

CONTROL SYSTEMS - EE2227

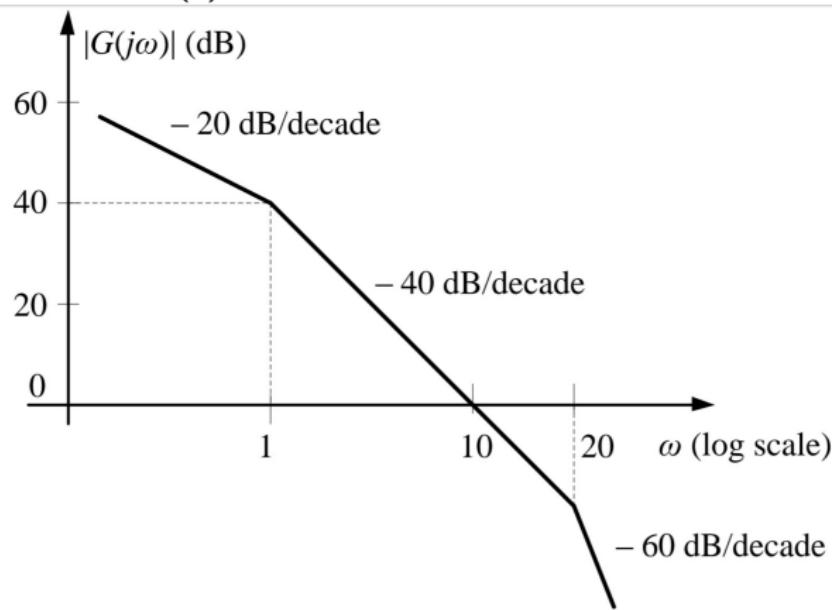
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GATE 2019 - problem 29

Q. The asymptotic Bode magnitude plot of minimum phase transfer function $G(s)$ is shown 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 ϕ is the sum of all the phases corresponding to each pole and zero.

phase corresponding to pole is =

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

phase corresponding to zero is =

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

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