Experiment-1

EEE 360 Control Lab

INTRODUCTION TO LABVIEW

AND

MATHEMATICAL MODELLING

Objectives of the Experiment:

-Learn basics of LabVIEW

-Construct mathematical models on LabVIEW environment

-Obtain mathematical models of real-life systems.

-Plot the response of the systems by using computer programs

-Understand the importance of the modeling in control systems

1.Preliminary Study:

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

2.Research on plotting and modeling in computer programs like Matlab or Scilab. Prepare yourself for the next questions.

3.What is the meaning of underdamped, overdamped and critically damped systems. Give two examples for each of them.

4.What is the meaning of transient response and steady state response, give two examples from real-life.

5.What is settling time, rise time, peak time? Why they are important?

6.Obtain the mathematical model (y(t)) of the spring-mass-damper system. Show all mathematical equations and all steps.
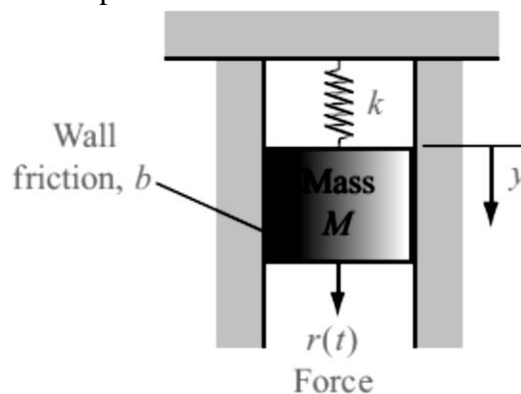

Figure 1. Spring-mass-damper system

7.For the system given previous question, y(0) = 0.15m, M=10, k=1, and b=0.5. Plot y(t) by using computer programs like Matlab or Scilab. (Take zero for initial velocity)

8.For the simple pendulum, obtain nonlinear equation of motion. Select L=0.5m, m=1kg, and g=9.8 m/s2. Obtain the response of the system for θ(0)=30.
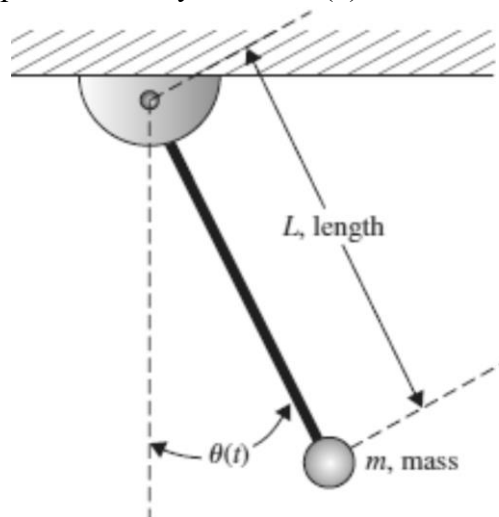

Figure 2. Simple pendulum

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.

