AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

Faculty of Engineering

Laboratory Report Cover Sheet

Title: Study of Amplitude and Frequency Modulator and Demodulator using Simulink

Experiment Number: 07	Course Title: Data Communication
Course Code: COE3103	Course Instructor: Nowshin Alam
Semester: Spring 2023-2024	Section: E Date of Submission: 22-04-2024

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	Marks Obtained	
	Total Marks	

Category	Proficient [6]	Good [5-4]	Acceptable [3-2]	Unacceptable [1]	Secured Marks
Introduction and/or Theory	• Explains all necessary and relevant theoretical background information, measures, and variables.	• Explains the important parts of theoretical background information, may be partially irrelevant or need more details.	• Explains some theoretical background information, but some information may be missing, irrelevant or inaccurate.	• A lot of information is missing, out of context and/or inaccurate.	
Experimental procedure/Code	• Working procedure or code is clearly presented and is supported by proper comments. • Simulation program file is provided which runs properly and shows the expected result. • Methods are clearly written, including all steps in sufficient detail for the experiment to be repeated.	• Working procedure or code is given for the experiment to be sufficient. • Simulation program file is provided which runs properly but the output does not perfectly align with expected result. • Methods are correct but the steps may be lacking in detail, making the experiment hard to be repeated.	• Working procedure or code is missing some steps and/or contains some mistakes. • Simulation program file is provided which runs properly but the output has many problems.	• Working procedure or code is absent or missing major steps and/or contains mistakes. • Simulation program file is not provided/is completely wrong.	
Block Diagrams and Graphical Results	• Clear, accurate diagrams and graphs are labeled neatly and accurately with excellent detail. • Simulated result meets all criteria; outcomes are described clearly and accurately.	• Diagrams and plots are included and are correctly labeled in brief, but there may be some lack of clarity. • Most criteria are met, but there may be some lack of clarity and/or incorrect information.	• Diagrams and plots are included and are labeled, minor mistakes may be present. • Results do not match exactly with the theoretical values and/or analysis is unclear.	• Needed plots/ diagrams are missing or are missing important labels. • Experimental results are missing or completely incorrect.	
Data Interpretation and analysis	• Interpretation and analysis of related outcomes (consequences and implications) are logical and reflect student's informed evaluation and ability to place evidence. • Any report questions are properly answered with detailed justification or calculations.	• Analysis is logically tied to information (because information is chosen to fit the desired conclusion); some related outcomes are not clear. • Report questions are answered correctly but may be lacking detail or contain minor logical error.	• Analysis is inconsistently tied to some of the information discussed; related outcomes (consequences and implications) are oversimplified. • Report questions are answered but contain wrong information or major logical error.	• Only the data was reported, there is no analysis. • Report questions are missing or are completely wrong.	
Overall writing quality	• Demonstrates thorough and sophisticated understanding. Conclusions drawn are appropriate for analyses; • Writing is strong and easy to understand; ideas are fully elaborated and connected; effective transitions between sentences; no typographic, spelling, or grammatical errors.	• Hypotheses are clearly stated, but some concluding statements not supported by data or data not well integrated. • Writing is clear and ideas are connected; effective transitions between sentences; minor typographic, spelling, or grammatical errors.	• Some hypotheses missing or misstated; conclusions not supported by data. • Writing lacks clarity, noticeable amount of typographic, spelling, or grammatical errors are present.	• Conclusions do not match hypotheses, not supported by data; no integration of data from different sources. • Very unclear language, many grammatical and spelling errors.	
Comments:				Total Marks (Out of 30):	

Part-1:

Introduction :

Analog-to-analog conversion or analog modulation is representatio of analog information by an analog signal. Analog modulation is needed if the medium is bandpass in nature or if only a bandpass channel is available to us.

Modulation of analog signal can be accomplished in 3 ways - AM, FM and PM. Here, we have to simulate and understand AM (Amplitude Modulation) and AM demodulation.

In AM transmission, the carrier 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.

Amplitude demodulation is the reverse process of modulation. It is used to recover the signal or to detect the message coded on the carrier signal. It filters out the carrier to determine the original signal amplitude.

