

Gate 2022_EE_17

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The Bode magnitude plot of a first order stable system is constant with frequency. The asymptotic value of the high frequency phase, for the system, is -180° . This system has

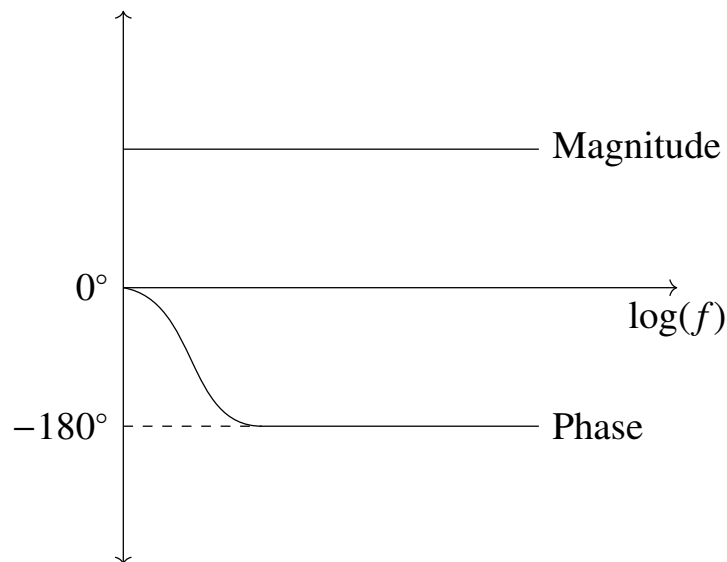


Fig. 1.

- (A) one LHP pole and one RHP zero at the same frequency.
- (B) one LHP pole and one LHP zero at the same frequency.
- (C) two LHP poles and one RHP zero.
- (D) two RHP poles and one LHP zero.

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Solution:

Flat constant magnitude response for all frequency of system shows that it is an all pass system.

In all pass system, poles and zeros are symmetrical about $j\omega$ axis.

Possible transfer functions are

$$T_1(s) = \frac{s - a}{s + a} \quad a > 0 \quad (1)$$

$$T_2(s) = \frac{a - s}{a + s} \quad a > 0 \quad (2)$$

$$s = j\omega \quad (3)$$

From the phase plot as $\omega \rightarrow \infty$ shows $\phi = -180^\circ$.

1) For $T_1(s)$:

Using equation (3)

$$T_1(j\omega) = \frac{j\omega - a}{j\omega + a} \quad (4)$$

$$\angle T_1(j\omega) = 180^\circ - \tan^{-1}\left(\frac{\omega}{a}\right) - \tan^{-1}\left(\frac{\omega}{a}\right) \quad (5)$$

$$= 180^\circ - 2 \tan^{-1}\left(\frac{\omega}{a}\right) \quad (6)$$

At $\omega = \infty$,

$$\angle T_1(j\omega) = 0^\circ \quad (7)$$

2) For $T_2(s)$:

Using equation (3)

$$T_2(j\omega) = \frac{a - j\omega}{a + j\omega} \quad (8)$$

$$\angle T_2(j\omega) = -\tan^{-1}\left(\frac{\omega}{a}\right) - \tan^{-1}\left(\frac{\omega}{a}\right) \quad (9)$$

$$= -2 \tan^{-1}\left(\frac{\omega}{a}\right) \quad (10)$$

At $\omega = \infty$,

$$\angle T_2(j\omega) = -180^\circ \quad (11)$$

Hence, the transfer function of given all pass filter.

$$T(s) = \frac{a - s}{a + s} \quad a > 0 \quad (12)$$

Hence, the system has one LHP pole and one RHP zero at the same frequency.