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.

<u>ATTENTION</u> : 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.

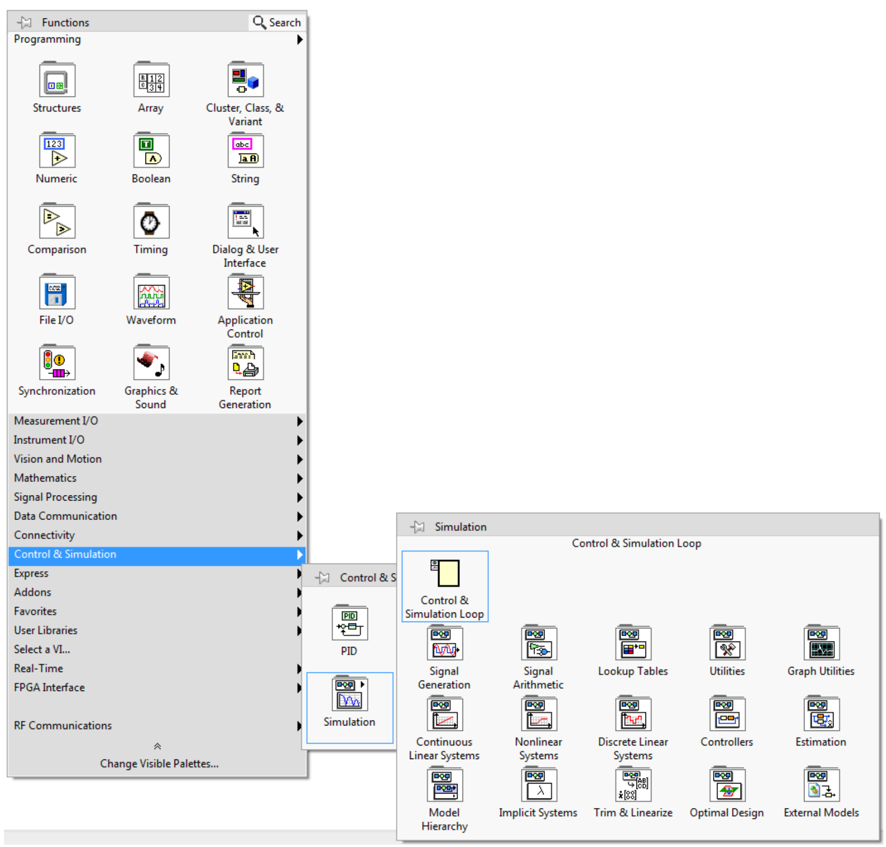

Figure 1: Control & Simulation Loop

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

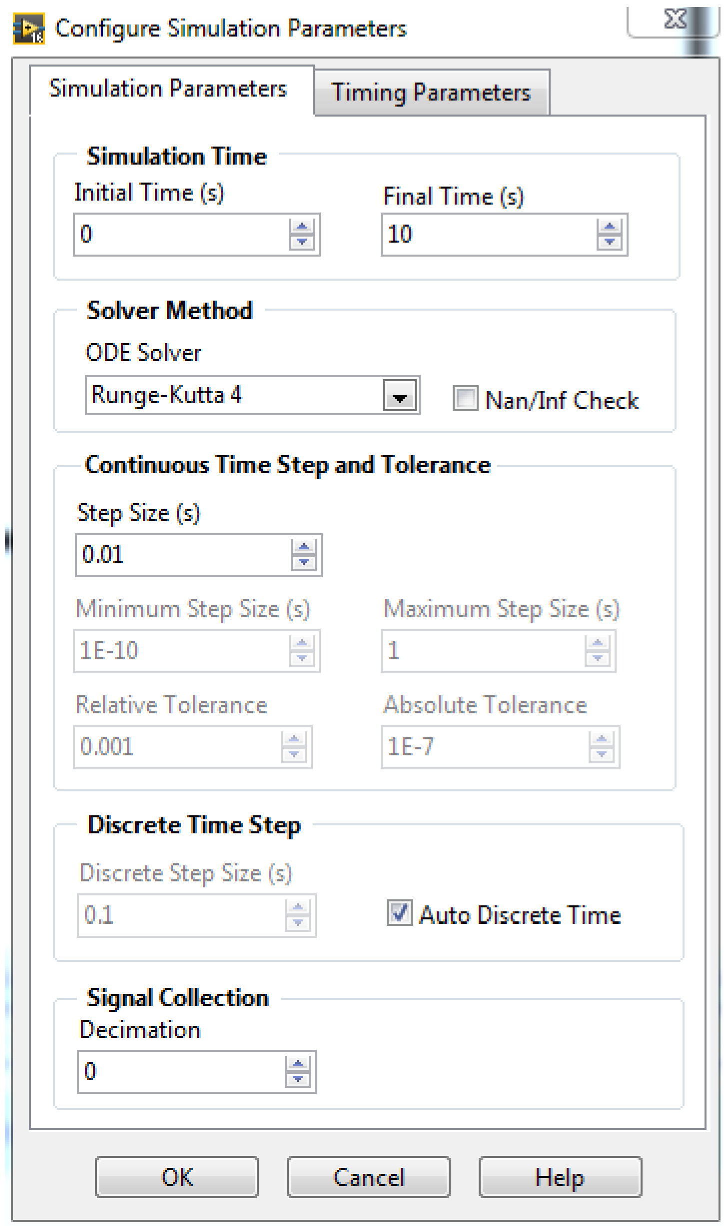

Figure 2: Parameters Window for the Control & Simulation Loop

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

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

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.

