BODIER PLOT.

AIM.

To plot the Bodier plot and find out Phase Margin and Gain Margin.

Apparatus Required.

Matlab, bode() → command used to plot the Magnitude and phase plots.

MANUAL CALCULATIONS.

Q: Given $G(s) = \frac{10}{(s+1)(s+3)}$

So $G(s) = \frac{10/3}{(1+s)(1+0.33s)}$

The corner frequencies are 1, 3

Term	Corner frequency	slope	change in slope
10	—	—	—
$\frac{1}{(1+s)}$	1	−20	−20
$\frac{1}{(1+0.33s)}$	3	−20	−40

Let the lowest corner frequency be ~~at~~ 0.001, highest be 10

$\omega_l = 0.001$

So Magnitude at 0.001 is

$M_{(0.001)} = 20\log\left(\frac{10}{3}\right) = 10.458\ dB$

$M(1) = 10.458 dB$

$M(2) = 10.458 - 20\log\left(\frac{2}{1}\right)$

$= \cancel{55.541 dB}$ 4.4369

~~$M(3) = -55.563 - 20\log\left(\frac{3}{2}\right)$~~

$M(3) = 4.4369 - 20\log\left(3/2\right)$

$= 0.9151$

$M(10) = 0.9151 - 40\log\left(10/3\right) = \cancel{-9.542}$ −20

$M(100) = -9.572 - 40\log\left(\frac{100}{10}\right) = -60$

$10/3 \rightarrow$ phase is $0°$

$1+s \rightarrow -\tan^{-1}(\omega)$ so $\phi = -\left[\tan^{-1}(\omega) + \tan^{-1}(0.33\omega)\right]$

$1+0.33s \rightarrow -\tan^{-1}(0.33\omega)$

ω	ϕ
0.001	−0.0763
0.01	−0.763
0.1	−7.61
1	~~−63.43~~
0.5	−36.02
1	−63.43
2	−97.125
3	−116.57
10	−157.59
50	−175.42
100	−177.7

Gain margin is for which the phase = −180° Magnitude

phase $= -\left[\tan^{-1}(\omega) + \tan^{-1}(\omega/3)\right]$

$= -\tan^{-1}\left(\dfrac{\omega + \omega/3}{1 - \frac{\omega^2}{3}}\right) = -\tan^{-1}\left(\dfrac{4\omega}{3 - \omega^2}\right)$

So $-\tan^{-1}\left(\dfrac{4\omega}{3-\omega^2}\right) = -180°$

$\tan^{-1}\left(\dfrac{4\omega}{3-\omega^2}\right) = 180$

for $\omega = 0$, $\omega = \infty$ they are equal

so for $\omega = \infty \rightarrow$ Magnitude is ~~∞~~ tending to $-\infty$

So ~~$M_{(\infty)}$~~ Gain Margin $= -(\text{magnitude})$

$= -(-\infty) = \infty$

phase Margin is for which Magnitude is zero

Magnitude = 0 dB for $\omega > 3$

So $\underbrace{M_{(dB)}}_{0} = \underbrace{M_{(3)}}_{0.9551} - 40\log\left(\frac{\omega}{3}\right)$

