American International University- Bangladesh
Department of Electrical and Electronic Engineering
COE 3201: Data Communication Laboratory

Title: Study of Amplitude Modulator and Demodulator using Simulink

Abstract:

This experiment is designed to-

1. To understand Simulink (MATLAB)
2. To understand the theoretical foundations of Analog Communications as well as of Amplitude Modulation and Demodulation (AM)
3. To design the Simulink model of the DSB-AM to analyze each signal in time and frequency domains using time scope and spectrum analyzer
4. To observe the real-time music transmission for DSB-AM modulated signal via USRP trans-receiver

Introduction:

1. What is Simulink?

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

1.1 Procedure

There are three sections to this procedure. The first, Section 2.1 will show you how to start the Simulink utility and introduce you to the Simulink workspace. In section 2.2, you will determine the step response of a second-order control system, and in Section 2.3, you will modify your model to produce examples of overdamped and undamped system responses.

1.2 Simulink Introduction

Start Matlab- Double click the Matlab icon on the desktop. It will take a minute or two for Matlab to finish initializing. The Matlab window should appear as shown in Figure 1. Note: Setup may differ depending on MATLAB version you are using.

Start Simulink by clicking on the Simulink Library. A Simulink window will open as shown in Figure 2. This window shows the libraries of Simulink Blocks that are available for you to use in constructing Simulink models.

