Home Work #7

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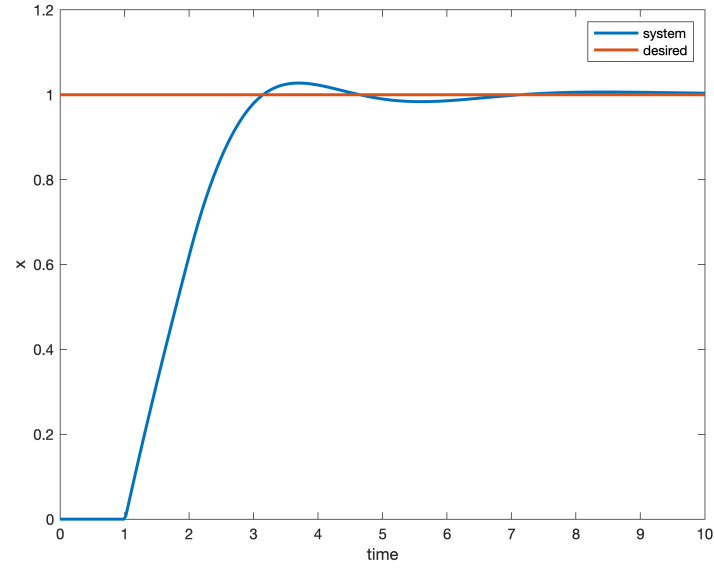
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1 Question 1

System:

$$G_{1_{(s)}} = \frac{1}{(s+1)(2s+1)} \exp(-s) = \frac{1}{2s^2 + 3s + 1}$$

We use Optimal PID to design controller with ITAE, ISE and IAE cont function.

- ITAE

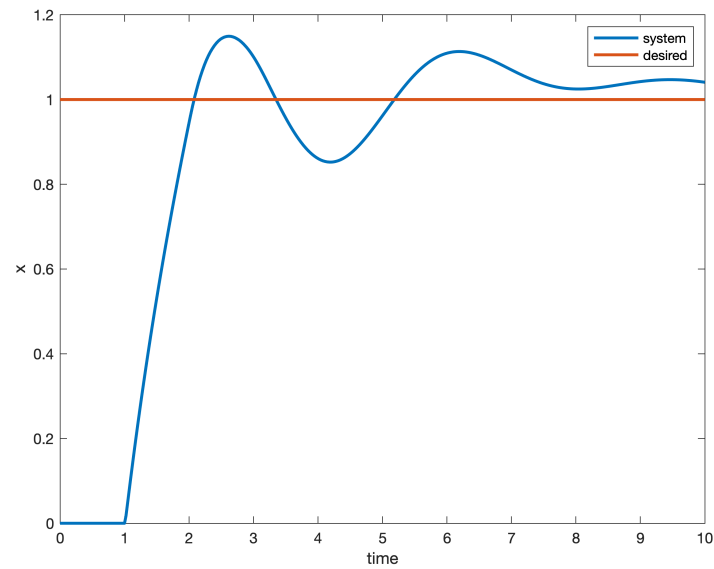$$K_p = 1.6922, \quad K_i = 0.5472, \quad K_d = 1.3675$$

Figure 1: Step responde with PID controller and ITAE cost function

- ISE

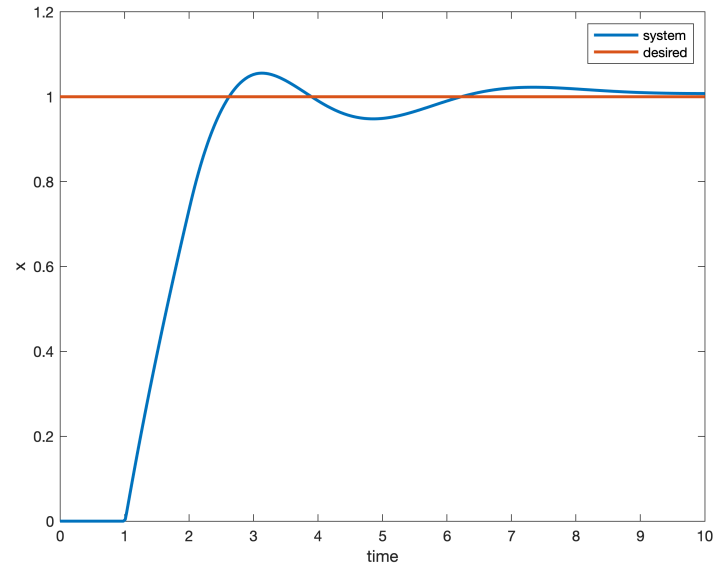$$K_p = 1.8957, \quad K_i = 0.8007, \quad K_d = 2.5416$$

