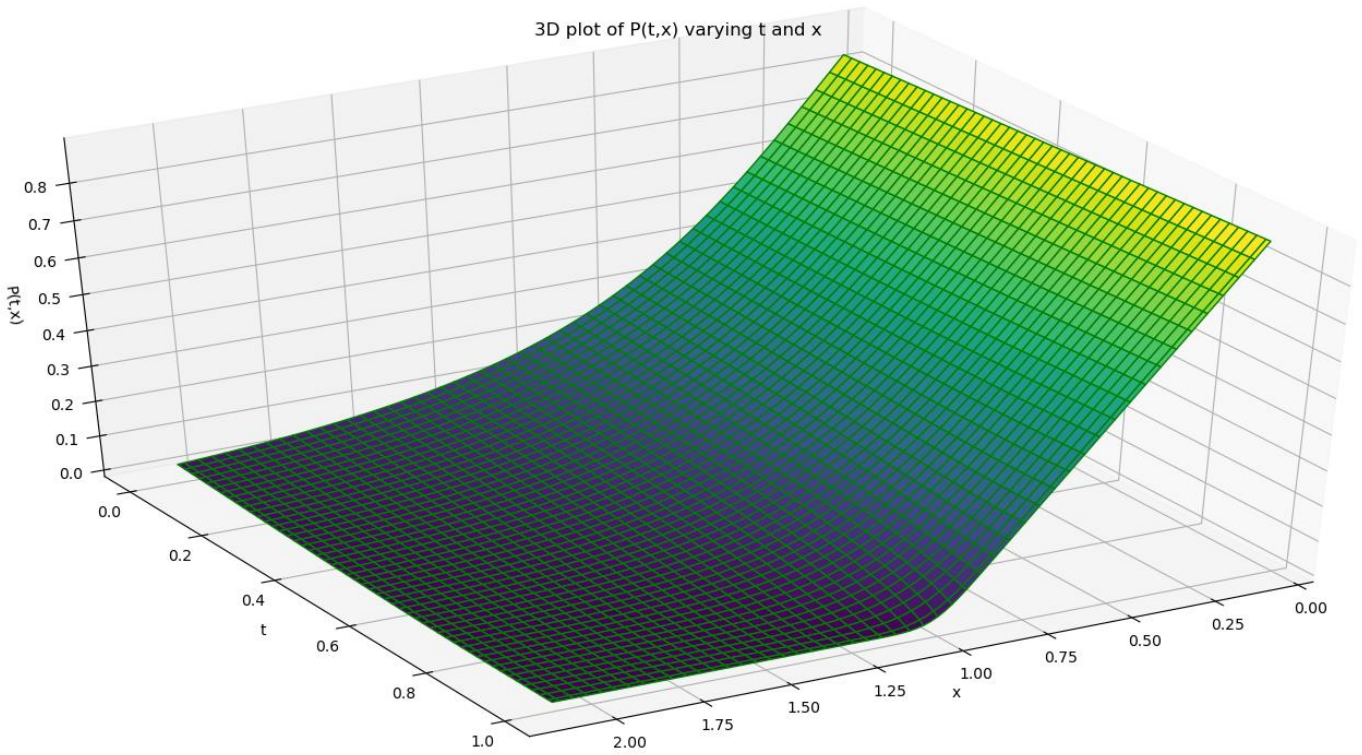




Question 3.

Smooth 3D plots (taking 100 time points):