Theory :

Suppose, Carrier signal $(S_c) = A_c \sin(2\pi f_c t)$

Message signal $(S_m) = A_m \sin(2\pi f_m t)$

Modulated signal $= (A_c + A_m \sin 2\pi f_m t) \sin 2\pi f_c t$

$= \left(1 + \frac{A_m}{A_c} \sin 2\pi f_m t\right) A_c \sin 2\pi f_c t$

$= (1 + m \sin 2\pi f_m t) A_c \sin 2\pi f_c t$

$m = \frac{A_m}{A_c} = \frac{\text{Message Signal Amplitude}}{\text{Carrier Signal Amplitude}}$

(modulation index)

Block Diagram

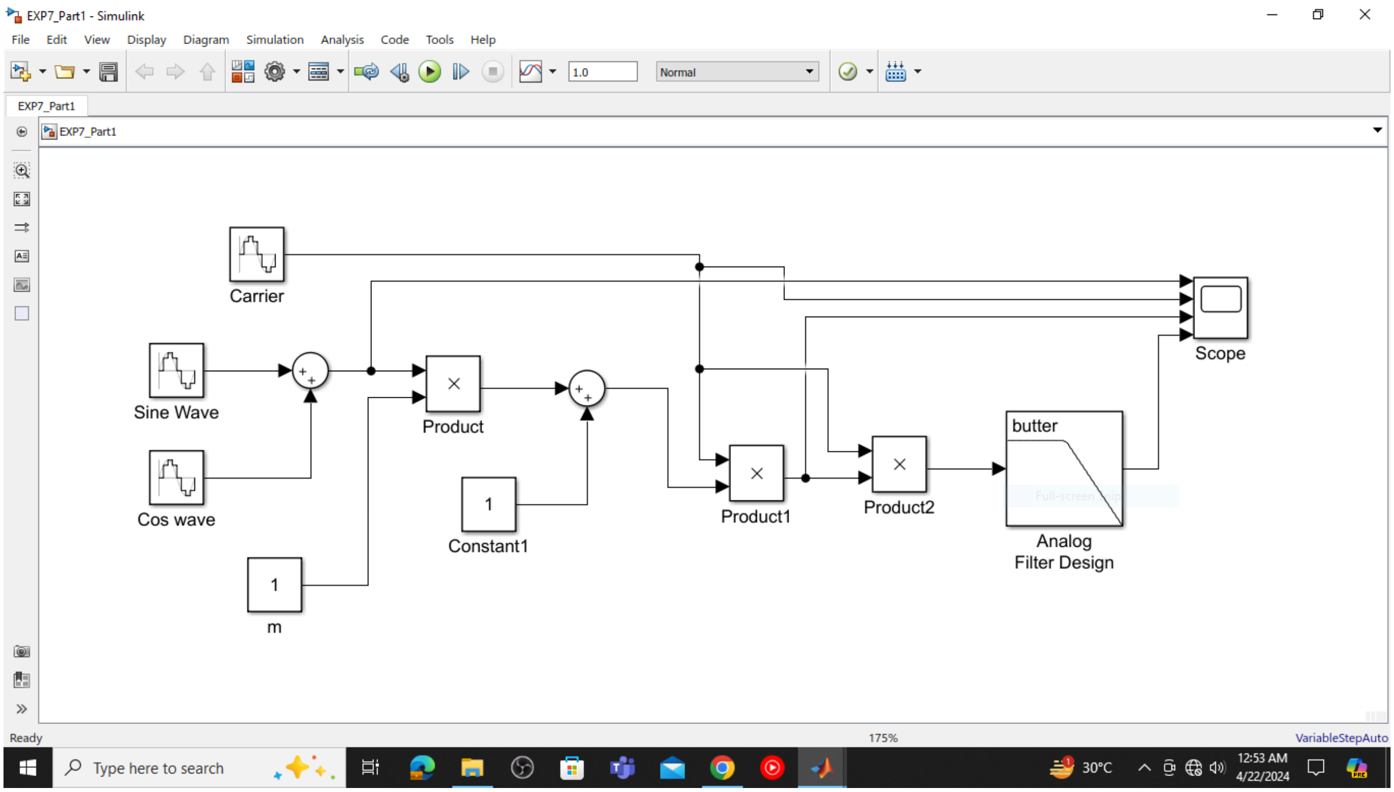


Figure: AM modulation and demodulation

Simulated Results:

Part 2 :

Introduction :

In Frequency modulated transmission, the frequency of the carrier signal is modulated to follow the changing voltage level ~~or~~ (amplitude) of the modulating signal. The peak amplitude and phase of the carrier signal remain constant, but as the amplitude of the information / message signal changes, the frequency of the carrier changes correspondingly.

