Type 7: Bode Plot

For Concept refer to Control System K-Notes, Bode Plots

Common Mistake:
Remember the x-axis is always in terms of logω and not in terms of ω, this is a common mistake while calculating slope.

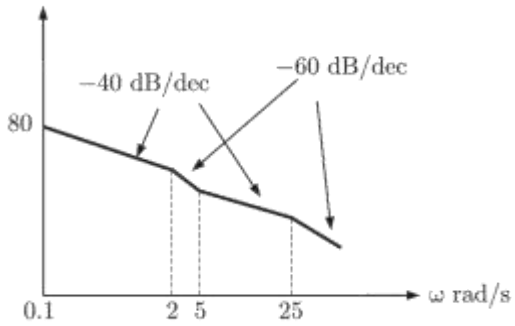
Sample Problem 7:
The asymptotic approximation of the log-magnitude v/s frequency plot of a system containing only real poles and zeros is shown. Its transfer function is

(A) $\frac{10(s+5)}{s(s+25)(s+2)}$

(B) $\frac{1000(s+5)}{s^2(s+25)(s+2)}$

(C) $\frac{100(s+5)}{s(s+25)(s+2)}$

(D) $\frac{80(s+5)}{s^2(s+25)(s+2)}$



Solution: (B) is correct option
Since initial slope of the bode plot is −40 dB/decade, so no. of poles at origin is 2.
Transfer function can be written in following steps:

- Slope changes from −40 dB/dec. to −60 dB/dec. at ω1 = 2 rad/sec., so at ω1 there is a pole in the transfer function.
- Slope changes from −60 dB/dec to −40 dB/dec at ω2 = 5 rad/sec., so at this frequency there is a zero lying in the system function.

- The slope changes from −40 dB/dec to −60 dB/dec at ω3 = 25 rad/sec, so there is a pole in the system at this frequency.

Transfer Function

$$T(s)=\frac{K(s+5)}{s^2(s+25)(s+2)}$$

Constant term can be obained as:

$$T(j\omega)\big|_{\text{at }\omega=.1}=80$$

So, $$80=20\log\left[\frac{K(5)}{(.1)^2\times 50}\right]$$

$$K=1000$$

therefore the Transfer Function is

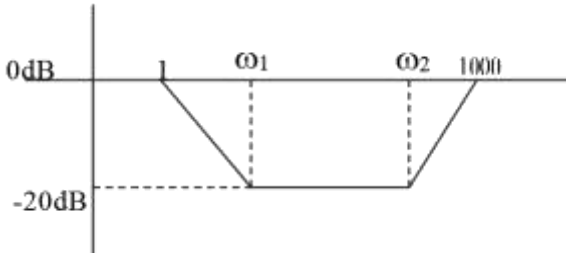
$$T(s)=\frac{1000(s+5)}{s^2(s+25)(s+2)}$$

Unsolved Problems:

Q.1 The Bode plot of a system is given its transfer function is

(A) $\frac{(1+0.1s)(1+0.01s)}{(1+s)(1+0.001s)}$ (B) $\frac{(1+0.1s)(1+s)}{(1+0.01s)(1+0.001s)}$

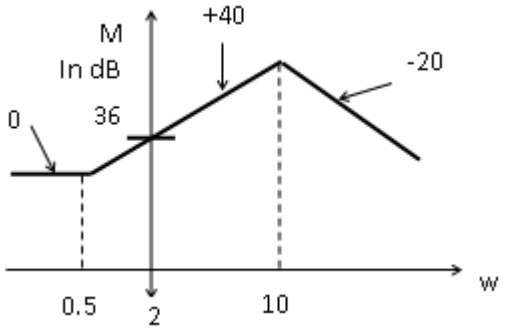
(C) $\frac{(1+10s)(1+s)}{(1+0.1s)(1+0.001s)}$ (D) $\frac{(1+0.001s)(1+s)}{s(1+10s)}$



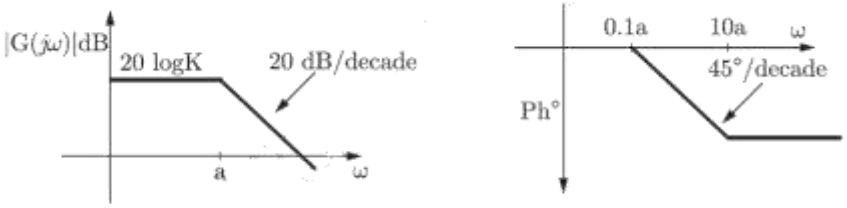
Q.2 What is the transfer function for given bode plot shown in the figure

(A) $\frac{4(s+0.5)^2}{(s+10)^3}$ (B) $\frac{16000(s+0.5)^2}{(s+10)^3}$

(C) $\frac{160(s+0.5)^2}{(s+10)^3}$ (D) $\frac{1600(s+0.5)^2}{(s+10)^3}$



Q.3 The asymptotic Bode plot of the transfer function $T(s)=\frac{K}{(1+\frac{s}{a})}$ is given in figure. The error in phase angle and dB gain at a frequency of $\omega = 0.5a$ are respectively



(A) 4.9^0, 0.97 dB (B) 5.7^0, 3 dB (C) 4.9^0, 3 dB (D) 5.7^0, 0.97 dB

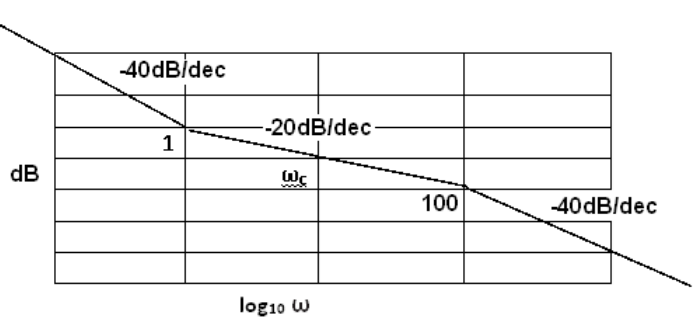
Q.4 The asymptotic magnitude Bode plot of an open loop system G(s) with K>0 and all poles and zeroes on the s-plane is shown in the figure. It is completely symmetric about ω_c . The minimum absolute phase angle contribution by G(s) is given by

(A) 78.6^0

(B) 90^0

(C) 101.4^0

(D) 180^0



Q.5 The open loop transfer function of a system is given by $G(s)H(s)=\frac{100(s+100)}{s(s+10)}$ in the straight –line approximation of the Bode plot $|G(j\omega)H(j\omega)|$ and $\angle G(j\omega)$ at ω=100 rad/sec are

(A) 0 dB and $\frac{-3\pi}{4}$rad (B) 0 dB and $\frac{\pi}{4}$rad (C) 20 dB and $\frac{-3\pi}{4}$rad (D) 20 dB and $\frac{\pi}{4}$rad