Figure 2: Step responde with PID controller and ISE cost function

- IAE

$$K_p = 1.8356, \quad K_i = 0.6085, \quad K_d = 1.7386$$

Figure 3: Step responde with PID controller and IAE cost function

PID designed with ITAE cost function work better system is fast with lower overshoot.
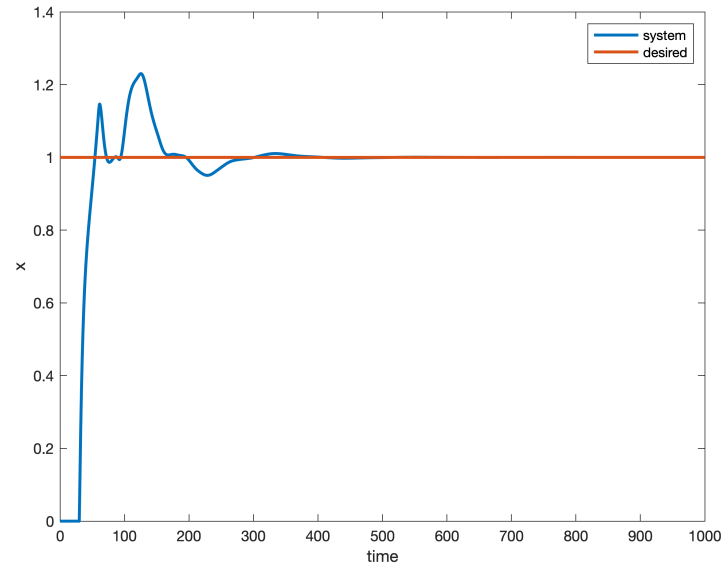
2   Question 2

System:

$$G_{1_{(s)}} = \frac{1}{(17s+1)(5s+1)} \exp(-30s) = \frac{1}{102s^2 + 23s + 1}$$

We use Optimal PID to design controller with ITAE, ISE and IAE cost function. In program we use 100 second for optimization but use 1000 second for simulation beacuse optimization takes too long time and in 100 second beacuse of long delay time we can't see system behavior.

- ITAE

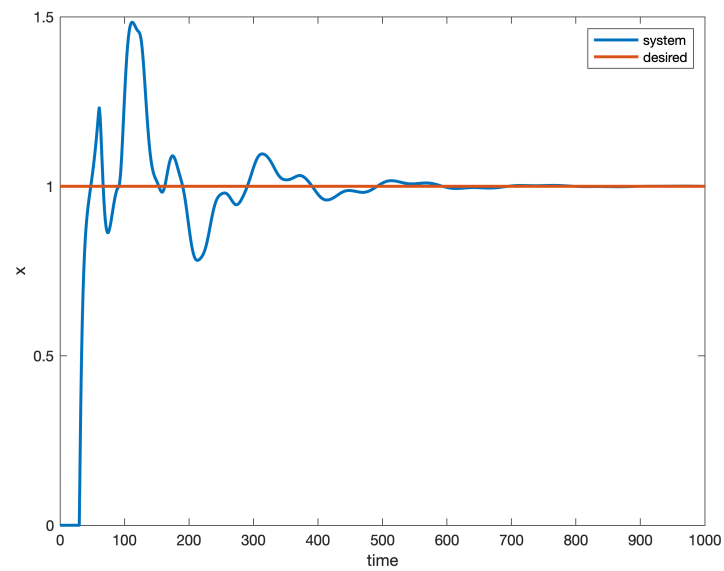$$K_p = 0.6867, \quad K_i = 0.0347, \quad K_d = 15.0543$$