$40\log\left(\frac{\omega}{3}\right) = 0.9551$

$\log\left(\omega/3\right) = \dfrac{0.9551}{40}$

$\log\left(\frac{\omega}{3}\right) = 0.20$

$\omega/3 = 1.054$

$\omega = 3.1622$

So at 3.1622 phase is

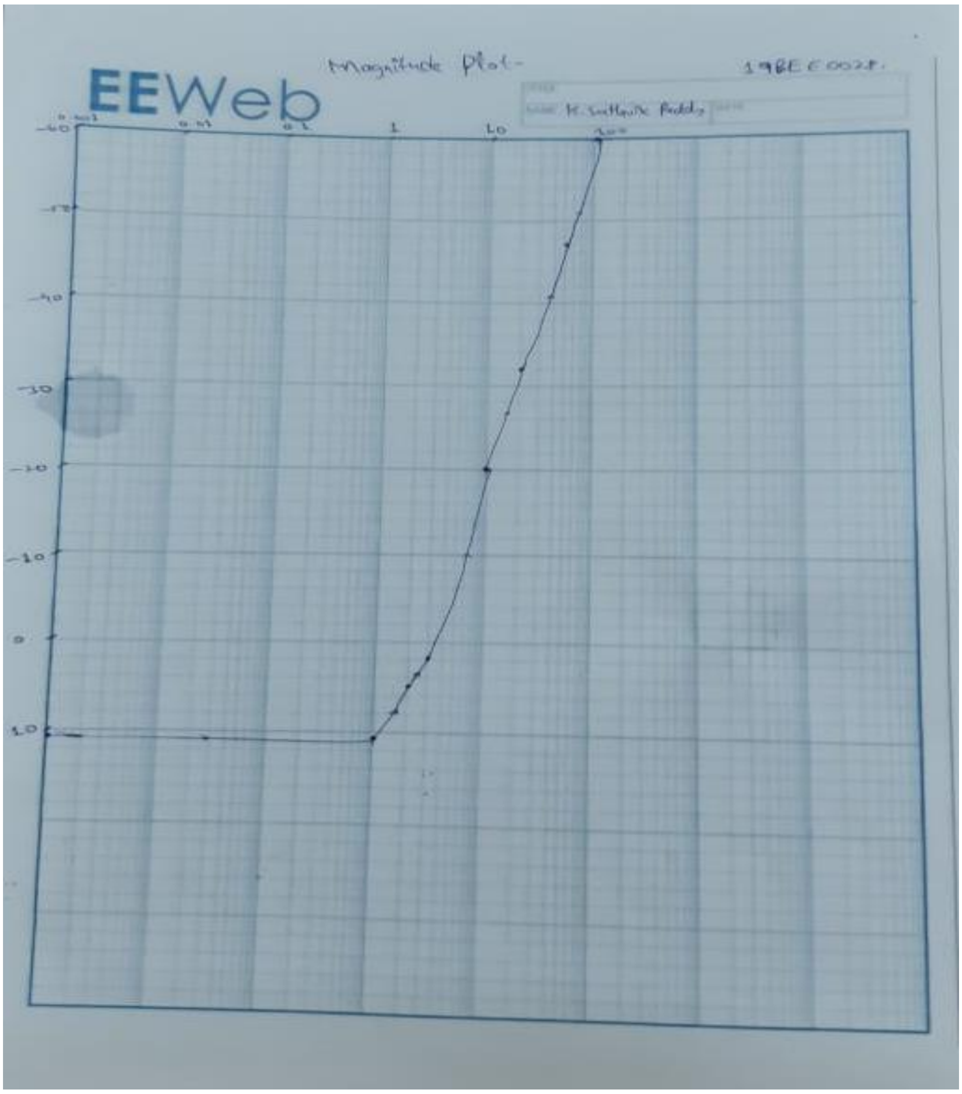
$= -\left[\tan^{-1}[3.1622] + \tan^{-1}\left[\frac{3.1622}{3}\right]\right]$

