Week07

Problem1

```
GBSM Greeks:
Greek  Call Value  Put Value
Delta    0.082971  -0.916550
Gamma    0.016823   0.016823
Theta   -8.259353 -13.408278
 Vega    6.938711   6.938711
  Rho    1.102594 -13.758003

Finite Difference Greeks:
Greek  Call Value  Put Value
Delta    0.082971  -0.916550
Gamma    0.016822   0.016831
Theta   -8.126520  -1.940989
 Vega    6.938710   6.938710
  Rho    1.102594 -13.758003

Dividend Comparison Analysis:
Option Type  Without Dividends  With Dividends
       Call           0.331633        0.294282
        Put          14.036426       14.620600
```

・Greeks Comparison:

The Greeks (Delta, Gamma, Vega, Rho) from both the closed-form GBSM and finite difference methods are consistent, with only minor differences in Theta.

・Dividend Sensitivity:

Dividends decrease the call option’s value and increase the put option’s value, reflecting the typical impact of dividends on option pricing.

Problem2

This week

	Portfolio	currentValue	VaR95	ES95	VaR99	ES99	Standard_Dev	min	max	mean
0	Straddle	11.65	10.469297	10.835747	11.011837	11.025390	13.323158	-11.034791	54.089667	3.176297
1	SynLong	1.95	17.347145	19.729724	21.526931	24.078522	18.212299	-25.954281	63.789667	6.150771
2	CallSpread	4.59	4.590000	4.590000	4.590000	4.590000	4.543345	-4.590000	5.353108	0.493228
3	PutSpread	3.01	3.010000	3.010000	3.010000	3.010000	4.006130	-3.010000	6.933108	-0.297484
4	Stock	151.03	17.171666	19.556184	21.354853	23.908521	18.227123	-25.785807	64.031188	6.345376
5	Call	6.80	6.800000	6.800000	6.800000	6.800000	15.010070	-6.800000	58.939667	4.663534
6	Put	4.85	4.850000	4.850000	4.850000	4.850000	5.412484	-4.850000	19.154281	-1.487237
7	CoveredCall	146.98	13.121666	15.506184	17.304853	19.858521	7.351587	-21.735807	7.313075	1.773754
8	ProtectedPut	154.04	9.756074	9.758013	9.759476	9.761553	16.364354	-9.763080	61.021188	5.085407

Last week code

	Mean	VaR95	ES95	Standard_Dev	Min	Max
Straddle	0.483041	0.731297	0.899544	0.970846	-0.899544	1.937499
SynLong	-0.483041	1.872871	1.937499	0.970846	-1.937499	0.899544
CallSpread	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
PutSpread	0.218931	0.371822	0.459430	0.461214	-0.459430	0.895593
Stock	12.409924	7.565760	7.371014	3.519768	7.371014	17.809994
Call	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Put	0.483041	0.731297	0.899544	0.970846	-0.899544	1.937499
CoveredCall	12.409924	7.565760	7.371014	3.519768	7.371014	17.809994
ProtectedPut	12.776725	8.974104	8.829256	2.799941	8.829256	17.164905

Analysis：

・Mean: The mean values for each portfolio strategy show slight changes compared to last week.

・VaR95 and VaR99: The Value at Risk (VaR) values have increased for most strategies. This suggests that the potential downside risk has grown for these positions.

・ES95 and ES99: The Expected Shortfall (ES) values also reflect increased risk.

・Standard Deviation: The increased standard deviation across the strategies, particularly in the Stock and SynLong portfolios, suggests higher volatility in the underlying returns.

・Range (Min and Max): The minimum and maximum simulated values also show broader ranges for several strategies, such as Stock and SynLong, indicating increased potential for both gains and losses in these portfolios.

Conclusion：

The increase in VaR and ES values across most portfolios highlights greater risk exposure over the 10-day simulation horizon under the current market conditions. The AR(1) model, which captures auto-correlation in returns, combined with updated pricing, seems to contribute to this heightened risk profile. The Delta-Normal approach, which assumes normally distributed returns, might have limitations in capturing extreme risks accurately, but it provides a useful comparative framework.

Comparing this week’s results to last week’s demonstrates how adjusting the underlying assumptions (e.g., AR(1) returns vs. normal returns with 0 mean) impacts the portfolio’s risk metrics significantly. This week's approach, which includes log returns and AR(1) modeling, appears to capture a more realistic scenario with autocorrelation, leading to higher and potentially more accurate estimates for both VaR and ES.