Theory :

If message signal is $m(t)$, the frequency modulated signal is expressed as in time domain,

$$s(t) = A_c \cos\left[2\pi f_c t + k_f \int_{-\infty}^{t} m(\lambda)\, d\lambda\right]$$

For frequency demodulation, one widely employed technique is Phase Locked Loop (PLL). In this method, the PLL operates by using feedback to ensure a Voltage Controlled Oscillator (VCO) remains synchronized with the carrier wave of the incoming signal. Consequently, the message signal is retrieved as the control input of the VCO.

Block Diagram :

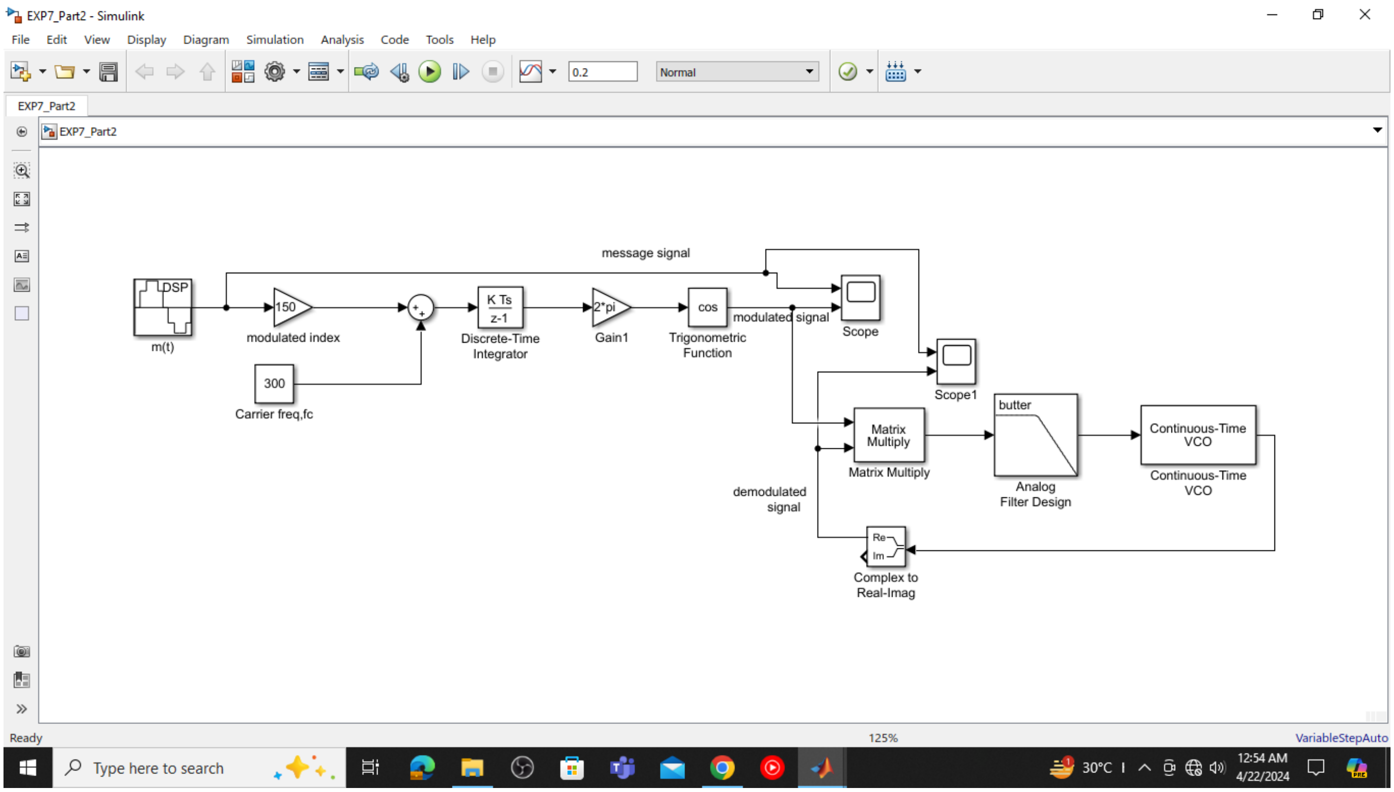
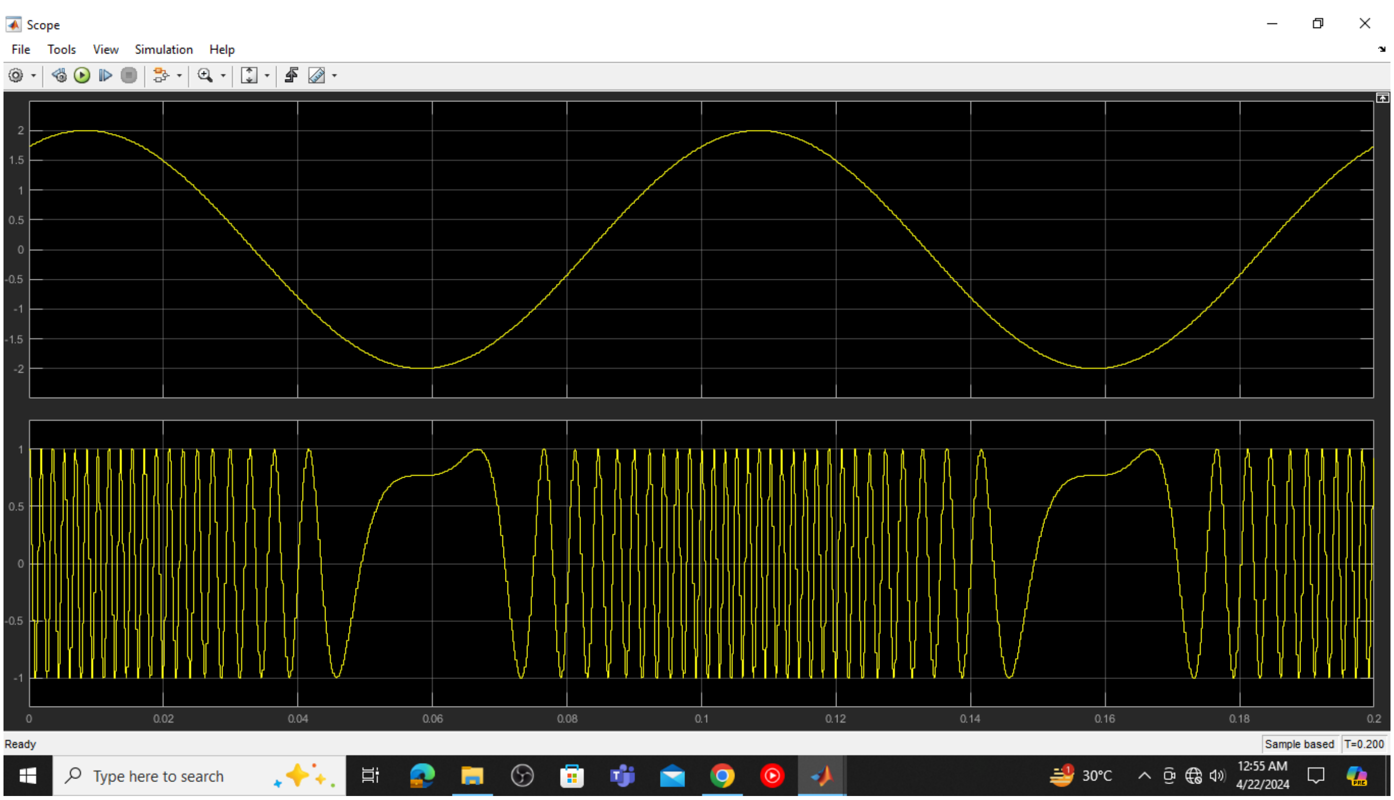
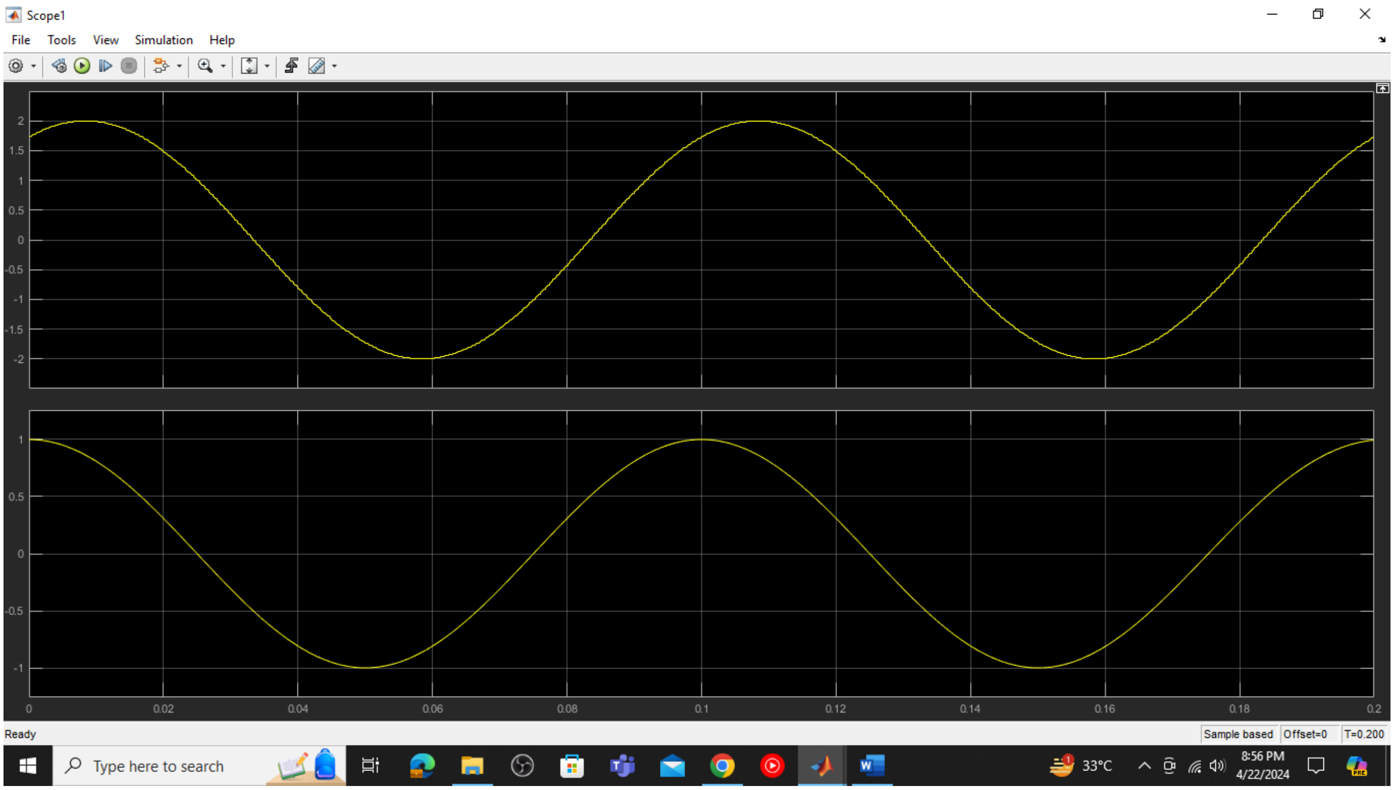


