

MA-374: Financial Laboratory

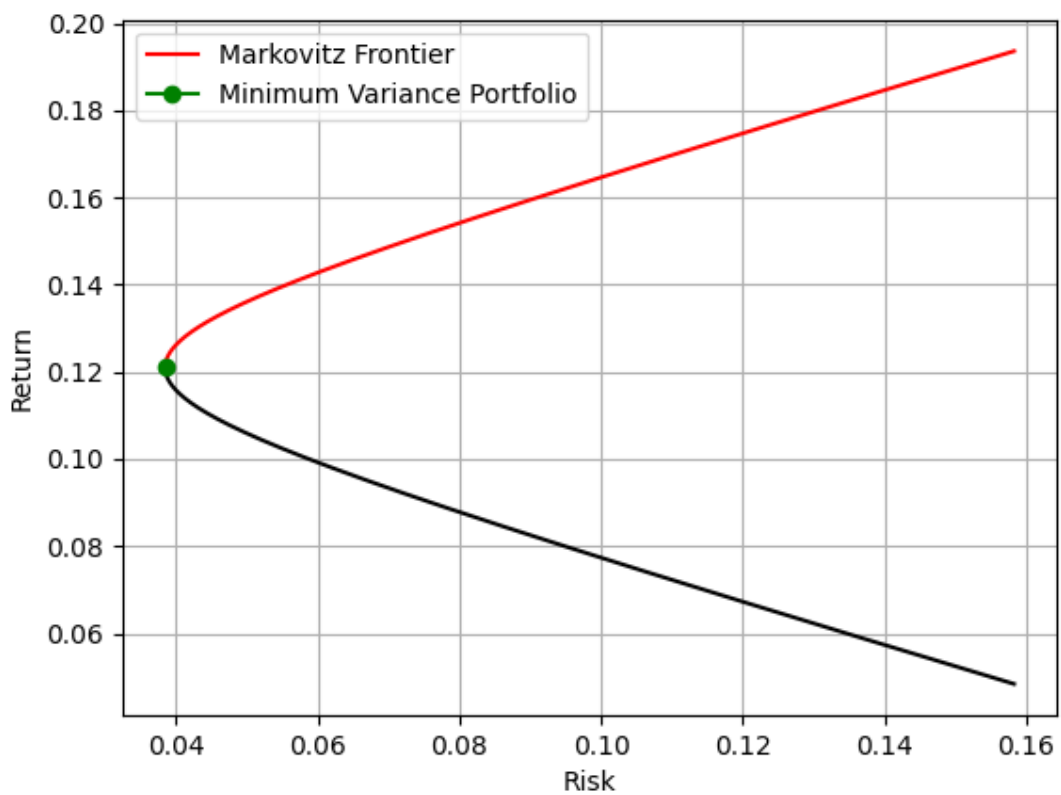
Assignment 04

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Question 1-

a) The Markovitz Frontier is as follows -



Minimum Risk = 0.03842681590342608
Mean corresponding to Minimum Risk = 0.12100082034454472

The minimum variance line is constructed using the following steps:

i) Obtain the required weights w using the following relation –

$$w = \frac{\begin{vmatrix} 1 & uC^{-1}m^T \\ \mu_V & mC^{-1}m^T \end{vmatrix} uC^{-1} + \begin{vmatrix} uC^{-1}u^T & 1 \\ mC^{-1}u^T & \mu_V \end{vmatrix} mC^{-1}}{\begin{vmatrix} uC^{-1}u^T & uC^{-1}m^T \\ mC^{-1}u^T & mC^{-1}m^T \end{vmatrix}}$$

where,

$u_v = \text{return}$

$u = [1, 1, 1, \dots, 1]$ with same dimensions as that of number of assets

ii) Obtain the risk using following relation –

$$\sigma_V^2 = wCw^T$$

and then take square root to obtain the risk in terms of standard deviation.

Now, the minimum variance portfolio has weights:

$$w = \frac{uC^{-1}}{uC^{-1}u^T}$$

Using this, we find the corresponding point on the minimum variance curve.

Now, the efficient frontier is the one with higher expected return and lower standard deviation (lower risk). So, the points with higher return than the minimum variance portfolio point shows the efficient frontier on the curve.