2.1. Repeat the Steps
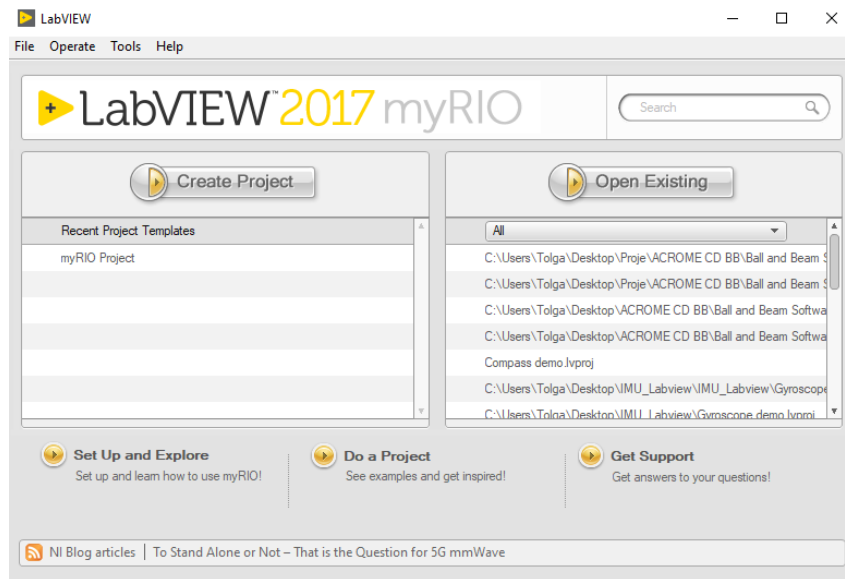
Open LabVIEW application

Figure 3. LabVIEW opening window

Select (**File->New VI**) A new VI open. Two windows are displayed. These are Block Diagram and Front Panel. At Code Diagram, your algorithms (or your codes) written in this part by using some tools that can be dragged to the block diagram window. Front panel is the main wind that displays the outputs of the systems. Therefore, related symbols can be dragged to this window like plot or numerical display.
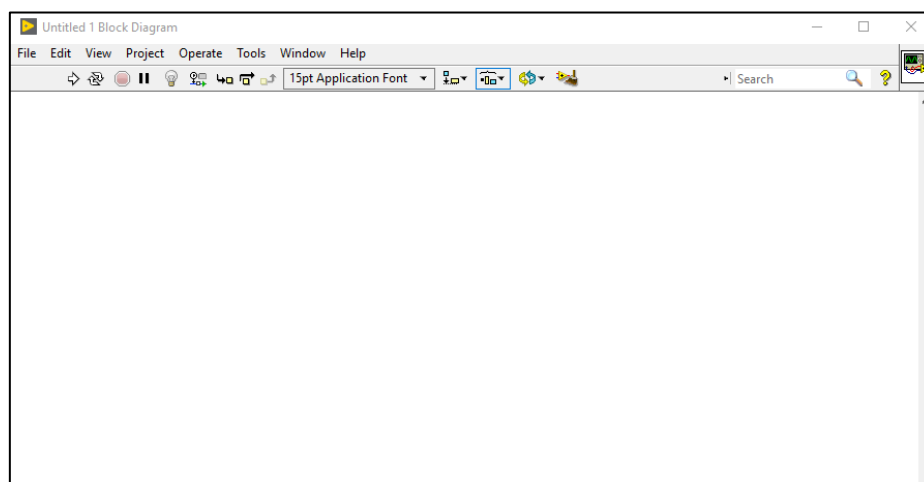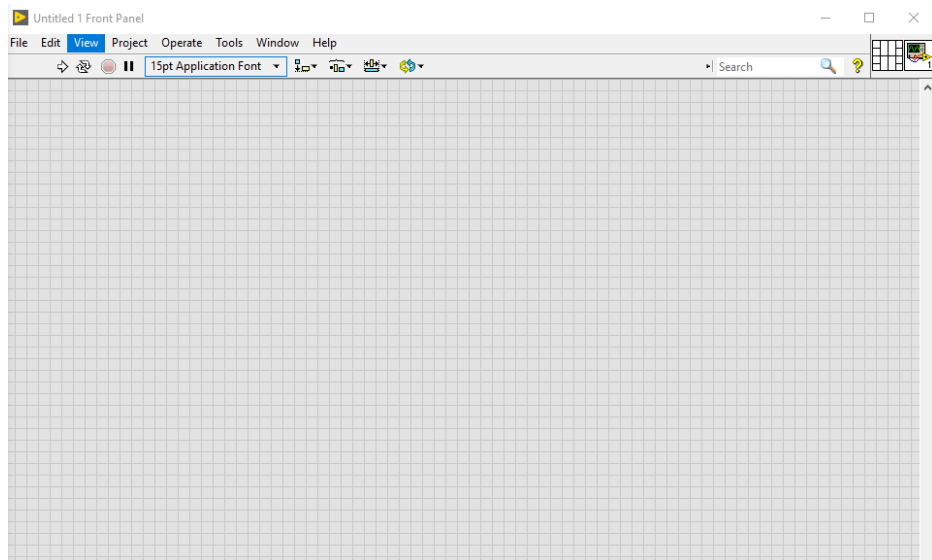

