

# CONTROL SYSTEMS - EE2227

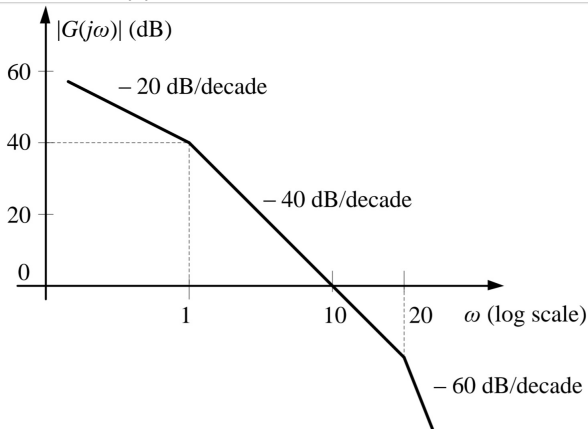
Ch Pranay Prakash( EE18BTECH11009)

IIT Hyderabad

February 12, 2020

## GATE 2019 - problem 29

Q. The asymptotic Bode magnitude plot of minimum phase transfer function  $G(s)$  is show below.



Consider the following two statements.

Statement 1: Transfer function  $G(s)$  has 3 poles and one zero

Statement 2: At very high frequency ( $\omega \rightarrow \infty$ ), the phase angle  $\angle G(j\omega) = -3\pi/2$

Which of the following is correct ?

- (A) Statement 1 is true and Statement 2 is false.
- (B) Statement 1 is false and Statement 2 is true.
- (C) Both the statements are true.
- (D) Both the statements are false.

## Solution

Since, each pole corresponds to -20 dB/decade and each zero corresponds to +20 dB/decade.

Therefore, from the given Bode plot we can get the Transfer equation,

$$G(s) = \frac{k}{s(1+s)(20+s)}$$

Now, from the Transfer equation we can conclude that, there are three poles (0, -1 and -20 ) and no zeros.

∴ Statement 1 is false .....(1)

# Calculating phase

Since we know that,  
phase  $\phi$  is the sum of all the phases corresponding to each pole and zero.

phase corresponding to pole is =

$$-\tan^{-1}\left(\frac{\textit{imaginary}}{\textit{real}}\right)$$

phase corresponding to zero is =

$$\tan^{-1}\left(\frac{\textit{imaginary}}{\textit{real}}\right)$$

now take,

$$s = j\omega$$

$$\Rightarrow G(j\omega) = \frac{k}{j\omega(1+j\omega)(20+j\omega)}$$

Therefore,

$$\phi = -\tan^{-1}\left(\frac{\omega}{0}\right) - \tan^{-1}(\omega) - \tan^{-1}\left(\frac{\omega}{20}\right)$$

$$\phi = -90^\circ - \tan^{-1}(\omega) - \tan^{-1}\left(\frac{\omega}{20}\right)$$

$$\therefore \omega \rightarrow \infty$$



$$\phi = -90^\circ - 90^\circ - 90^\circ$$

$$\phi = -270^\circ$$

$$\phi = -3\pi/2$$

$\therefore$  Statement 2 is true .....(2)

thus, from (1) and (2) option (B) is correct.

# Thank You