Control & Automation Engineering Department

KON309E Microcontroller Systems - Experiment 5

Aim: Implementation of P and PI type controllers.

Preliminaries:

1. Construct the circuit given in Figure 1, where

   $C_1 = 220\mu F$

   $C_2 = 100\mu F$

   $R_1 = 10K\Omega$

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2. Obtain the transfer function of the system.

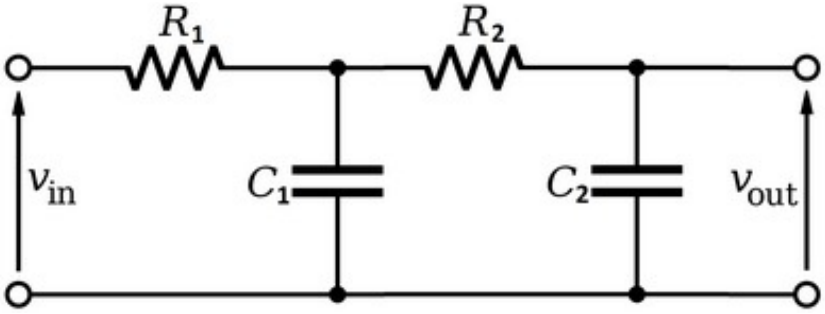

Figure 1: Circuit diagram of the system to be controlled

In this experiment, participants are expected to achieve tasks given below.

1. Implement the control system using one of the presented methods in the lecture notes (differential equation solution via ODE solvers or direct digital implementation via difference equation).
2. Choose the sampling time as **0.1 seconds**.
3. **Simulate the system first** (Hardware-in-the-Loop).
4. Use a button to give the reference to the system. When button is pressed, reference of **1V** will be given to the system. When the button is pressed again, the reference will be **0V**. You can think of it as an ON/OFF button.
5. First give a reference of 1V **and** after the system is in steady state give a reference of 0V.
6. Send the output of the system, reference and the control signal to PC via UART and visualize the data using the "SerialPlot" program.
7. Control the system with a P type controller with $K = 2.5$.

$$F(s) = K = 2.5$$

8. Control the system with a PI type controller with $K_P = 2.8$ and $K_I = 0.8$.

$$F(s) = K_P + \frac{K_I}{s} = 2.8 + \frac{0.8}{s}$$

9. Note that the given controller gains are for a continuous time controller and you need to discretize the controller (MATLAB function: *c2d()*) before implementation.
10. **Do the same for the actual system.**
11. Read the output of the actual system from an analog input pin.
12. Give the control signal to the system using PWM.

Please consider the following steps when preparing your reports.

1. Describe the experiment **in your own words** and explain what you learned.
2. Add your codes as screen shots.
   - Don't forget to comment your codes **in your own words** with explanations.
3. Explain how you implemented the control system for both simulation and the actual system.
4. Explain why the PI controller is needed for this system.
5. Explain the constraints regarding the control signal.
6. Compare the simulation and the actual system.
7. Include plots of system output, reference and control signal for both simulation and the actual system.
8. Add a photo of your whole circuit.