Signals & Systems Laboratory

CSE- 301L

Lab # 12

OBJECTIVES OF THE LAB

This lab aims at the understanding and introduction to Simulink, an extension to Matlab.

12.1 Working with Simulink

12.1.1 What is Simulink

Simulink is an extension to Matlab. In Simulink, you build block diagram models of dynamic systems instead of text code. It is easy to model complex nonlinear systems. Simulink can model both continuous and discrete-time components.

12.1.2 Getting started with Simulink

Start Matlab and open Simulink by clicking on the Simulink Library or simply typing Simulink in command widow. This might take a while. A Simulink window will open as shown in Figure 1 below. This window shows the libraries of Simulink Blocks that are available for you to use in constructing Simulink models.

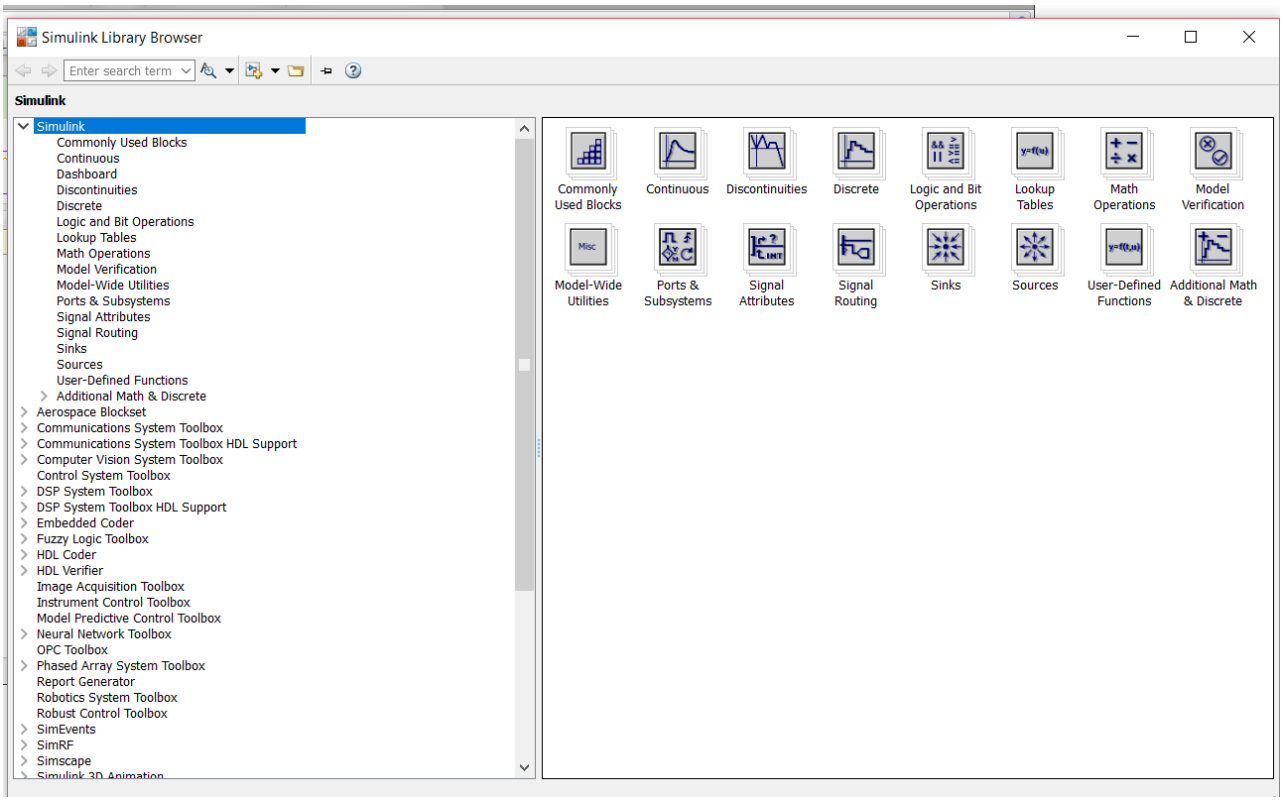

Figure 1: Simulink Library Browser Window

12.1.3 Creating a Model in Simulink

Open an existing model or create a new one. To create a new model, select File>NewModel, and new model window will appear as shown in Figure 2.

