1 PID controller - 30 pts

For the unity feedback system shown below, where

\[ G(s) = \frac{K}{(s + 1)(s + 4)} \]

design a PID controller that will yield a peak time of 1.047 seconds and a damping ratio of 0.8, with zero steady-state error for a step input.

![Block diagram](image)

2 Passive-circuit realization - 20 pts

Identify and realize the following compensators with passive networks.

(a) \[ \frac{s + 2}{s + 5} \]

(b) \[ \left( \frac{s + 0.1}{s + 0.01} \right) \left( \frac{s + 1}{s + 10} \right) \]
3 Controller design - 25 pts

Given the following open-loop plant,

\[ G(s) = \frac{1}{(s + 2)(s + 3)(s + 10)} \]

design a controller to yield a 15% overshoot and a settling time of 0.75 second. Place the third pole 10 times as far from the imaginary axis as the dominant pole pair. Use the phase variables for state-variable feedback.

4 Observer design - 25 pts

Consider the plant

\[ G(s) = \frac{1}{s(s + 3)(s + 7)} \]

whose state variables are not available. Design an observer for the observer canonical variables to yield a transient response described by \( \xi = 0.4 \) and \( \omega_n = 75 \). Place the third pole 10 times farther from the imaginary axis than the dominant poles.