LUQMAN HAKIMI BIN ABDUL NASIR A17KE0048

Section 5

Q1)

a) i) Poles = $(s+4)$, $(s+2+j1)$, $(s+2-j1)$

Zero = $(s+3)$

$$G(s) = \frac{(s+3)}{(s+4)(s+2+j1)(s+2-j1)} = \frac{(s+3)}{(s+4)(s^2+4s+5)}$$

ii) $\sigma_a = \frac{(-4-2+j1-2-j1)-(-3)}{3-1} = -2.5$

$\theta_a =$

$k=0$, $\theta_a = \frac{180^\circ}{2} = 90^\circ$

$k=1$, $\theta_a = \frac{180 \times 3}{2} = 270^\circ$

since there's only two assymtote

iii) $= \sum \theta_z - \sum \theta_p + 180$

$= \tan^{-1}\left(\frac{1}{1}\right) - \left[\tan^{-1}\left(\frac{1}{-2}\right) + 90\right] + 180$

$= 108.43^\circ$

b) i) $\zeta = 0.59$ $\omega_n = 4.08$ rad/s $OS = 10\%$

i) $-\zeta\omega_n \pm j\omega_n\sqrt{1-\zeta^2} = -2.4 \pm j3.29$

ii) $k = \frac{1}{|G(s)H(s)|} = \frac{(s+4)(s^2+4s+5)}{(s+3)} = 10.96$

iii) $1 + kGH = 0$

$$\frac{(s+3)}{(s+4)(s^2+4s+5)} + 1 = 0$$

$$\frac{(s+3)}{(s+4)(s^2+4s+5)} + \frac{(s+4)(s^2+4s+5)}{(s+4)(s^2+4s+5)} = 0$$

$$\frac{(s+3)(s+4)(s^2+4s+5)}{(s+4)(s^2+4s+5)} = 0$$

$s^3 + 8s^2 + 21s + 20 + 10.96s + 32.88 = 0$

$s^3 + 8s^2 + 31.96s + 52.88 = 0$

$(s + 3.18)(s + 2.41 \pm j3.29) = 0$

$s_1 = -3.18$

$s_2 = -2.4 + j3.29$

$s_3 = -2.4 - j3.29$

~~3.14~~

$\frac{3.18}{2.4} = 1.325 < 5$

cannot use 2nd approximation method.

iv) T_s
T_p
e_{ss}

$T_s = \frac{4}{2.4} = 1.67\ s$

$T_p = \frac{\pi}{3.29} = 0.955.$

$e_{ss} = \frac{1}{1+K_p}$

$K_p = \lim_{s \to 0} KG(s) = 0.15$

Q2)

$$G(s) = \frac{K(s^2 - 2s + 8)}{(s+3)(s^2 + 4s + 5)}$$

$s_d = -0.88 \pm j1.72$

$\%OS = 20\%$

a) $$\zeta = \frac{-\ln(20/100)}{\sqrt{\pi^2 + \ln^2(20/100)}} = 0.46$$

$\zeta\omega_n = 0.88$

$(0.46)\omega_n = 0.88$

$\omega_n = 1.91$ rad/s

$T_{snew} = \frac{3}{5} T_{sold}$ $\qquad T_{s\,old} = \frac{4}{0.88} = 4.55$

$= \frac{3}{5}(4.55)$

$= 2.73$

$T_{snew} = 2.73 = \frac{4}{\zeta\omega_n}$

$\omega_n = \frac{4}{2.73(0.46)}$

$= 3.185$

Real

Q3)

$$G(s) = \frac{12}{s(s+6)}$$

$$1 - G(s) = \frac{12}{6} \frac{1}{s(s/6 + 1)}$$

i) $$G(j\omega) = \frac{\because 12}{(\omega)\sqrt{\omega^2 + 6^2}}$$

$$|G(j\omega)| \text{ in dB} = 20\log 12 - 20\log\omega - 20\log\sqrt{\omega^2 + 6^2}$$

ii) 6.02 dB - 38.78 dB

$= -32.74$ dB

b) $$G(s) = \frac{100}{s+10} \qquad 20\log 10 = 20\text{dB}$$

$$= \frac{100}{100}\left(\frac{1}{s/10 + 1}\right)$$

c)