**ANKARA UNIVERSITY**
**Engineering Faculty**
**Departmant of Electrical and Electronics Engineering**

**Experiment-2**

**EEE 360 Control Lab**

FEEDBACK CONTROL SYSTEM

AND

BLOCK DIAGRAMS

<u>**Objectives of the Experiment:**</u>

-Learn basics of LabVIEW

-Construct feedback control systems on LabVIEW environment

-Understand block diagram representation of control systems.

-Learn the relatively complex systems response by using computer programs

-Understand the difference between closed-loop and open-loop systems

## 1.Preliminary Study:

1.Please read experimental study section to understand what you are going to do in the experiment.

2.Research on related topics in computer programs like Matlab or Scilab. Prepare yourself for the next questions.

3.Learn and read related documents to understand how to use CD Step Response box in Labview.

4.What is steady state error? Why it is important? Give two real life example for steady state error.

5.Obtain the transfer function for the system given below. Show all steps and calculations.


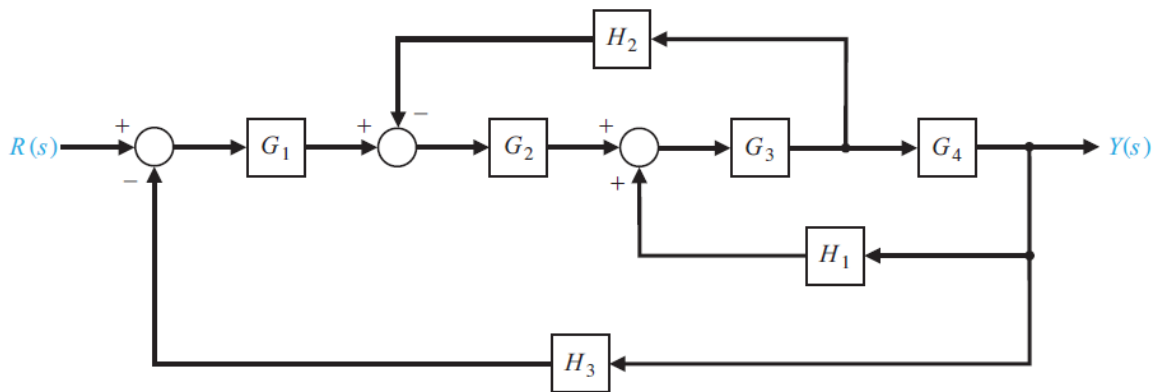
Figure 1. Example for the Experiment-2

6.Use the computer program (Matlab or Scilab) to obtain transfer function for the system in Figure 1.

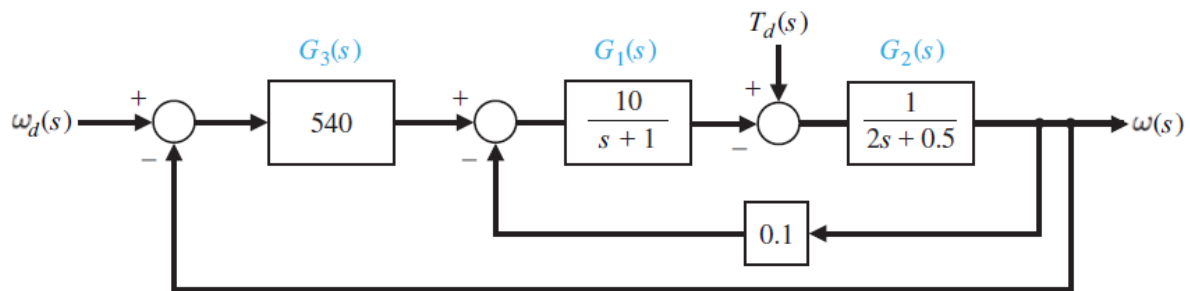7. Obtain the transfer function for the system given in Figure 2.



Figure 2. Example for the Experiment-2

8.Obtain the step response for the system in Figure 2 by using computer programs (like Matlab or Scilab)

9.Use the computer program (Matlab or Scilab) to obtain transfer function for the system in Figure 2.

## 2.Experimental Study:

This section is given in two parts. The application in the first part (Repeat the Steps) is expected to be repeated by the student and to find the same result obtained. Thus, the student understands the subject and learns how to use it. In the second part (Do it Yourself), the jobs to be done are listed, but they are not explained how to do them. He solves and fills in the datasheet using the information (s)he learned in the first part and what he did in the preliminary study.