$\phi = -118.96°$

Phase Margin $= -180 - (\phi)$

$= -180 + 118.96$

$= -61.04°$



Magnitude Plot-
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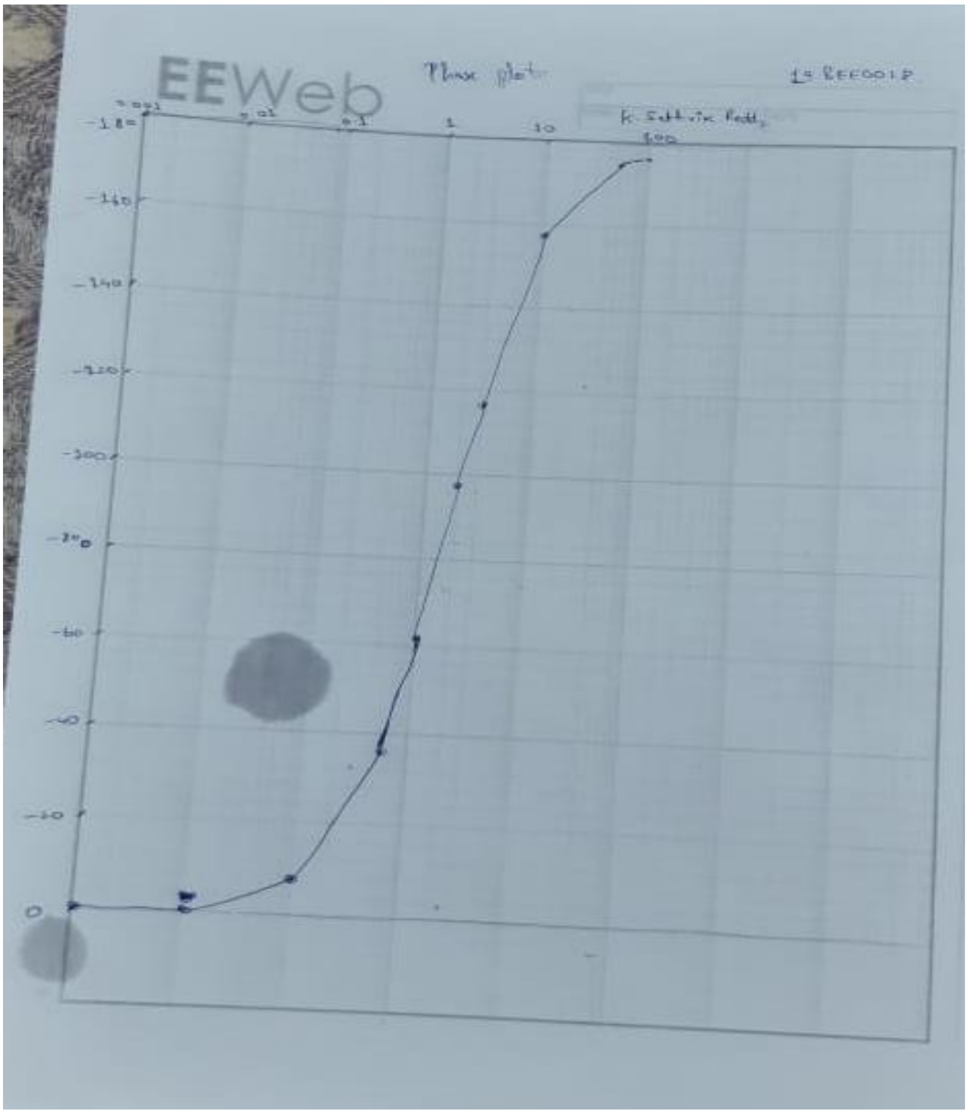
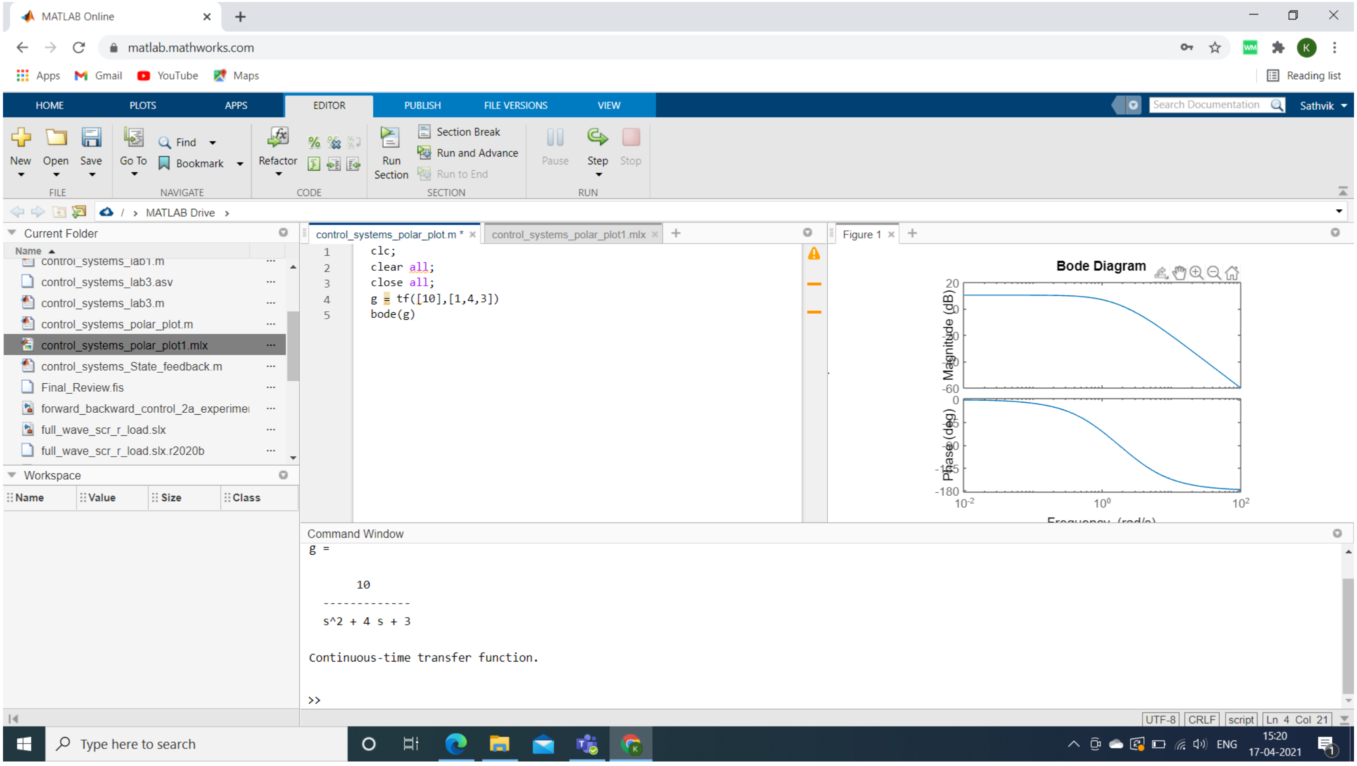


MATLAB CODE.



RESULT.

The values of Gain Margin and phase margin are calculated the gain margin is infinite and phase margin is -60.04.

INFERENCE.

From the above experiment I inferred that the gain margin is positive and phase margins is negative as gain margin is positive the system is stable.