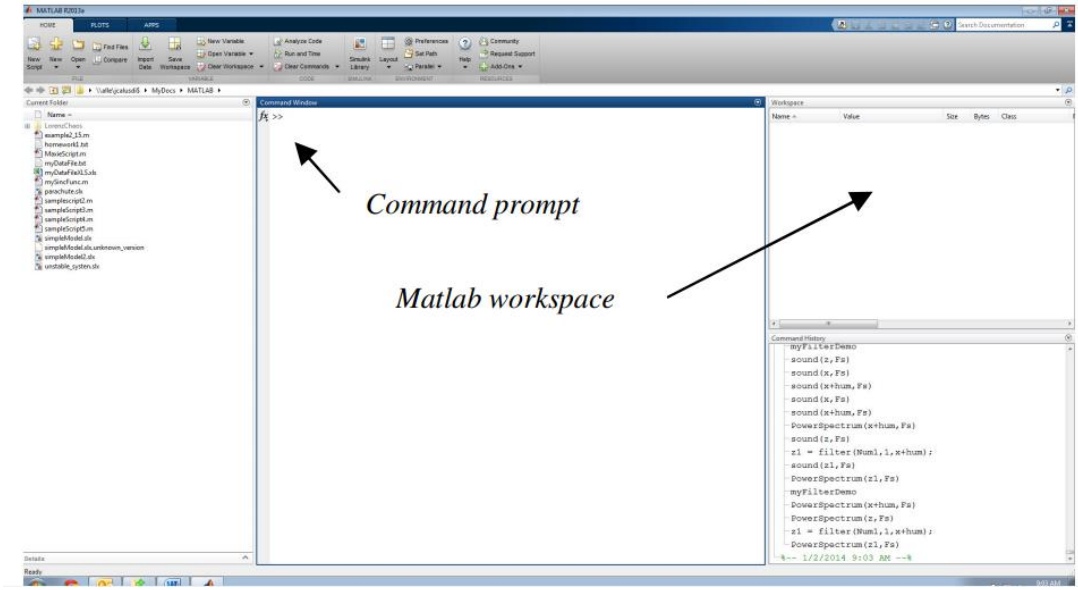


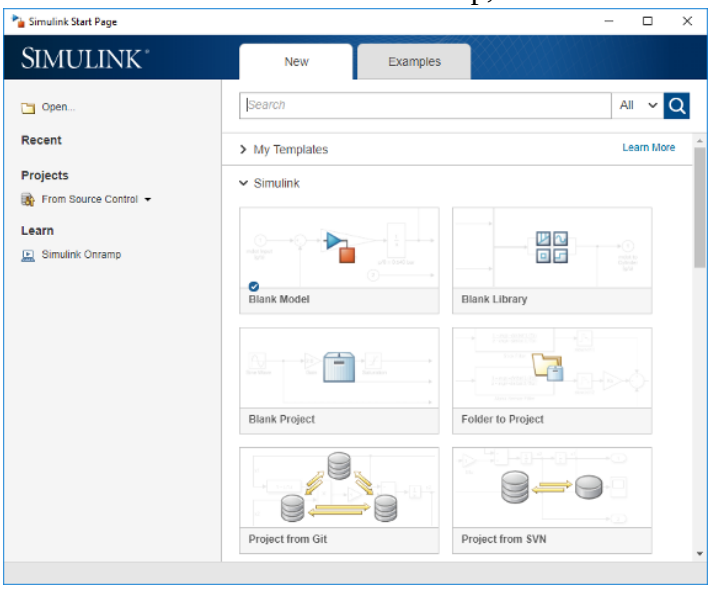
Figure 1: Matlab Main Window

Open an existing model or create a new one. To create a new model, select **File->New->Model**, and new model window will appear as shown in Figure 3. An existing model will look like Figure 4.

1.3 Open New Model

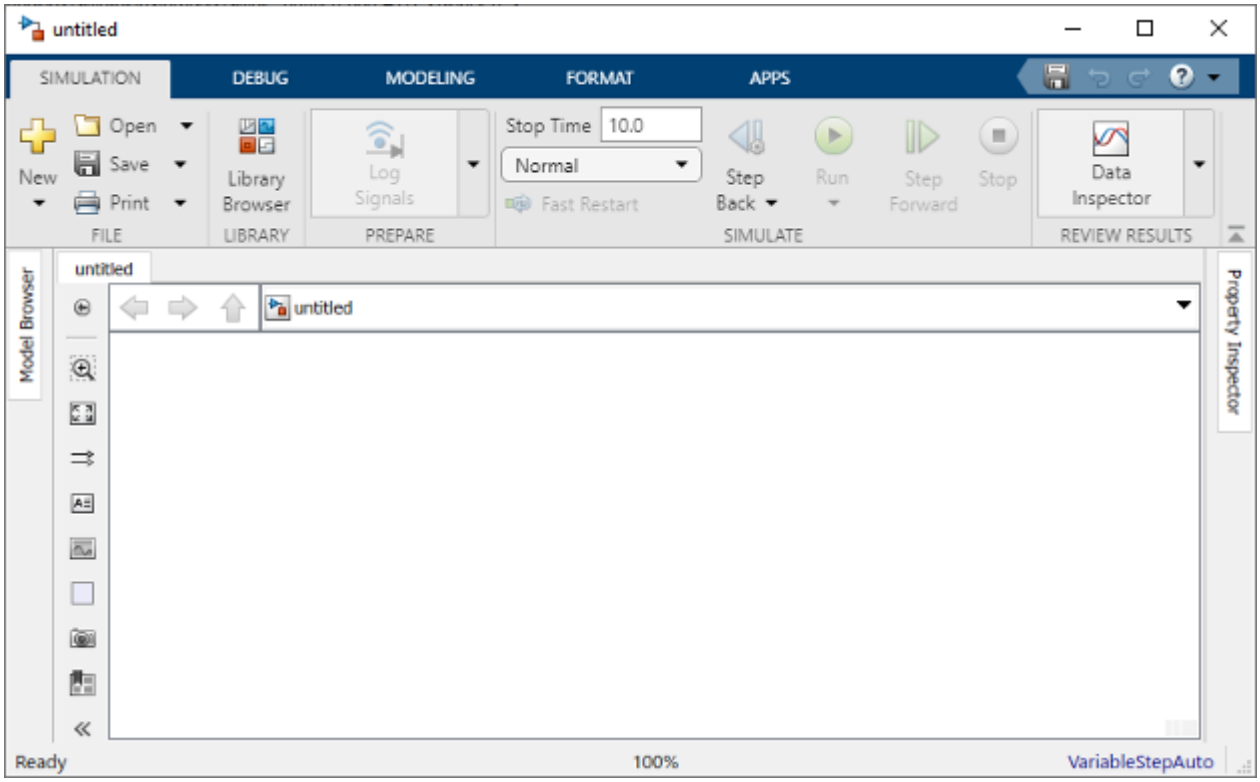
Use the Simulink Editor to build your models.

1. Start MATLAB®. From the MATLAB toolstrip, click the **Simulink** button  .



2. Click the **Blank Model** template.

   The Simulink Editor opens.