Look at the Experiment 1 document. Be sure you learn every step at the previous experiment. You may need the information from the previous experiment.

### 2.1. Repeat the Steps

Some keyboard shortcuts may help you to access the panels of Labview.

1. Ctrl-E: Toggle between front panel and block diagram
2. Ctrl-T: Tile front panel and block diagram
3. **Ctrl-B: Delete all broken wires**
4. Ctrl-R: Run VI
5. ESC: Stop VI
6. Ctrl-drag: Copy functions, subVIs, front panel objects
7. Ctrl-drag rectangle: Create space on block diagram or front panel
8. Ctrl-Z: Undo; Ctrl-Shift-Z: Redo
9. **Ctrl-H: Toggle context help window**
10. Ctrl-Shift-A: Align objects
11. Ctrl-I: View VI properties window
12. Ctrl-W: Close VI
13. Ctrl-Shift-W: List all windows
14. Double-click to select word
15. Triple-click to select all text
16. Home, End, Ctrl-Home, Ctrl-End, Ctrl-←, Ctrl-→
17. Shift-right click: View tool selection box; Shift-tab: Select the auto-tool

We would like to obtain G(s)/H(s) in the s-plane.

$$G(s) = \frac{6s^2 + 1}{s^3 + 3s^2 + 3s + 1} \qquad H(s) = \frac{(s+1)(s+2)}{(s+2i)(s-2i)(s+3)}.$$

Open LabVIEW application observe two windows Front Panel and Block Diagram. The aim of this study is to calculate G(s)/H(s). Five different symbols are used for this application. First please find **Control & Simulation** on Block diagram window. All these new bloks are inside Control & Simulation. Find the following blocks:

**Control & Simulation -> Control Design -> Dynamic characteristics -> CD Pole-Zero Map:** Plots the poles and zeros of a system model on an XY graph that represents a complex plane. You can display this data in the CD Pole-Zero S Grid or CD Pole-Zero Z Grid indicator.

**Control & Simulation -> Control Design -> Model interconnection -> CD Divide Models:** Divides a linear model by a constant gain. This operation is equivalent to multiplying the model by the inverse of the gain. Therefore, if this VI cannot calculate the inverse of gain, LabVIEW returns an error. You also can divide two models by one another. In this situation, both models

either must be continuous-time models or must have the same sampling time if they are discrete-time models.

**Control & Simulation -> Control Design -> Model Construction -> CD Convert to Transfer Function Model:** Converts a system model to transfer function form. Wire data to the State-Space Model input to determine the polymorphic instance to use or manually select the instance

**Control & Simulation -> Control Design -> Model Construction -> CD Construct Zero-Pole-Gain Model:** Creates a zero-pole-gain representation of a system using the Zeros, Poles, Gain, Delay, and Sampling Time (s). This VI also produces a zero-pole-gain model which specifies the data in symbolic form.

**Control & Simulation -> Control Design -> Model Construction -> CD Transfer Function Model:** Creates a transfer function representation of a system using the Sampling Time (s), Numerator, Denominator, and Delay. This VI also produces a transfer function model which specifies the data in symbolic form.
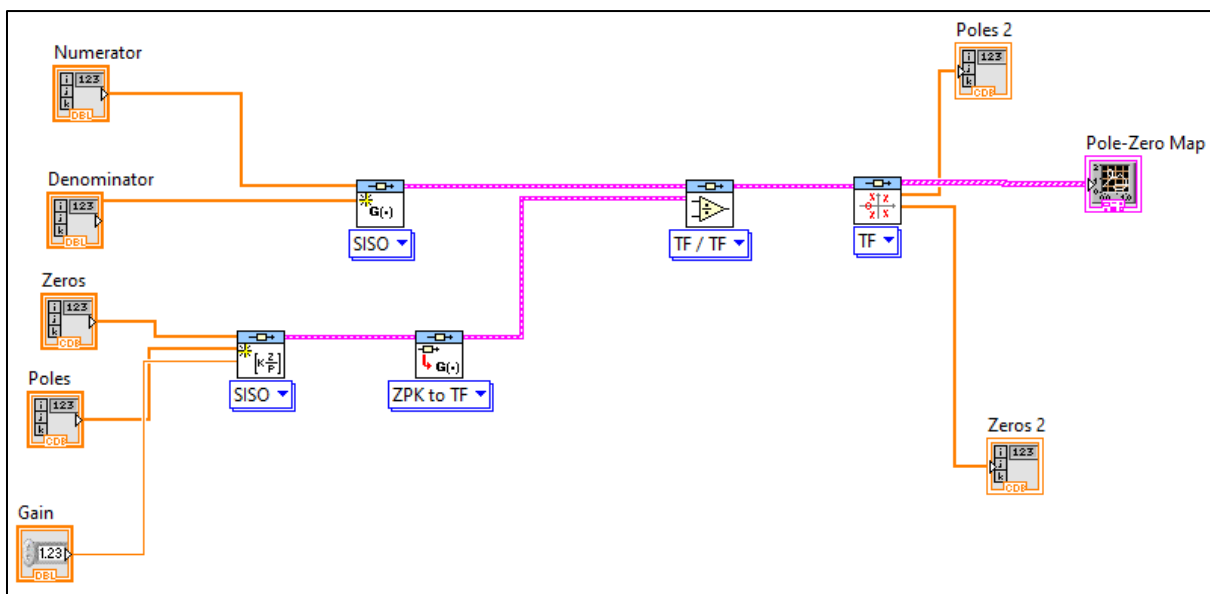


