Pre-Lab 4 LabVIEW Tutorial

Overview

In this tutorial, you will be using the Control & Simulation library in LabVIEW to simulate the step response for the transfer function of a system.

**ATTENTION:** After you go over the tutorial, please make sure to submit the required plots for your pre-lab in **step 22**.

Procedure

1. Open LabVIEW 2016 (or whichever version of LabVIEW is installed on the computer). If you see the *Set Up and Explore* screen, close out of the window.
2. In the initial menu, click **Create Project**. Select the template **Blank VI**, and click Finish.
3. You will see two windows open: The **Front Panel**, and **Block Diagram**. See Section 1.5 of Lab 2 for a description of these two windows.
4. Save the VI as “PreLab4_LabVIEWsimulation.”
5. From the Block Diagram, right click in an empty area to open the Block Library. Click the double arrow at the bottom expand the menu.
6. Select **Control & Simulation >> Simulation**. If you do not see the **Control Design & Simulation**. Select **Control & Simulation Loop**, and draw the window in the block diagram.
7. For ease of access, go into the **Control & Simulation** library and pin it in your Block Diagram.
8. The Control & Simulation Loop can be configured to solve an ODE using a numerical method. Right click on the small window in the upper left corner of the loop. Click on Properties.
9. Change the parameters of the block to match Figure 2:
   - Initial Time -> 0
   - Final Time -> 10
   - Step Size -> 0.01
   - ODE Solver -> Runge-Kutta 4

Figure 2: Parameters Window for the Control & Simulation Loop
10. From Control & Simulation, select Simulation >> Continuous Linear Systems. Drag a Transfer Function block inside of the Control & Simulation Loop.

11. Right Click on the Transfer Function block and select Configuration. This is where you will set up the transfer function for the simulation.

12. The general equation for a transfer function in this LabVIEW block is

\[ H(s) = \frac{b_0 s^n + b_1 s^{n-1} + \ldots + b_{n-1} s + b_n}{a_0 s^n + a_1 s^{n-1} + \ldots + a_{n-1} s + a_n} \]

13. Determine the coefficients of the transfer function for your simulation. Enter these values in the Numerator and Denominator coefficients of the transfer function, and verify that your transfer function is correct in the preview. Figure 3 shows the configuration window for the Transfer Function block. Please note that your coefficients may not match the ones in the figure.

14. From Control & Simulation >> Simulation >> Signal Generation, select Step Signal and place one in the loop of your block diagram.

15. Right Click the Step Signal and select Configuration. Set the parameters of the step signal to the following:
   - Initial Value -> 0
   - Final Value -> 1
   - Step Time -> 0
16. Find the SimTime Waveform in Control & Simulation >> Simulation >> Graph Utilities. Place this block into the Control & Simulation Loop. You should also see a graph appear in the Front Panel.

17. Connect the output of the Step Signal to the input (u(t)) of the Transfer Function. You can create a wire by hovering the cursor over the block. A terminal should appear on the right side of the block. Hover your cursor over that terminal until the icon changes to a spool of thread. The color of terminal indicates the data type for that signal.

18. Connect the output (y(t)) (there are two terminals output and state) of the Transfer Function block to the input (value) of the SimTime Waveform block. The final block diagram will look like Figure 4.

![Figure 4: Control & Simulation Loop Block Diagram](image)

19. You are now ready to run the Step Response simulation. From the Front Panel, click on the right arrow in the toolbar to run the simulation.

20. After a few seconds, the step response will be generated on the Waveform Chart in the Front Panel. Resize the graph by right clicking in the Waveform Chart and selecting Visible Items -> Graph Pallete. Three small icons should appear towards the bottom left of the Waveform Chart. Click the magnifying glass icon and select the bottom left graphic to resize the x and y-axis to fit the entire step response in the graph.

![Figure 5: Graph Pallete](image)

21. Verify the values for the time constant, \( \tau \), and steady state gain, \( K \), you obtained from question 2 of the prelab. Click on the magnifying glass from the Graph Pallete and select the top left graphic to zoom in on a certain selection of the step response.
22. Include the screenshots of the step response with your Lab 4 Prelab submission for the following transfer functions.

a) \( \frac{1}{s+1} \)

b) \( \frac{1}{s^2+s+1} \)

c) \( \frac{1}{s^2+2s+1} \)