KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
ELECTRICAL ENGINEERING DEPARTMENT

EE380 [091]	SEC#_____	Quiz #10
Name:_____	ID:_____	Grade:_____

DO NOT USE CALCULATOR

The open loop transfer function is given by

$$G(s)H(s) = \frac{K}{s(s+2)(s+10)}$$

1) Determine the value of K such that the system may have a gain margin of 6 dB

2) Determine the value of K such that the system may have a phase margin of 45°

① $\angle GH = -90 - \tan^{-1}(\omega/2) - \tan^{-1}(\omega/10) = -180 \Rightarrow \omega = \sqrt{20}$

$$|GH|_{\omega=\sqrt{20}} = \frac{K}{240} \Rightarrow 20\log\frac{240}{K} = 6 = 20\log 2$$

$$\therefore \boxed{K = 120}$$

② $\angle GH + 180 = 45^\circ \Rightarrow \angle GH = -135^\circ$

$$-90 - \tan^{-1}(\omega/2) - \tan^{-1}(\omega/10) = -135 \Rightarrow \tan^{-1}(\omega/2) + \tan^{-1}(\omega/10) = 45$$

$$\therefore \frac{\omega/2 + \omega/10}{1 - \omega^2/20} = 1 \Rightarrow \frac{12\omega}{20-\omega^2} = 1 \Rightarrow \omega^2 + 12\omega - 20 = 0$$

$$\therefore \omega_g = \frac{-12 \mp \sqrt{144+80}}{2} = \frac{-12 \pm \sqrt{224}}{2} \simeq 1.5$$

$$|GH|_{\omega=\omega_g} = 1 \Rightarrow \frac{K}{1.5\sqrt{4+(1.5)^2}\sqrt{100+(1.5)^2}} = 1$$

$$\therefore K \simeq 38$$