3. From the **Simulation** tab, select **Save > Save as**. In the **File name** text box, enter a name for your model. For example, `simple_model`. Click **Save**. The model is saved with the file extension `.slx`.

1.4 Open Simulink Library Browser

Simulink provides a set of block libraries, organized by functionality in the Library Browser. The following libraries are common to most workflows:

- Continuous — Blocks for systems with continuous states
- Discrete — Blocks for systems with discrete states
- Math Operations — Blocks that implement algebraic and logical equations
- Sinks — Blocks that store and show the signals that connect to them
- Sources — Blocks that generate the signal values that drive the model

1. From the Simulation tab, click the **Library Browser** button  .

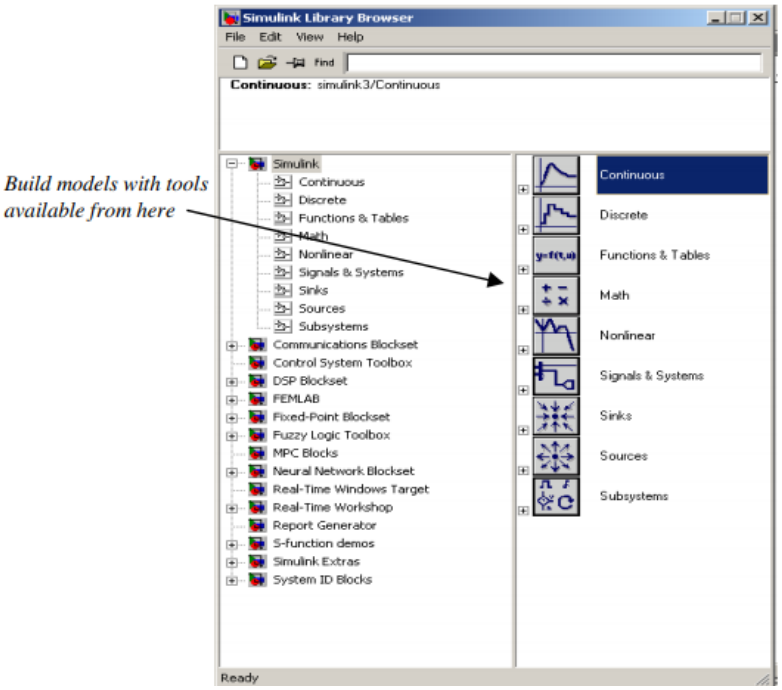
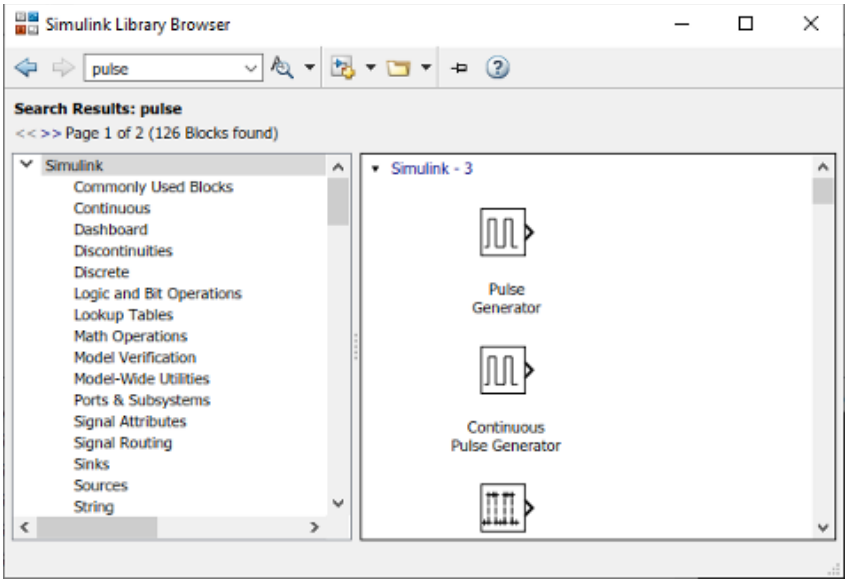


Figure 2: Simulink Library Browser Window

2. Set the Library Browser to stay on top of the other desktop windows. On the Simulink Library Browser toolbar, select the **Stay on top** button  .