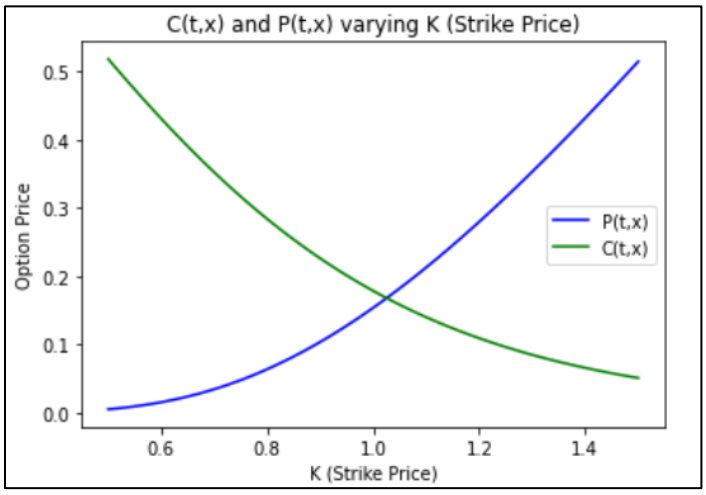


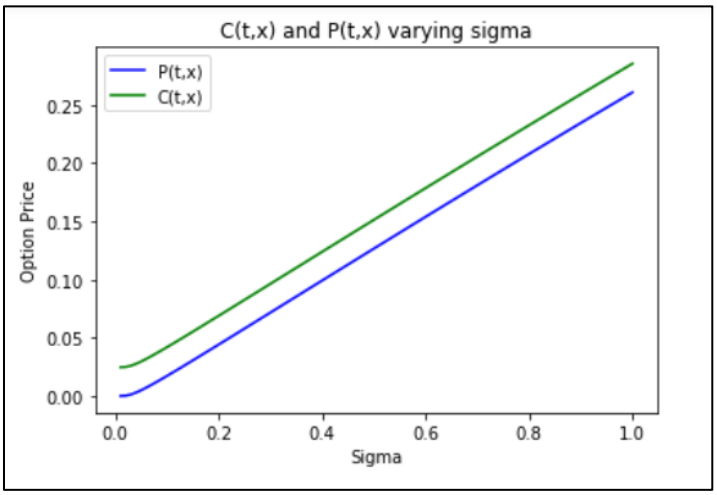
Question 4. Model parameters:

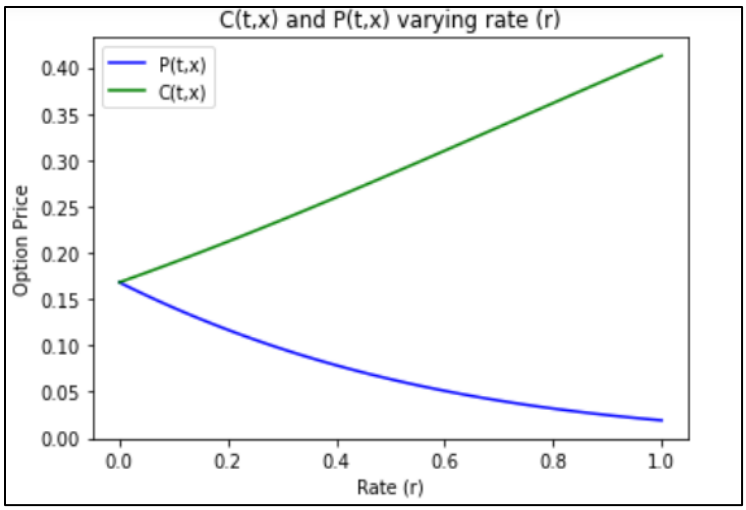
(Strike Price (K), sigma(σ), rate (r) and Final Time (T))

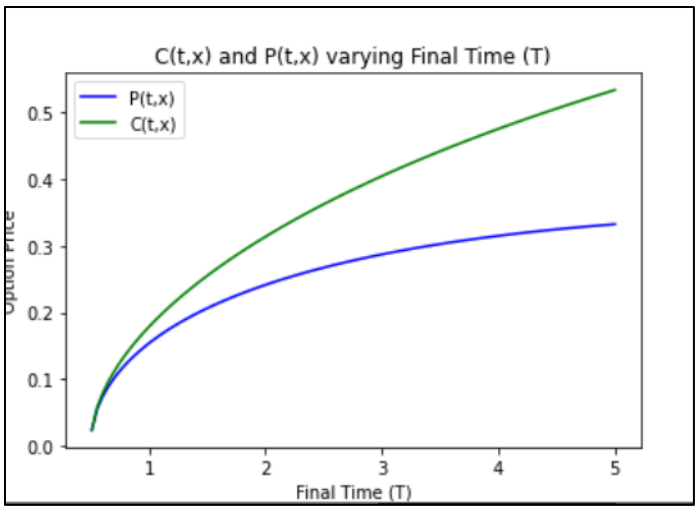
For the sensitivity analysis: x = 1, t =0.5