(marked by Red)

b) Output-

Serial Number	Weights	Return	Risk
1	[0.71489209 0.27997879 0.00512913]	0.128254	0.0413761
2	[0.6109764 0.32127861 0.06774499]	0.135515	0.0491834
3	[0.50706072 0.36257843 0.13036085]	0.142776	0.0599808
4	[0.40314504 0.40387825 0.19297671]	0.150037	0.0724434
5	[0.29922936 0.44517808 0.25559257]	0.157297	0.0858491
6	[0.19531367 0.4864779 0.31820843]	0.164558	0.0998186
7	[0.09139799 0.52777772 0.38082429]	0.171819	0.114145
8	[-0.01251769 0.56907755 0.44344015]	0.17908	0.128709
9	[-0.11643338 0.61037737 0.50605601]	0.186341	0.143439
10	[-0.22034906 0.65167719 0.56867187]	0.193601	0.158288

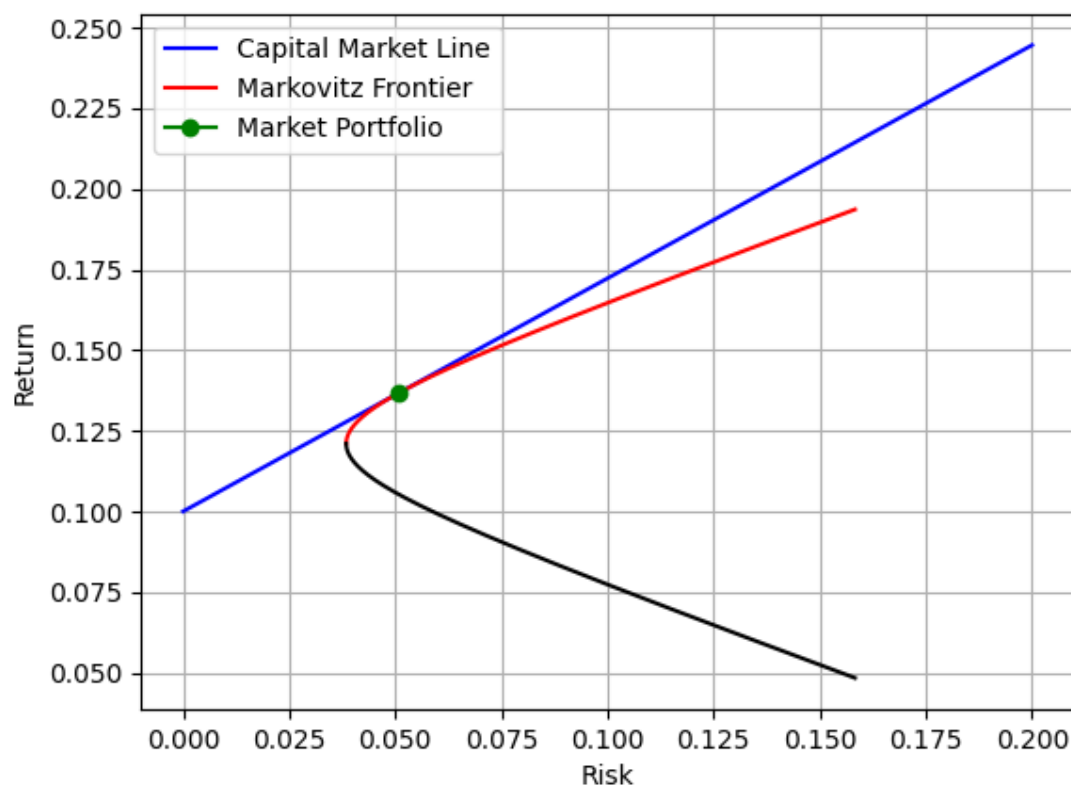
c) Output-

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PART C-  
For risk = 15%,  
The maximum return is: 0.18955479960265448  
Corresponding weights of the portfolio are: [-0.16243566  0.62866033  0.53377534]  
  
For risk = 15%,  
The minimum return is: 0.052446841086434964  
Corresponding weights of the portfolio are: [ 1.79984338 -0.1512198  -0.64862357]
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d) Output-

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PART D-  
For return = 18%, the minimum risk is: 13.056827102483865 %
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e) Plot-



