Title: Study of Frequency Modulation and Demodulation using Simulink.

Abstract: In this experiment, we are going to study frequency modulator and demodulator using Simulink. The objectives of this experiment are to build knowledge of frequency modulation, and demodulation using Simulink and to comprehend the usage of Simulink for solving communication engineering challenges. For this experiment, we used MATLAB (Version: MATLAB2016a) software. The result of this experiment is in the result session.

Introduction:

Frequency: The quantity of waves that pass a set location in a predetermined period is known as frequency.

Signal: An electromagnetic or electrical current known as a signal is used to transfer data from one system or network to another.

Carrier Signal and Frequency: A waveform (often sinusoidal) that has been modulated (changed) with an information-bearing signal to transmit information is referred to as a carrier signal, or simply carrier.

Carrier frequency is referred to as the frequency of a carrier wave that is modified to transmit signals. It is measured in cycles per second or Hertz.

Amplitude: A signal's amplitude is its value at any given location on the wave.

Modulation: Modulation, which involves incorporating information into an electrical or optical carrier signal, is the process of transforming data into radio waves.

Demodulation: Demodulation is the process of separating a carrier wave's original information-carrying signal.

Amplitude Modulation: The method of amplitude modulation involves changing the amplitude of the wave signal before it is broadcast. It is frequently used to send information using a radio carrier wave and is known by the abbreviation AM. Electronic communication is where amplitude modulation is most commonly utilized.

Simulink: Simulink is a graphical programming environment for MATLAB-based multidomain dynamical systems that allows for modelling, simulation, and analysis. Its main user interface consists of a graphical block diagramming tool and a set of block libraries that can be customized.

Double Side Band (DSB): A form of amplitude modulation is DSB. On either side of the carrier frequency, there are two sidebands. Suppress is a verb that means to take away. The carrier is

meant to be removed by the suppressed carrier. As a result, DSB SC is a transmission in which the carrier component is not present at the modulator's output.

Single Side Band (SSB): Single-sideband modulation, often known as SSB or SSB-SC, is a type of modulation used to transmit information via radio waves, such as an audio signal. It is an improved kind of amplitude modulation that makes better use of transmitter power and bandwidth.

Bandwidth: The most data that can be sent through an internet connection in a specific amount of time.

Angle Modulation: The procedure of angle modulation involves changing the carrier's frequency or phase in response to the message signal.

Phase Modulation (PM): A modulation pattern used to prepare communication signals for transmission is called phase modulation.

Frequency Modulation (FM): FM is the process of encoding information in a carrier wave by altering the wave's instantaneous frequency.

Carson's Rule: According to Carson's rule, the bandwidth needed to transmit an angle-modulated wave is equal to the product of the peak frequency deviation and the modulating signal's highest frequency.

According to Carson rule signal, BW is given as: **B.W = (β + 1) 2fm. B B.W. = 2[Δf + fm]**

Frequency Demodulation: A crucial step in receiving a frequency modulated transmission is FM demodulation.

Phase-locked loops (PLL) Demodulation: Phase-locked loops (plls) explain a popular technique for creating signals whose frequencies are fixedly related to the reference signal's frequency (like multiple). Additionally, it can be used to measure frequency and frequency demodulation.

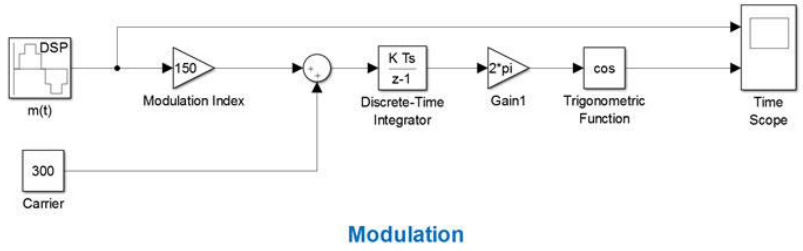


Figure 1: Block Diagrams for the FM Modulator.

