Problem 1

\[ \sigma = \frac{\sum \text{finite poles} - \sum \text{finite zeros}}{\# \text{finite poles} - \# \text{finite zeros}} \]

\[ \phi_n = \frac{(2k + 1)180}{\# \text{finite poles} - \# \text{finite zeros}}, \quad k = 0, 1, 2, \ldots \]

Given the system above and \( G(s) = \frac{k}{s(s+2)(s+1)} \) and \( H(s) = H(s) = s + 10 \)

Sketch the root locus and comment on the stability.

\[ \text{Exists on real axis between } 0.8-1.5, -2.4-10 \]

\[ \theta_m = 90^\circ \]

\[ \Delta_m = \frac{-1 - 2 - (-10)}{2} = \frac{7}{2} = 3.5 \]

System will become unstable for higher gains.

Problem 2

For the system above, assume the system is stable and find the steady state error for step, ramp, and parabolic inputs.

\[ K_p = \lim_{s \to 0} G(s) \]

\[ K_r = \lim_{s \to 0} sG(s) \]

\[ K_n = \lim_{s \to 0} s^2G(s) \]

\[ s = \frac{1}{1 + K_p} \]

\[ K_p = \lim_{s \to 0} G(s) = \frac{k}{9k} = \frac{1}{9} \]

\[ C_s = \frac{1}{1 + \frac{1}{4}} = \frac{4}{5} = \frac{9}{10} \]

\[ C_s = \infty \text{ to ramp and parabolic} \]