2D graphs

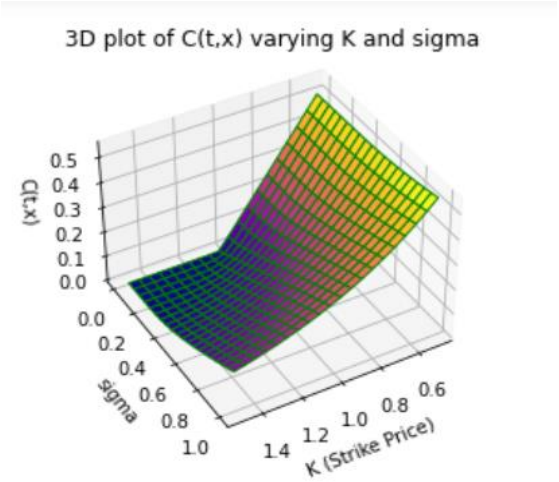
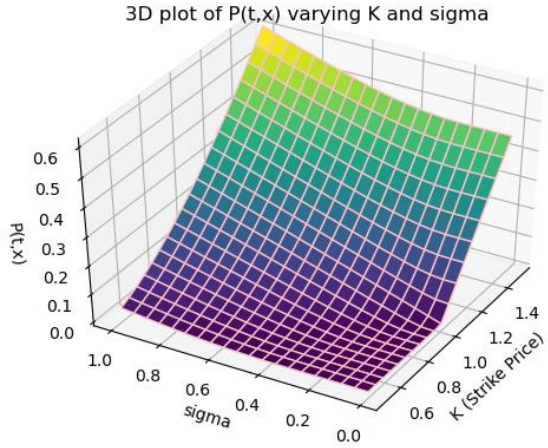
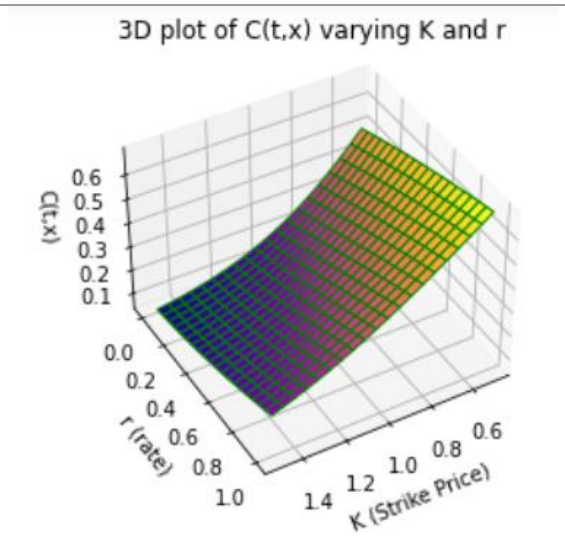
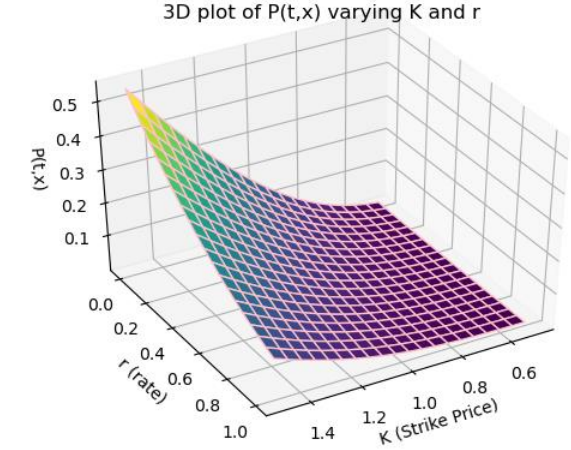


