National University of Sciences and Technology (NUST)
School of Electrical Engineering and Computer Science

Department of Electrical Engineering and Computer Science

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Semester: 5th

Section: BEE 12C

EE-232: Signals and Systems

Lab 12: Implementation and Analysis of Amplitude Modulation Transmitter and Receiver System

Group Members

		PLO4 – CLO3	PLO5 - CLO3	PLO8 - CLO4	PLO9 - CLO4
Name	Reg. No	**Viva / Quiz / Lab Performance**	**Analysis of data in Lab Report**	**Modern Tool Usage**	**Ethics and Safety**
		5 Marks	**5 Marks**	**5 Marks**	**5 Marks**
Danial Ahmad	331388				
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1 Table of Contents

2 Amplitude Modulation Transmitter and Receiver System

2.1 Objectives

- Understand the operations carried out in the amplitude modulation and understand their applications
- Apply the concepts on real world signals and systems

2.2 Equipment

Software

- *MATLAB*

2.3 Lab Instructions

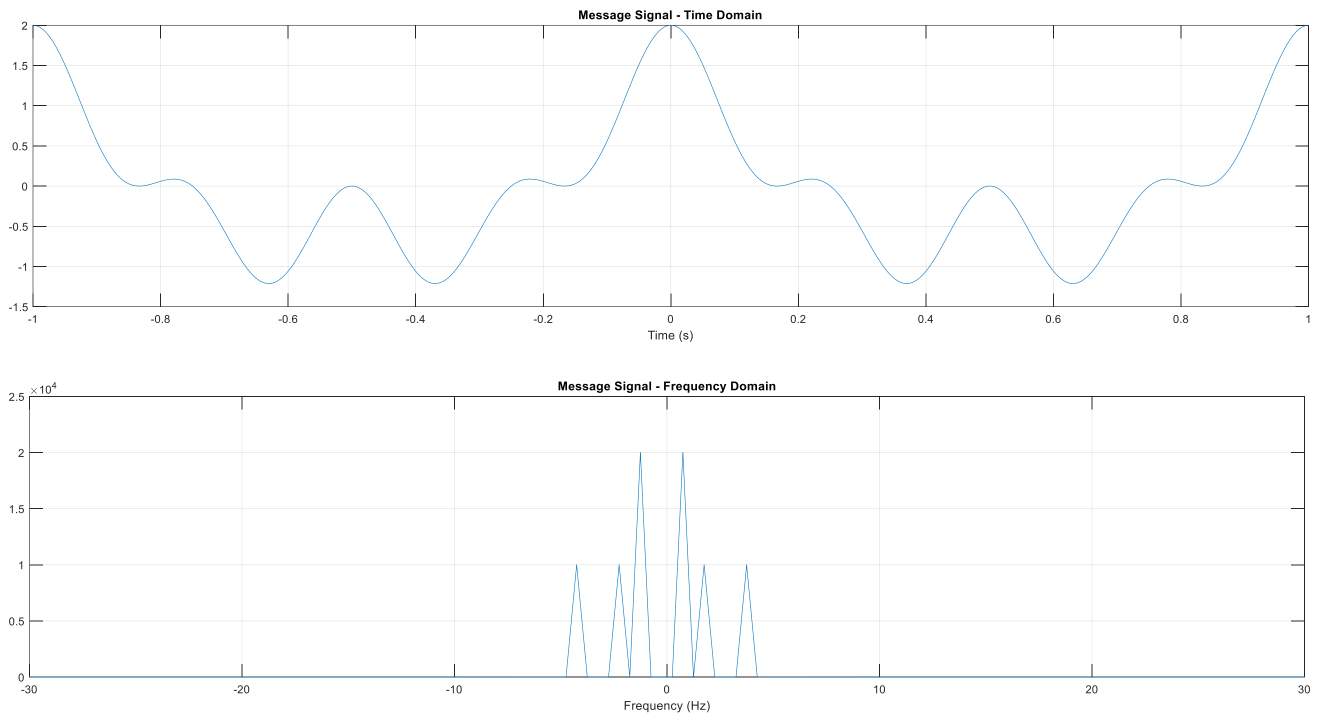
All questions should be answered precisely to get maximum credit. Lab report must ensure following items:

