Lab Report: *07*

Title: *Amplitude and Frequency Modulation and Demodulation (AM and FM)*

Course Title: *Data and Telecommunication Laboratory*

Course Code: *CSE-260*

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Objective:

The objective of this experiment is to study and implement **Amplitude Modulation (AM)** and **Frequency Modulation (FM)** techniques, including their modulation and demodulation processes. The experiment also involves analyzing the time-domain and frequency-domain characteristics of the modulated signals.

Theory:

Amplitude Modulation (AM)

- **Definition**: AM is a modulation technique where the amplitude of the carrier signal is varied in proportion to the message signal. It is widely used in radio broadcasting.

Frequency Modulation (FM)

- **Definition**: FM is a modulation technique where the frequency of the carrier signal is varied in proportion to the message signal. It is commonly used in high-fidelity radio broadcasting and television sound.

Experimental Setup:

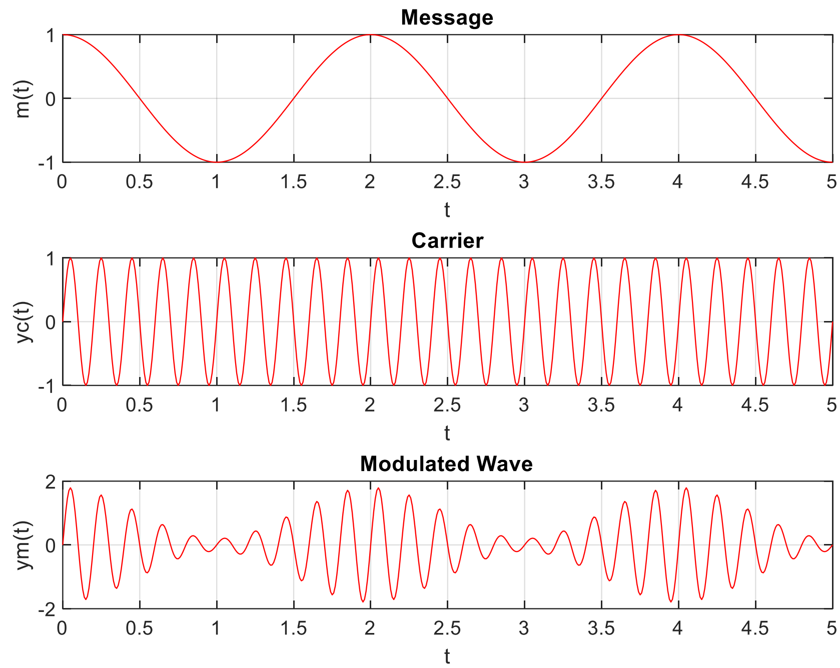
Tools and Software:

- MATLAB
- Python (with libraries: numpy, matplotlib, scipy)

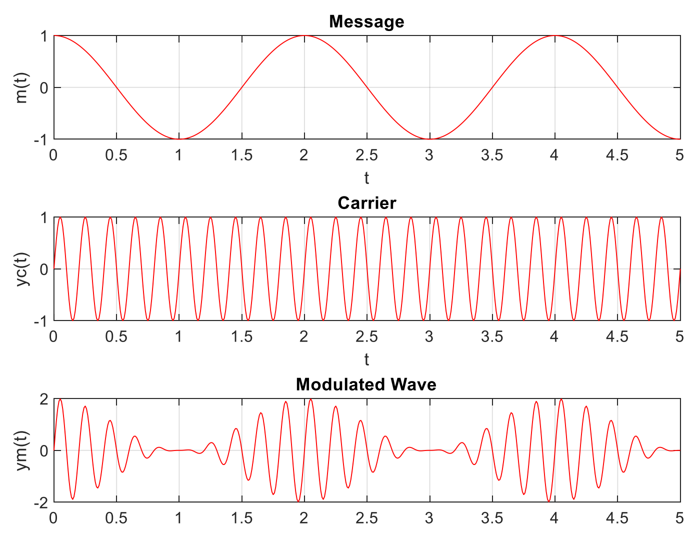
Signals Used:

1. **Message Signal**:
    - For AM: $m(t) = cos(\pi t)$ (sinusoidal signal).
    - For FM: $m(t) = sin(2\pi \cdot 2t)$ (sinusoidal signal).
2. **Carrier Signal**:
    - For AM: $c(t) = sin(10\pi t)$ (high-frequency sinusoidal signal).
    - For FM: Carrier frequency $f_c = 30$ Hz.

```
%Modulation
t = 0:0.01: 5;
y1 = cos(pi*t); %message
y2 = sin(10*pi*t); %carrier
m=0.8; % modulation index
ym=(1+m*y1).*y2; %Modulated wave

subplot(3,1,1)
plot(t,y1, 'r')
xlabel('t')
ylabel('m(t)')
title('Message')
grid on

subplot(3,1,2)
plot(t,y2, 'r')
xlabel('t')
ylabel('yc(t)')
title('Carrier')
grid on

subplot(3,1,3)
plot(t,ym, 'r')
xlabel('t')
ylabel('ym(t)')
title('Modulated Wave')
grid on
```



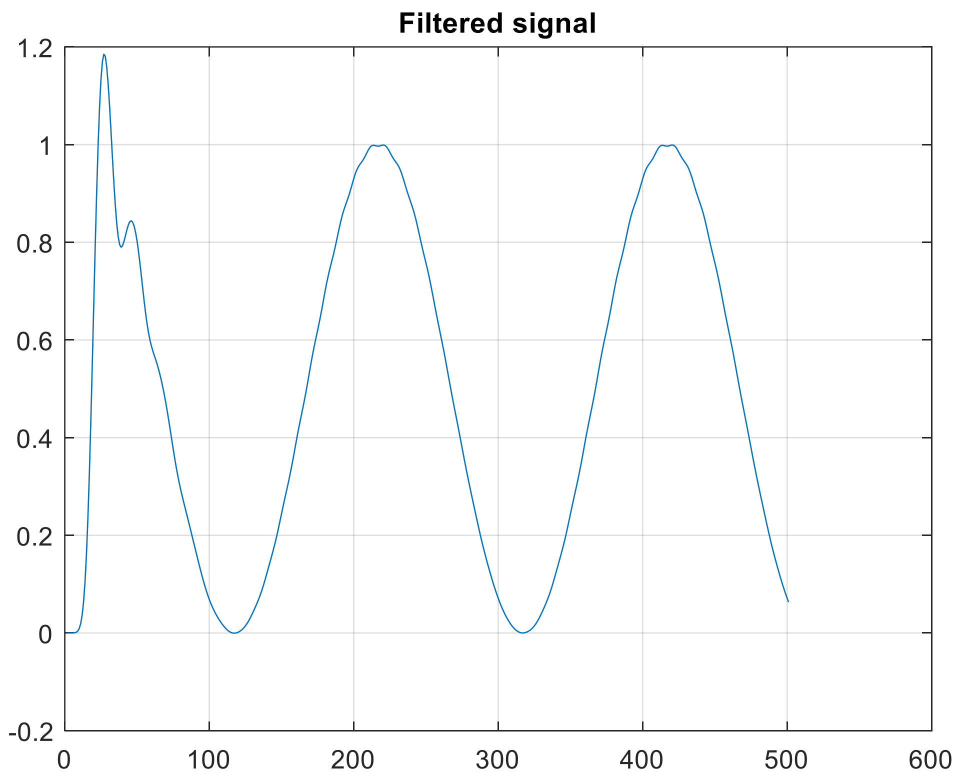
For m=1



Demodulation:

```
%Demodulation
```

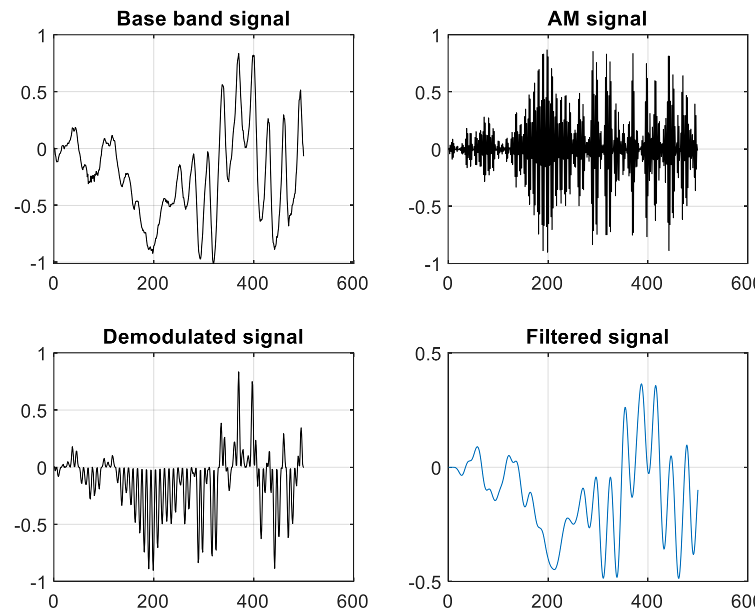
```
z = ym.*y2; %multiply by carrier then filter it
[b,a]=butter(8, 0.1); %Butterworth filter with cut off 0.1
and order 8
r = filter(b, a, z);
plot(r)
title('Filtered signal');
grid on
```



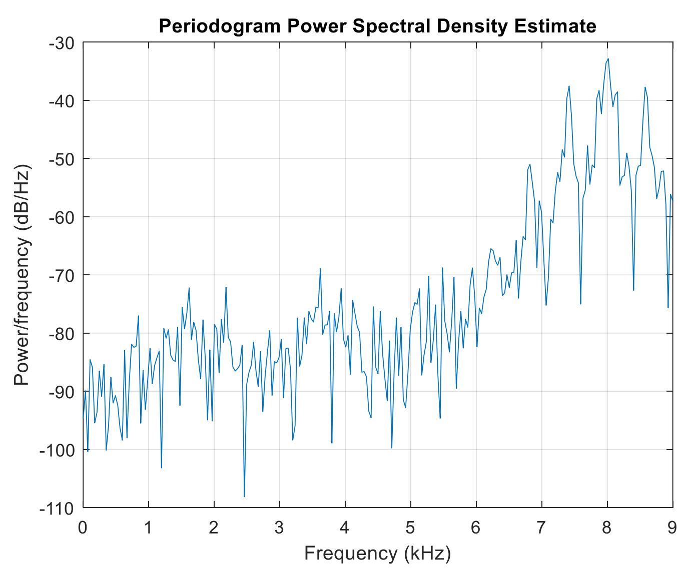
Audio Signal:

AM Modulation

```
% AM modulator and demodulator
load mtlb
in=mtlb;
x=in(1:500); %500 samples of speech