Figure 4. Block diagram

Figure 5. Front panel

You can (right click) on the windows **both front panel and code display** to view the installed libraries and theirs symbols. These windows are like Simulink computer program.
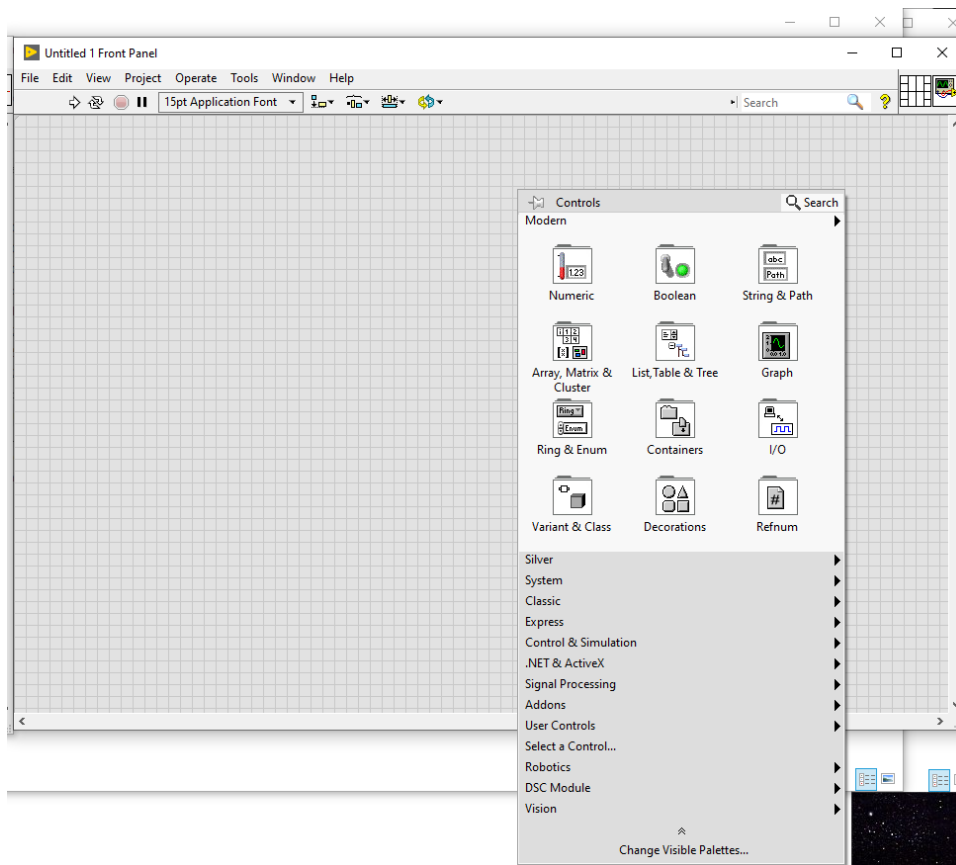

Figure 6. Front Panel Libraries.

Figure 7 shows the LabVIEW front panel of sin function. The aim is to draw the sin function. In order to draw this function, the number of FOR loop, angle value and graphic representation

are required. To do this, the front panel comes, and the **mouse is right clicked**, <u>Numeric</u> is selected and then <u>**Numeric Control**</u> is selected two times. For plotting select **Graph -> Waveform Chart**. Obtain the following Front Panel
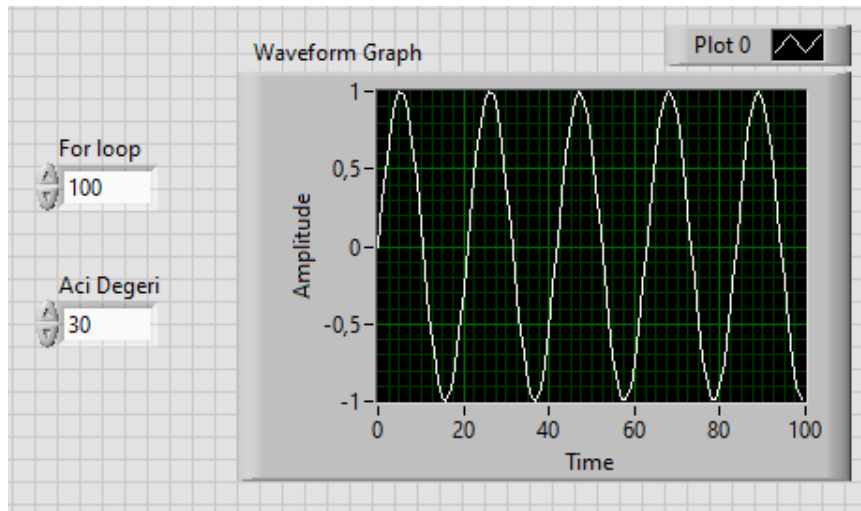