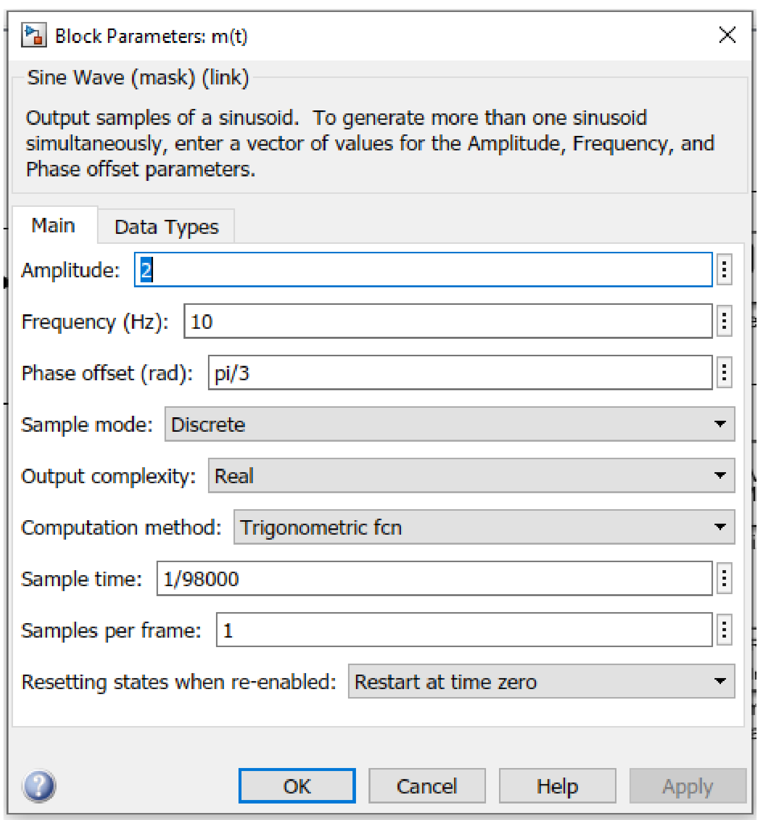
Figure: FM modulation and demodulation

Simulated Results:

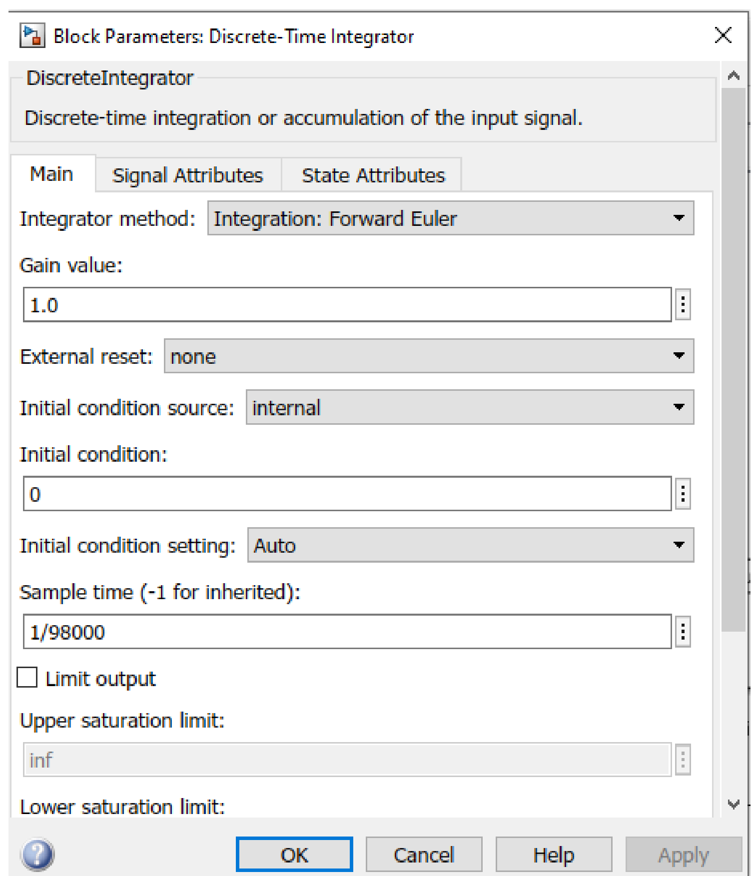




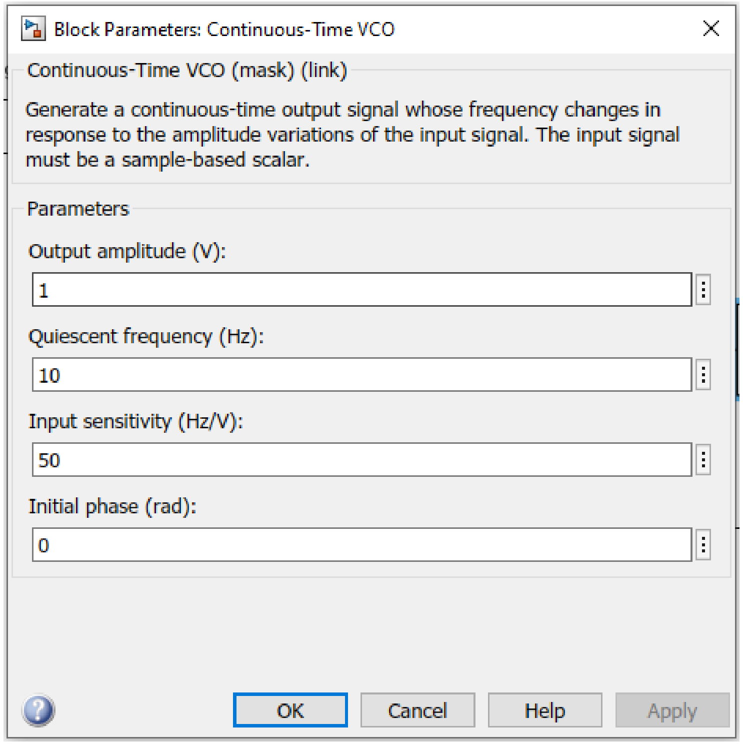
Scope1
File Tools View Simulation Help
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
1
0.5
0
-0.5
-1
0 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18 0.2
Ready
Sample based Offset=0 T=0.200
Type here to search
33°C
8:56 PM
4/22/2024