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PART E-  
The market portfolio corresponding to risk free return 10%, is: [0.59375  0.328125  0.078125]  
The Return is: 0.13671875  
The Risk is: 5.081128919221594 %
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The equation for CML is obtained using the following formula:

$$\mu = r_F + \frac{\mu_M - r_F}{\sigma_M} \sigma$$

where,

μ_M = return corresponding to the market portfolio

μ_{rf} = risk free return

σ_M = risk corresponding to the market portfolio

The equation of the CML is: $\mu = 0.72 \sigma + 0.1$

f)

PART F-

The required portfolio with risk = 10%, is:

Weight of risk-free security is: -0.9680665771282883

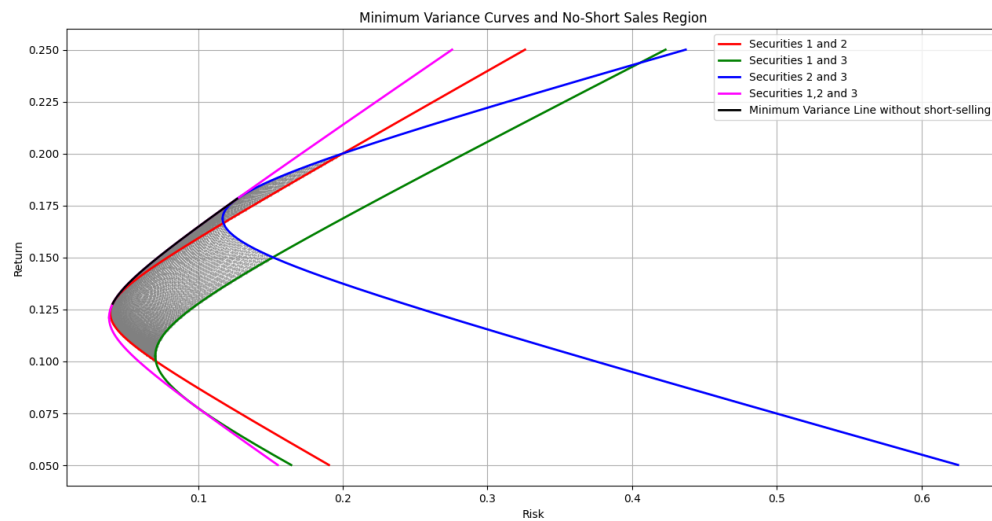
Weight of risky security is: [1.16853953 0.64577185 0.1537552]

The required portfolio with risk = 25%, is:

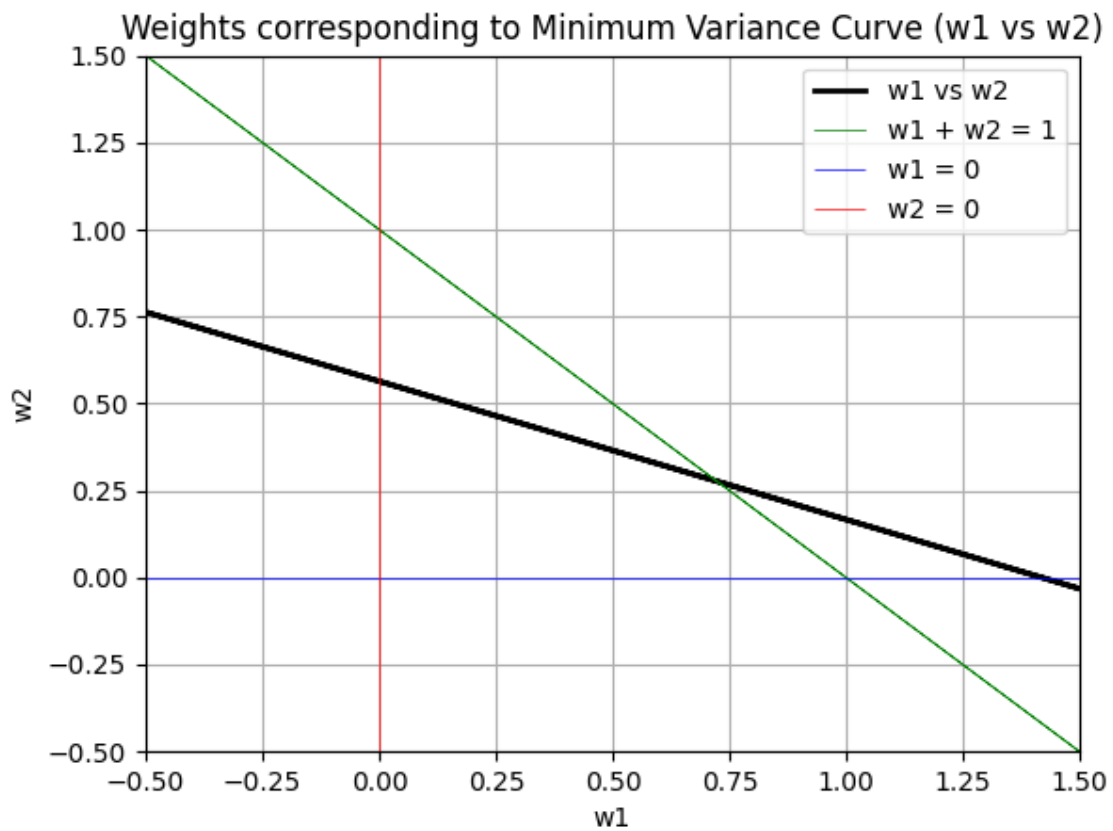
Weight of risk-free security is: -3.920166442820721

