AMERICAN INTERNATIONAL UNIVERSITY–BANGLADESH (AIUB)

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING

DATA COMMUNICATION LABORATORY

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Section: I

Group: 4

EXPERIMENT NO: 7 (Part 2)

Study of Frequency Modulation and Demodulation using Simulink (MATLAB)

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Abstract:

This experiment aims to enhance comprehension of communication engineering problem-solving through the utilization of Simulink. The focus lies on two primary objectives: firstly, gaining insight into the application of Simulink for addressing communication engineering issues, and secondly, fostering a deep understanding of Frequency Modulation and Demodulation processes through Simulink simulations. The study involves practical exploration and application of Simulink tools to navigate and solve challenges within the realm of communication engineering, with a specific emphasis on the intricacies of Frequency Modulation and Demodulation techniques.

Theoretical Background:

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

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

Frequency Demodulation

Phase Locked Loop (PLL) Demodulation: The PLL demodulates the FM signal using feedback force a Voltage-Controlled-Oscillator (VCO) to remain in phase with the carrier of the incoming signal. The message is recovered as the control input of the VCO [2]. In the simulation experiment we used the VCO to demodulate the information signal. [1] [3]

Building Simulink Model of Frequency Modulation and Demodulation:

The frequency modulator and demodulator structures are as explained below. In the first model, you are provided a FM structure that is very similar to the theoretical background of this experiment. In the second model, you will observe the PLL frequency demodulator blocks provided by Simulink. [3]

Frequency Modulation:

The Simulink model for FM modulator is:

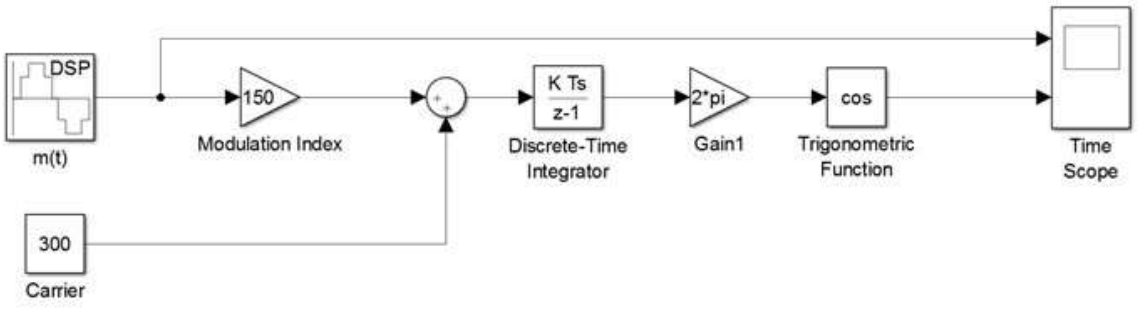

Figure 1: Block Diagrams for the FM Modulator [3]

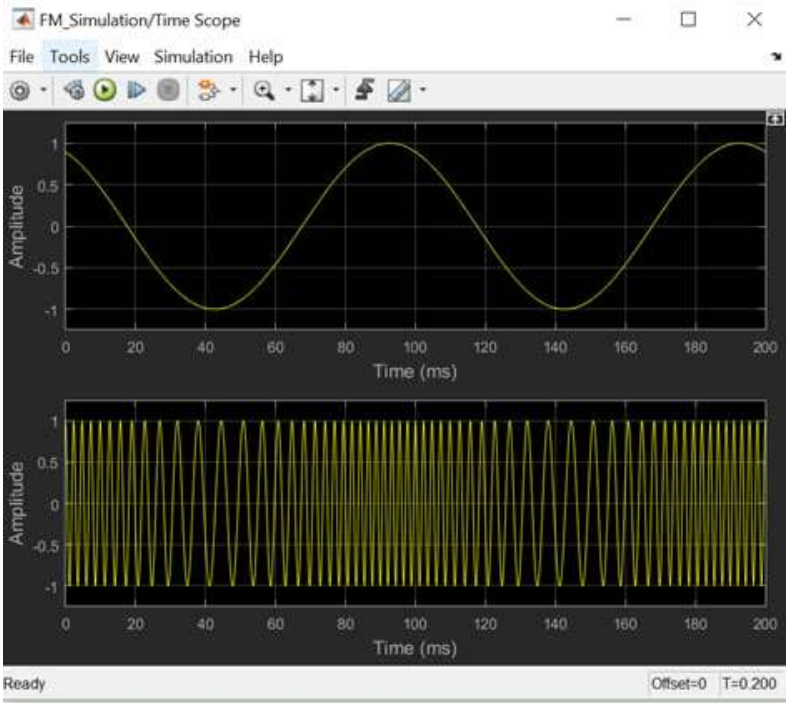

Figure 2: Time Scope [3]

