MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

BACHELOR OF TECHNOLOGY IN ELECTRICAL AND ELECTRONICS ENGINEERING

LAB REPORT

EET 3351: COMMUNICATION SYSTEMS

GROUP MEMBERS:

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OBJECTIVES

1. To understand the theoretical foundations of Analog Communications as well as of Double-Side-Band Amplitude Modulation and Demodulation (DSB-AM).
2. To design the Simulink model of the DSB-AM to analyze each signal in time and frequency domains using time scope and spectrum analyzer.
3. To examine the effects of the Additive Gaussian Channel (AWGN) in the Simulink Model of DSB-AM.

BACKGROUND THEORY

Amplitude Modulation (AM) is a method of transmitting signals, such as audio or other data, using variations in the amplitude of a carrier wave. In Double Sideband Amplitude Modulation (DSB-AM), the carrier signal is modulated with the message signal in a way that produces both upper and lower sidebands, carrying the same information. This form of modulation is widely used due to its simplicity in implementation and compatibility with existing radio frequency systems.

The demodulation process aims to recover the original message signal from the modulated carrier. This is typically done using synchronous detection techniques, where a locally generated carrier signal is used to extract the original message signal. The process involves multiplying the received signal with the local oscillator followed by low-pass filtering to isolate the baseband signal. Understanding and simulating this process helps in evaluating signal recovery and system performance under various parameters, including noise and filtering effects.

EQUIPMENT /SOFTWARES USED

I. Computer
II. Matlab_Simulink

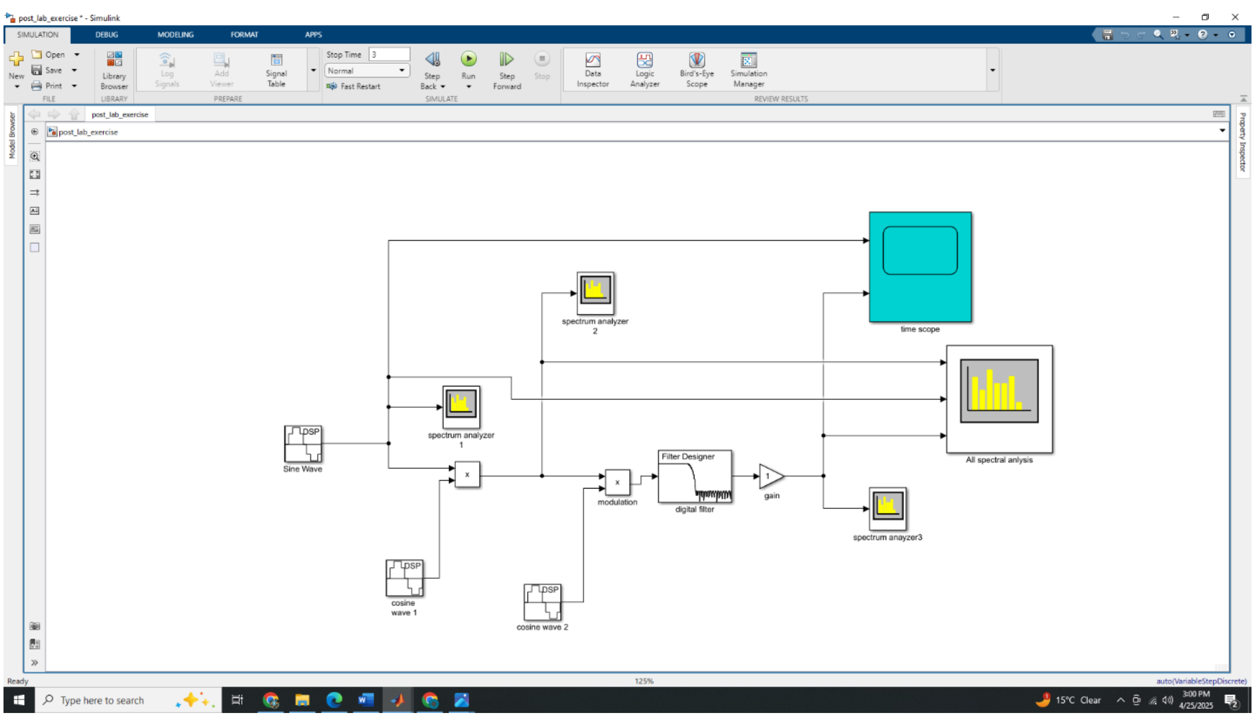
PROCEDURE

The circuits were built in Simulink as per instructed by the task's guidelines.