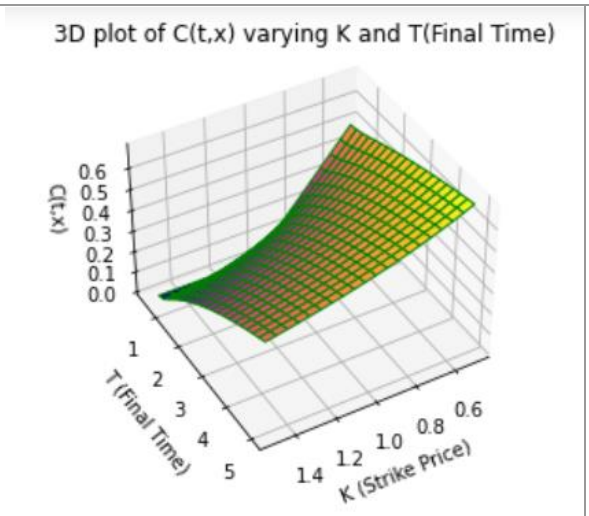
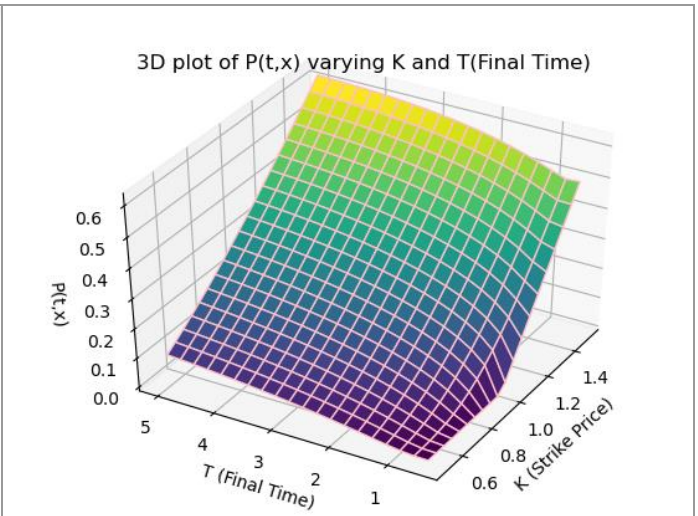
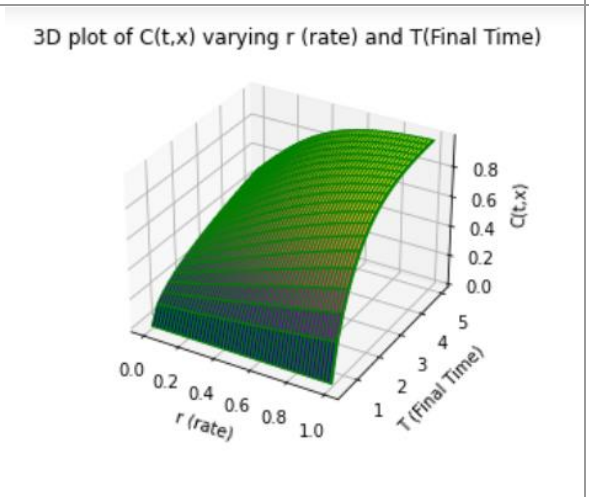
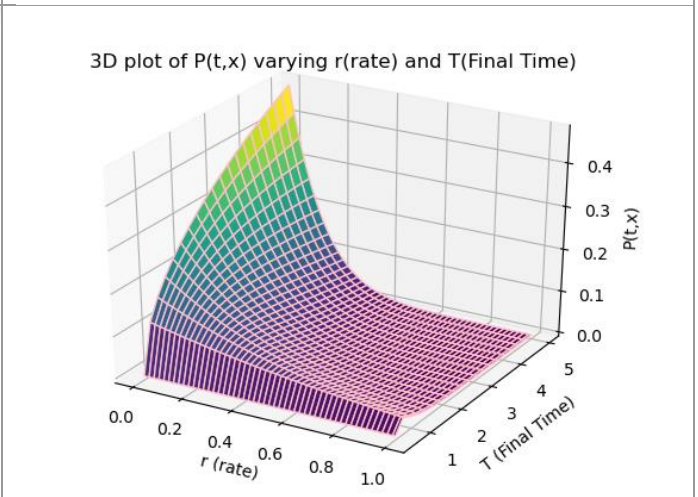
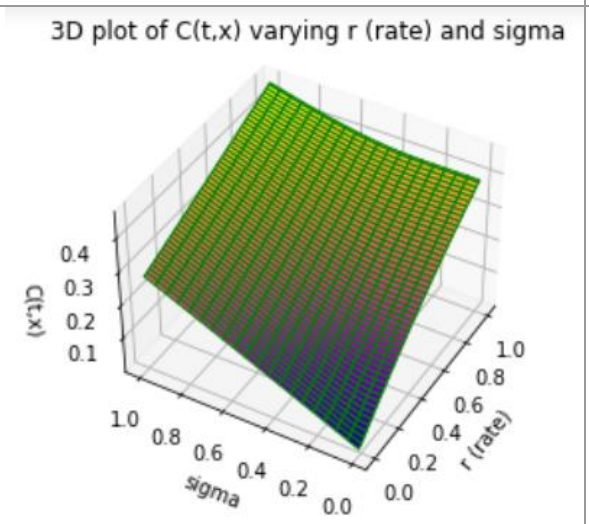
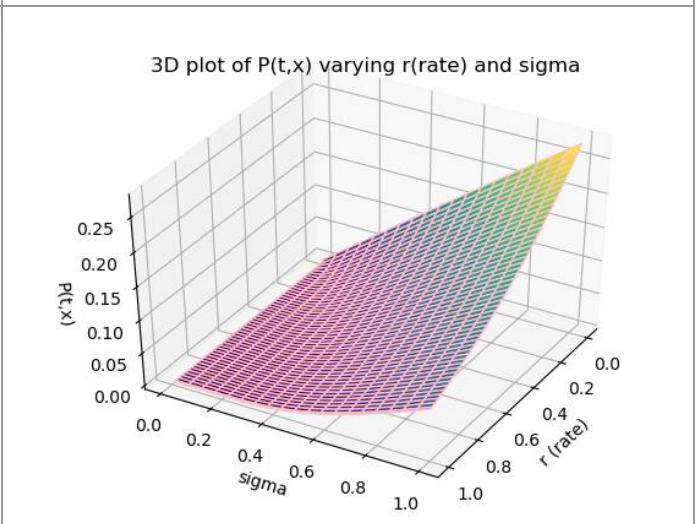