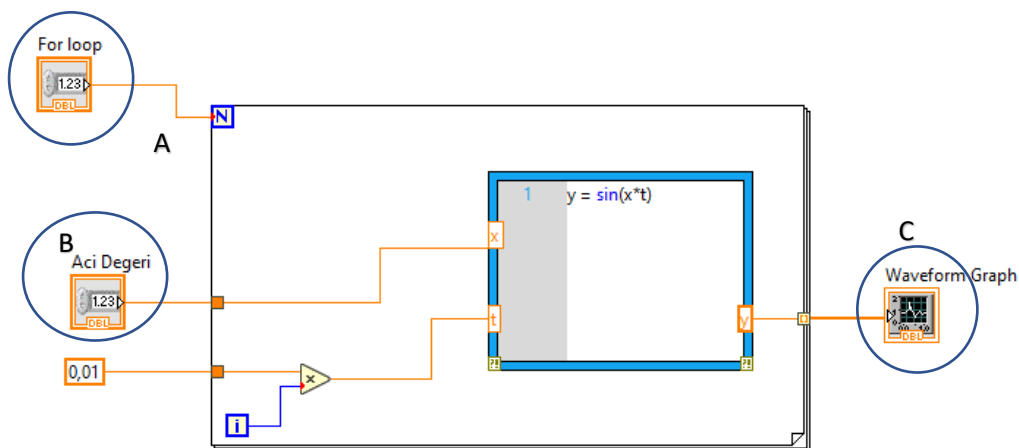Figure 7. Sin Function Front Panel

Figure 8. Sin Function Code Editor

From Figure 8, when Numeric Control symbols and Graph is added to the Front panel A, B and C is displayed on Code Editor.

Now for Code editor, sin(xt) will be programed. Time is given as t at the Figure 8. Time is given as an incremental variable at the FOR loop. Therefore, initially FOR loop is added to the Code Editor. Select **Structures -> For Loop**. At the loop there are two data entry points named as **N** and **i**. N is for the for-loop size and i is the index of the for loop. Connect **Numeric Control** to the N. This **Numeric Control** become the size of FOR loop.

As mentioned above, time will be added to the system by a variable. As the for-loop increases time also increases with a defined rate. For a constant time, change rate select **Numeric->Numeric Constant.** The value for tame change is 0.01. This rate is multiplied by For-loop index. That will be time of the sinusoidal signal.

İnside the for-loop there will be MathScript. This is a tool that can be used s syntax like Matlab. It is a Matlab like script environment. You can find in **Structures->MathScript.** Input and output variables must be added to the MathScript. The inputs Are x and t and output is y. Right

Click MathScript blue rectangle and select **add input** and **add output** for adding input and output to the MathScript block. Now fill the front panel and Block diagram (Code editor) as given in Figure 7 and Figure 8 and observe the output at Figure 7.

2.2. Do it Yourself!

1.Consider the system given in preliminary work Figure 1. Make the simulation for the system and obtain the output response. Draw this response to the datasheet. A1

2.Change the mass of the system and observe settling time. Fill the table given in B1

3. Consider the system given in preliminary work Figure 2. Make the simulation for the system and obtain the output response. Draw this response to the datasheet. A2

4.Change the m and L of the system and observe stop time. Fill the table given in B2

5. Discuss the obtained results in 1,2,3, and 4. Observe the changes at the outputs and explain the reason.
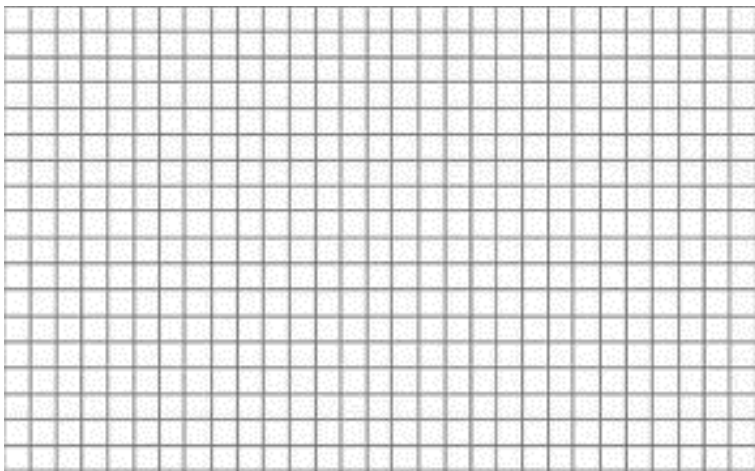
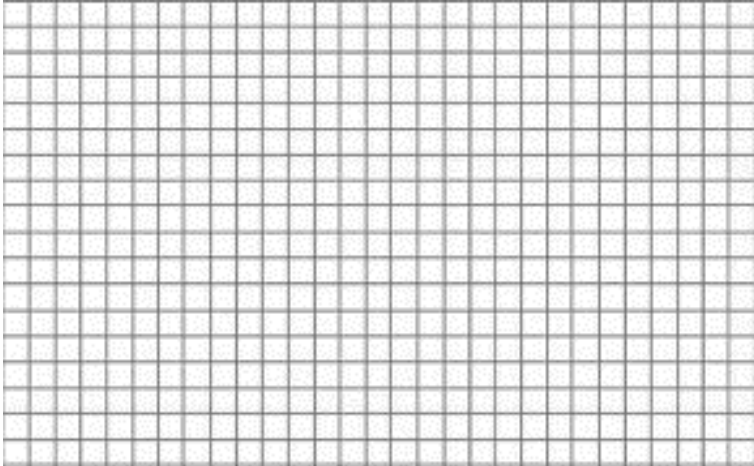## Data Sheet (Student Copy):