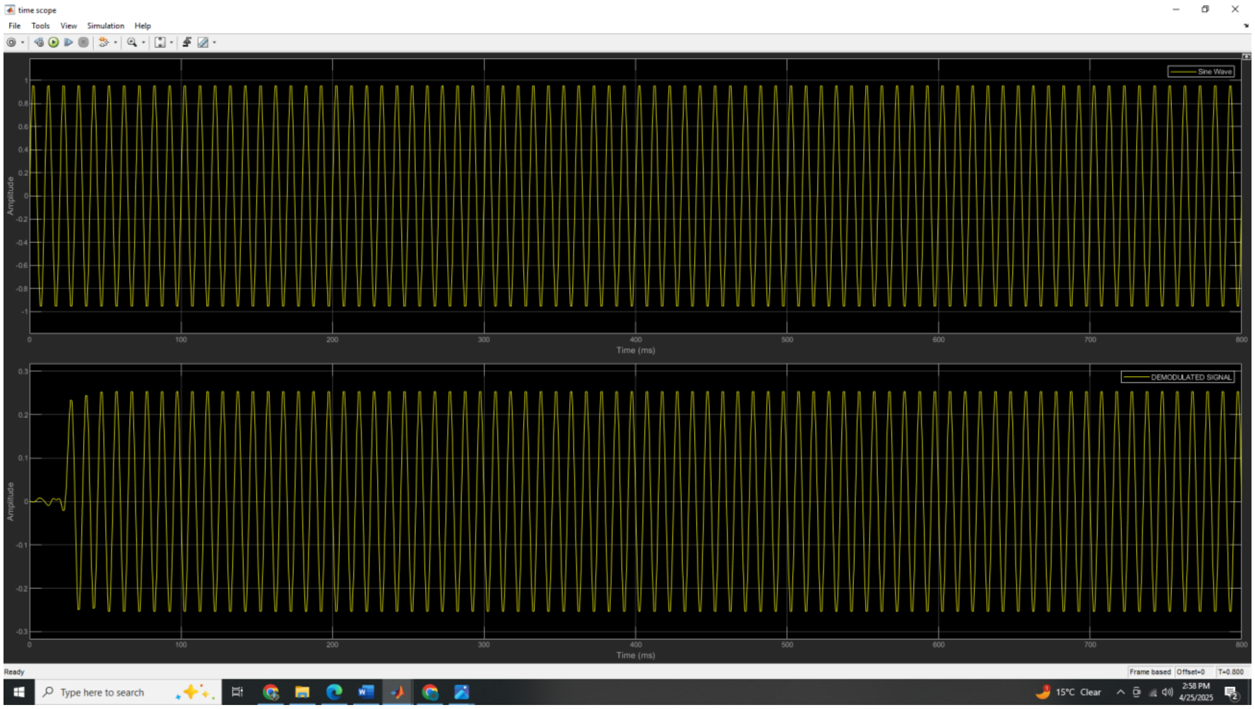
RESULTS

The screeshots below shows the results from the Simulink simulations of both tasks.

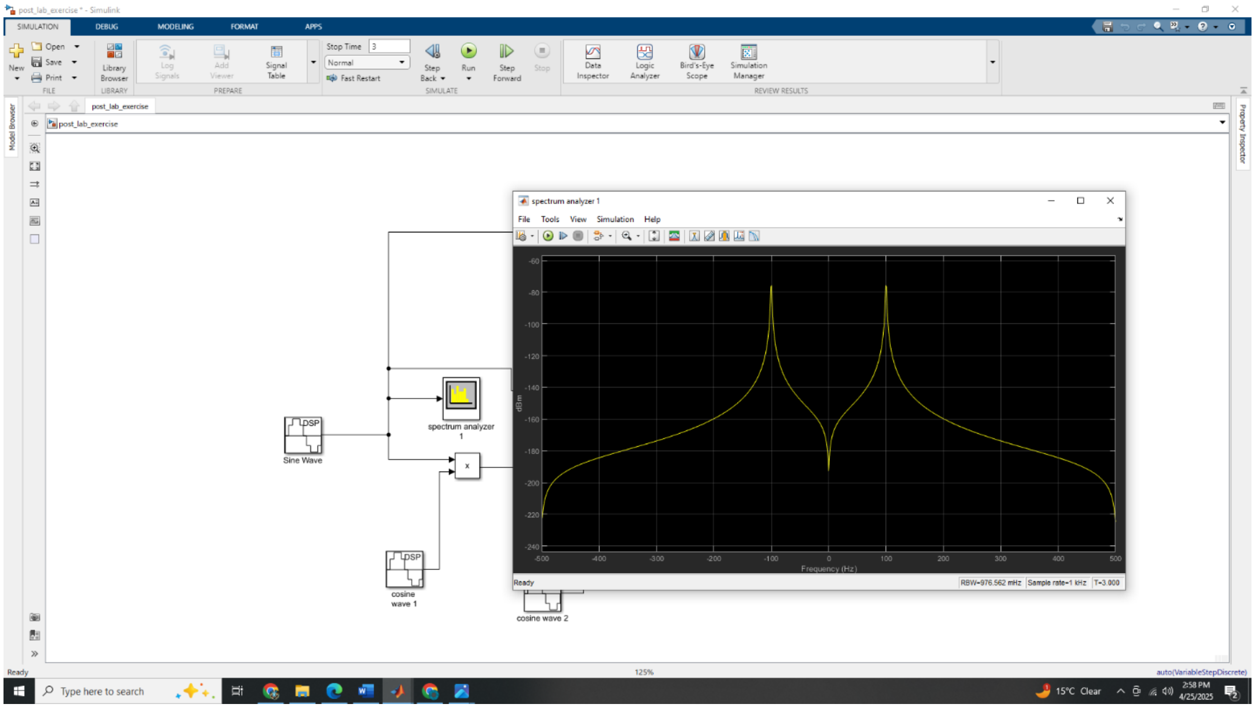
The circuit of the first task in the Simulink is as shown below.