- Lab objectives
- MATLAB codes
- Results (Graphs/Tables) duly commented and discussed
- Conclusion

3 Lab Tasks

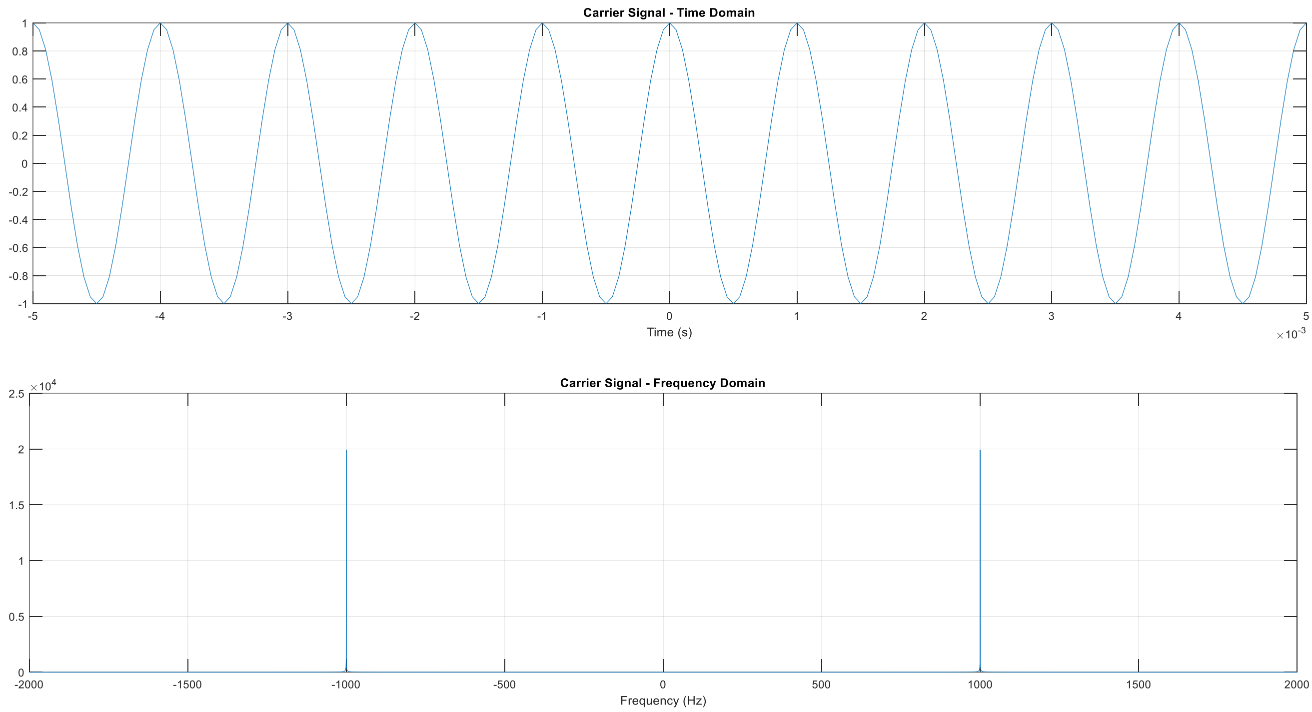
1. Generate a signal defined by the following equation, $y[n] = cos\,[2\pi n] + 0.5\,cos\,[4\pi n] + 0.5cos\,[8\pi n]$, and let it be your message signal. Plot and analyze both the time domain and frequency domain plots.

```
Fs = 20000;
n = -1:1 / Fs:1;
L = length(n);
freq_axis = Fs * ((-L / 2:L / 2 - 1) / L);
m_sig = cos(2 * pi * n) + 0.5 * cos(4 * pi * n) + 0.5 * cos(8 * pi * n);
figure
subplot(211)
plot(n, m_sig);
grid
xlabel('Time (s)')
title('Message Signal - Time Domain')
subplot(212)
plot(freq_axis, abs(fftshift(fft(m_sig))));
axis([-30 30 0 25000]);
grid
xlabel('Frequency (Hz)')
title('Message Signal - Frequency Domain')
```



2. Generate a cosine of 1000Hz and call it your carrier signal. Plot and analyze both the time domain and the frequency domain plots.

