Type 10: Gain Margin and Phase Margin

For Concept, refer to Control System K-Notes, Frequency Response Analysis

Sample Problem 10:

The frequency response of a linear system *G* (*j*ω) is provided in the tubular form below

$\lvert G(j\omega)\rvert$	1.3	1.2	1.0	.8	.5	.3
$\angle G(j\omega)$	-130^0	-140^0	-150^0	-160^0	-180^0	-200^0

Gain Margin and phase margin are

(A) 6 dB and 30^0

(B) 6 dB and -30^0

(C) -6 dB and 30^0

(D) -6 dB and -30^0

Solution: (A) is correct option

Gain margin is simply equal to the gain at phase cross over frequency (ω_p). Phase cross over frequency is the frequency at which phase angle is equal to -180^0. From the table we can see that $+G(j\omega_p) = -180^0$, at which gain is 0.5.

$$GM = 20\log_{10}\left(\frac{1}{\lvert G(j\omega_p)\rvert}\right)$$

$$= 20\log_{10}\left(\frac{1}{.5}\right) = 6dB$$

Phase Margin is equal to 180^0 plus the phase angle ϕ_g at the gain cross over frequency (ω_g). Gain cross over frequency is the frequency at which gain is unity. From the table it is clear that $G(j\omega_g) = 1$, at which phase angle is -150^0

$\phi_{PM} = 180^0 + \angle G(j\omega_g)$

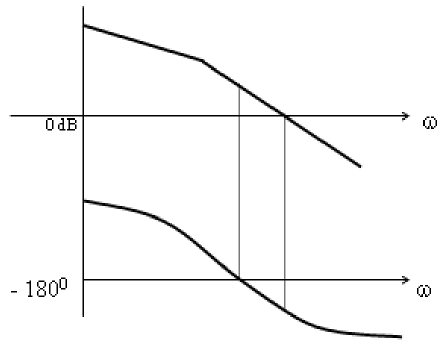
$= 180^0 - 150^0 = 30^0$

Unsolved Problems:

Q.1 The open loop transfer function of a system is $\dfrac{K}{s(1+0.2s)(1+0.05s)}$. Determine the value of 'k' such that the phase margin is 60^0?

(A) 2.3 (B) 3.3 (C) 3.2 (D) 5.2

Q.2 The Bode plot of a unity feedback system is shown. The system has



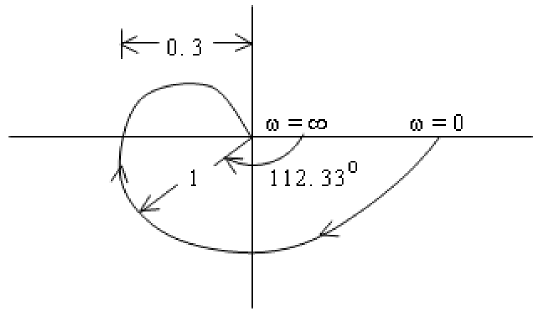
(A) +ve P.M. and –ve G.M

(B) +ve P.M. and +ve G.M

(C) –ve P.M. and –ve G.M

(D) +ve P.M. and +ve G.M

Q.3 A unity feedback system has OLTF G(s). Polar plot is shown in the figure. The gain margin and phase margin are



(A) GM = – 0.3, PM = 112.33^0

(B) GM = 0.3, PM = 112.33^0

(C) GM = 3.33, PM = 67.67^0

(D)None of the above

Q.4 The open loop transfer function of a unity feedback control system is given as $G(s)=\dfrac{1}{s(1+sT_1)(1+sT_2)}$ .The phase crossover frequency and the gain margin are, respectively.

(A) $\dfrac{1}{\sqrt{T_1T_2}}$ and $\dfrac{T_1+T_2}{T_1T_2}$

(B) $\dfrac{1}{T_1+T_2}$ and $\dfrac{T_1+T_2}{T_1T_2}$

(C) $\dfrac{1}{\sqrt{T_1T_2}}$ and $\dfrac{T_1T_2}{T_1+T_2}$

(D) $\dfrac{1}{T_1+T_2}$ and $\dfrac{T_1T_2}{T_1+T_2}$

Q.5 In the G(s)H(s)-plane, the Nyquist plot of the loop transfer function $G(s)H(s)=\dfrac{\pi e^{-0.25s}}{s}$ passes through the negative real axis at the point

(A) (– 0.25, *j*0) (B) (– 0.5, *j*0) (C) 0 (D) 0.5