Figure 4: Step responde with PID controller and ITAE cost function

- ISE

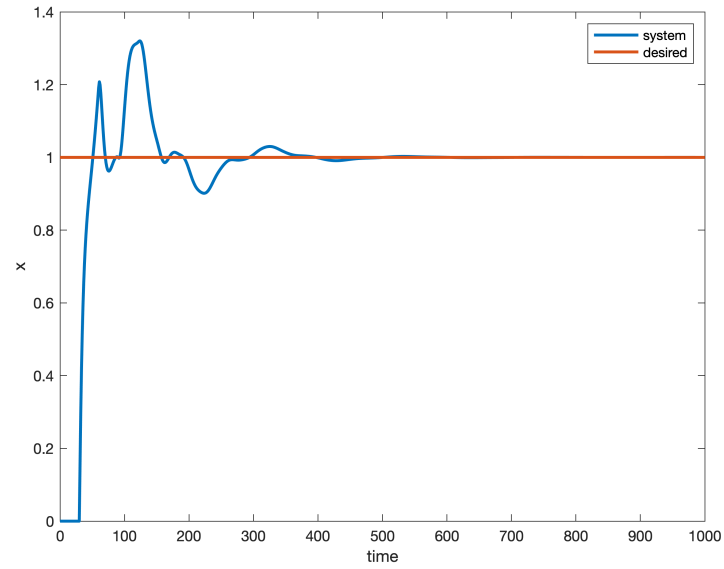$$K_p = 0.5399, \quad K_i = 0.0446, \quad K_d = 20.8391$$

Figure 5: Step responde with PID controller and ISE cost function

- IAE

$$K_p = 0.6522, \quad K_i = 0.0393, \quad K_d = 17.5028$$

Figure 6: Step responde with PID controller and IAE cost function

PID designed with ITAE and IAE cost function work better system is fast with lower overshoot but in ITAE cost function system has better undershoot.
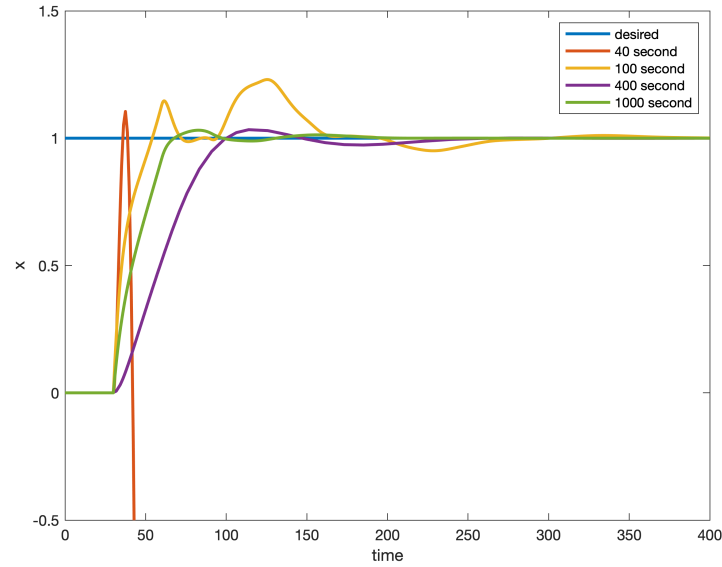
3   Question 3

Question 1 work well but in question 2 we have a long time delay so challenge for time optimization appears here. So we choise second system.

System:

$$G_{1_{(s)}} = \frac{1}{(17s + 1)(5s + 1)} \exp(-30s) = \frac{1}{102s^2 + 23s + 1}$$

We use Optimal PID to design controller with ITAE cost function. In program we use 40, 100, 400 and second for optimization but use 400 second for simulation to see system behavior. ITAE cost function work well in last question so we use this cost function in different time optimization.

Figure 7: Step responde with PID controller and ITAE cost function for different time

In 40 second system is unstable but in other time system is stable and when we increse time PID conteller work better.

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