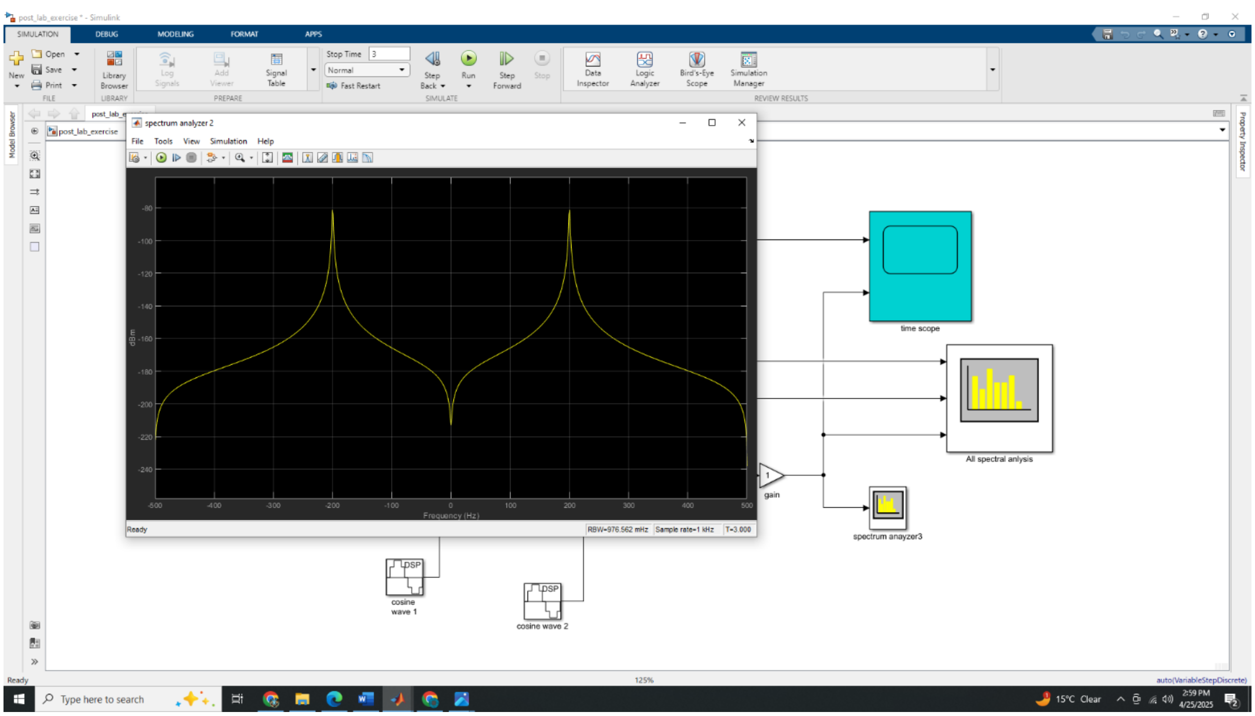
The screenshot below shows the message and demodulated signal (labelled)



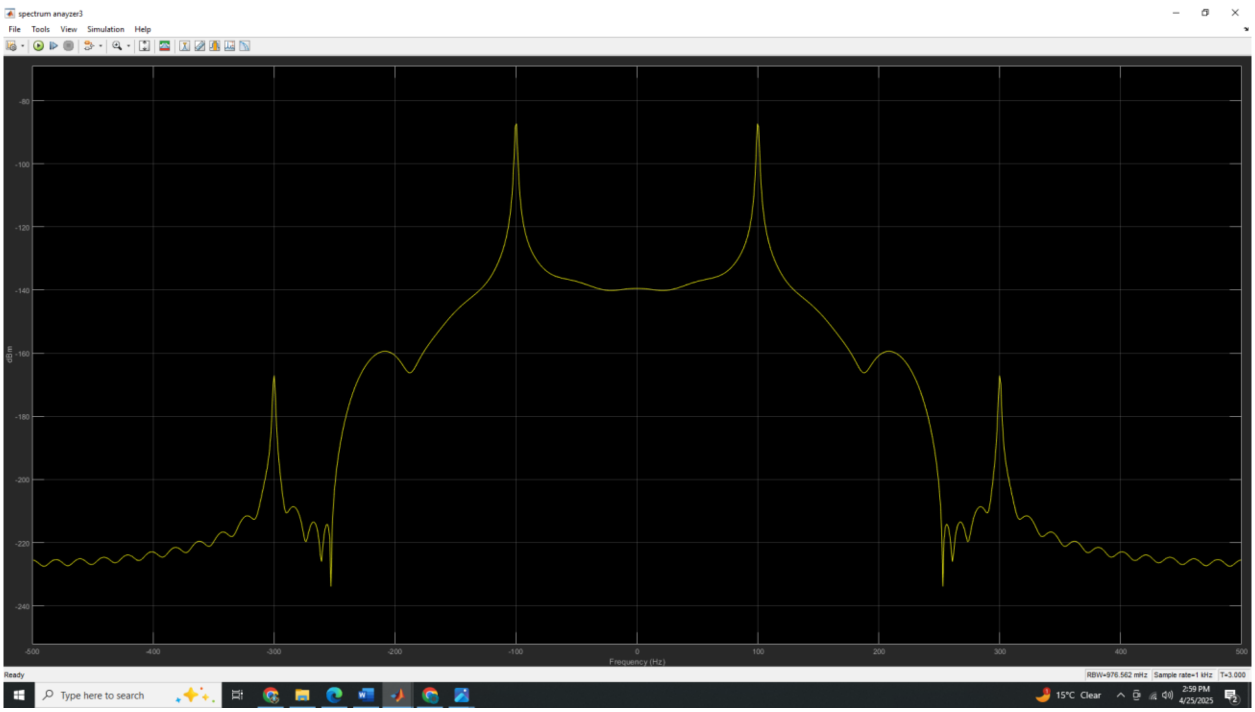
The screenshot below shows the spectral (frequency domain) of the message signal.