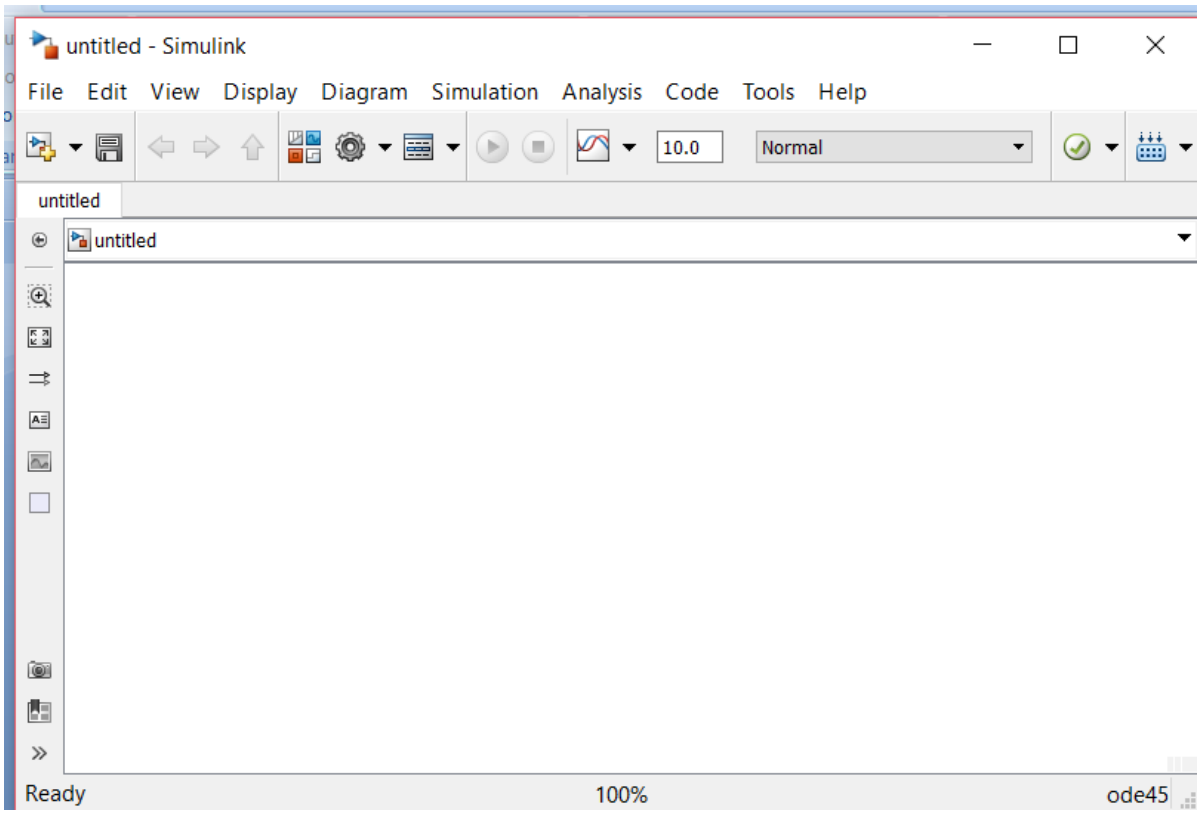

Figure 2: Simulink Model Window with Untitled Workspace for Building a New Model.

12.1.4 Develop a Simulink Model

In the model window place the items on the diagram and wire them together as shown in Figure 3. From the directory of tools select the items you want to use and wire items together. To wire the items click on a device's terminal then drag (hold left mouse key down) until you get to the target device's terminal. To split wires, hold CTRL key down and then click on the wire you want to split. Drag to the desired terminal. Move your blocks or wires around until the items appear as you want to place them.

12.1.5 Basic Elements

There are two major classes of elements in Simulink:

- Blocks and lines.