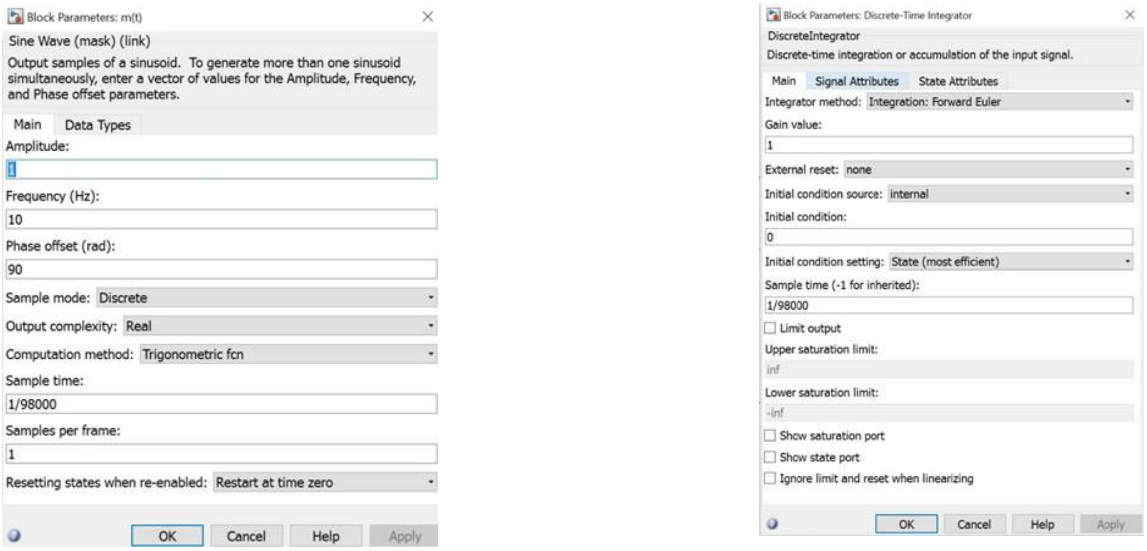


Figure 2: Blocks' Parameters for FM Modulator.

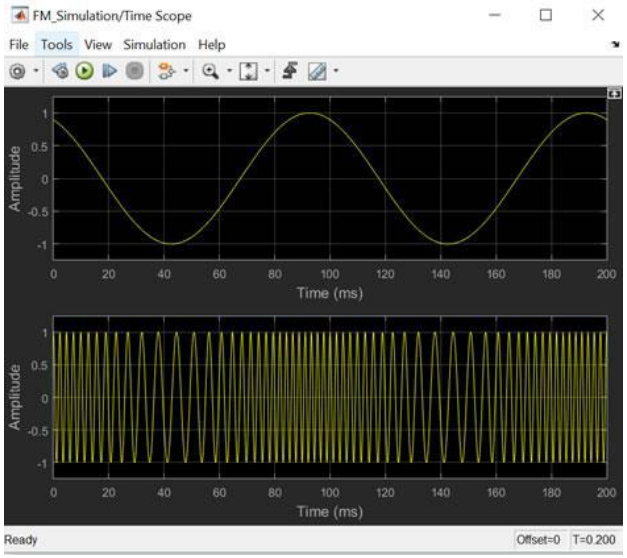
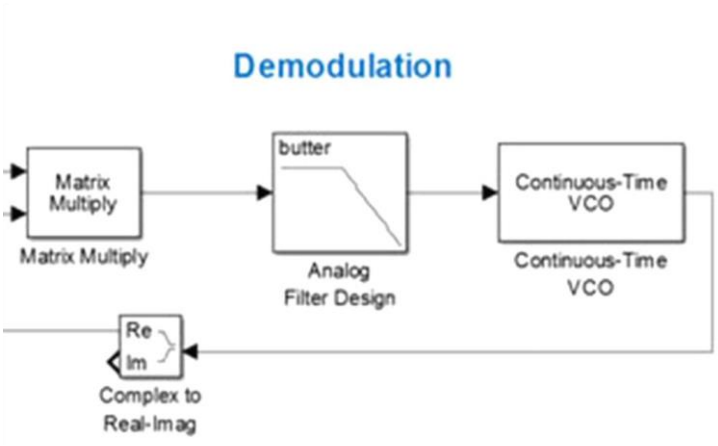