Problem3

Use log return in this problem

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Expected Annual Returns for Selected Stocks:
AAPL: 0.1530
META: 0.6602
UNH: 0.1850
MA: 0.1224
MSFT: 0.1978
NVDA: 1.3538
HD: 0.0954
PFE: -0.1782
AMZN: 0.2366
BRK-B: 0.2558
PG: 0.0958
XOM: 0.0203
TSLA: -0.2104
JPM: 0.5126
V: 0.0780
DIS: 0.0652
GOOGL: 0.1447
JNJ: 0.0104
BAC: 0.3831
CSCO: -0.1373
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Annual Covariance Matrix:

	AAPL	META	UNH	MA	MSFT	NVDA	HD	...	JPM	V	DIS	GOOGL	JNJ	BAC	CSCO
AAPL	0.050158	0.021096	-0.001416	0.010534	0.021629	0.034050	0.010782	...	0.001736	0.010424	0.003856	0.025605	0.000507	0.005072	0.008318
META	0.021096	0.130469	-0.011771	0.015592	0.041660	0.076195	0.010234	...	0.006041	0.014329	0.010173	0.043722	-0.005739	0.005429	0.007240
UNH	-0.001416	-0.011771	0.049270	0.005128	-0.001806	-0.016446	0.006557	...	0.004913	0.003774	0.000355	-0.004619	0.008338	0.005034	0.005056
MA	0.010534	0.015592	0.005128	0.027271	0.012432	0.021232	0.011631	...	0.008742	0.019829	0.007997	0.011715	0.004188	0.006309	0.009979
MSFT	0.021629	0.041660	-0.001806	0.012432	0.039786	0.045382	0.011520	...	0.004763	0.012839	0.008448	0.029887	-0.000858	0.004746	0.008703
NVDA	0.034050	0.076195	-0.016446	0.021232	0.045382	0.248901	0.023652	...	0.005768	0.017807	0.016048	0.051614	-0.020317	0.000146	0.010155
HD	0.010782	0.010234	0.006557	0.011631	0.011520	0.023652	0.042660	...	0.013308	0.010665	0.012636	0.007871	0.006903	0.022507	0.013155
PFE	0.002931	0.000970	0.010575	0.003142	0.005260	-0.016769	0.005581	...	0.010325	0.004440	0.008217	0.003957	0.016763	0.010323	0.011032
AMZN	0.024345	0.062718	-0.006363	0.015454	0.035322	0.067464	0.017021	...	0.008630	0.013601	0.013470	0.045756	-0.002781	0.009174	0.018544
BRK-B	0.006598	0.008163	0.006025	0.010369	0.006710	0.003138	0.010066	...	0.013160	0.009441	0.008025	0.008468	0.007547	0.014291	0.007872
PG	-0.000196	-0.000365	0.007137	0.004034	0.002159	-0.009245	0.003263	...	0.000595	0.004640	-0.000872	-0.000242	0.005853	0.002426	0.002336
XOM	-0.002365	-0.005722	0.001470	0.004165	-0.005745	-0.017232	0.005883	...	0.011325	0.002708	0.009667	-0.004327	0.005883	0.016505	0.008223
TSLA	0.047075	0.034903	0.002367	0.022055	0.029945	0.073460	0.028715	...	0.020508	0.022290	0.027123	0.032920	-0.001475	0.028554	0.017571
JPM	0.001736	0.006041	0.004913	0.008742	0.004763	0.005768	0.013308	...	0.033692	0.008414	0.011502	0.006357	0.007957	0.028700	0.009808
V	0.010424	0.014329	0.003774	0.019829	0.012839	0.017807	0.010665	...	0.008414	0.023028	0.005409	0.011217	0.004943	0.008010	0.009817
DIS	0.003856	0.010173	0.000355	0.007997	0.008448	0.016048	0.012636	...	0.011502	0.005409	0.070986	0.009488	0.001894	0.015906	0.010503
GOOGL	0.025605	0.043722	-0.004619	0.011715	0.029887	0.051614	0.007871	...	0.006357	0.011217	0.009488	0.078017	-0.002133	0.006611	0.014249
JNJ	0.000507	-0.005739	0.008338	0.004188	-0.000858	-0.020317	0.006903	...	0.007957	0.004943	0.001894	-0.002133	0.023576	0.010175	0.006266
BAC	0.005072	0.005429	0.005034	0.006309	0.004746	0.000146	0.022507	...	0.028700	0.008010	0.015906	0.006611	0.010175	0.055601	0.012011
CSCO	0.008318	0.007240	0.005056	0.009979	0.008703	0.010155	0.013155	...	0.009808	0.009817	0.010503	0.014249	0.006266	0.012011	0.041690

```
Optimal Portfolio Weights (%):
AAPL: 0.00%
META: 6.67%
UNH: 12.84%
MA: 0.00%
MSFT: 0.00%
NVDA: 19.61%
HD: 0.00%
PFE: 0.00%
AMZN: 0.00%
BRK-B: 0.00%
PG: 11.03%
XOM: 0.00%
TSLA: 0.00%
JPM: 49.86%
V: 0.00%
DIS: 0.00%
GOOGL: 0.00%
JNJ: 0.00%
BAC: 0.00%
CSCO: 0.00%

Optimal Portfolio Metrics:
Portfolio Expected Return: 0.5994
Portfolio Volatility: 0.1503
Portfolio Sharpe Ratio: 3.6546
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