Figure 3. Block diagram for the G(s)/H(s)

Construct the block diagram as given in Figure 3. Lear the blocks by using the shortcut **Ctrl-H**. You will observe figure 4 after you construct and run the application. After the application complied. You will enter the roots and numerator and denominator of the G(s) and H(s) with the gain. As the output of this system poles and zeros will be observed form Font Panel. In addition to that the poles are displayed on s-plane.

To construct the block diagram for each block you can select the property of the block as given in Figure 5a. After selecting the property of each block. You can add numeric control or indicator or etc. by right click the small dot on the block and select **Create->Constant/Control or Indicator.**
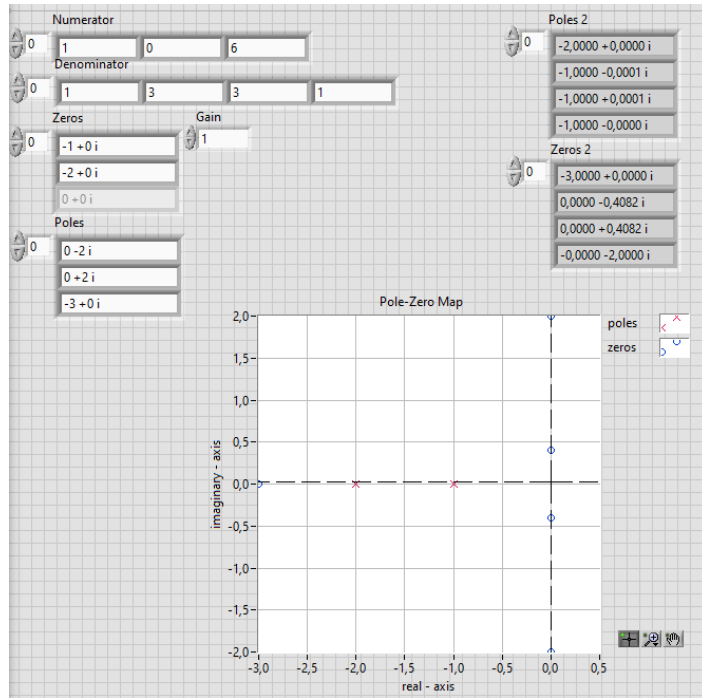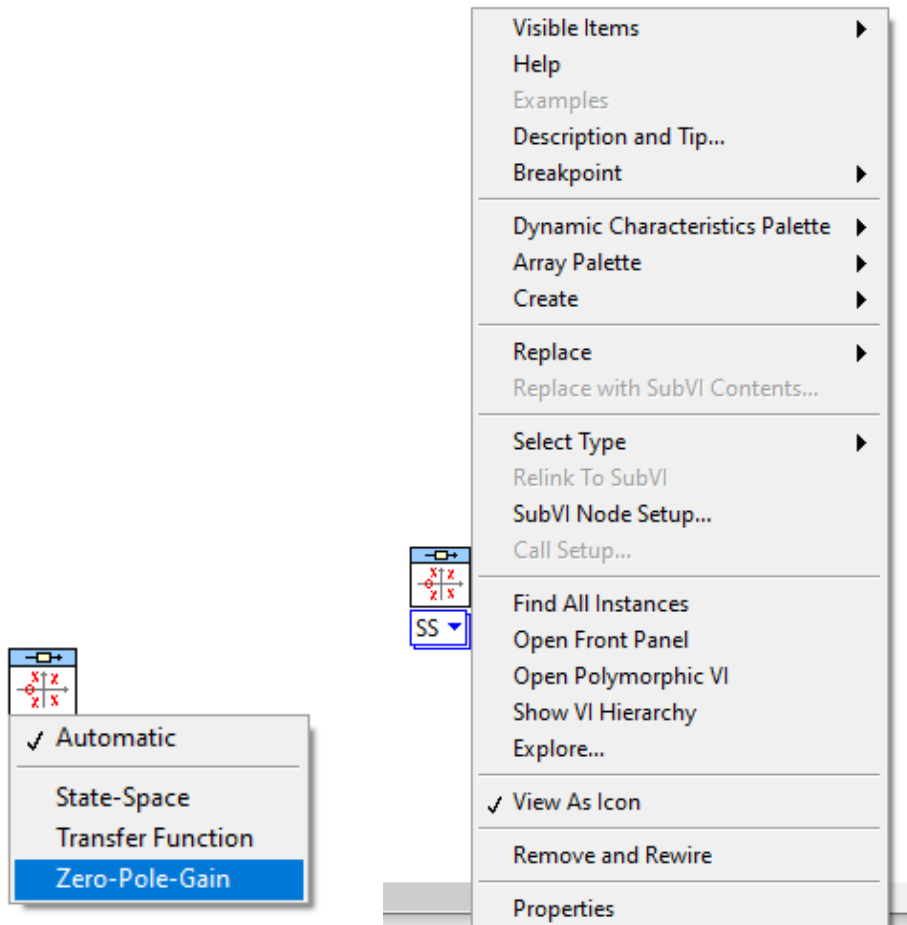
Figure 4. Front panel for the G(s)/H(s)