Blocks are used to generate, modify, combine, output, and display signals. Lines are used to transfer signals from one block to another.

- Blocks
  The subfolders underneath the "Simulink" folder indicate the general classes of blocks available for us to use:
  - Continuous: Linear, continuous-time system elements (integrators, transfer functions,

statespace models, etc.)

• Discrete: Linear, discrete-time system elements (integrators, transfer functions, state-space models, etc.)

• Functions & Tables: User-defined functions and tables for interpolating function values

• Math: Mathematical operators (sum, gain, dot product, etc.)

• Nonlinear: Nonlinear operators (coulomb/viscous friction, switches, relays, etc.)

• Signals & Systems: Blocks for controlling/monitoring signal(s) and for creating subsystems

• Sinks: Used to output or display signals (displays, scopes, graphs, etc.)

• Sources: Used to generate various signals (step, ramp, sinusoidal, etc.)

Blocks have zero to several input terminals and zero to several output terminals. Unused input terminals are indicated by a small open triangle. Unused output terminals are indicated by a small triangular point. The block shown below has an unused input terminal on the left and an unused output terminal on the right.

Building the system model is then accomplished through a series of steps:

1. The necessary blocks are gathered from the Library Browser and placed in the model window.
2. The parameters of the blocks are then modified to correspond with the system we are modeling.
3. Finally, the blocks are connected with lines to complete the model.

12.1.5.1. Gathering Blocks

Each of the blocks that we want to use in our model can be taken from the Simulink Library Browser. To place the Sine Wave block into the model window, follow these steps:

1. Click on the "+" in front of "Sources" (this is a subfolder beneath the "Simulink" folder) to display the various source blocks available for us to use.
2. Scroll down until you see the "Sine Wave" block. Clicking on this will display a short explanation of what that block does in the space below the folder list.
3. To insert a Sine Wave block into your model window, click on it in the Library Browser and drag the block into your workspace.

The same method can be used to place the Gain and Scope blocks in the model window. The "Gain" block can be found in the "Math" subfolder and the "Scope" block is located in the "Sink" subfolder. Arrange the three blocks in the workspace (done by selecting and dragging an individual block to a new location) so that they look similar to the following:

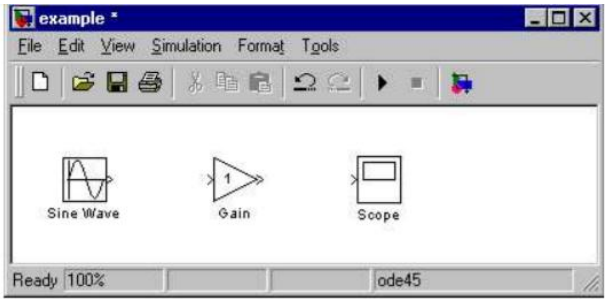

Figure 3: Simulink Model with unconnected blocks

12.1.5.2. Modifying the Blocks

Simulink allows us to modify the blocks in our model so that they accurately reflect the characteristics of the system we are analyzing. For example, we can modify the Sine Wave block by double-clicking on it. Doing so will cause the following window to appear:

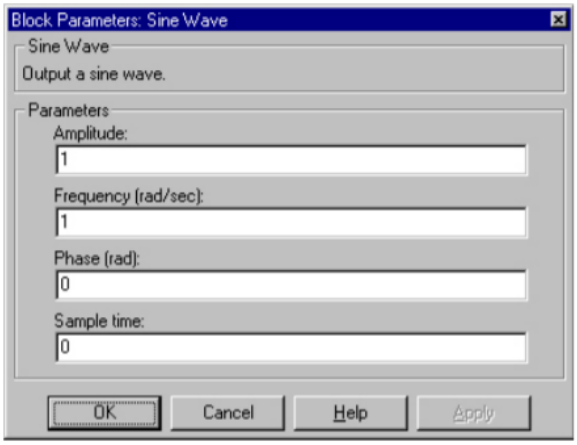

Figure 4: Block Parameters Sine Wave

This window allows us to adjust the amplitude, frequency, and phase shift of the sinusoidal input. The "Sample time" value indicates the time interval between successive readings of the signal. Setting this value to 0 indicates the signal is sampled continuously.