Weight of risky security is: [2.92134883 1.61442961 0.384388]

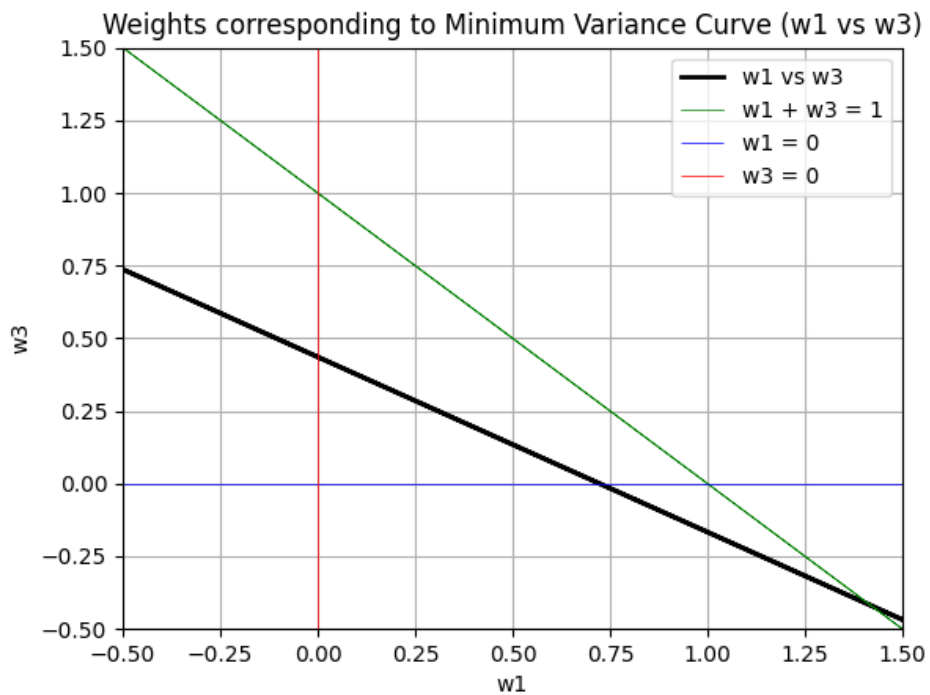
Question 2-



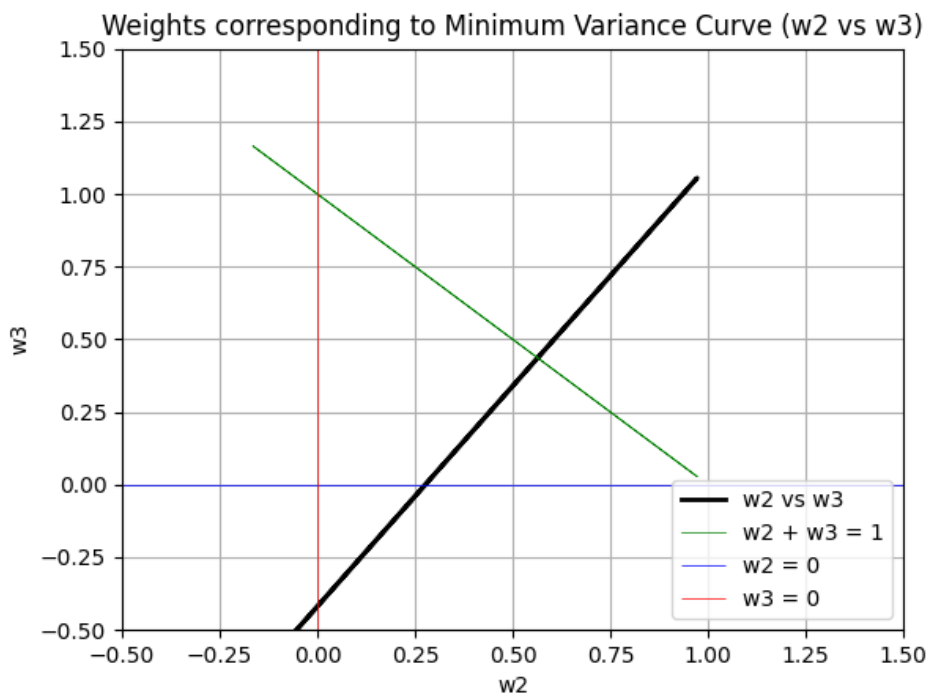
The region shaded in Gray color depicts the feasible region where no short sales are allowed.



Eqn of line w1 vs w2 is:
 $w2 = -0.40 w1 + 0.56$



Eqn of line w1 vs w3 is:
 $w3 = -0.60 w1 + 0.44$



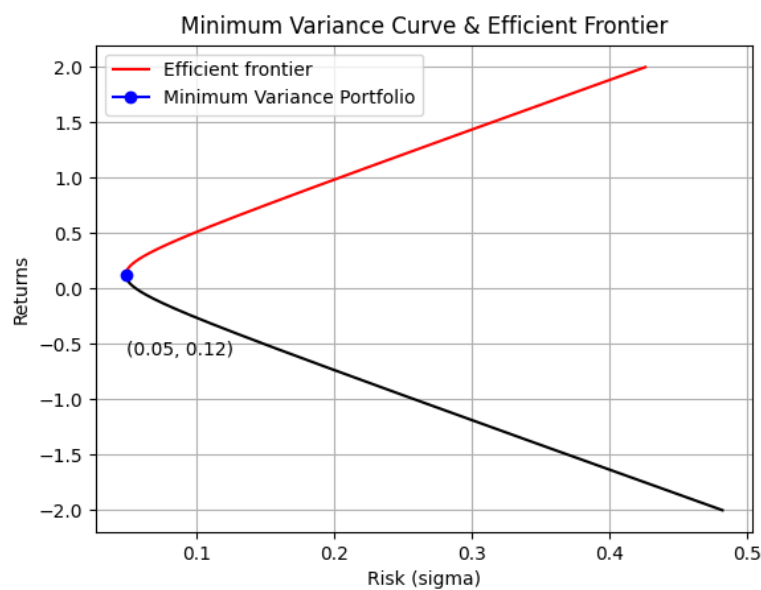
Eqn of line w2 vs w3 is:
 $w3 = 1.52 w2 + -0.42$

Question 3-

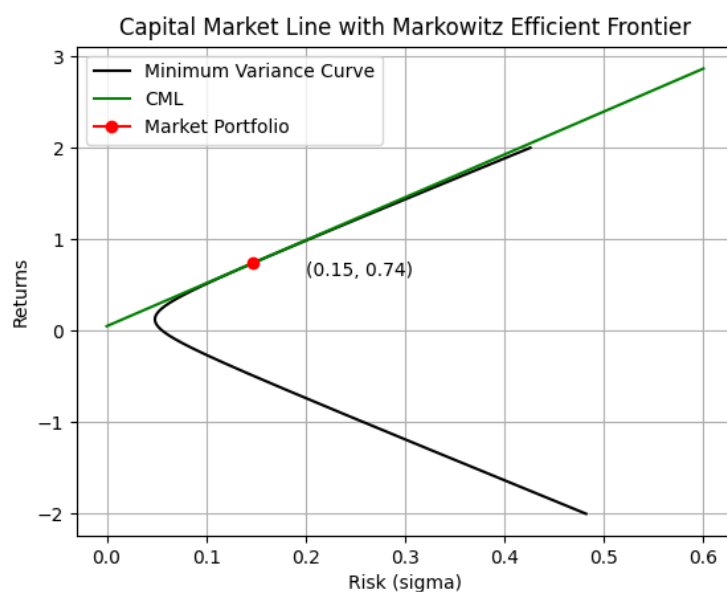
The data for the stocks had been collected for the time period of 5 years between 01/01/2018 to 01/12/2022 every month (total of 60 data points).