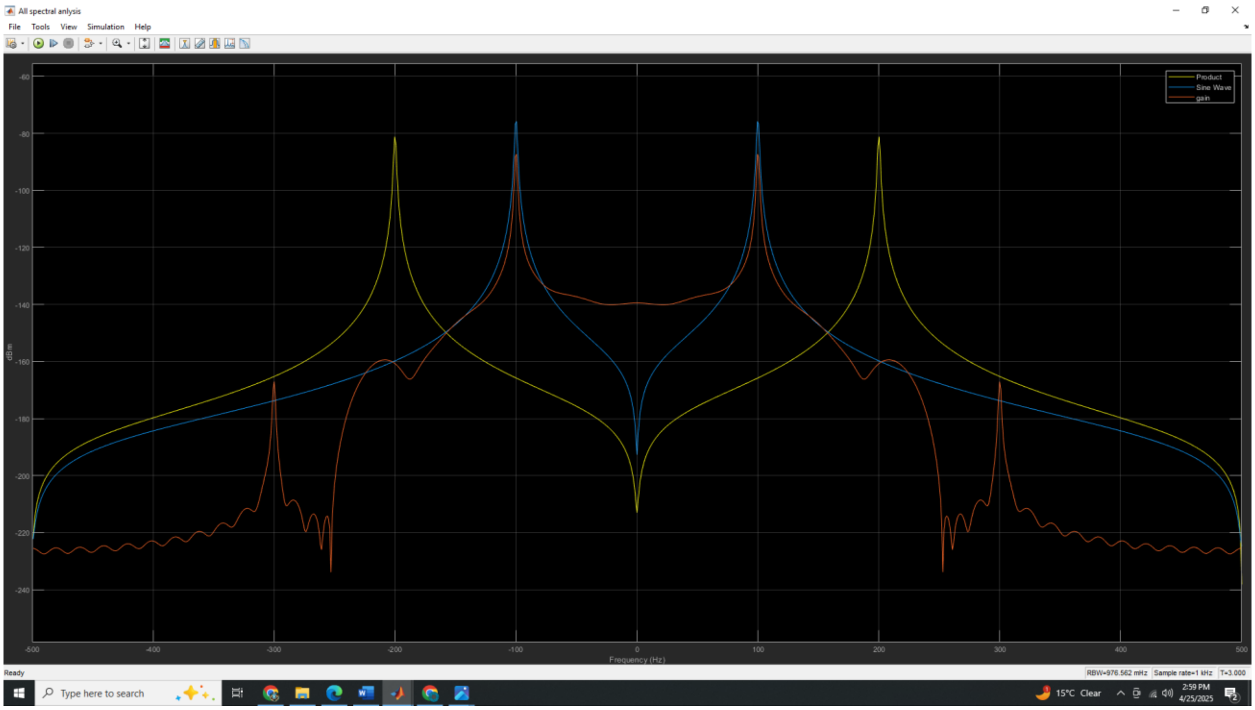
The screenshot below shows the spectral (frequency domain) of the carrier signal.



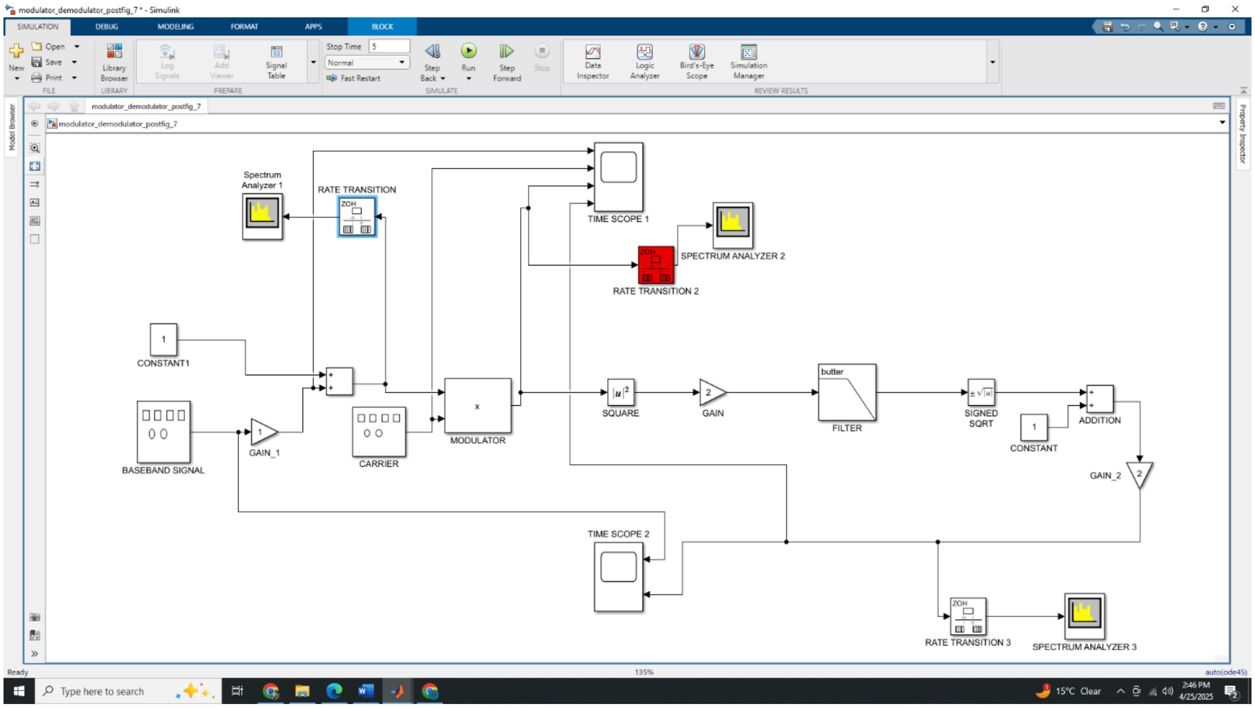
The screenshot below shows the spectral (frequency domain) of the demodulated signal signal.



