Problem 30

1. The zero steady-stat error specification for a unit-step input is automatically achieved as the PI compensator raises the system type to 1.

To achieve a peak overshoot less than 60 %, choose

$$\zeta > \frac{|\ln(m_p)|}{\sqrt{\pi^2 + \ln^2(m_p)}} = 0.6483$$

Using MATLAB construct the root locus plot of the compensated plant

$$G_p(s) = \frac{1}{(s+1)(s+2)(s+10)}$$

Using the MATLAB functions sgrid and rlocfind, determine the proportional gain k_p that yields dominant closed-loop poles with $\zeta = 0.6483$

$$\boxed{K_p = 24.98}$$

Problem 1

1. Following the design rules provided in Lecture 26, place the compensator zero at $-\zeta\omega_n/10$, where $-\zeta\omega_n$ is the real part of the desired dominant closed-loop poles. From MATLAB

$$-\zeta\omega_n = -1.339$$

$$\boxed{z = -\zeta\omega_n/10 = 0.1339}$$

Given a numeric value for z and the relationship $z = -K_I/K_p$ solve for K_I

$$K_I = -K_p z = -(24.9812)(0.1339)$$

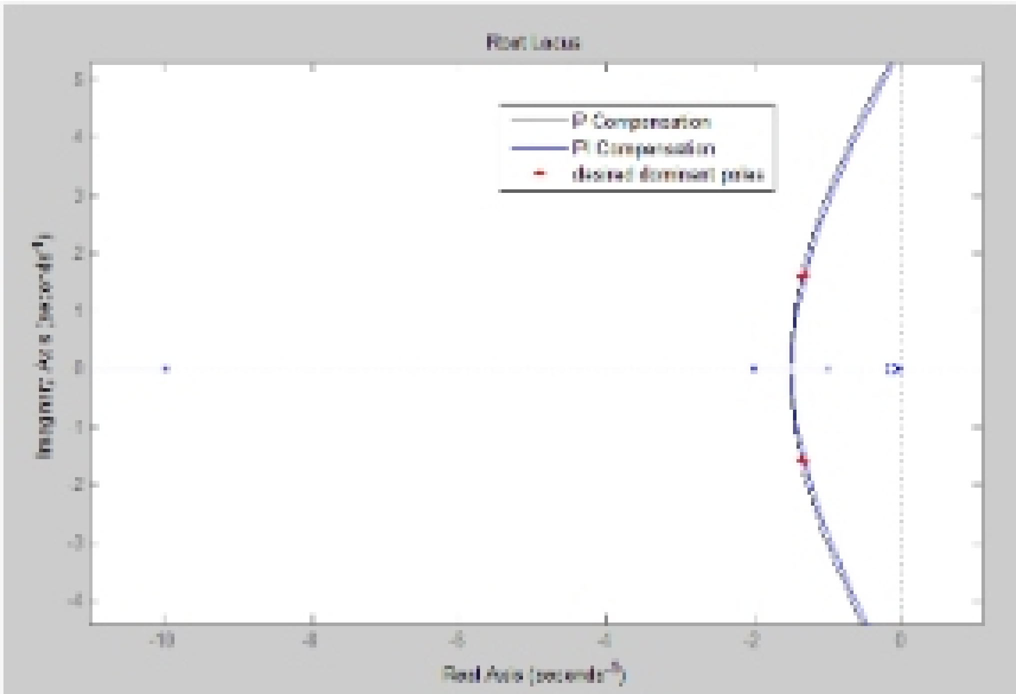
$$\boxed{K_I = 3.345}$$

The compensator is

$$\boxed{G_c(s) = K_p + \frac{K_I}{s} = 24.9812 + \frac{3.345}{s}}$$

Problem 1

- The plot below shows the root locus plots for the uncompensated plant G_p. and the compensated loop transfer function $G_c G_p$. Observe that the PI compensator bends the root locus to the right.



The unit-step response shown below satisfies the two design requirements. However, placing a pole at the origin has significantly increased the settling time