(a)


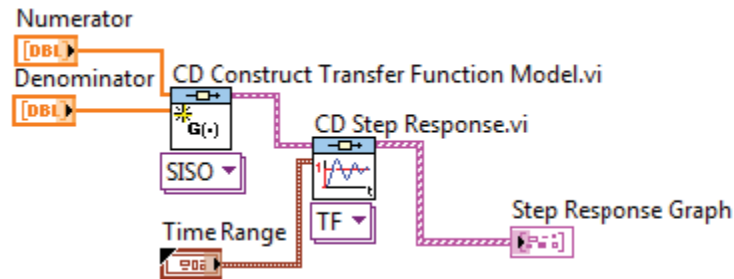
(b)

Figure 5. Properties of the Block

## 2.2. Do it Yourself!

1. Consider the system given in preliminary work Figure 1. Make the simulation for the system and obtain the transfer function. Write the poles and zeros of the transfer function in A1. (Assume all inputs are step function)

**Note That:** You can find step response module in

CD Step Response inside Control & Simulation -> Control Design ->Time Response

The example for the Do it Yourself case is given below.



2.Obtain the step response for the system in the previous step. Draw the output to A2. (Assume all inputs are step function)

3. Consider the system given in preliminary work Figure 1. Make the simulation for the system and obtain the transfer function. Write the poles and zeros of the transfer function in A3.

4. Obtain the step response for the system in the previous step. Draw the output to A4.

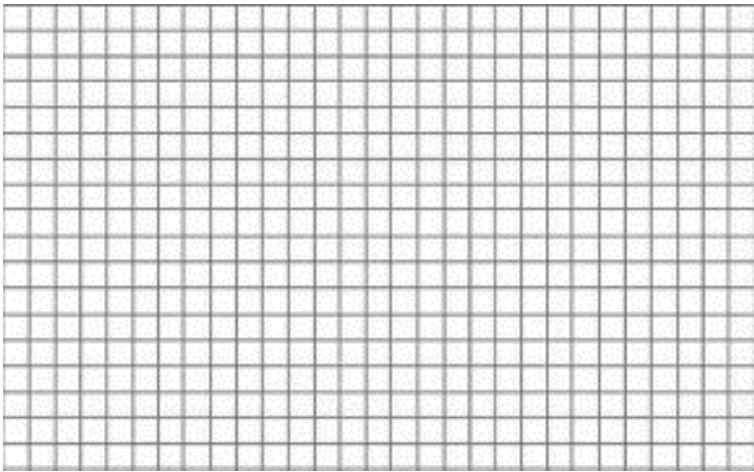5.What is the steady state error for the figures in (2) and (4).