The companies considered are TCS, RIL, WIPRO, L&T, IOC, ICICI Bank, ONGC, TATA MOTORS, HDFC BANK, and INFOSYS. The monthly return was obtained as the difference in stock prices between the beginning of 2 consecutive months. The annual return was calculated suitably.

a) Output-

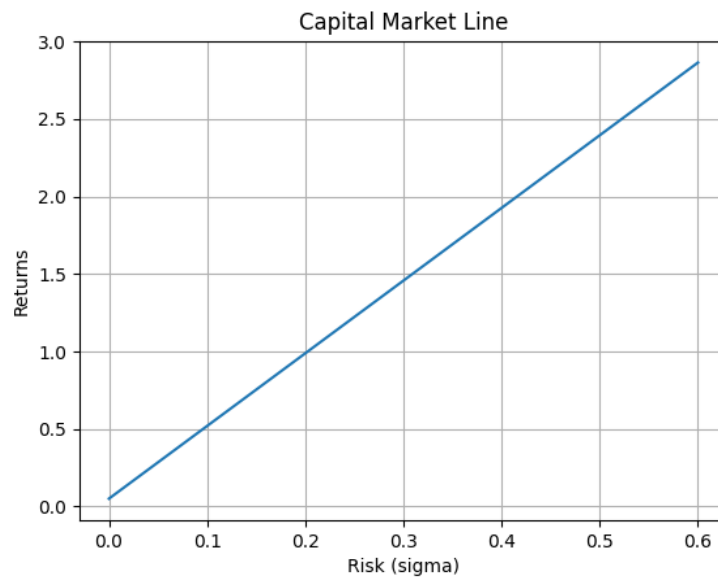


b) Output-



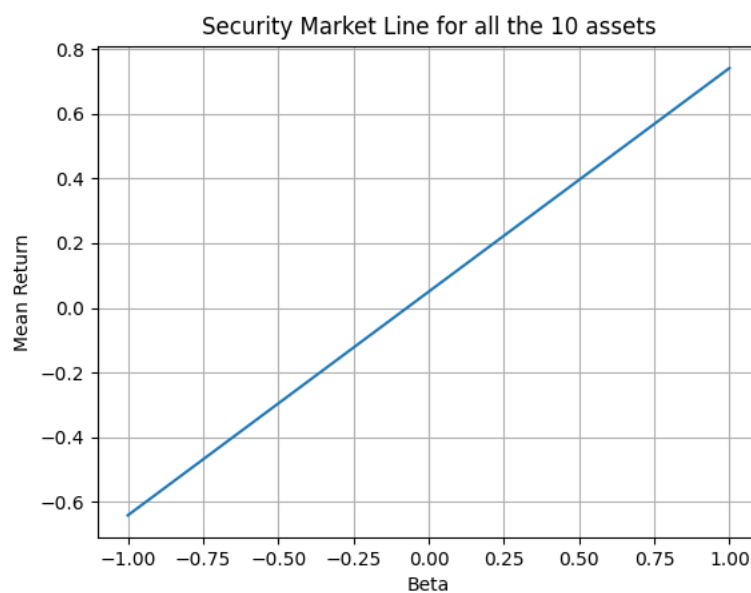
PART B-
 Market Portfolio Weights= [0.30107845 0.87227909 0.0092151 0.0988124 -1.51079958 1.13766182
 -0.16501756 -0.14995034 0.11187847 0.29484216]
 Return = 0.7421869414731268
 Risk = 14.752961806204501 %

c) Output-



PART C-
 Equation of CML is:
 $y = 4.69x + 0.05$

d) Output-



PART D-
 Eqn of Security Market Line is:
 $\mu = 0.69 \text{ beta} + 0.05$