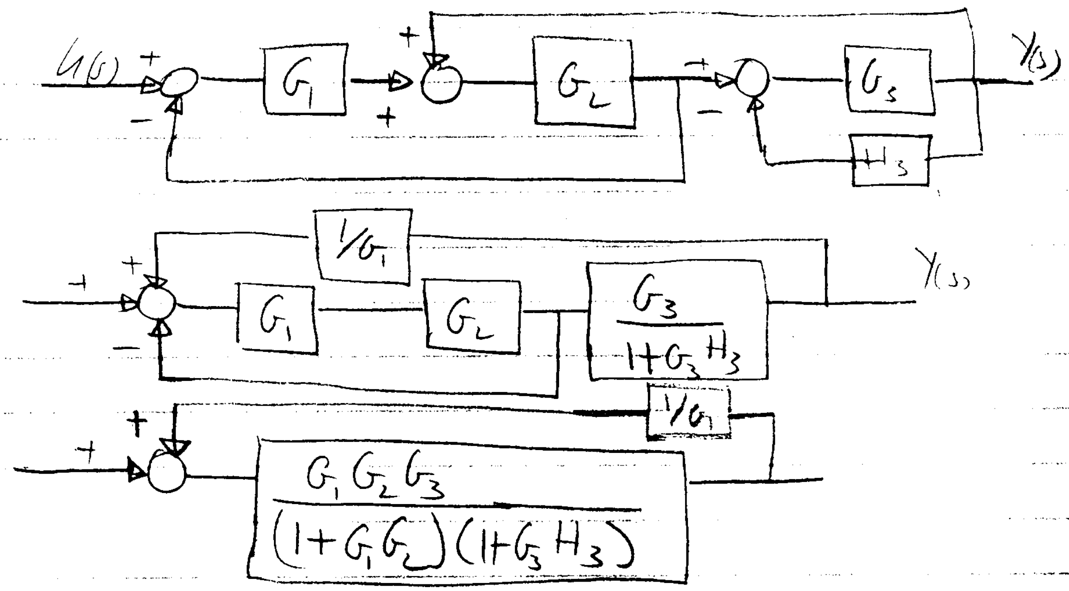
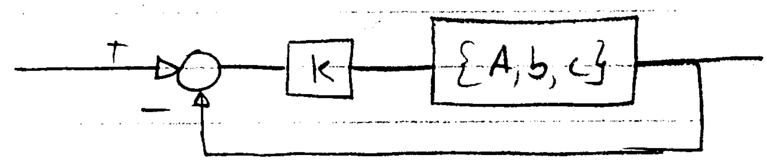
ELEC 360 Midterm Nov 98

(4) 1.



$$G(s) = \frac{G_1 G_2 G_3}{(1+G_1G_2)(1+G_3H_3) - \frac{\cancel{G_1} G_2 G_3}{\cancel{G_1}}} = \frac{G_1 G_2 G_3}{1 + G_1G_2 + G_3H_3 + G_1G_2G_3H_3 - G_2G_3}$$

(4) 2.



$$G(s) = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} s+4 & -5 \\ -1 & s \end{bmatrix}^{-1} \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \frac{1}{s(s+4)-5} \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} s & 5 \\ 1 & s+4 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$= \frac{s+2}{s^2+4s-5}$$

$$G_{tot}(s) = \frac{(s+2)K}{s^2+4s-5+K(s+2)} = \frac{(s+2)K}{s^2+(4+K)s+(2K-5)}$$

necessary and sufficient $\left.\begin{matrix} 4+K>0 & K>-4 \\ 2K-5>0 & K>2.5 \end{matrix}\right\} \Rightarrow K>2.5$

(2) 3. $\quad G(s) = \dfrac{\overset{b_2}{4}s + \overset{b_3}{6}}{s^3+3s+2s+\underset{a_3}{1}}$

$$A = \begin{bmatrix} 0 & 0 & -1 \\ 1 & 0 & -2 \\ 0 & 1 & -3 \end{bmatrix} \qquad b = \begin{bmatrix} 6 \\ 4 \\ 0 \end{bmatrix} \qquad c = [0, 0, 1]$$

$\beta_0 = 0,\ \beta_1 = 0,\ \beta_2 = 4$

$\beta_3 = b_3 - a_1\beta_2 = 6 - 3\cdot 4 = -6$

or

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} \qquad b = \begin{bmatrix} 0 \\ 4 \\ -6 \end{bmatrix} \qquad c = [1, 0, 0]$$

(4) 4. $\quad G(s) = \dfrac{s+1}{s^2(s+4)}$

zeros: -1 $\quad$ poles: $0, 0, -4$

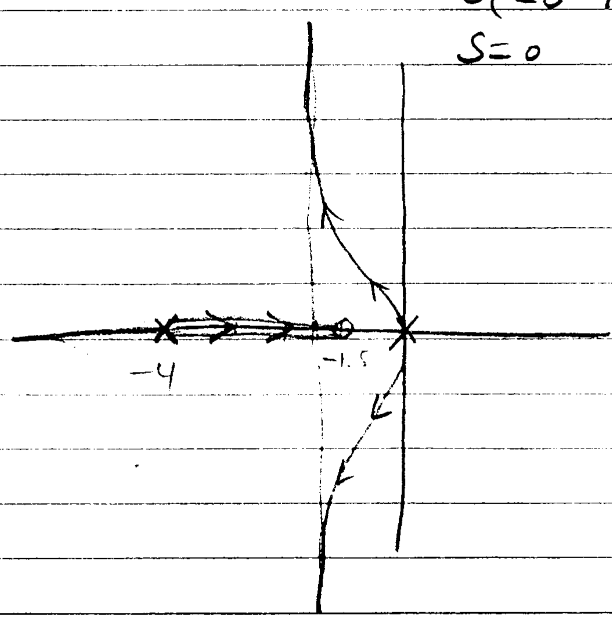
asymptotes: $\phi = (2k+1)\dfrac{180}{2} = \pm 90°$ $\quad \sigma = \dfrac{-4+1}{2} = -1.5$

break-away points $\quad (3s^2+8s)(s+1) - (s^3+4s^2) = 0$

$s(3s^2+8s+3s+8-s^2-4s) = 0$

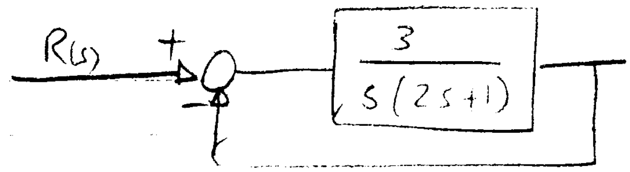
$s(2s^2+7s+8) = 0$

$s = 0 \qquad \underbrace{s = \dfrac{-7}{4} \pm \dfrac{\sqrt{49-64}}{4}}_{\text{complex conjugate} \Rightarrow \text{not possible}}$



- The system has an underdamped response for all $K>0$.
- Settling time decreases until it becomes $t_s = \dfrac{4}{1.5}$
- frequency of oscillations increases as $K\uparrow$.
- damping ratio from $0 \to \zeta_{max} \to 0$.

(3) 5.



Open-loop system is type 1 $\quad K_p = \infty \quad K_v = 3$

e_{ss} for step $\quad e_{ss} = \dfrac{1}{1+K_p} = 0$

e_{ss} for ramp $\quad e_{ss} = \dfrac{1}{K_v} = \dfrac{1}{3}$