12.1.5.3. Connecting the Blocks

For a block diagram to accurately reflect the system we are modeling, the Simulink blocks must be properly connected. In our example system, the signal output by the Sine Wave block is transmitted to the Gain block. The Gain block amplifies this signal and outputs its new value to the Scope block, which graphs the signal as a function of time. Thus, we need to draw lines from the output of the Sine Wave block to the input of the Gain block, and from the output of the Gain block to the input of the Scope block.

Lines are drawn by dragging the mouse from where a signal starts (output terminal of a block) to where it ends (input terminal of another block). When drawing lines, it is important to make sure that the signal reaches each of its intended terminals. Simulink will turn the mouse pointer into a crosshair when it is close enough to an output terminal to begin drawing a line, and the pointer will change into a double crosshair when it is close enough to snap to an input terminal. A signal is properly connected if its arrowhead is filled in. If the arrowhead is open, it means the signal is not connected to both blocks. To fix an open signal, you can treat the open arrowhead as an output terminal and continue drawing the line to an input terminal in the same manner as explained before.

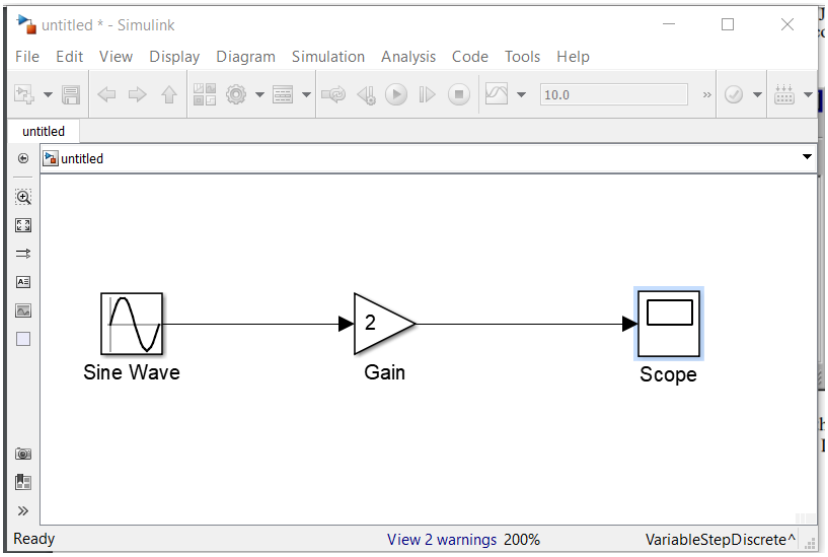

Figure 5: Properly Connected Blocks

12.1.6. Running the Simulations

Now that our model has been constructed, we are ready to simulate the system. Before starting simulation, we need to set the simulation parameters. To do this, go to the Simulation menu and click on Configuration Parameters. The Configuration Parameters dialog box opens on your desktop.

