SHUBHAM GUPTA 180749

QUIZ - 4

1) a) for P only

$$G_{OL} = \frac{2K_c e^{-s}}{(s+1)^3} \qquad \text{assume } GM = 1$$

$$\angle G_{OL} = -\omega - 3\tan^{-1}\omega = -\pi$$

$$\boxed{\omega = 0.282}$$

$$|G_{OL}| = 1 = \frac{2K_c}{\left(\sqrt{(\omega)^2+1}\right)^3}$$

$$\frac{5.165}{2} = K_c$$

$$\boxed{K_c = 2.58} = K_u$$

for PI $\quad PM = 45°$

$$P_u = \frac{2\pi}{\omega}$$

$$\angle G_{OL} = -\omega - \tan^{-1}\omega = -\frac{3\pi}{4}$$

$$\boxed{P_u = 22.28}$$

$$\boxed{\omega = 0.178}$$

~~$|G_{OL}| = 1 = \frac{2K_c}{\left(\sqrt{(\omega)^2+1}\right)^3}$~~

$$\boxed{K_u = 2.58} \qquad \boxed{P_u = 22.28}$$

	K_c	τ_I	τ_D
P	1.29	-	-
PI	1.172	18.56	-
PID	1.517	11.14	2.785

(A)

SHUBHAM GUPTA 180749

QUIZ-4

c) $\boxed{z_1 = 22.28}$ $\underline{GM = 2}$ PM $\boxed{\phi = 45^\circ}$

$$G_{OL} = \frac{2K_c(22.28s+1)(e^{-s})}{(22.28s)(5s+1)^3}$$

$$\angle G_{OL} = -\omega - 3\tan^{-1}5\omega - \frac{\pi}{2} + \tan^{-1}(22.28\omega) = \frac{-3\pi}{4}$$

$$\boxed{\omega = 0.148 \text{ rad/sec}}$$

$$|G_{OL}| = \frac{1}{2} = \frac{2K_c\sqrt{(22.28\omega)^2+1}}{22.28\omega(\sqrt{25\omega^2+1})^3}$$

solving for K_c :—

$$K_c = \frac{6.348}{4 \times 3.446}$$

$$\boxed{K_c = 0.46}$$

b). $z_1 = 22.8$ [redacted]° $\boxed{GM = 2}$

$$\angle G_{OL} = -\omega - 3\tan^{-1}5\omega - \frac{\pi}{2} + \tan^{-1}(22.28\omega) = [redacted]$$

$$\boxed{\omega = 0.254 \text{ rad/sec}}$$

$$|G_{OL}| = \frac{1}{2} = \frac{2K_c\sqrt{((22.28\omega)^2+1)}}{22.28\omega(\sqrt{25\omega^2+1})^3}$$

$$K_c = \frac{22.902}{4 \times 5.747}$$

$$\boxed{K_c = 0.996}$$

SHUBHAM GUPTA 180749

QUIZ-4

d). $\boxed{T_1 = 22.28}$ $\boxed{M_T = 2\ dB}$

$$G_{OL} = \frac{2K_c(22.28s+1)e^{-s}}{22.28s(5s+1)^3}$$

$$T = \frac{G_{OL}}{1+G_{OL}} = \frac{\frac{2K_c(22.28s+1)e^{-s}}{22.28s(5s+1)^3}}{1+\frac{2K_c(22.28s+1)e^{-s}}{22.28s(5s+1)^3}}$$

$$T = \frac{2K_c(22.28s+1)e^{-s}}{22.28s(5s+1)^3 + 2K_c(22.28s+1)e^{-s}}$$

$$|T(j\omega)| = \frac{2K_c\sqrt{(22.28\omega)^2+1}}{2785\omega^4 + 1671\omega^3 + 334.2\omega^2 + 22.28\omega + (44.56K_c\omega + 2K_c)e^{-s}}$$

$$e^{-s} = \cos\omega + j\sin\omega$$

$$2785\omega^4 - 334.2\omega^2 - 1671\omega^3 j + 22.28\omega j$$

$$(44.56K_c\omega j + 2K_c)(\cos\omega + j\sin\omega)$$

$$44.56K_c\cos(\omega)\,\omega j + (2K_c\cos\omega - 44.56K_c\sin(\omega)\omega)$$

$$2K_c\sin\omega j$$

$$\sqrt{\left[(2785\omega^4 - 334.2\omega^2 + 2K_c\cos\omega - 44.56K_c\omega\sin\omega)\right]^2 + \left[(-1671\omega^3 + 22.28\omega + 44.56K_c\omega\cos\omega + 2K_c\sin\omega)\right]^2}$$

$$\frac{d|T(j\omega)|}{d\omega} = 0 \quad (A)$$

$$20\log_{10}|T| = 2$$

$$|T| = 1.258 \quad (B)$$

solve (A) & (B) to get K_c