Frequency Modulator and Demodulator:

The Simulink model of the complete FM modulator and demodulator is shown next:

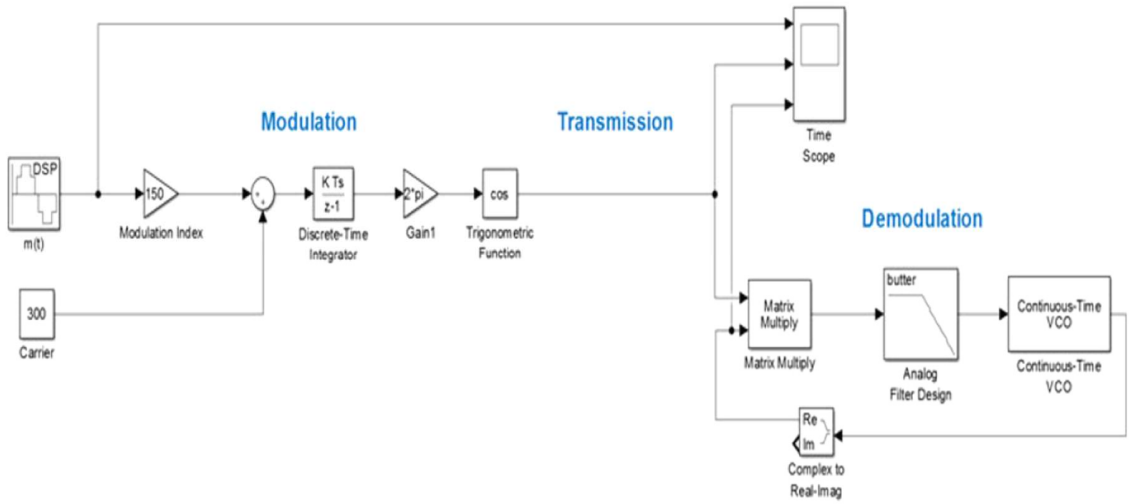

Figure 3: FM Modulator and Demodulator [3]