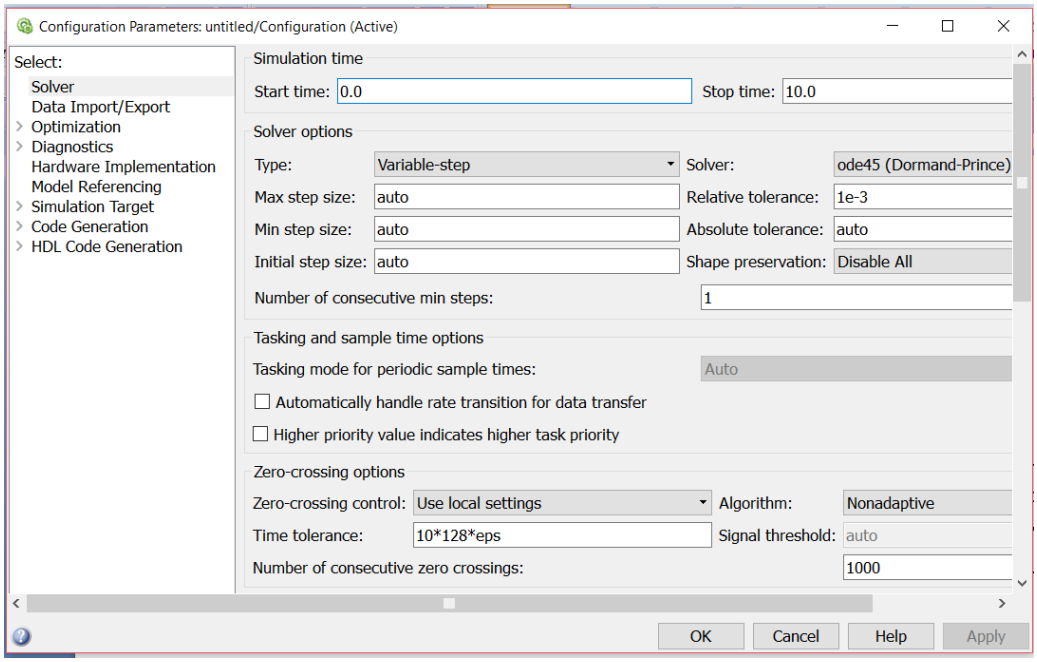

Figure 6: Simulation Parameters

Go to the Simulation menu and click on Start, or just click on the "Start/Pause Simulation" button in the model window toolbar (looks like the "Play" button on a VCR). Because our example is a relatively simple model, its simulation runs almost instantaneously. With more complicated systems, however,

you will be able to see the progress of the simulation by observing its running time in the lower box of the model window. Double-click the Scope block to view the output of the Gain block for the simulation as a function of time. Once the Scope window appears, click the "Auto scale" button in its toolbar (looks like a pair of binoculars) to scale the graph to better fit the window. Having done this, you should see the following:

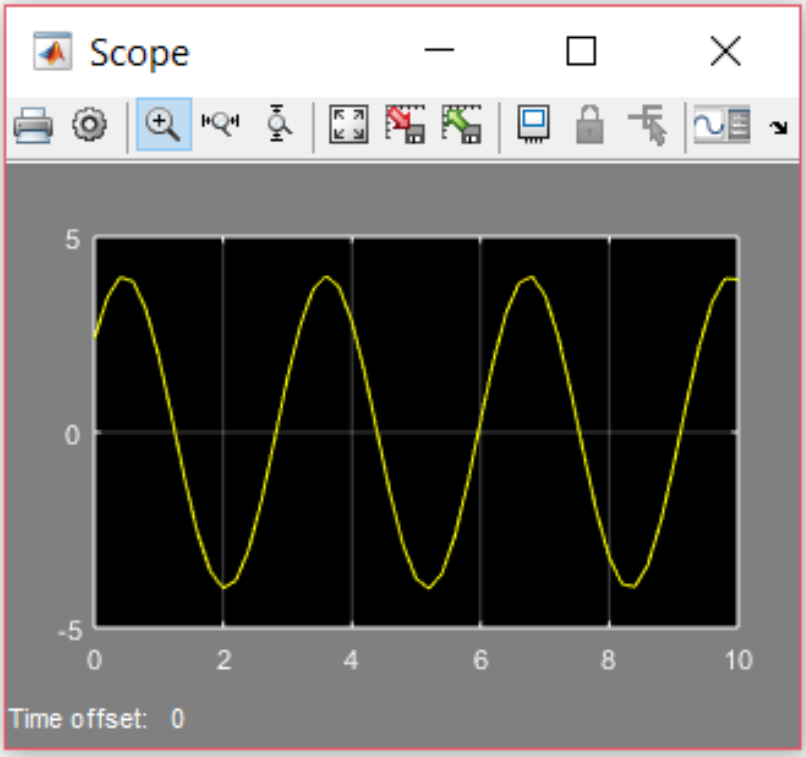

Figure 7: Scope output

----------TASK ----------

Design any signals and systems example in simulink.