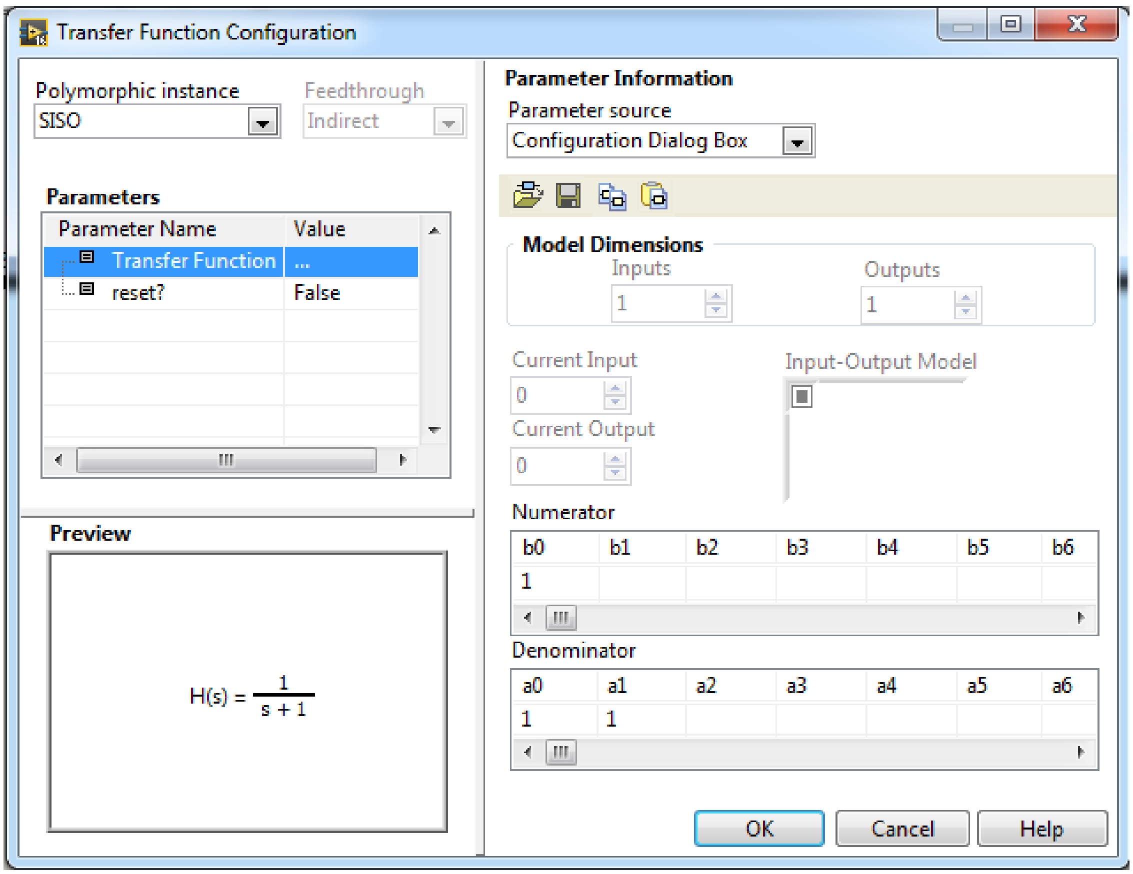

Figure 3: Transfer Function Configuration

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.

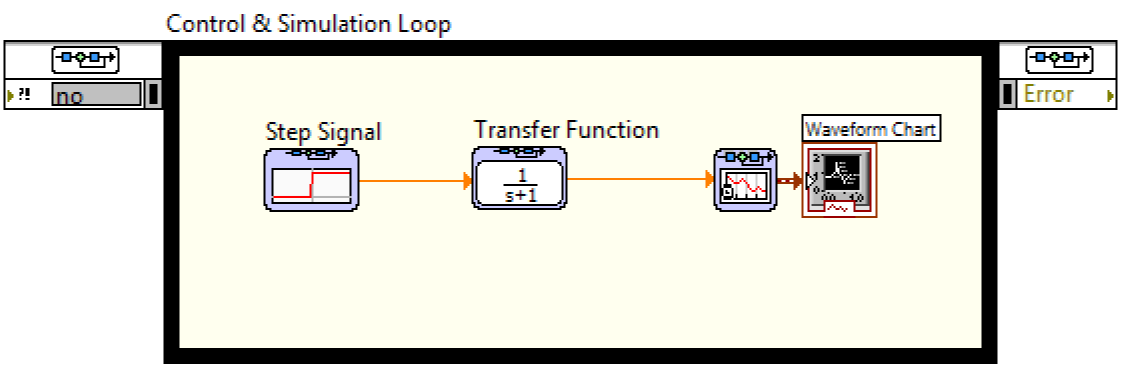

Figure 4: Control & Simulation Loop Block Diagram

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.

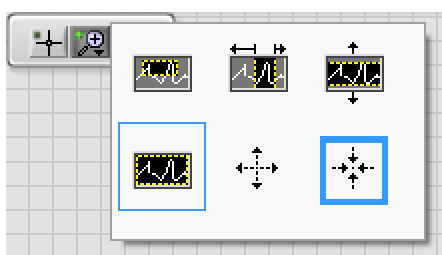

Figure 5: Graph Pallete

21. Verify the values for the time constant, τ, 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. **<u>Include the screenshots of the step response with your Lab 4 Prelab submission for the following transfer functions.</u>**

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

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

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