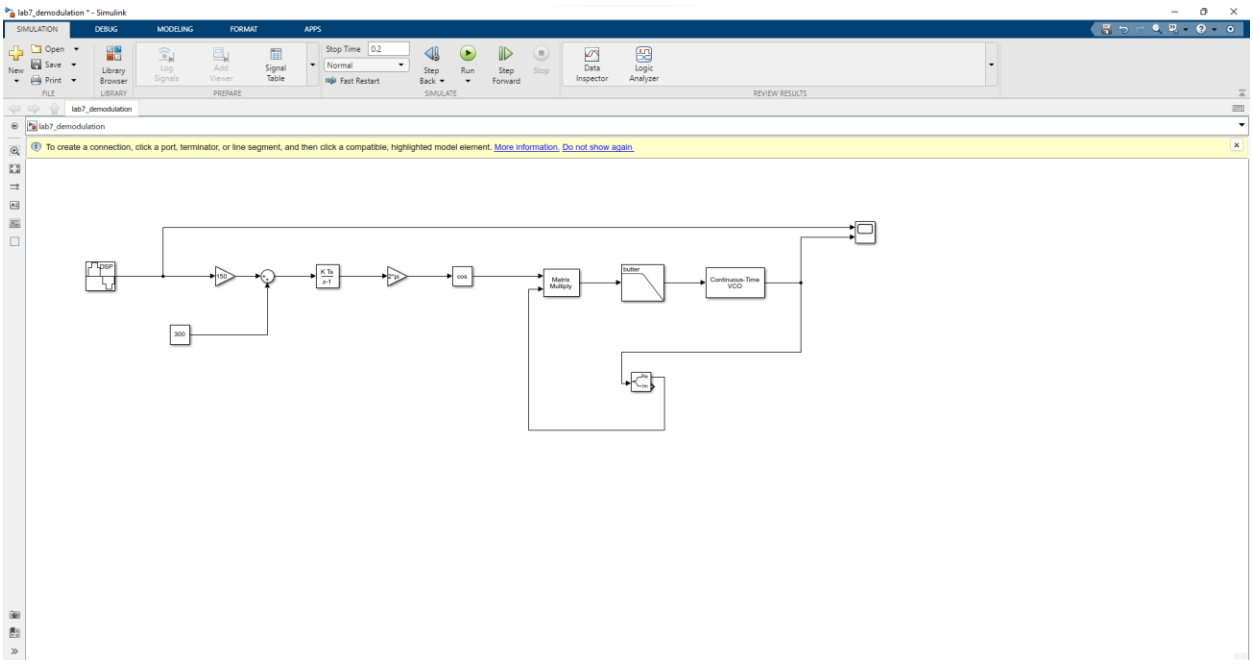
Figure 3: Time Scope.