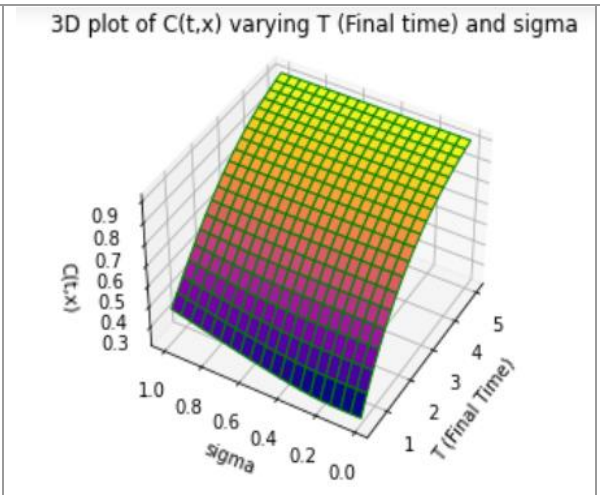
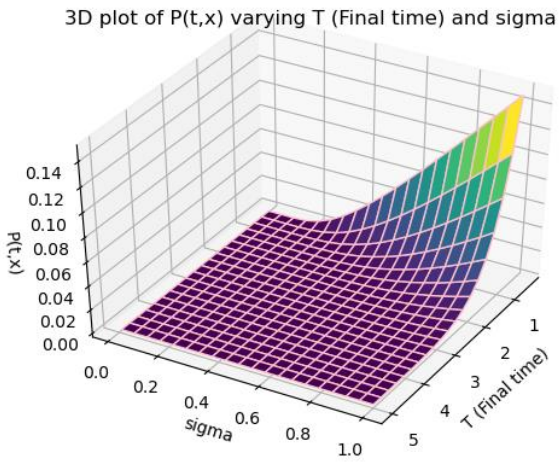




3D graphs

Parameters	Call Option Price	Put Option Price
K and sigma		
K and r		

K and T		
r and T		
r and sigma		

T and sigma		

Tables for sensitivity analysis:

1. Varying Strike Price (K):

Strike Price(K)	Call Option Price(C(t,x))	Put Option Price(P(t,x))
0.5	0.52	0.01
0.6	0.43	0.02
0.7	0.35	0.04
0.8	0.28	0.07
0.9	0.22	0.11
1.01	0.18	0.16
1.11	0.14	0.22
1.21	0.11	0.28
1.31	0.08	0.36
1.41	0.06	0.44

2. Varying Sigma:

Sigma	Call Option Price(C(t,x))	Put Option Price(P(t,x))
0.01	0.02	0.0
0.11	0.04	0.02
0.21	0.07	0.05
0.31	0.1	0.07
0.41	0.13	0.1
0.51	0.15	0.13
0.61	0.18	0.16
0.71	0.21	0.18
0.81	0.24	0.21
0.91	0.26	0.24