A1

B1

Mass	Settling Time
5	
15	
20	
30	

A2

B2
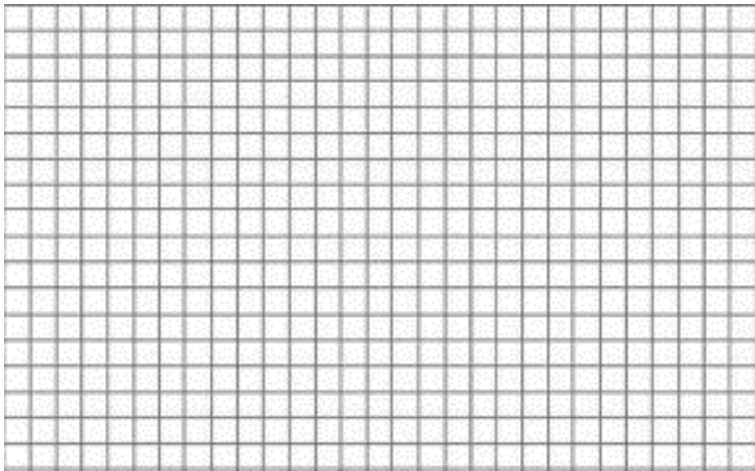
m	L	Stop Time
1	1	
2	0.5	
2	1	
0.5	1	

Names of students in the group:

Data Sheet (Instructor Copy):

A1

B1

Mass	Settling Time
5	
15	
20	
30	

A2

B2
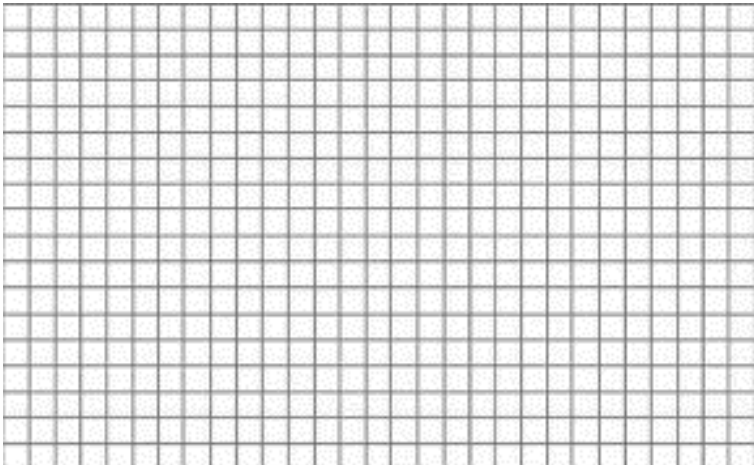
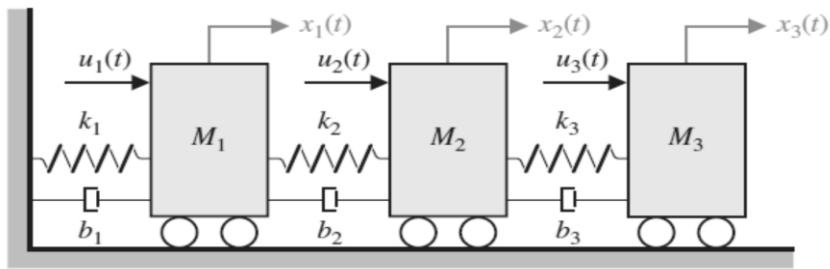| m	L	Stop Time
1	1	
2	0.5	
2	1	
0.5	1	

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 6 and 8.

3.Explain your outcomes from the experiment.

4.For the mechanical system give below, where $u_1(t)$, $u_2(t)$, and $u_3(t)$ are inputs and $x_1(t)$, $x_2(t)$, and $x_3(t)$ are outputs.

Obtain the differential equations and transfer functions