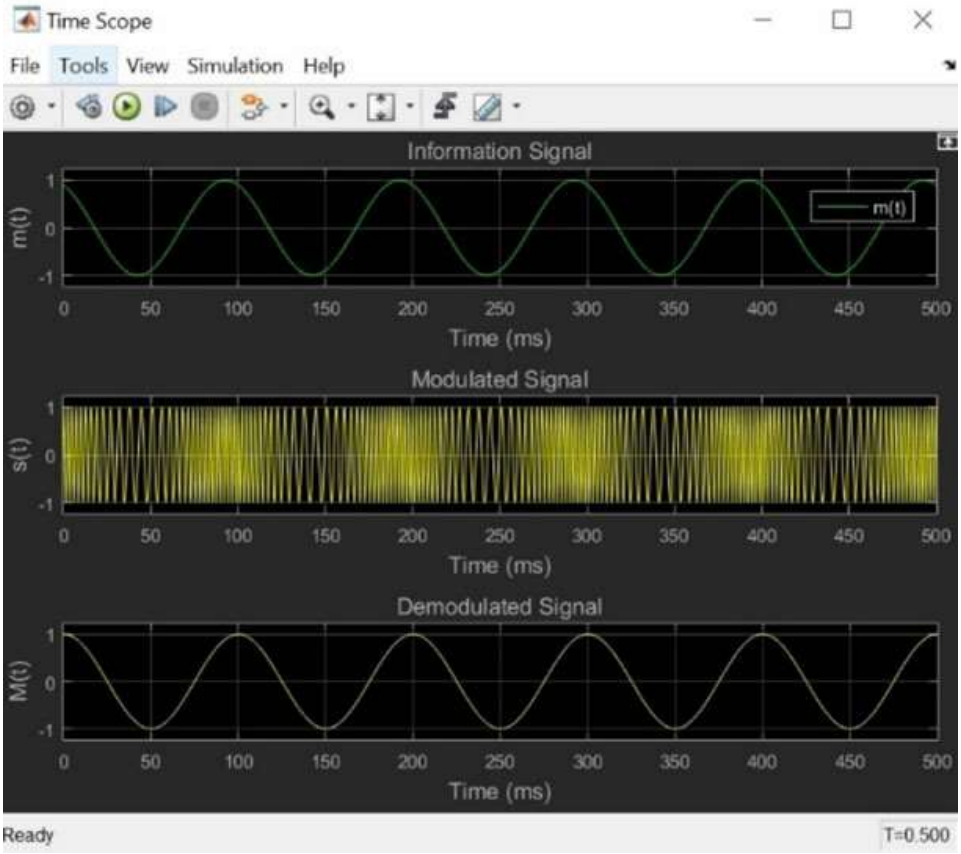

Figure 4: Time Scope for Model-1 [3]

Performance Task:

Question:

Message signal, $m(t) = a*\sin(2\pi f_m t + \pi/3)$, $a = 2$, $f_m = 10$. Use FM modulation and demodulation on the given signal and use two scopes to show your output.

First scope should show message signal and modulated signal. Second scope should show message signal and demodulated signal.

Lab Report must contain (a) A block diagram of FM modulator, (b) A block diagram of FM demodulator, (c) A block diagram of FM modulator and demodulator in a single window, (d) Two scope figures.

Answer:

a)

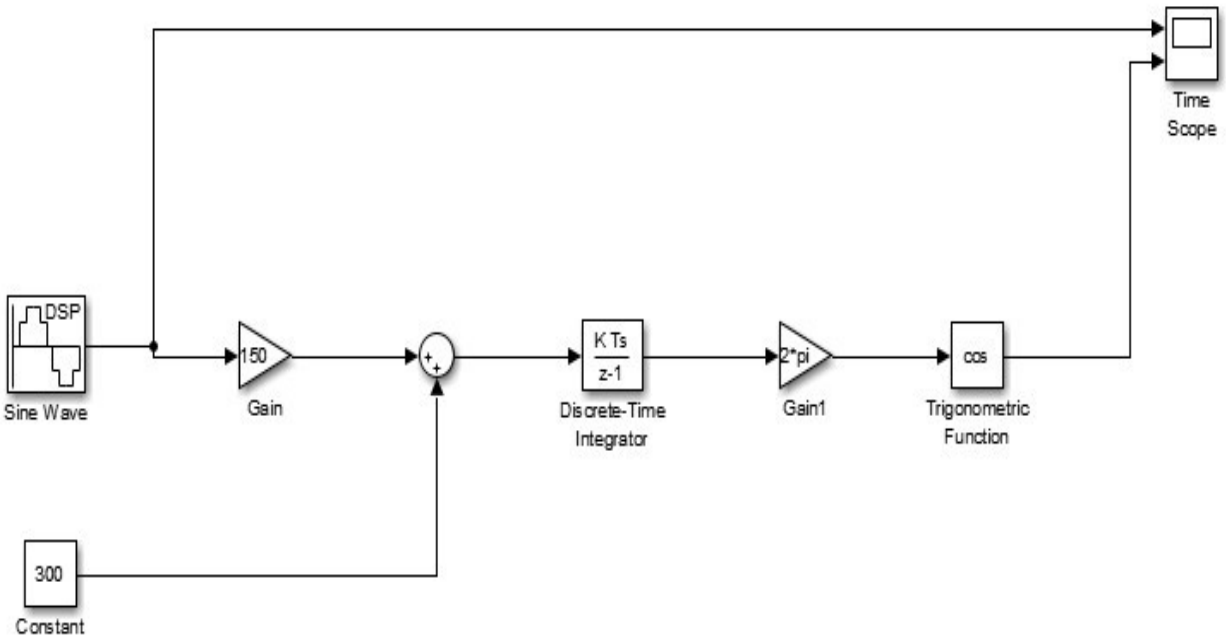

Figure 5: FM Modulation

b)