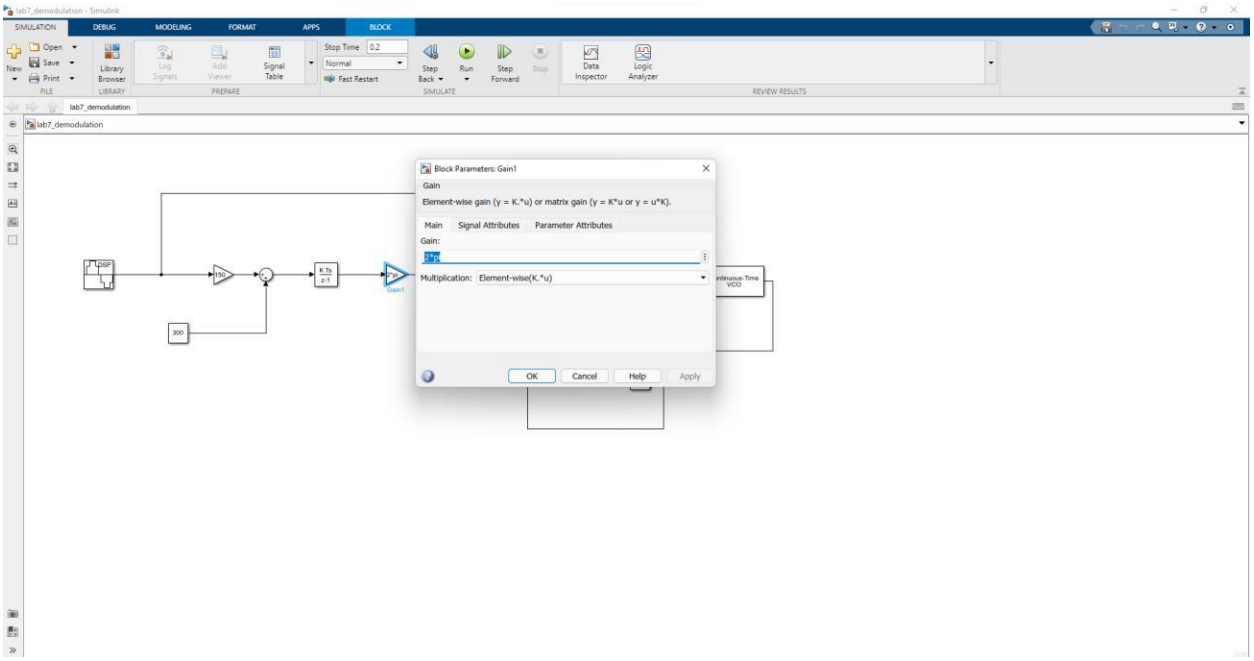


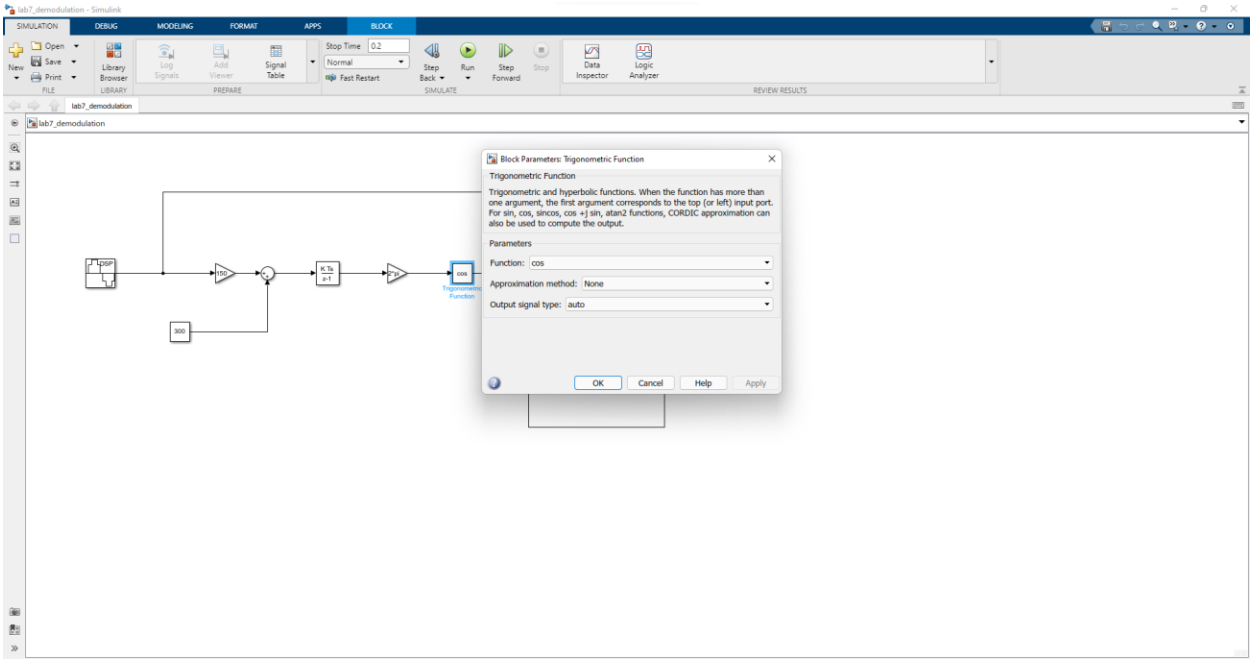
Apparatus: MATLAB (Version: MATLAB2016a) software.