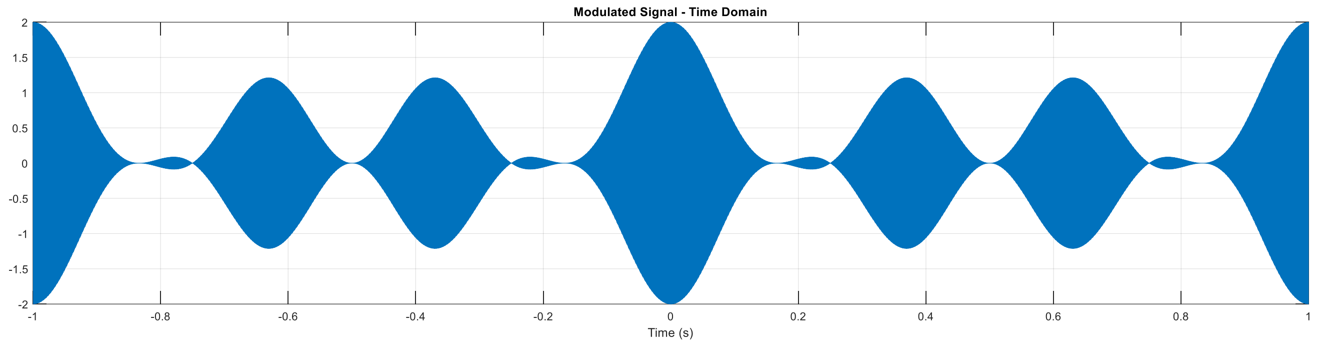
```
c_sig = cos(2000 * pi * n);
figure
subplot(211)
plot(n, c_sig);
axis([-0.005 0.005 -1 1]);
grid
xlabel('Time (s)')
title('Carrier Signal - Time Domain')
subplot(212)
plot(freq_axis, abs(fftshift(fft(c_sig))));
axis([-2000 2000 0 25000]);
grid
xlabel('Frequency (Hz)')
title('Carrier Signal - Frequency Domain')
```

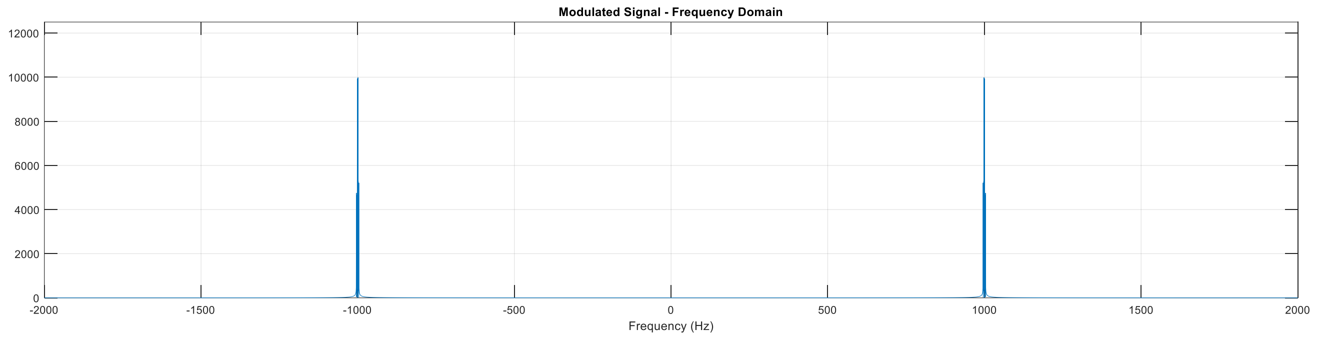


3. Now generate the signal that we will receive at the end of the transmitter system. Plot and analyze both the time and the frequency plots. This signal is the amplitude modulated signal, carefully examine these plots. Try identifying how the amplitude of the amplitude modulated signal varies with time.

```
mod_sig = m_sig .* c_sig;
figure
subplot(211)
plot(n, mod_sig);
grid
```

