Automatic Tuning of PID Controller

Example:

• For the fourth-order plant \( G(s) = \frac{10}{(s+1)(s+2)(s+3)(s+4)} \), design a PID controller based on Ziegler-Nichols tuning rule.

Automatic PID Tuning with SISOTool

1. Import system model into SISOTool
   
   Matlab code:
   
   ```matlab
   s=tf('s'); G=10/(s+1)/(s+2)/(s+3)/(s+4);
   sisotool(G)
   ```

2. In CETM, from “Analysis Plot” tab, launch closed-loop step response
Automatic Tuning of PID Controller

Automatic PID Tuning with SISOTool ...

3. In CETM, from “Automated Tuning” tab, under “Optimization Based Tuning”, select “PID Tuning”

4. Choose the controller type:
   - P, PI, PID, PID with derivative filter
     - Here, choose “PID with derivative filter”

5. Select “Tuning algorithm”
   - Robust response time
   - Parameter search
   - Ziegler-Nichols open-loop
   - Ziegler-Nichols closed-loop
   - Internal Model Control (IMC)
     - Here, choose “Robust response time”
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6. Click on “Update Compensator” button

Tuned PID controller:

\[ G_{cpid}(s) = 2.9402 \frac{(1+\frac{s}{1.2})(1+\frac{s}{1.2})}{s(1+\frac{s}{1.4e0.002})} \]

Closed-loop step response:
Automatic Tuning of PID Controller

Automatic PID Tuning with Simulink

Example:

• For the fourth-order plant \( G(s) = \frac{10}{(s+1)(s+2)(s+3)(s+4)} \), design a PID controller using automated tuning in Simulink Control Design tool.

1. Build the system model in Simulink with a PID control block in a negative unity feedback structure
   • Add a “Step” input block and set its step-time = 0
   • Add a “Scope” and a “Mux” to view system response

2. Double click on the PID block and choose:
   • Continuous-time or Discrete-time
     • Here, choose Continuous-time
   • PID, PI, PD, P, I
     • Here, choose “PID” (it includes derivative filter)
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Automatic PID Tuning with Simulink

3. In the PID block’s parameter window, click on “Tune…” button
   • The “Step reference tracking” plot will appear in “PID Tuner” window

4. In “PID Tuner” window, press “Show parameters”
   • The window expands and shows the tuned parameter values

5. In “PID Tuner” window, you may
   • Adjust the response time with the slider
   • Select a different plot type
     • Step reference tracking
     • Step disturbance rejection
     • Open-loop Bode plot
     • Open-loop Nichols chart
   • Automatically update block parameters

Tuned PID controller:

\[ G_{cpid}(s) = 3.1456 + \frac{2.0524}{s} + 0.7867 \frac{8.9601}{1 + \frac{8.9601}{s}} \]