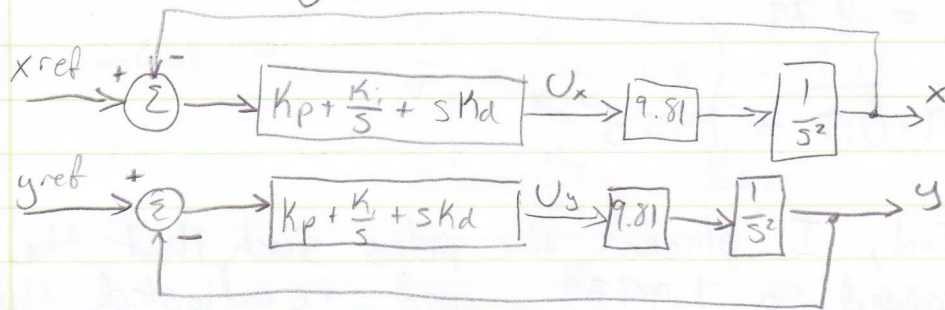


Project 5



- a) Take $K_i = 0$, use RootLocus to find parameters K_p and K_d such that $\epsilon \geq 0.7$ and all zeros and poles are within the circle $\omega_n < \frac{1}{5T_s}$, $T_s = 0.1s$

$$\frac{x}{x_{ref}} = \frac{9.81(K_p + sK_d)(\frac{1}{s^2})}{1 + 9.81(K_p + sK_d)(\frac{1}{s^2})} = \frac{9.81(K_p + sK_d)}{s^2 + 9.81(K_p + sK_d)}$$

Characteristic eqn.

$$1 + 9.81K_d L(s)$$

$$L(s) = \frac{s + \frac{K_p}{K_d}}{s^2}$$

$$\omega_n < \frac{1}{5T_s} ; T_s = 0.1$$

$$\Rightarrow \omega_n < \frac{1}{0.5} \Rightarrow \omega_n < 2$$

Using RLTool, I chose the zero $\frac{K_p}{K_d}$ to be 1.40 and $9.81 \cdot K_d$ to be 2.79, based on the damping factor and frequency constraints. I had to place the zero such that part of the locus barely satisfied both constraints, and then place the poles in that range on the locus.

$$9.81 \cdot K_d = 2.79$$

$$\frac{K_p}{0.284} = 1.40$$

$$K_d = 0.284$$

$$K_p = 0.398$$