Gaurav Gupta 2018UIC3093 ICE-2
Control System-1

Bode Plot -

Ex-2.) Draw the Bode plot of the unity feedback system with forward gain as:

$$G(s) = \frac{40}{(s+2)(s+5)}$$

Also determine the gain margin, phase margin and comment on the stability of the system.

Solution:

1.) Convert transfer function to costant form

$$G(s)H(s) = \frac{40}{(s+2)(s+5)} = \frac{4}{(1+0.5s)(1+0.2s)}$$

2.) Convert to sinusodial form-

$$G(j\omega)H(j\omega) = \frac{4}{(1+0.5j\omega)(1+0.2j\omega)}$$

3) Different part of the plot
(i) Constant term $K=4$
(ii) Type of system: 0, this means initial slope is 0dB/dec and initial magnitude is $20\log K = 20\log 4 = 12.04$dB
(iii) Corner frequencies: $\omega_{c1} = 1/0.5 = 2$ rad/s,
$\omega_{c2} = 5$ rad/s

4.) Draw reference slopes and axes.

5.) Draw magnitude plot.

6.) Draw phase plot, $\phi = \angle G(j\omega)H(j\omega) = -\tan^{-1}(0.5\omega) - \tan^{-1}(0.2\omega)$
Using this expression, tabulate some values of ϕ w.r.t ω

ω	0.1	1	2	5	10	20	∞
ϕ	-40.08°	-37.87°	-66.8°	-113.2°	-142.1°	-160.26°	-180°

Step 7) Gain cross-over and phase cross-over ν and corresponding values of phase and magnitude

$\omega_{gc} = 5.18$ rad/s, $\phi(\omega_{gc}) = 115°$

$\omega_{pc} = \infty$ rad/s, $M(\omega_{pc}) = -\infty$ dB

Step 8) Stability margins

Gain Margins, $GM = 0 - M(\omega_{pc}) = 0 - (-\infty) = +\infty$ dB

Phase Margins, $PM = 180° - \phi(\omega_{gc}) = 180° - 115° = 65°$

The phase plot curve is asymptotic to -180° axis at high ν and the gain at high crossover is -ive such that the GM is -∞. Since, both PM and GM +ive, therefore, the system is stable. Further the GM is infinite, hence, the system inherently stable.