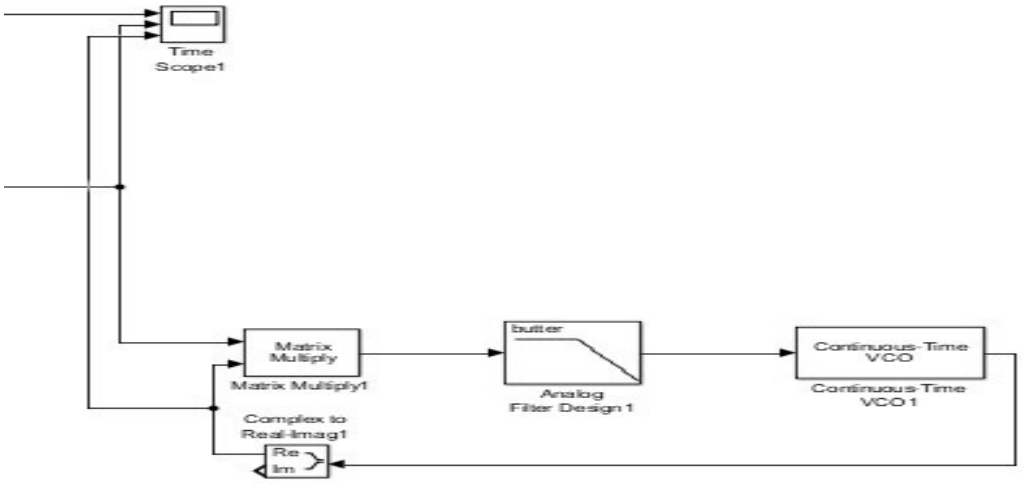

Figure 6: FM Demodulation

c)

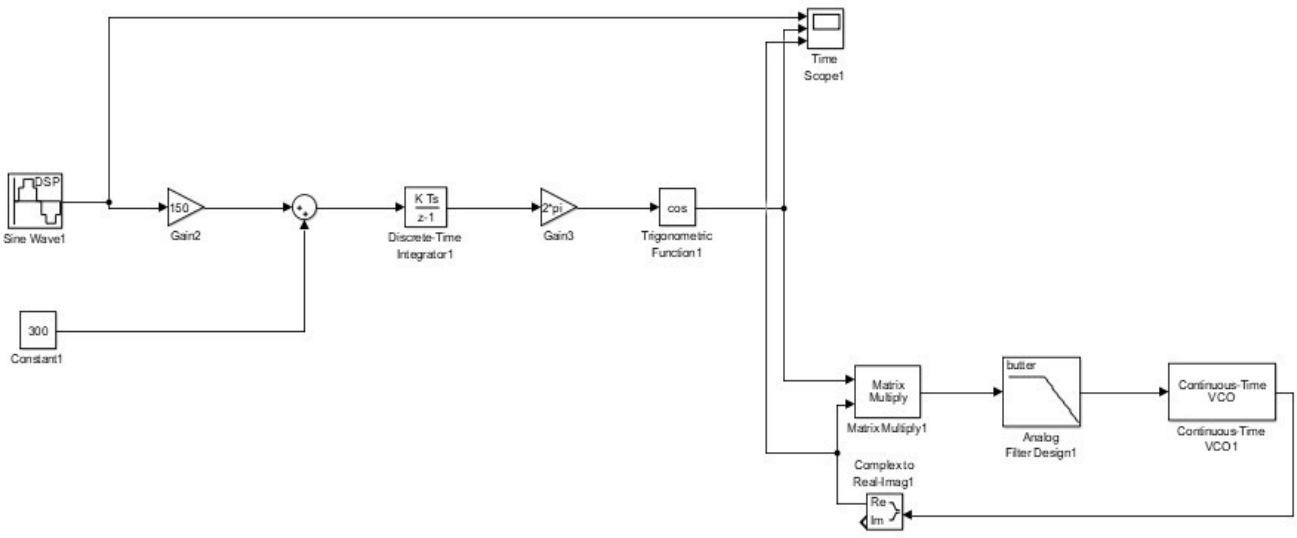

Figure 7: FM Modulation and Demodulation

d)