3. Varying Rate (r):

Rate	Call Option Price(C(t,x))	Put Option Price(P(t,x))
0.0	0.17	0.17
0.1	0.19	0.14
0.2	0.21	0.12
0.3	0.24	0.1
0.4	0.26	0.08
0.51	0.29	0.06
0.61	0.31	0.05
0.71	0.34	0.04
0.81	0.36	0.03
0.91	0.39	0.02

4. Varying Final Time (T):

T	Call Option Price(C(t,x))	Put Option Price(P(t,x))
0.51	0.02	0.02
0.96	0.17	0.15
1.42	0.24	0.2
1.87	0.3	0.23
2.32	0.35	0.26
2.78	0.39	0.28
3.23	0.42	0.29
3.68	0.45	0.31
4.14	0.48	0.32
4.59	0.51	0.33

5. Varying K and Sigma:

Strike Price(K)	Sigma	Call Option Price(C(t,x))	Put Option Price(P(t,x))
0.5	0.01	0.512345	0.0
0.605263	0.114211	0.409681	0.0
0.710526	0.218421	0.307393	0.000377
0.815789	0.322632	0.221171	0.016819
0.921053	0.426842	0.171749	0.070061
1.026316	0.531053	0.148517	0.149493
1.131579	0.635263	0.139505	0.243145
1.236842	0.739474	0.138476	0.344781
1.342105	0.843684	0.142383	0.451352
1.447368	0.947895	0.149653	0.561285

6. Varying K and Rate:

Strike Price(K)	Rate	Call Option Price(C(t,x))	Put Option Price(P(t,x))
0.5	0.0	0.50633	0.00633
0.605263	0.105263	0.439952	0.014183
0.710526	0.210526	0.385594	0.02513
0.815789	0.315789	0.341642	0.038277
0.921053	0.421053	0.306385	0.052583
1.026316	0.526316	0.278251	0.067098
1.131579	0.631579	0.255904	0.081066
1.236842	0.736842	0.238254	0.093933
1.342105	0.842105	0.224432	0.10533
1.447368	0.947368	0.213755	0.115037

7. Varying K and T:

Strike Price(K)	T	Call Option Price(C(t,x))	Put Option Price(P(t,x))
0.5	0.5	0.5	0.0
0.605263	0.973684	0.423979	0.015075
0.710526	1.447368	0.39334	0.070995
0.815789	1.921053	0.382929	0.142766
0.921053	2.394737	0.381812	0.219613
1.026316	2.868421	0.385726	0.297425
1.131579	3.342105	0.392647	0.374325
1.236842	3.815789	0.401475	0.449358
1.342105	4.289474	0.411559	0.52201
1.447368	4.763158	0.422484	0.591999

8. Varying Rate (r) and T:

Rate	T	Call Option Price(C(t,x))	Put Option Price(P(t,x))
0.0	0.5	0	0
0.10101	0.973684	0.184174	0.137454
0.20202	1.447368	0.307606	0.133419
0.30303	1.921053	0.443571	0.093675
0.40404	2.394737	0.585992	0.05107
0.505051	2.868421	0.719341	0.021691
0.606061	3.342105	0.828433	0.007054
0.707071	3.815789	0.905814	0.00171
0.808081	4.289474	0.953514	0.000299
0.909091	4.763158	0.979294	3.6e-05

9. Varying r and sigma:

Rate	Sigma	Call Option Price(C(t,x))	Put Option Price(P(t,x))
0.0	0.01	0.002821	0.002821
0.10101	0.114211	0.061988	0.012737
0.20202	0.218421	0.118702	0.022626
0.30303	0.322632	0.172574	0.031979
0.40404	0.426842	0.223708	0.040786
0.505051	0.531053	0.272211	0.049047
0.606061	0.635263	0.318188	0.056765
0.707071	0.739474	0.361744	0.063945
0.808081	0.843684	0.402976	0.070593
0.909091	0.947895	0.441982	0.076719

10. Varying sigma and T:

T	Sigma	Call Option Price(C(t,x))	Put Option Price(P(t,x))
0.5	0.01	0.221199	0.0
0.973684	0.114211	0.385436	0.0
1.447368	0.218421	0.515038	0.0
1.921053	0.322632	0.617309	0.0
2.394737	0.426842	0.698013	1e-06
2.868421	0.531053	0.761699	3e-06
3.342105	0.635263	0.811956	5e-06
3.815789	0.739474	0.851614	6e-06
4.289474	0.843684	0.882909	8e-06
4.763158	0.947895	0.907605	9e-06