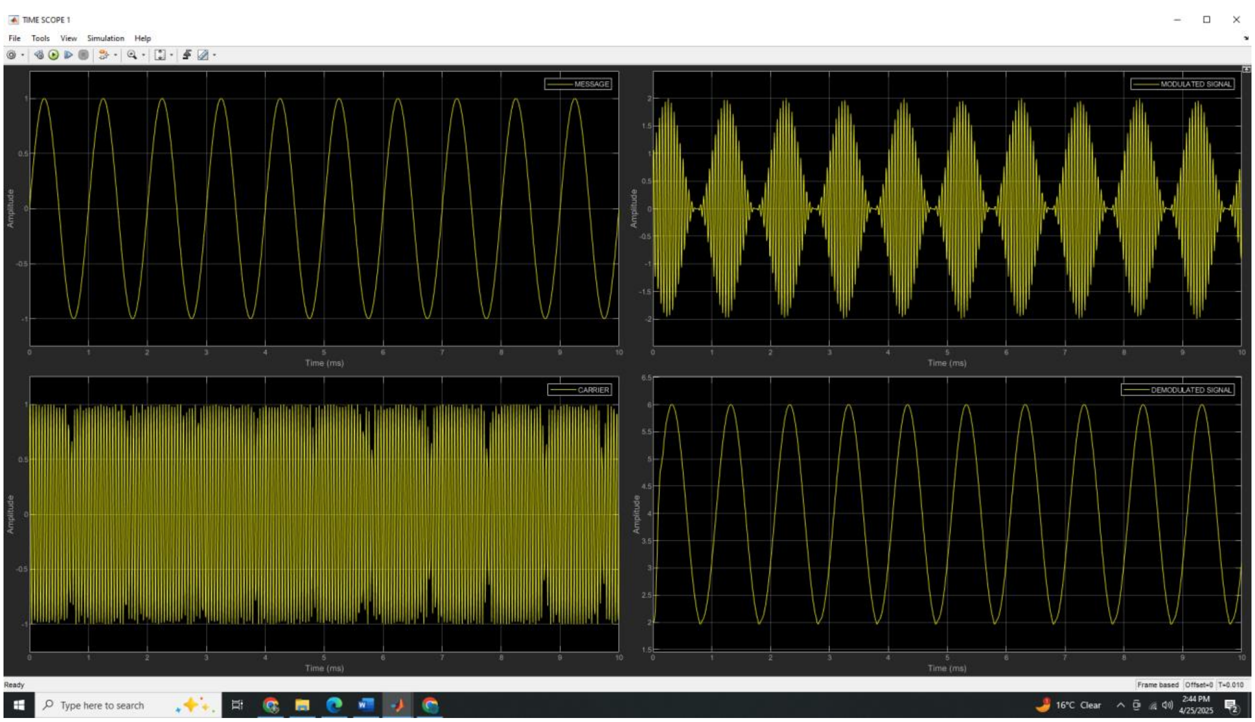
All frequency spectra shown on the same analyzer.



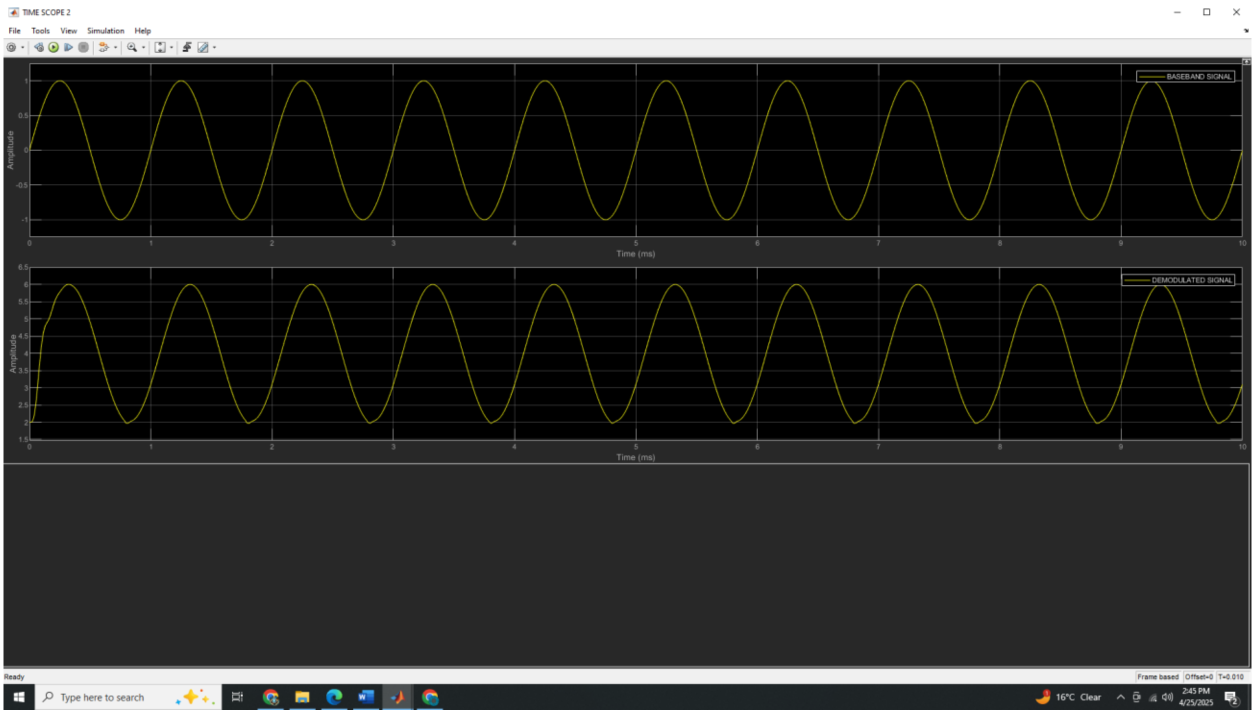
The circuit for the second task in Simulink is as shown below



