CONTROL SYSTEMS - EE2227

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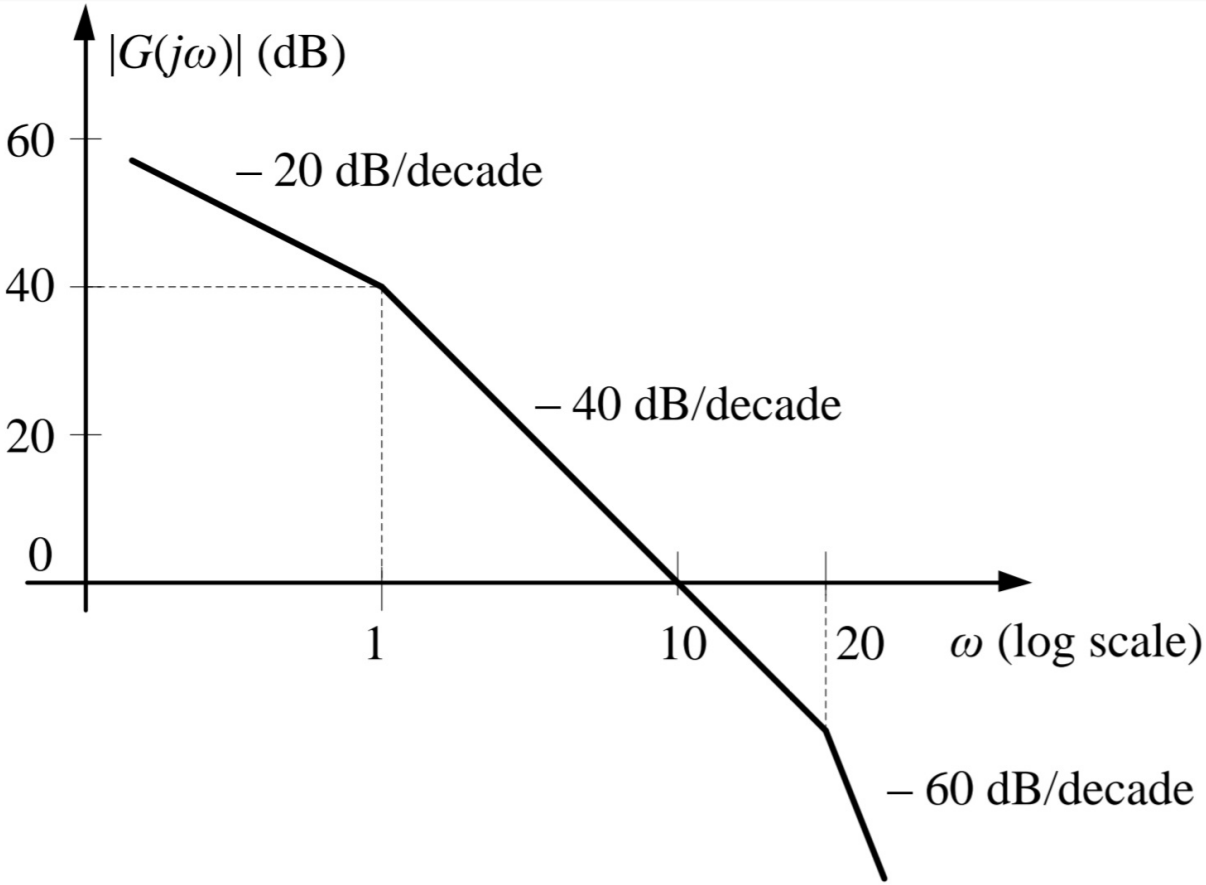
GATE 2019 - problem 29

Q. The asymptotic Bode magnitude plot of minimum phase transfer function G(s) is 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 ($\omega \to \infty$), 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.

$\therefore$ 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 $=$

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

phase corresponding to zero is $=$

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

now take,

$$s = j\omega$$

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

Therefore,

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

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

$$\because \omega \to \infty$$

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

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

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

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

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

Thank You