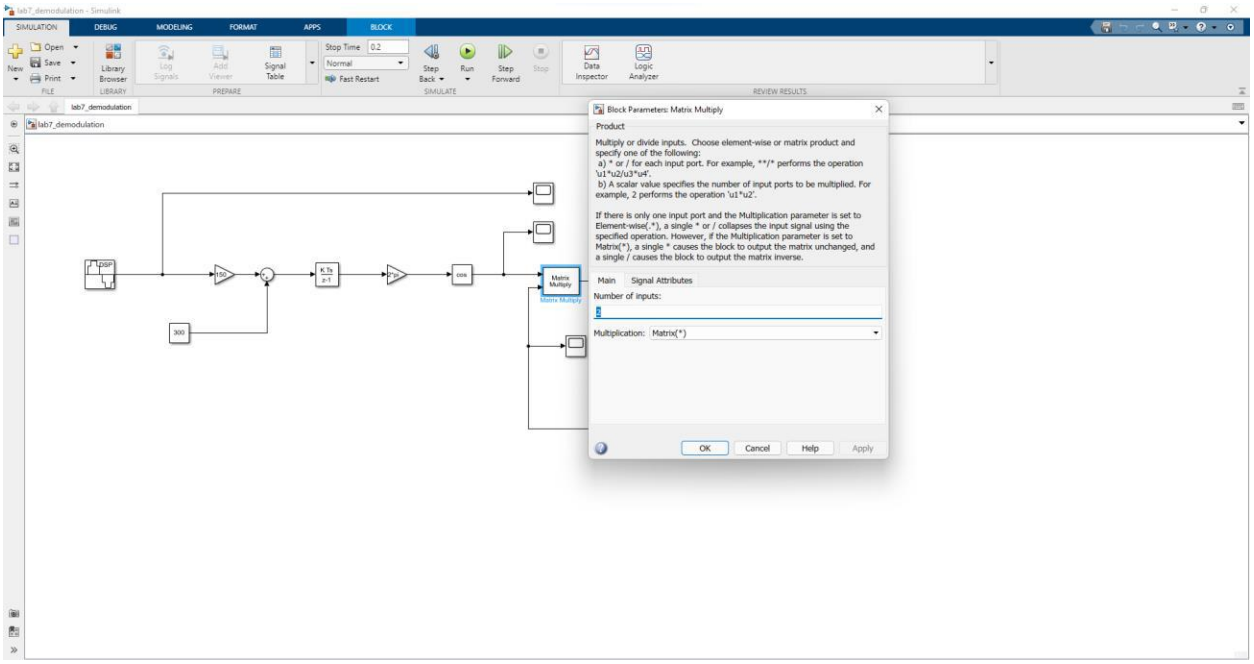
Results:

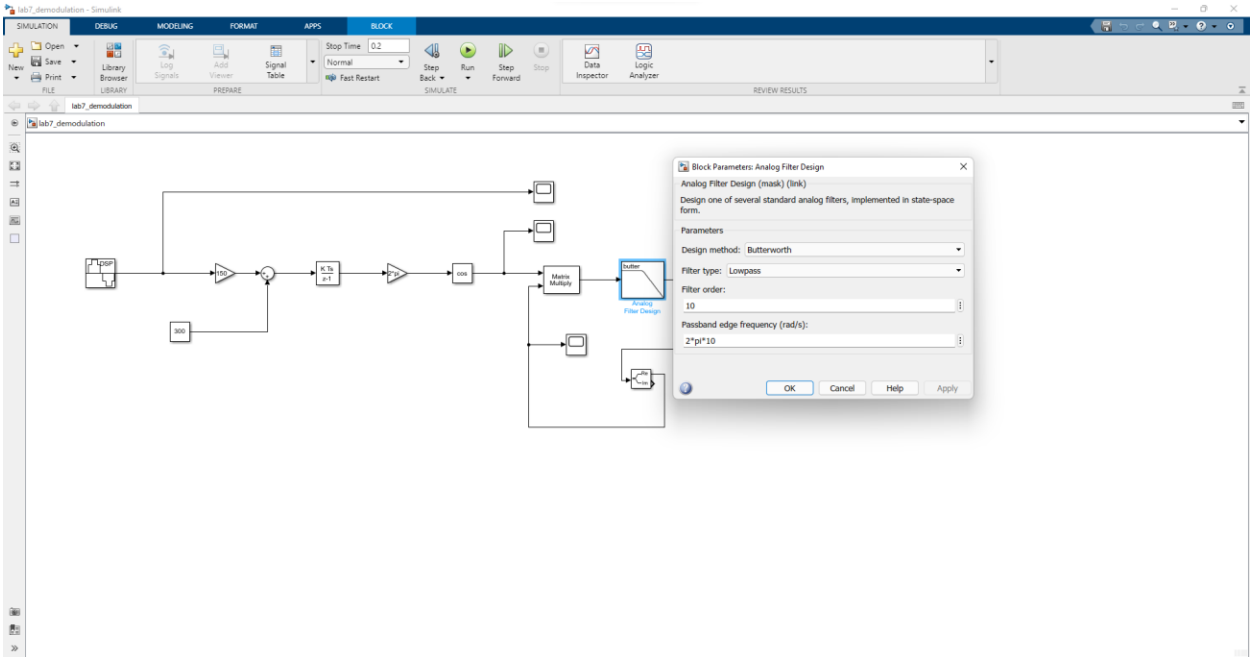
Block Diagram:

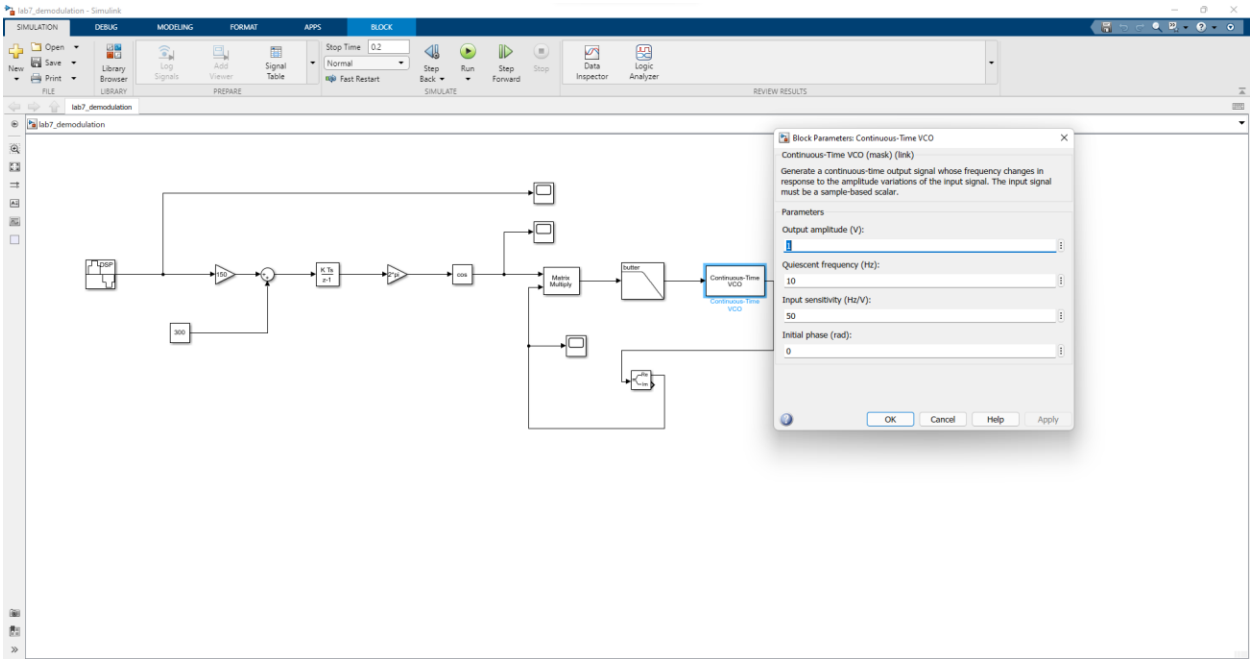


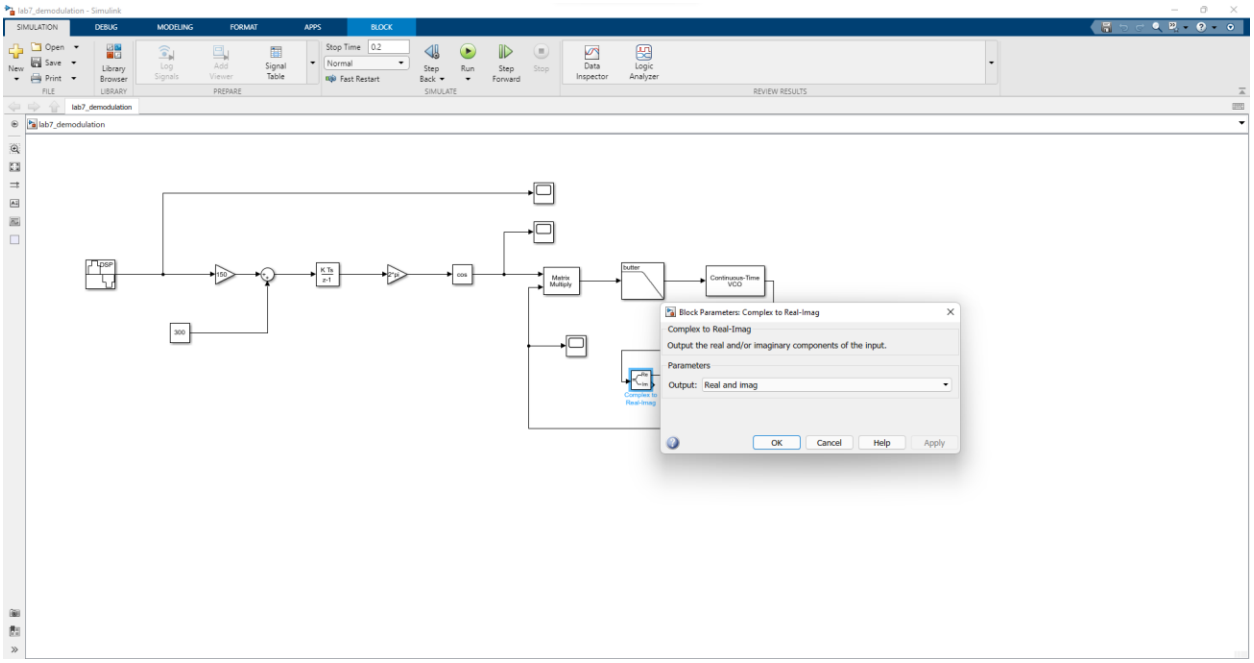

lab7_demodulation - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
BLOCK
Block Parameters: Gain1
Gain
Element-wise gain (y = K.*u) or matrix gain (y = K*u or y = u*K).
Main
Signal Attributes
Parameter Attributes
Gain:
Multiplication: Element-wise(K.*u)
OK
Cancel
Help
Apply
DSP
150
300
K Ts z-1
Gain1


lab7_demodulation - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
BLOCK
Block Parameters: Trigonometric Function
Trigonometric Function
Trigonometric and hyperbolic functions. When the function has more than one argument, the first argument corresponds to the top (or left) input port. For sin, cos, sincos, cos +j sin, atan2 functions, CORDIC approximation can also be used to compute the output.
Parameters
Function: cos
Approximation method: None
Output signal type: auto
OK
Cancel
Help
Apply
DSP
150
300
K Ts z-1
cos

