Assignments

1. **Transfer Functions:**
   Create a Python/MATLAB program that connects two transfer functions in cascade:
   $$H_1(s) = \frac{5s+1}{s^2+3s+2}, \qquad H_2 = \frac{2s+4}{s+5}$$
   Find the poles and zeros of the combined system. Plot them on the complex plane and discuss the stability of the system.

2. **System Response:**
   Simulate and compare the step responses of two systems:
   $$G_1(s) = \frac{5}{s^2+2s+5}, \qquad G_2(s) = \frac{5}{s^2+5s+6}$$
   Analyze the difference in response characteristics (settling time, overshoot, etc.) and discuss the implication for control design.

Assignments

3. System Response:

Create a Python/MATLAB program that simulate the response of the system $G(s) = \frac{10}{s^2+5s+10}$ to the following inputs:

a. a unit step
b. a sinusoidal input
c. a ramp input

Plot and compare the system responses for each type of input.

4. System Response:

Model a simple real-world system (you can choose any system, e.g., spring-mass-damper, RLC circuit, etc.) and simulate its response to different inputs using Python/MATLAB program.

Assignments

5. PID Controller:

Implement a PID controller to maintain the temperature of a room at a desired setpoint $T_{\text{setpoint}} = 25°C$. The current room temperature $T(t)$ is affected by the heating power $P(t)$ applied at time t. The rate of temperature change is modeled as:

$$\frac{dT(t)}{dt} = -K(T(t) - T_{\text{ambient}}) + \frac{P(t)}{C}$$

where K is a heat loss constant ($K = 0.1$), C is the thermal capacity of the room ($C = 5$), and T_{ambient} is the ambient temperature ($T_{\text{ambient}} = 20°C$).

Create a Python/MATLAB program that implement the PID controller and simulate the system for a total of 100 time steps and plot the temperature over time.

Bonus challenge: Tune the PID parameters for the best system response, minimizing overshoot and settling time