Prob1.

Based on the given data, I can get following results:

closed_form_greeks

Delta of the call option is: 0.083

Delta of the put option is: -0.917

Gamma of the call option is: 0.017

Gamma of the put option is: 0.017

Vega of the call option is: 6.939

Vega of the put option is: 6.939

Theta of the call option is: -8.127

Theta of the put option is: -1.941

Rho of the call option is: -0.03

Rho of the put option is: -1.243

Carry Rho of the call option is: 1.133

Carry Rho of the put option is: -12.515

finite_diff_greeks

Delta of the call option is: 0.083

Delta of the put option is: -0.917

Gamma of the call option is: 0.017

Gamma of the put option is: 0.017

Vega of the call option is: 6.904

Vega of the put option is: 6.904

Theta of the call option is: -8.098

Theta of the put option is: -1.913

Rho of the call option is: -0.03

Rho of the put option is: -1.243

Carry Rho of the call option is: 1.131

Carry Rho of the put option is: -12.516

The american call option value without dividend is: 0.336

The american put option value without dividend is: 14.037

Delta of the call option is: 0.083

Delta of the put option is: -0.917

Gamma of the call option is: 0.017

Gamma of the put option is: 0.017

Vega of the call option is: 6.939

Vega of the put option is: 6.939

Theta of the call option is: -8.127

Theta of the put option is: -1.941

Rho of the call option is: -0.03

Rho of the put option is: -1.243

Carry Rho of the call option is: 1.133

Carry Rho of the put option is: -12.515

The american call option value with dividend is: 0.298

The american put option value with dividend is: 14.559

Delta of the call option is: 0.069

Delta of the put option is: -0.938

Gamma of the call option is: 0.017

Gamma of the put option is: 0.017

Vega of the call option is: 5.97

Vega of the put option is: 5.478

Theta of the call option is: -7.058

Theta of the put option is: -0.239

Rho of the call option is: 0.941

Rho of the put option is: -12.409

Sensitivity of dividend of the call option is: -0.025

Sensitivity of dividend of the put option is: 0.941

Prob2.

For normal assumption:

Portfolio	Mean	VaR	ES
Call	7.607054	2.074576	4.325813
CallSpread	4.275023	-0.135424	2.115813
CoveredCall	7.612714	-6.273567	-3.707571
ProtectedPut	12.946369	-5.290995	-3.228300
Put	-0.404211	2.918456	3.234679
PutSpread	-0.153084	1.581085	1.784589
Stock	13.325135	-3.695424	-0.405807
Straddle	7.202843	-0.361853	0.404461
SynLong	8.011265	4.511005	8.247164

For delta assumption:

Portfolio	Mean	VaR	ES
Call	0	9.507293	11.922529
CallSpread	0	1.874478	2.350671
CoveredCall	0	4.516813	5.664266
ProtectedPut	0	9.480362	11.888757
Put	0	2.673244	3.352356
PutSpread	0	1.32849	1.665981
Stock	0	12.149628	15.236124
Straddle	0	6.834049	8.570174
SynLong	0	12.180537	15.274885

For last week's result:

Portfolio	Mean	VaR	ES
Call	-6.8	6.800000	NaN
CallSpread	-4.59	4.590000	NaN
CoveredCall	23.006512	-7.342766	-3.84709
ProtectedPut	15.946512	-0.282766	3.21291
Put	-4.85	4.850000	NaN
PutSpread	-3.01	3.010000	NaN
Stock	18.956512	-3.292766	0.20291
Straddle	-11.65	11.650000	NaN
SynLong	-1.95	1.950000	NaN

After observation, last week's result does not have similar results with normal or delta assumption. Every method has different pros and cons. Therefore, we need to pick which method to simulate data based on the requirements.

Prob3.

Based on the given data, I have following result:

Annual return:

annual_return:

AAPL	0.166884
META	0.458165
UNH	0.248938
MA	0.087849
MSFT	0.102993
NVDA	0.847466
HD	0.064752
PFE	-0.103135
AMZN	0.113618
BRK-B	0.180952
PG	0.164055
XOM	-0.030168
TSLA	-0.126380
JPM	0.302341
V	0.044387
DIS	0.052459
GOOGL	0.089594
JNJ	0.039141
BAC	0.161958
CSCO	-0.131256

The 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

The super-efficiency portfolio is shown in weights:

AAPL	7.9
META	2.1
UNH	9.8
MA	0.0
MSFT	3.7
NVDA	4.4
HD	0.0
PFE	0.4
AMZN	0.0
BRK-B	5.6
PG	23.9
XOM	11.0
TSLA	0.0
JPM	7.6
V	2.6
DIS	3.9
GOOGL	0.8
JNJ	16.5
BAC	0.0
CSCO	0.0