**Data Sheet (Student Copy):**

A1

A2

A3

A4

Names of students in the group:

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**Data Sheet (Instructor Copy):**

A1

[blank box]

A2

[grid]

A3

[blank box]

A4

[grid]

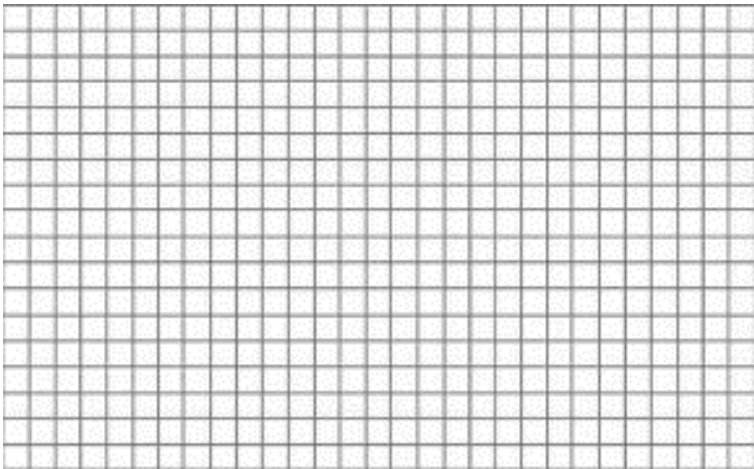## Report:

1.Please answer all the questions give in experimental study. Please use Data Sheet you obtained from the experiment.

2.Re-make the calculations in preliminary study questions 5 and 7.

3.Explain your outcomes from the experiment. What can you do to remove or decrease steady state error?

4.Find the transfer function for the system given below. Show all steps and calculations.
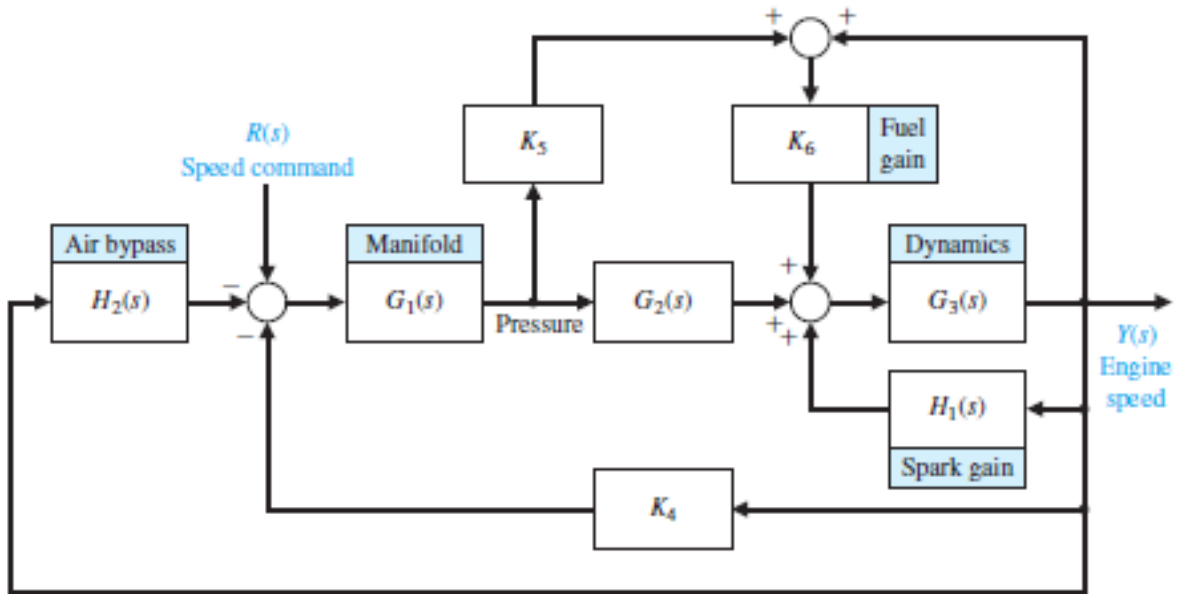


5.Draw step response of the system in (4) by using computer programs like Matlab or Scilab.