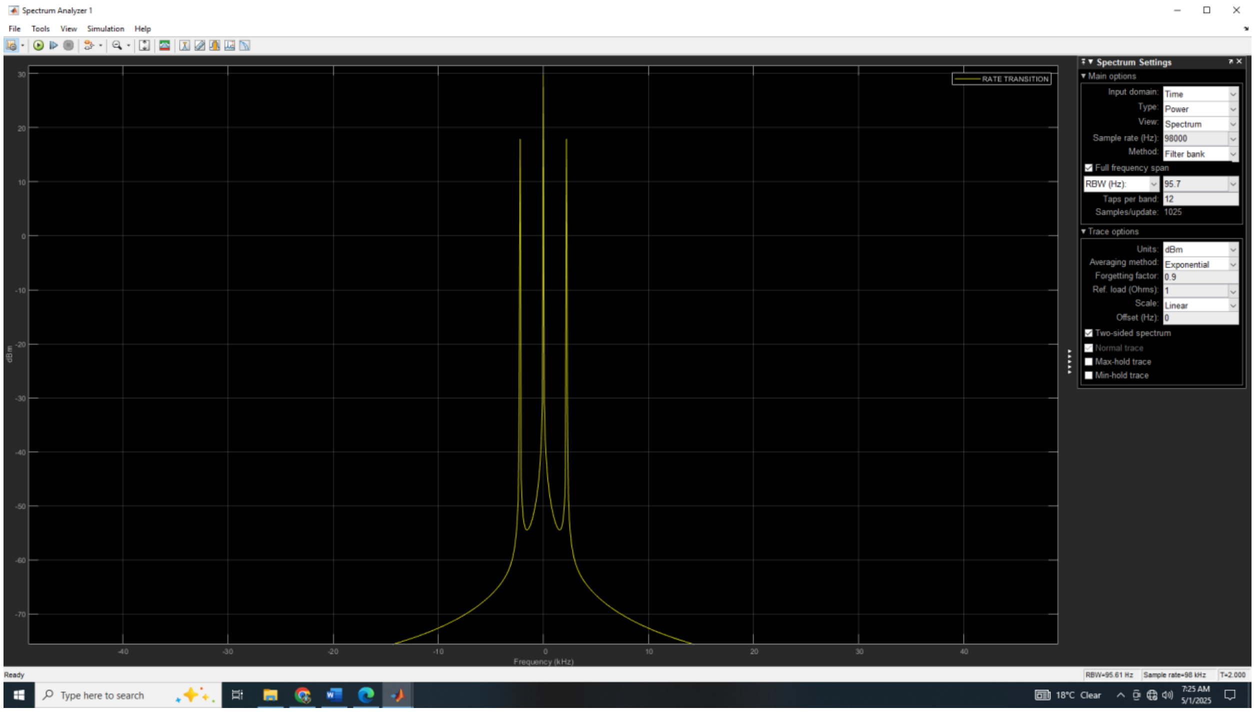
The screenshot below shows the message signal, carrier signal, modulated and demodulated signal (labelled)



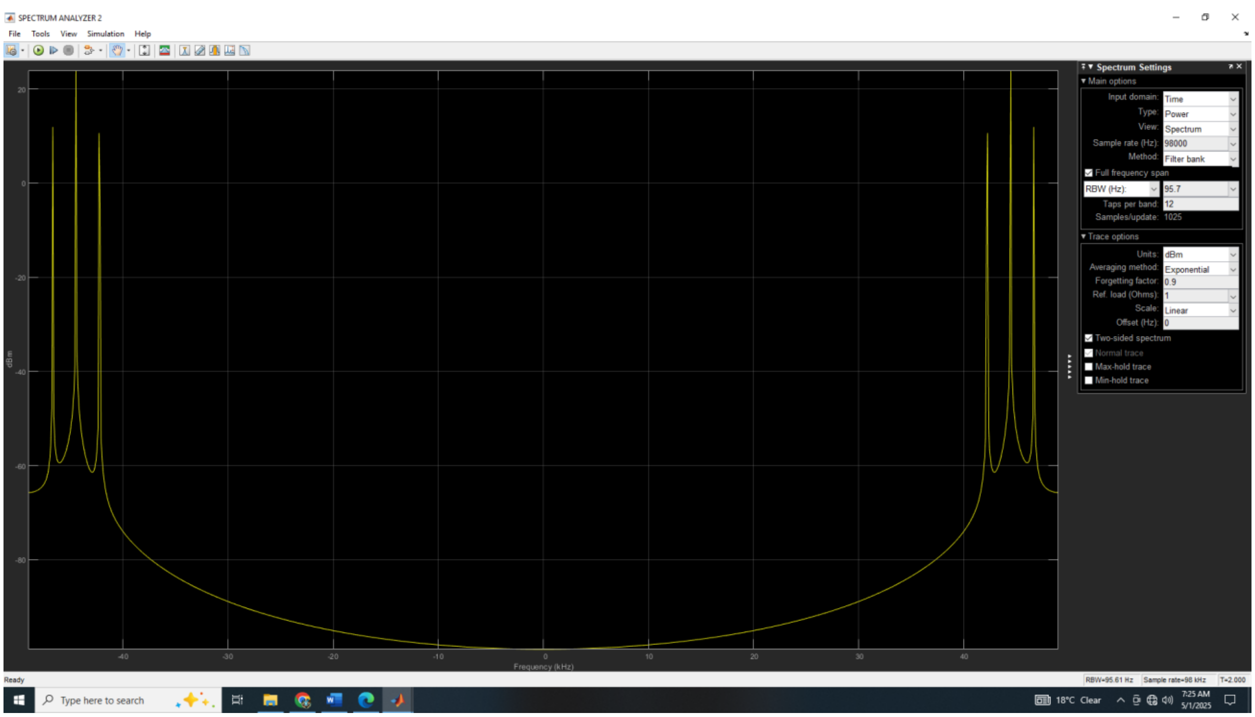
The screenshot below shows the message and demodulated signal (labelled)