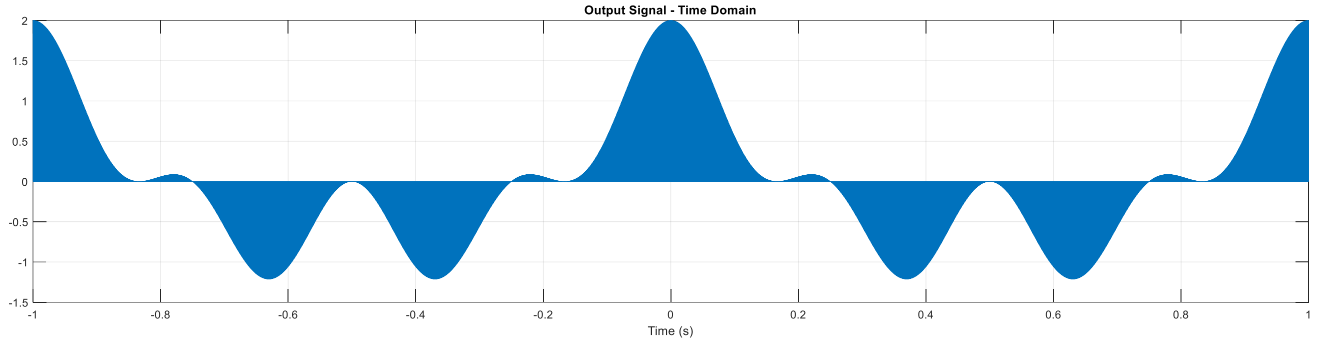
```
xlabel('Time (s)')
title('Modulated Signal - Time Domain')
subplot(212)
plot(freq_axis, abs(fftshift(fft(mod_sig))));
axis([-2000 2000 0 12500]);
grid
xlabel('Frequency (Hz)')
title('Modulated Signal - Frequency Domain')
```

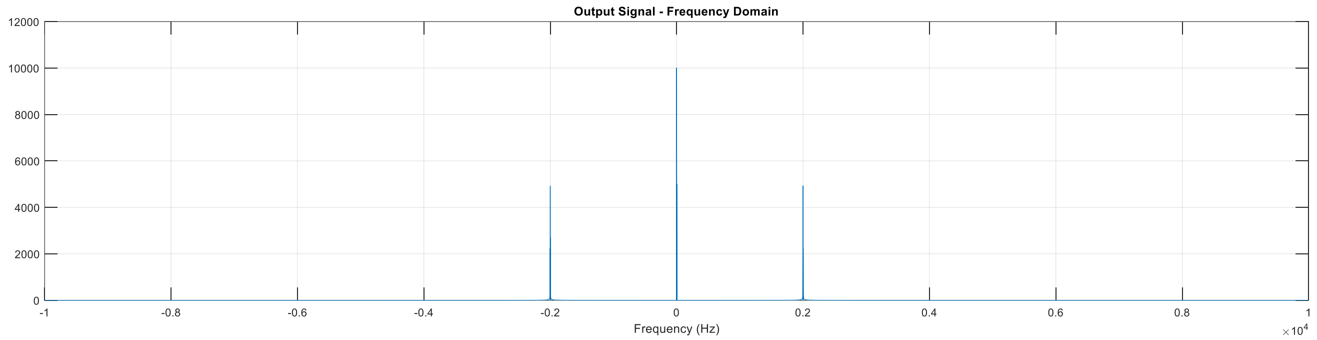




4. Assuming we have a noise less channel we receive the signal generated in the previous part as the input to the receiver circuit. Generate the output signal by implementing the system given in the block diagram. Plot and analyse the output signal.