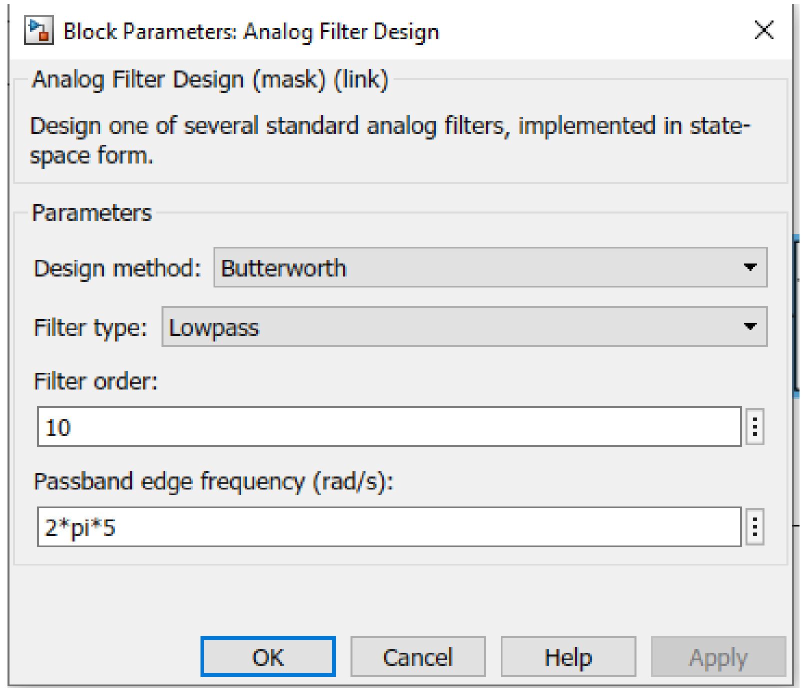


Block Parameters: m(t)
Sine Wave (mask) (link)
Output samples of a sinusoid. To generate more than one sinusoid simultaneously, enter a vector of values for the Amplitude, Frequency, and Phase offset parameters.
Main
Data Types
Amplitude: 2
Frequency (Hz): 10
Phase offset (rad): pi/3
Sample mode: Discrete
Output complexity: Real
Computation method: Trigonometric fcn
Sample time: 1/98000
Samples per frame: 1
Resetting states when re-enabled: Restart at time zero
OK
Cancel
Help
Apply



Block Parameters: Discrete-Time Integrator
DiscreteIntegrator
Discrete-time integration or accumulation of the input signal.
Main
Signal Attributes
State Attributes
Integrator method: Integration: Forward Euler
Gain value:
1.0
External reset: none
Initial condition source: internal
Initial condition:
0
Initial condition setting: Auto
Sample time (-1 for inherited):
1/98000
Limit output
Upper saturation limit:
inf
Lower saturation limit:
OK
Cancel
Help
Apply





Conclusion :

In summary, the experiment successfully met its goals by enhancing our understanding of modulation and demodulation using Simulink. Both ~~theoriee~~ theoretical discussions and practical simulations provided valuable insights into the principles behind ~~FO~~ modulation and demodulation.

The knowledge and skills gained from the experiment can be applied to various communication engineering tasks, including the design and analysis of AM or FM-based communication systems. Mastery of the AM and FM modulation and demodulation techniques will help us to address challenges in signal processing and communication system design, contributing to advancements in ~~telecommunical~~ tele-communications and related fields.