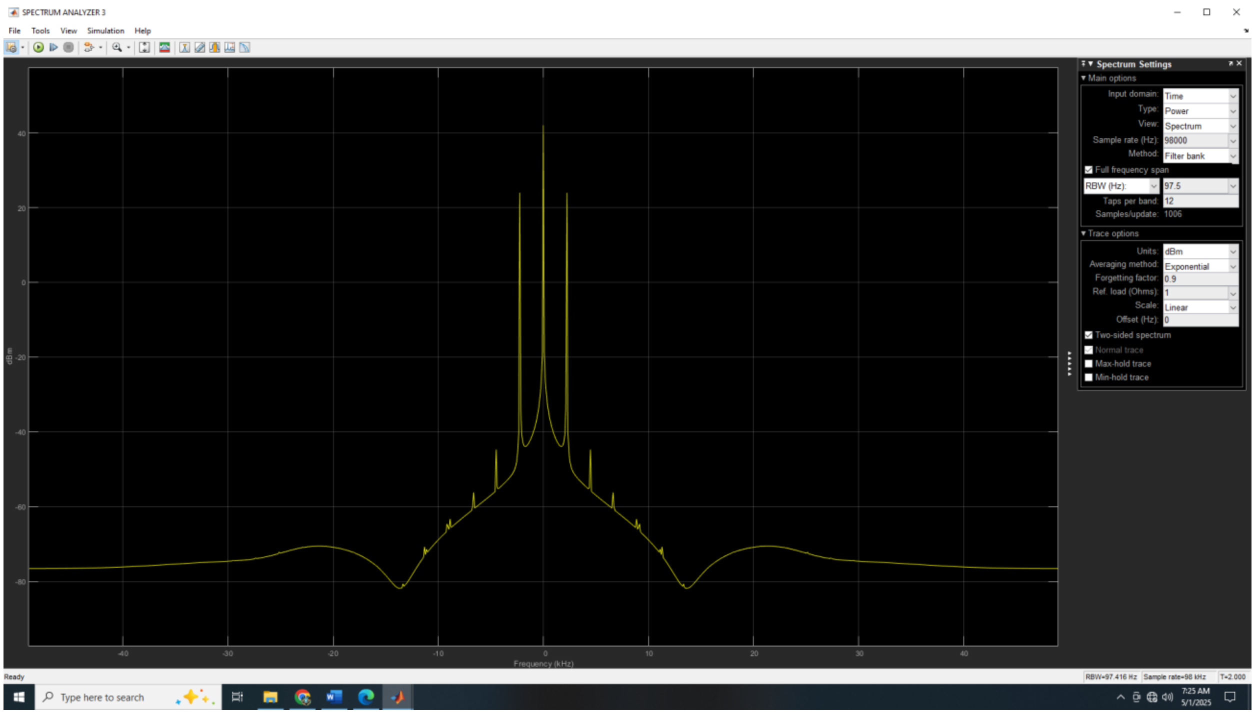
Spectrum for message signal.



Spectrum for modulated signal



Spectrum for the demodulated signal.



The explanation below is for the function of each block put in simple terms

Explanation of what each group Block Does:

Modulation Path

1. Message Signal Block.

- generates the message signal (m(t)), the information you want to transmit.

2. Carrier Signal Block (sine/cosine wave)

- produces a high-frequency sinusoid that will carry the message signal

3. Add block

Prepares the signal for modulation. In some cases, adds a DC offset to the message signal if needed.

4. Product (Modulation) Block.

Multiplies the message and carrier signals together. This generates the modulated DSB-AM signal.

5. Spectrum Analyzer - shows the frequency-domain (spectrum) of the modulated signal. Helps verification of modulation is happening correctly.