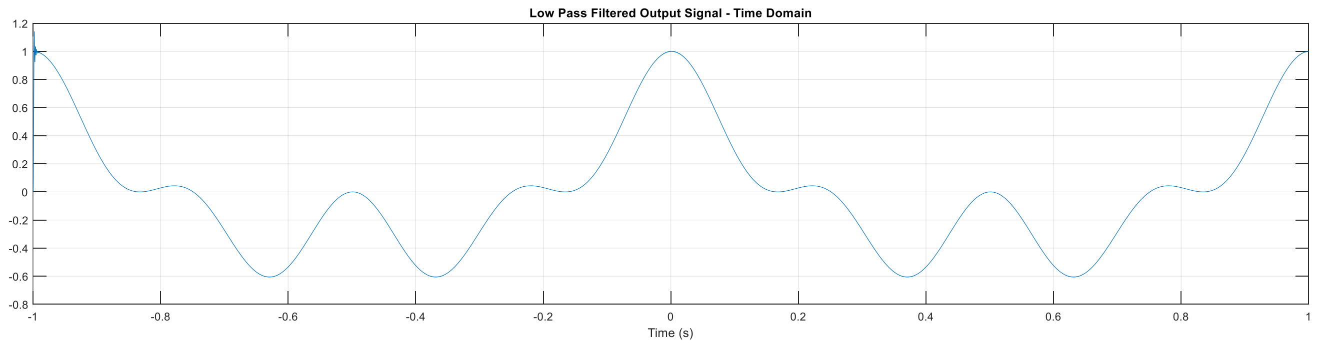
```
out_sig = mod_sig .* c_sig;
figure
subplot(211)
plot(n, out_sig);
grid
xlabel('Time (s)')
title('Output Signal - Time Domain')
subplot(212)
plot(freq_axis, abs(fftshift(fft(out_sig))));
grid
xlabel('Frequency (Hz)')
title('Output Signal - Frequency Domain')
```

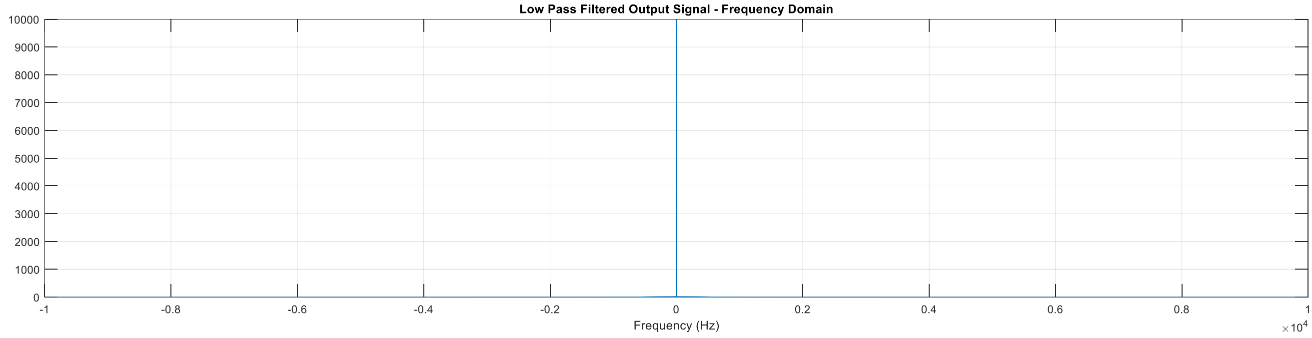




5. Can you identify what operation (in terms of filtering) we need to perform to retrieve our original message signal? Explain how you arrived at your answer.

```
lpFilt = designfilt('lowpassiir', 'FilterOrder', 5, ...
'PassbandFrequency', 500, 'PassbandRipple', 0.09, ...
    'SampleRate', Fs);
filtered_sig = filter(lpFilt, out_sig);
figure
subplot(211)
plot(n, filtered_sig);
grid
xlabel('Time (s)')
title('Low Pass Filtered Output Signal - Time Domain')
subplot(212)
plot(freq_axis, abs(fftshift(fft(filtered_sig))));
grid
xlabel('Frequency (Hz)')
title('Low Pass Filtered Output Signal - Frequency Domain')
```





Answer: As the output signal of part 4 had high frequency components at 2 kHz and -2 kHz, the time domain signal was distorted. To remove this distortion, the signal was passed through a 5th order low-pass filter with a passband frequency of 500 Hz, and the resulting time domain signal was nearly identical to the original message signal.

4 Conclusion

In this lab we learnt and implemented the concepts of amplitude modulation on MATLAB. We plotted and analyzed the carrier, message and modulated signal in both time and frequency domains. We also learnt how to demodulate the signal by the use of low-pass filter, specifically 5th order low pass filter.