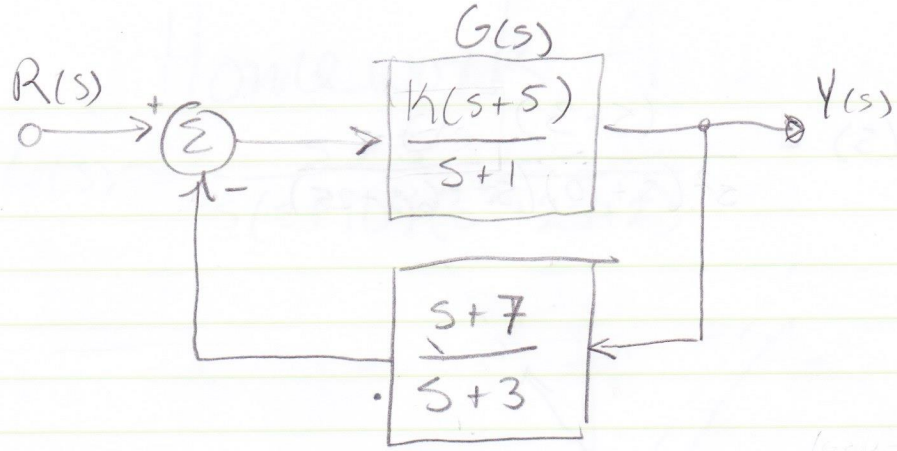
5.20 c)



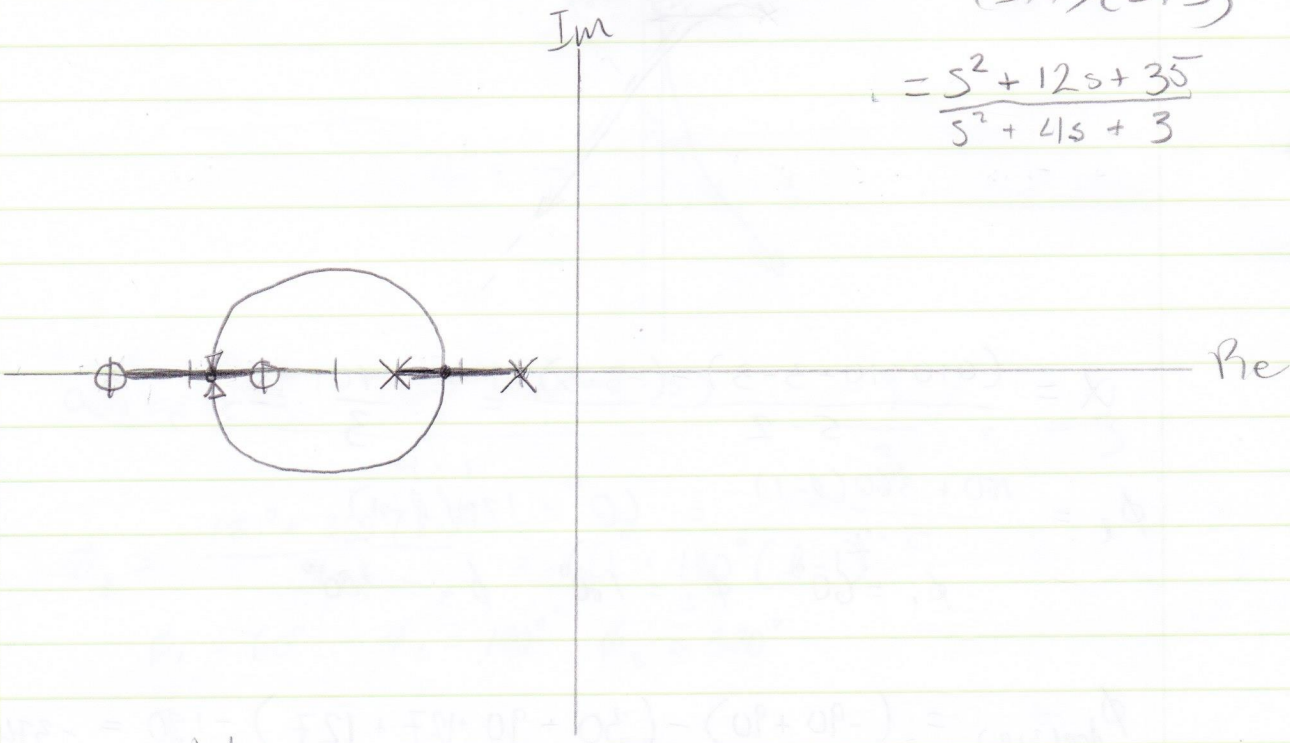
$$\frac{Y}{R} = \frac{\frac{K(s+5)}{s+1}}{1 + \frac{K(s+5)}{s+1}\frac{(s+7)}{s+3}}$$

Sketch R.L. of Characteristic eqn

$1 + KL(s)$

where $L(s) = \frac{(s+5)(s+7)}{(s+1)(s+3)}$

$= \frac{s^2 + 12s + 35}{s^2 + 4s + 3}$



No asymptotes,

Breakaway points: $\frac{dL(s)}{ds} = \frac{(2s+12)(s^2+4s+3) - (2s+4)(s^2+12s+35)}{(s^2+4s+3)^2} = 0$

Numerator $= -8s^2 - 64s - 104 = 0$, $s = -5.7$ & -2.3

Breakaway angles $\phi_w = \frac{180 + 360(w-1)}{2}$ $\phi_1 = 90°$ $\phi_2 = -90°$