Fs=18000; %sampling rate of plot
Fc=8000; %carrier frequency
in_phase = 0;%initial phase angle
y=ammod(x,Fc,Fs,in_phase);
%AM with double sideband suppressed carrier
subplot(2,2,1)
plot(x, 'k'); %base band signal
title('Base band signal');
grid on
subplot(2,2,2)
plot(y, 'k') % AM signal
title('AM signal');
grid on
z=demod(y,Fc,Fs,'am'); %demodulated signal
subplot(2,2,3)
plot(z, 'k') % demodulated signal
grid on
title('Demodulated signal');
subplot(2,2,4)
[b,a]=butter(8, 0.1); %Butterworth filter with cut off 0.1 and order 8
r=filter(b, a, z);
plot(r)
title('Filtered signal');
grid on
```




```
periodogram(y,[],512,Fs);
```



FM Modulation:

```
%FM modulation
fs = 1000; % Sample rate (Hz)
ts = 1/fs; % Sample period (s)
fd = 25; % Frequency deviation (Hz)
t = 0:ts:2;
t=t';
x = sin(2*pi*2*t);
M_s = comm.FMModulator('SampleRate',fs,'FrequencyDeviation',fd);
y = step(M_s, x);
subplot(3,1,1)
plot(t,[x real(y)]) %plot both x and y

% Demodulation
DEMOD = comm.FMDemodulator('SampleRate',fs,'FrequencyDeviation',fd);
z = step(DEMOD,y);
subplot(3,1,2)
plot(t,z,'r')
xlabel('Time (s)')
ylabel('Amplitude')
title('Demodulated signal')
grid on

%psd of FM
subplot(3,1,3)
periodogram(real(y),[],512,fs);
```