Problem 1

Closed Form Greeks For GBSM

	Greeks	Call Option	Put Option
0	Delta	0.082971	-0.916550
1	Gamma	0.016823	0.016823
2	Vega	6.938711	6.938711
3	Theta	-8.126522	-1.940991
4	Rho	1.102594	-13.758003
5	Carry Rho	1.132954	-12.515272

Greeks For Finite Difference Derivative Calculation

	Greeks	Call Option	Put Option
0	Delta	0.082971	-0.916550
1	Gamma	0.016823	0.016823
2	Vega	6.938711	6.938711
3	Theta	-8.126522	-1.940991
4	Rho	-0.030360	-1.242731
5	CarryRho	1.132954	-12.515272

Based on the results, we can find that the different methods give the same outcomes except for Rho.

American Call Option Price: 0.2986340478681555
American Put Option Price: 14.55932724012951

Greeks For BTAM

	Greeks	Call Option	Put Option
0	Delta	0.074842	-0.935932
1	Gamma	0.018483	0.015880
2	Vega	6.319465	5.667652
3	Theta	-7.425581	-0.416989
4	Rho	0.887512	-12.334293
5	CarryRho	NaN	NaN

Dividend Sensitivity for Call Option: -0.021538913125285216
Dividend Sensitivity for Put Option: 0.9391384416801428

Problem 2

Delta-Normal

	Portfolio	PortfolioDelta	Mean	DN_VaR	DN_ES
0	Straddle	1.201974e+02	1.201974e+02	1.452452e+03	1.821434e+03
1	SynLong	2.098026e+02	2.098026e+02	2.535232e+03	3.179283e+03
2	CallSpread	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
3	PutSpread	-2.241398e+01	-2.241398e+01	2.708480e+02	3.396544e+02
4	Stock	1.650000e+02	1.650000e+02	1.993842e+03	2.500358e+03
5	Call	1.650000e+02	1.650000e+02	1.993842e+03	2.500358e+03
6	Put	-4.480259e+01	-4.480259e+01	5.413896e+02	6.789244e+02
7	CoveredCall	-5.237325e-08	-5.237325e-08	6.328727e-07	7.936478e-07
8	ProtectedPut	1.360388e+02	1.360388e+02	1.643878e+03	2.061489e+03

Last Week's Result

# Row	Portfolio	currentValue	VaR95	ES95	VaR99	ES99	Standard_Dev	min	max	mean
#	String15	Float64	Float64	Float64	Float64	Float64	Float64	Float64	Float64	Float64
# 1	Straddle	13.37	1.59287	1.59974	1.60279	1.6031	3.07899	-1.60326	28.6683	0.715321
# 2	SynLong	1.05	15.024	18.7003	21.2042	23.9804	9.57415	-32.3764	40.9259	0.085685
# 3	CallSpread	4.54	3.51345	3.88525	4.13763	4.27922	2.23396	-4.50097	5.34574	-0.111517
# 4	PutSpread	3.17	2.48937	2.73656	2.89494	2.97702	1.91194	-3.14849	6.38197	0.199446
# 5	Stock	170.15	14.863	18.5549	21.0697	23.8553	9.57807	-32.2719	41.0705	0.277155
# 6	Call	7.21	6.02145	6.47039	6.77088	6.92939	5.51029	-7.16986	34.7971	0.400503
# 7	Put	6.16	5.11342	5.50292	5.75038	5.87433	4.49544	-6.12879	25.2066	0.314818
# 8	CoveredCall	165.52	10.7263	14.2082	16.5864	19.312	5.57598	-27.65	8.64519	-0.202631
# 9	ProtectedPut	174.47	7.77495	8.58728	9.14112	9.48572	6.45865	-10.0885	36.7674	0.492976

- The **Normal Distribution** and **Fitted AR(1) Model** provide similar and higher estimates of risk.
- The **VaR** and **ES** calculated by the two methods are quite similar.

Problem 3

	Stock	Weight	Return
0	AAPL	0.0000	-2.253823
1	META	0.0026	1.172346
2	UNH	0.0000	-0.114615
3	MA	0.0000	1.773019
4	MSFT	0.0000	-0.368813
5	NVDA	0.0000	-3.702442
6	HD	0.1057	3.037572
7	PFE	0.0000	-5.385713
8	AMZN	0.0000	-0.014672
9	BRK-B	0.1501	2.170457
10	PG	0.4020	2.943831
11	XOM	0.0000	1.502708
12	TSLA	0.0000	-4.043305
13	JPM	0.0000	0.183736
14	V	0.0000	0.364972
15	DIS	0.0530	2.259346
16	GOOGL	0.0000	-3.157294
17	JNJ	0.0653	1.943940
18	BAC	0.0000	0.016937
19	CSCO	0.2213	3.712624

```
Expected Return = 2.9016135536959844
Expected Volatility = 0.12554491218852082
Expected Sharpe Ratio = 22.713892061420275
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