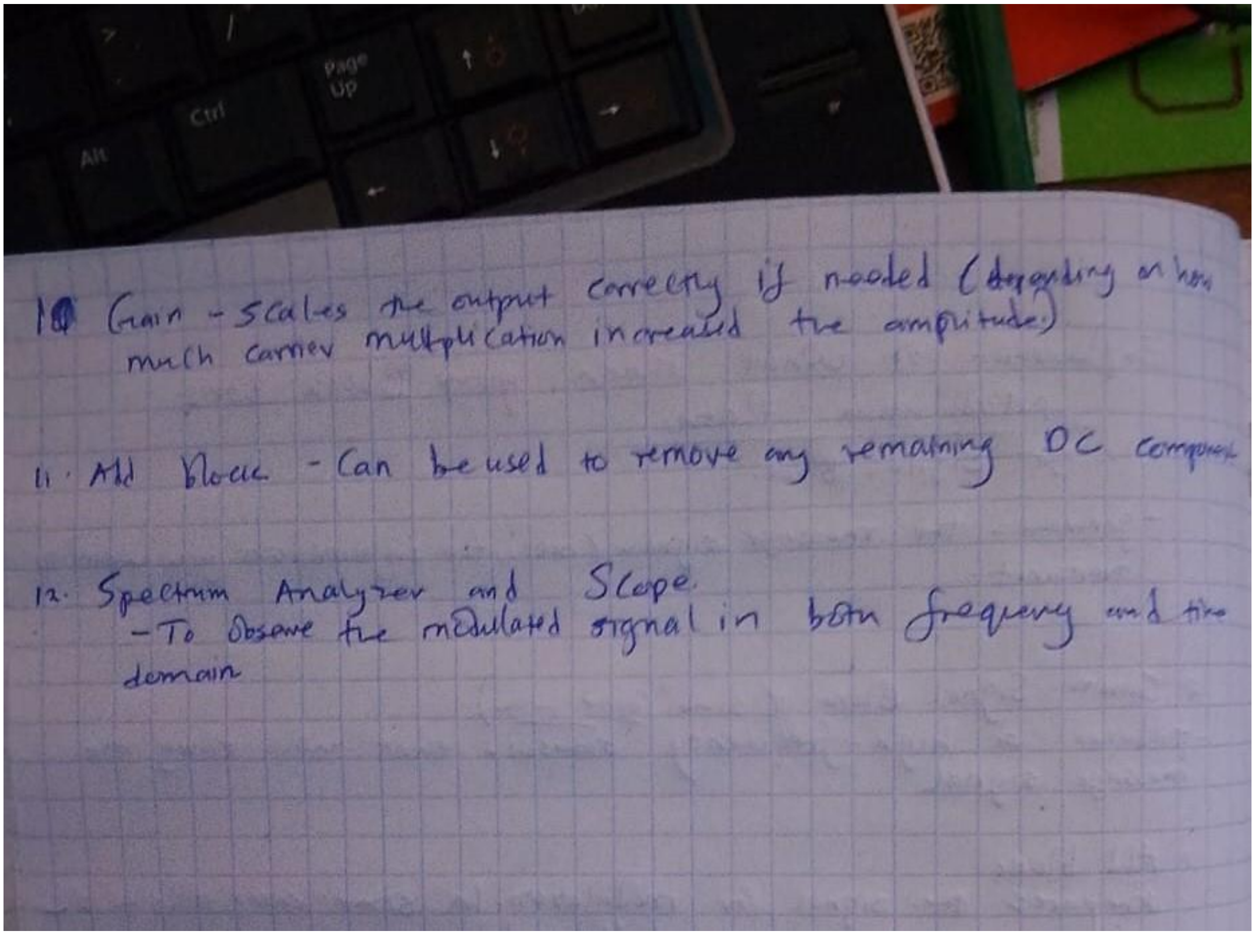
6. Time scope - shows the time-domain waveform of the signals.

Demodulation path

8. Product Block

- Multiplies the received modulated signal with the same carrier. This is called coherent (synchronous) detection.

9. Butterworth Filter - removes the high frequency components from the product. Passes only the original message signal. Act as a low pass filter



10. Gain - Scales the output correctly if needed (depending on how much carrier multiplication increased the amplitude)

11. Add block - Can be used to remove any remaining DC component

12. Spectrum Analyzer and Scope.
 - To observe the modulated signal in both frequency and time domain

OBSERVATIONS

- ✓ The message signal was successfully modulated using a high-frequency carrier by simple multiplication, producing a double-sideband AM waveform.
- ✓ In the frequency domain, the modulated signal showed symmetrical upper and lower sidebands around the carrier frequency, confirming proper DSB-AM behavior.
- ✓ During demodulation using synchronous detection, the original message signal was accurately recovered when a low-pass filter was applied after multiplication with a synchronized carrier.
- ✓ The presence of an Additive White Gaussian Noise (AWGN) channel introduced noise components across the spectrum,

affecting the clarity of the demodulated signal but not fully distorting it.

- ✓ The quality of signal reconstruction was highly dependent on the filter design; sharper and properly tuned filters gave better baseband recovery

DISCUSSION

From the simulations, it was observed that amplitude modulation (AM) effectively transfers the message signal by varying the amplitude of the high-frequency carrier signal. The time-domain plots clearly showed the message signal embedded within the envelope of the modulated wave. The frequency domain analysis verified the presence of both upper and lower sidebands, confirming the double sideband nature of the modulation.
During demodulation, synchronous detection was used to retrieve the original message signal. Multiplying the modulated signal with a synchronized carrier followed by low-pass filtering successfully reconstructed the baseband signal. The quality of the recovered signal depended on the accuracy of carrier synchronization and the performance of the low-pass filter.

CONCLUSIONS

The experiment successfully demonstrated the principles of Double Sideband Amplitude Modulation (DSB-AM) and demodulation using MATLAB Simulink. The time and frequency domain analyses verified the theoretical concepts, and the simulations provided clear visualizations of signal behavior throughout the modulation and demodulation processes. The addition of AWGN showed the impact of noise on communication systems and the role of filters in signal recovery. Overall, the lab enhanced understanding of analog modulation techniques and practical communication system design.

REFERENCES

1. B.P. Lathi, *Modern Digital and Analog Communication Systems*, Oxford University Press, 2010.
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5. Meru University Lab Manual – EET 3351: Communication Systems.