To browse through the block libraries, select a category and then a functional area in the left pane. To search all of the available block libraries, enter a search term.

For example, find the Pulse Generator block. In the search box on the browser toolbar, enter pulse, and then press Enter. Simulink searches the libraries for blocks with pulse in their name or description and then displays the blocks.



Get detailed information about a block. Right-click the Pulse Generator block, and then select **Help for the Pulse Generator block**. The Help browser opens with the reference page for the block. Blocks typically have several parameters. You can access all block parameters by double-clicking the block.

2. What is AM Modulation?

In AM transmission, the carrier signal is modulated so that its amplitude varies with the changing amplitudes of the modulating signal. The frequency and phase of the carrier remain the same; only the amplitude changes to follow variations in the information. AM is normally implemented by using a simple multiplier because the amplitude of the carrier signal needs to be changed according to the amplitude of the modulating signal.

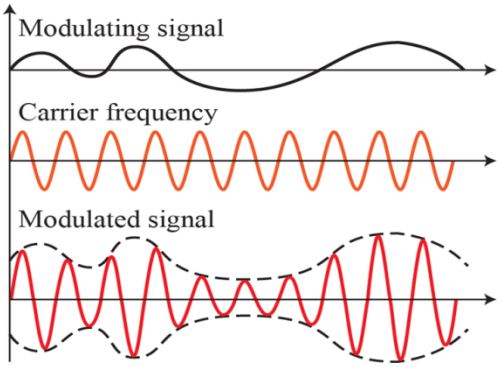


Figure 3: AM Modulation

2.1 Building AM modulation diagram in Simulink:

Open Simulink and build a block diagram as figure 4.

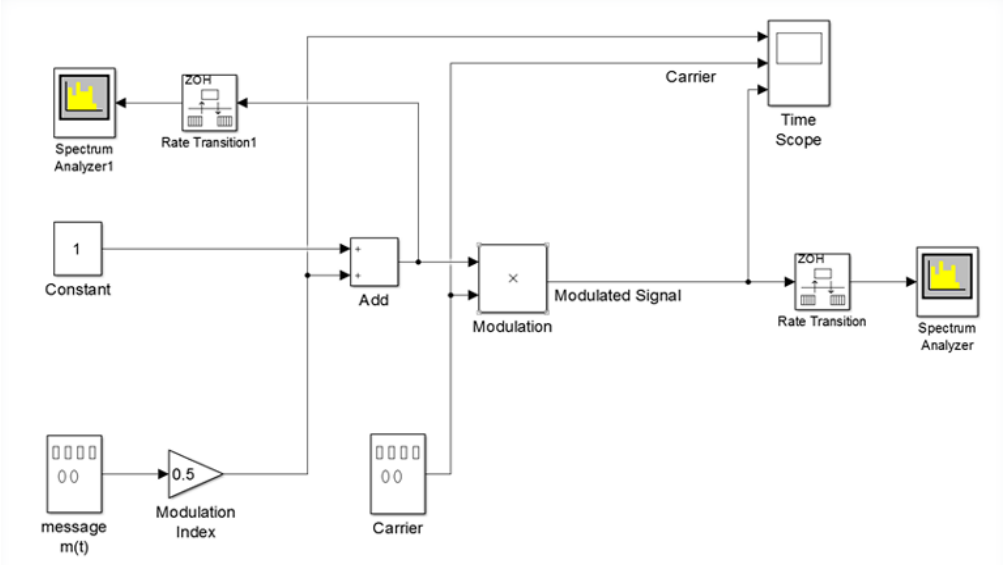


Figure 4: AM modulation block diagram

Parameters:

- Double click on the signal generator, and then set the frequency as 1 kHz with a waveform of sine
- Adjust the carrier sine wave's frequency as 20 kHz
- Set the simulation time such as 0.01 to observe the signals clearly
- Run your simulation
- In order to observe the spectrum analyzer, please increase the simulation time to 1 or 2 seconds.
- The message signal is multiplied by the modulation index, then it is added a DC carrier, finally is multiplied with a sinusoidal carrier signal in order to transmit the AM modulated signal.