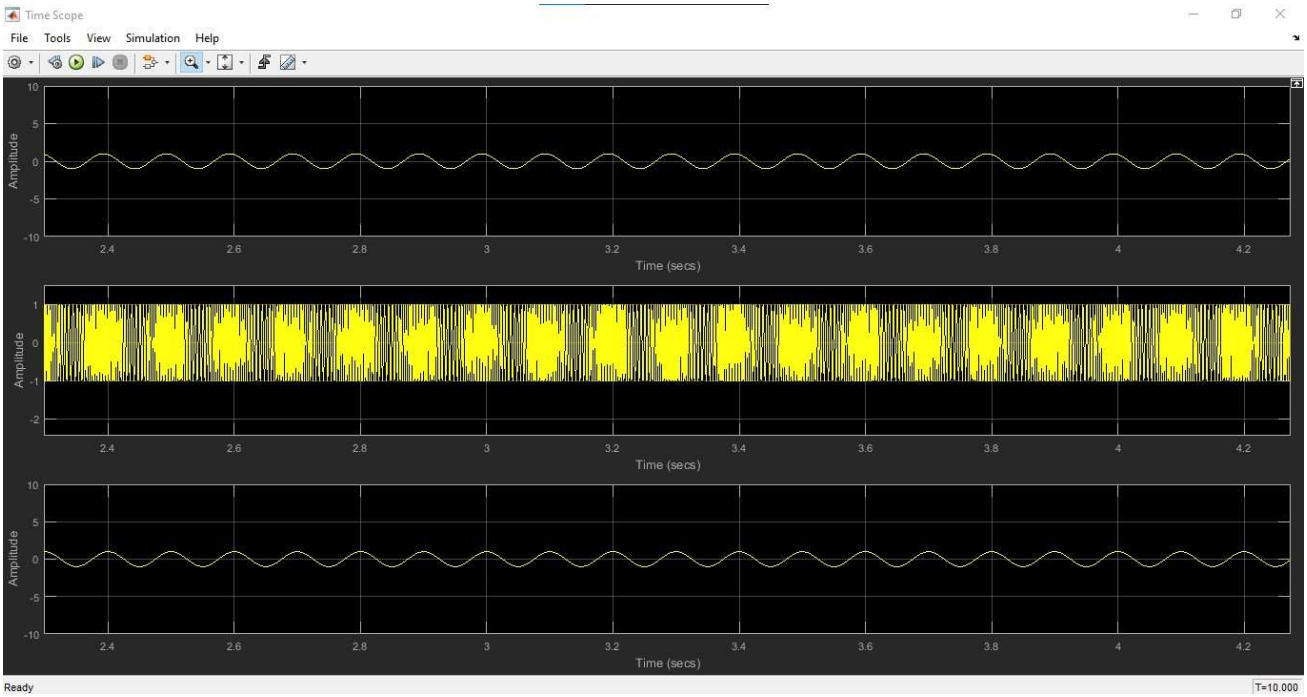

Figure 8: Two scope image of Modulation and Demodulation

Discussion & Conclusion:

In this study, the utilization of MATLAB-based Simulink for Frequency Modulation (FM) and Demodulation processes was explored. The simulation involved the generation of a sine wave as a message signal, followed by modulation and subsequent demodulation stages. Key components such as gain, integrator, trigonometric functions, sine wave generators, analog filter design, and continuous-time voltage-controlled oscillators (VCOs) were employed in the simulation. The inclusion of a time scope function facilitated the visualization of the output throughout the process. By systematically inputting values into the designated fields, the expected results were obtained. This experiment underscores the efficacy of Simulink in modeling and analyzing Frequency Modulation and Demodulation in a controlled MATLAB environment, offering valuable insights for communication engineering applications.

References:

[1] W. Stallings, Data and computer communications. 2000., Accessed: Nov.24, 2023. [Online]. Available:https://www.portcity.edu.bd/files/636444710465881602_Dataandcomputercommunications.pdf [Online Copy]

[2] B. A. Forouzan, C. A. Coombs, and S. C. Fegan, Introduction to data communications and networking. McGraw-Hill Science, Engineering & Mathematics, 1998., Accessed: Nov.24, 2023. [Online]. Available: https://archive.mu.ac.in/myweb_test/syllFybscit/dcn.pdf [Online Copy]

[3] Lab Manual Accessed: Nov.24, 2023.