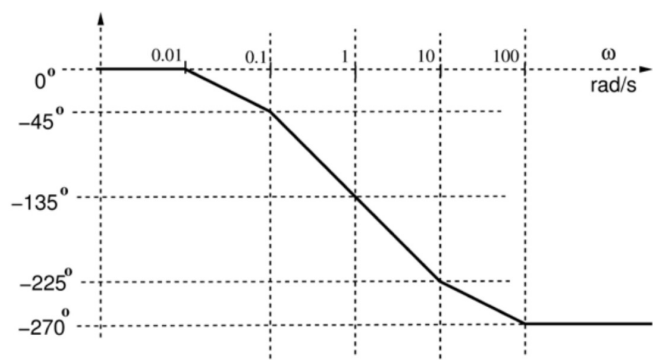


Control Systems

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From the plot,

$$-45^\circ = -\tan^{-1}\left(\frac{0.1}{0.1}\right) - \tan^{-1}\left(\frac{0.1}{10}\right) - \tan^{-1}\left(\frac{0.1}{p_1}\right) \quad (2.1.1.3)$$

p_1 is approximately 1, i.e, for p_1 in 0.95 to 1.05 the ϕ is approximately equals to -45° .

2.1.2. Find the value of p_1 using bode phase plot properties.

Solution: In asymptotic Bode plot for a single pole, the phase at pole is -45° and the phase changes from 0 to -90 in 2 decades i.e, from $pole/10$ to $10 \times pole$.

Bode phase plot for a transfer function having pole at p

$$\phi(\omega) = \begin{cases} 0 & 0 < f < p/10 \\ -45 \times (\log(f) - \log(p/10)) & p/10 < f < 10p \\ -90 & 10p < f \end{cases} \quad (2.1.2.1)$$

Adding the bode phase plots corresponding to the 0.1,10.

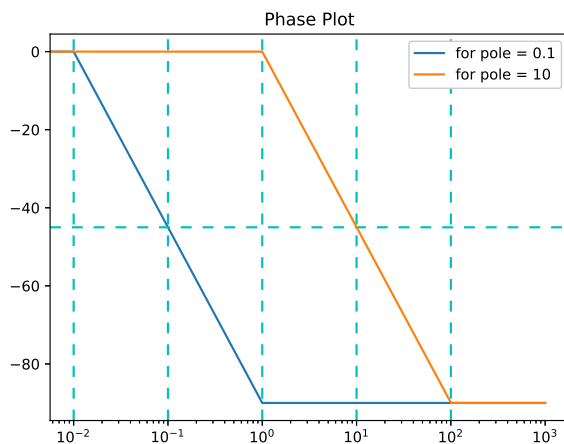


Fig. 2.1.2

The values before the 0.1 does not change when compared to figure 2.1.1, so $p_1/10$ is greater than or equal to 0.1.

In the plot obtained by adding these two plots the slope at 0.1 doesn't change, but in figure 2.1.1 there is a change so $p/10 = 0.1$

$$\Rightarrow p_1 = 1 \quad (2.1.2.2)$$

The following code plots Fig. 2.1.2

codes/ee18btech11037.py

2.2 Example

3 SECOND ORDER SYSTEM

3.1 Damping

3.2 Example

4 ROUTH HURWITZ CRITERION

4.1 Routh Array

4.2 Marginal Stability

4.3 Stability

4.4 Example

5 STATE-SPACE MODEL

5.1 Controllability and Observability

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5.3 Example

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6 NYQUIST PLOT

7 COMPENSATORS

7.1 Phase Lead

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8 GAIN MARGIN

8.1 Introduction

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9 PHASE MARGIN

10 OSCILLATOR

10.1 Introduction

10.2 Example