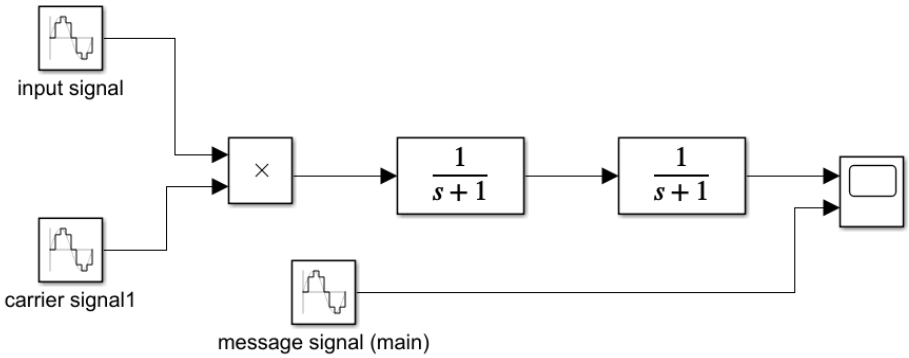
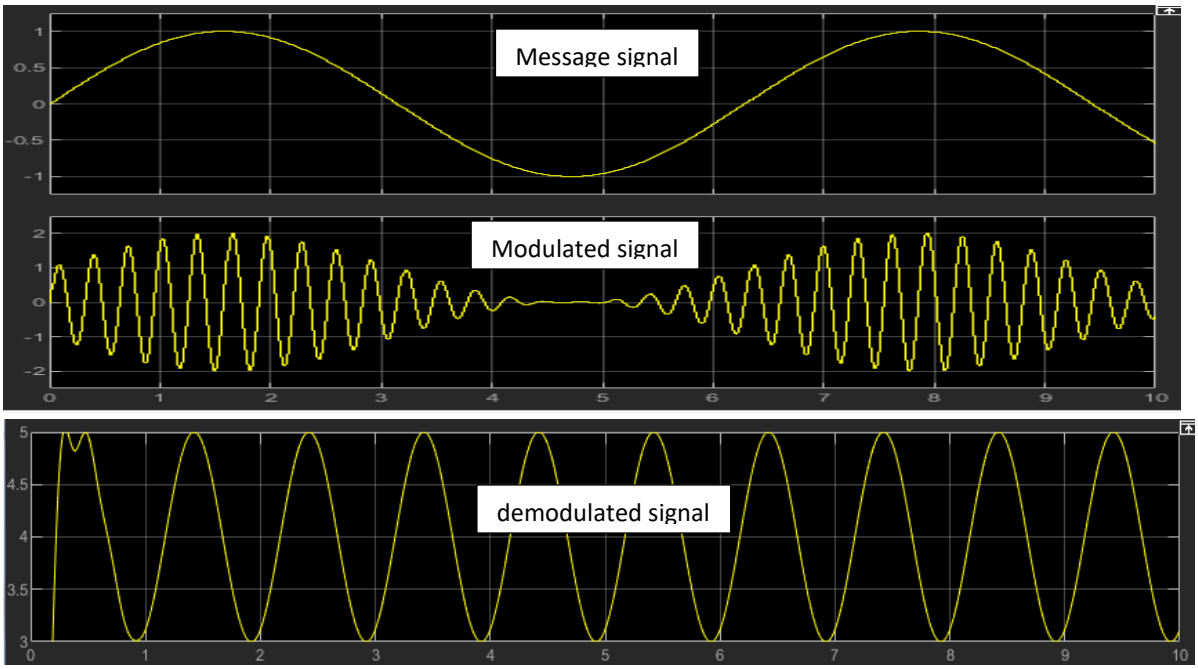


Figure 5: AM demodulation block diagram

Output :



Performance Task:

You have a signal ‘m(t) = (2*sin(2*pi*4*t)+3*cos(2*pi*6*t))’. Apply amplitude modulation (AM) on the given signal with carrier signal ‘c(t) = (2*cos(2*pi*50*t))’, and then do demodulation to get back the original message signal m(t). Use appropriate modulation index (μ). Remember your demodulated signal should have same amplitude and frequency as m(t) has.

Formula for modulation: $s(t) = (1+ \mu*(m(t)))*c(t)$

Formula for demodulation: $m'(t) = (s(t)*2*c(t)-1)*(1/ \mu)$ [Remember you have to use a low pass filter here to match $m'(t)$ with $m(t)$]