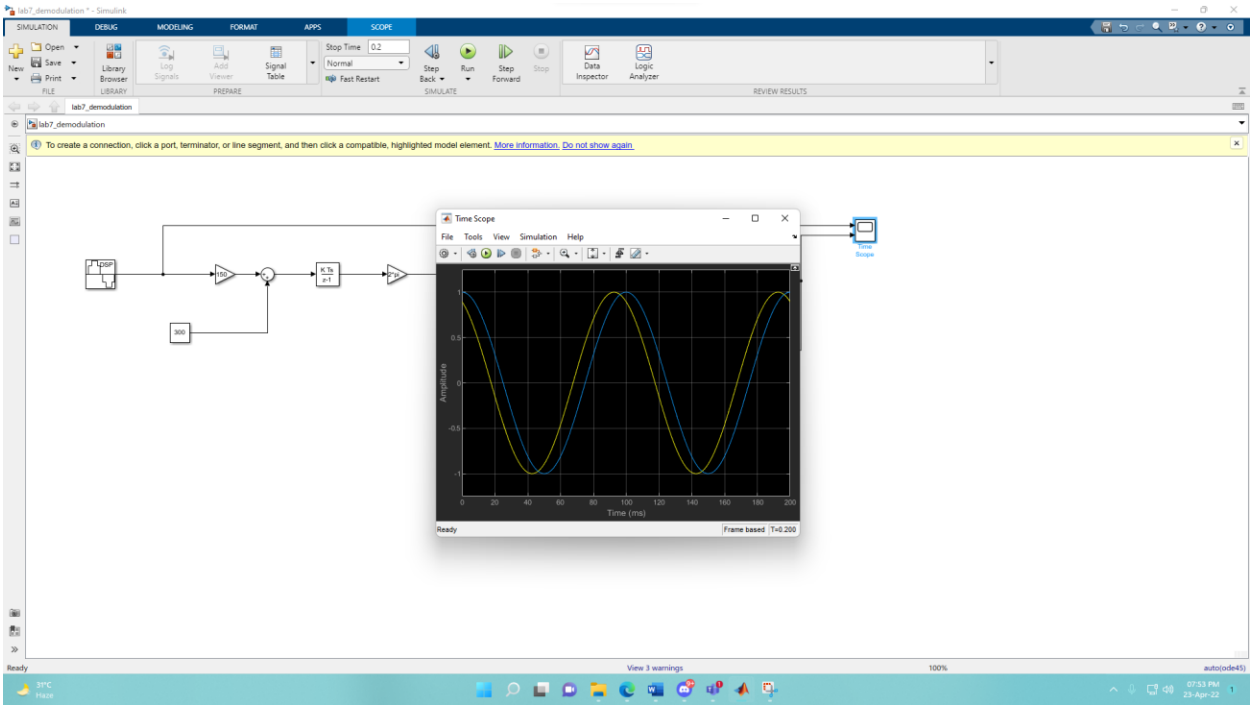

lab7_demodulation - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
BLOCK
Block Parameters: Matrix Multiply
Product
Multiply or divide inputs. Choose element-wise or matrix product and specify one of the following:
a) * or / for each input port. For example, '*/' performs the operation 'u1*u2/u3*u4'.
b) A scalar value specifies the number of input ports to be multiplied. For example, 2 performs the operation 'u1*u2'.
If there is only one input port and the Multiplication parameter is set to Element-wise(.*), a single * or / collapses the input signal using the specified operation. However, if the Multiplication parameter is set to Matrix(*), a single * causes the block to output the matrix unchanged, and a single / causes the block to output the matrix inverse.
Main
Signal Attributes
Number of inputs:
Multiplication: Matrix(*)
OK
Cancel
Help
Apply


lab7_demodulation - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
BLOCK
Block Parameters: Analog Filter Design
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method: Butterworth
Filter type: Lowpass
Filter order:
10
Passband edge frequency (rad/s):
2*pi*10
OK
Cancel
Help
Apply


lab7_demodulation - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
BLOCK
lab7_demodulation
Block Parameters: Continuous-Time VCO
Continuous-Time VCO (mask) (link)
Generate a continuous-time output signal whose frequency changes in response to the amplitude variations of the input signal. The input signal must be a sample-based scalar.
Parameters
Output amplitude (V):
1
Quiescent frequency (Hz):
10
Input sensitivity (Hz/V):
50
Initial phase (rad):
0
OK
Cancel
Help
Apply


lab7_demodulation - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
BLOCK
lab7_demodulation
Block Parameters: Complex to Real-Imag
Complex to Real-Imag
Output the real and/or imaginary components of the input.
Parameters
Output:
Real and imag
OK
Cancel
Help
Apply

Output Waveform:



Discussion and conclusion: In this experiment, we learned how to work in MATLAB Simulink and create the diagram. Also, we generated FM using Simulink and saw the output waveforms. We did not face any problems. For the next user, we have suggested that carefully make the diagram and insert values, and note down the teacher's important notes.

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