Experiment No: 1

Experiment Name: To design and Observe the amplitude modulation. in Matlab.

Objective: i) Observe the wave form of amplitude modulation modulated signal.

Theory: Modulation is defined as the process by which some characteristics usually amplitude, frequency or phase of voltage (usually sinusoidal voltage) is varied in accrodance with the instanteneous value of some other voltage, called the modulating voltage.

The term carrier is applied to the voltage whose characteristic is varied and the term modulating voltage is used for the voltage in accrodanc with which the variation is made.

Accrodingly modulation process may be classified as

i) Amplitude modulation

ii) Frequency modulation

iii) Phase modulation.

Expression for Amplitude Modulated voltage:

In amplitude modulation, the amplitude of the carrier voltage varies in accordance with the instantaneous value of the modulating voltage. Let, the modulating voltage or the signal be given by the expression,

$$v_m = V_m \cos \omega_m t$$

where, ω_m = angular frequency

V_m = Amplitude.

Let the carrier voltage be given by

$$v_c = V_c \cos \omega_c t$$

For convenience in calculation the phase angle θ has been taken as zero. since it does not play any part in the modulation process. This however, does not in any way reduce the generality of the expression.

On amplitude modulation, amplitude of the carrier no longer remains constant but varies with time as given by the following expression.

$$V(t) = V_c + k_a V_m \cos w_m t$$

where, k_a, $V_m \cos w_m t$ is the change in the carrier amplitude.

The instantaneous value of modulated carrier voltage is then given by.

$$v = V(t) \cos w_c t$$

$$= \left[V_c + k_a V_m \cos w_m t\right] \cos w_c t$$

$$= V_c\left[1 + \frac{k_a V_m}{V_c} \cos w_m t\right] \cos w_c t$$

Let, m_a is modulation index or modulatio factor or depth of modulation and is given by

$$m_a = \frac{k_a V_m}{V_c}$$

$$\therefore\ v = V_c\left[1 + m_a \cos w_m t\right] \cos w_c t.$$

Code: MATLAB code for Amplitude Modulation is,

```
clc
clear all
close all
Ac=input('Enter carrier signal amplitude: ');
Am=input('Enter message signal amplitude: ');
fc=input('Enter carrier frequency: ');
fm=input('Enter message frequency: ');
m=input('Enter modulation index: ');
t=input('Enter time period: ');
t1=linspace(0,t,1000);
y1=sin(2*pi*fm*t1);
y2=sin(2*pi*fc*t1);
eq=(1+m.*y1).*(Ac.*y2);
subplot(311);
plot(t1,y1);
xlabel('Time');
ylabel('Amplitude');
title('Message signal')
subplot(312)
plot(t1,y2);
xlabel('Time');
ylabel('Amplitude');
title('Carrier signal');
subplot(313);
plot(t1,eq);
plot(t1,eq,'r');
xlabel('Time');
ylabel('Amplitude');
title('Amplitude Modulated signal');
```

Input & Output:

Enter carrier signal amplitude: 5

Enter message signal amplitude: 1

Enter carrier frequency: 20000

Enter message frequency: 1000

Enter modulation index: .5

Enter time period: 5

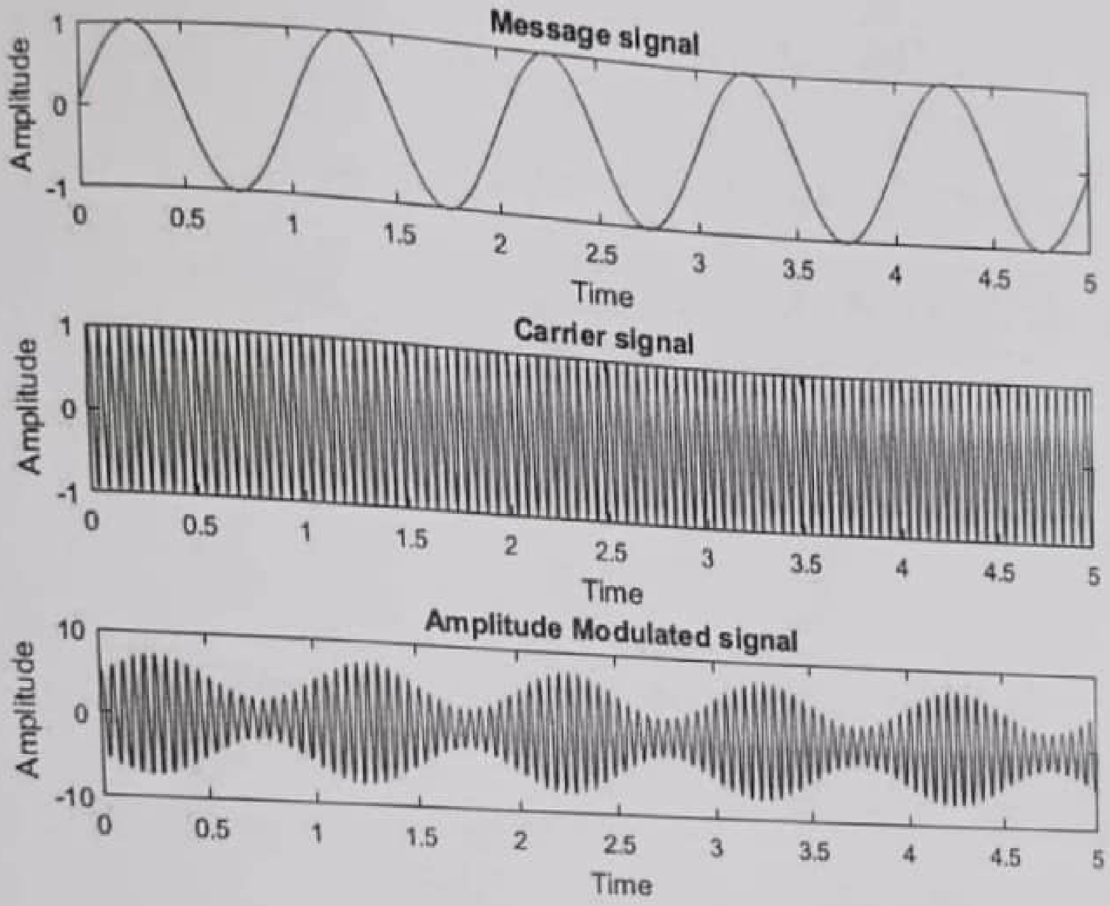


Fig 2: Amplitude Modulation using MATLAB

Discussion: The output of our experiment and the theoritical expected value exactly same. So, the experiment is correct.

Precaution: i) Write code in Matlab carefully.

ii) Input perfect value to get perfect output.

Experiment No. : 2

Experiment Name: To design and Observe the frequency modulation in Matlab.

Objective: i) Observe the wave from of the frequency modulated signal.

Theory: Modulation is defined as the process by which some characteristics, usually amplitud, frequency or phase of voltage (usually sinusoidal voltage) is varied in accrodance with the instanteneous value of som other voltage, called the modulating voltage. The term carrier is applied to the voltage whose characteristic is varied and the term modulating voltage is used for the voltage in accrodance with which the variation is made.

Let. the carrier voltage be given by

$$v_c = V_c \sin(\omega_c t + \theta)$$

where, ω_c is angular frequency of the carrier.

V_c is the amplitude of carrier (Volt).

θ_c is the phase angle in radians.

Let, $\quad \phi = \omega_c t + \theta$

So, $\quad v_c = V_c \sin\phi$

Obviously the angular frequency ω_c is related to the phase angle ϕ by the relation

$$\omega_c = \frac{d\phi}{dt}$$

On frequency modulation, the frequency of the carrier on longer remains constant but varies with time in accordance with the instanteneous value of the modulating voltage. Thus the frequency of the carrier voltage after frequency modulation is given by.

$$\omega = \omega_c + k_f \cdot V_m$$

$$= \omega_c + k_f V_m \cos \omega_m t$$

where, k_f is the constant of proportionality.

Now,

$$\phi = \int \omega dt$$

$$= \int [\omega_c + k_f V_m \cos \omega_m t] dt$$

$$= \omega_c t + k_f V_m \frac{1}{\omega_m} \sin \omega_m t + \theta_i$$

where, θ_i is constant of integration and represents a ~~nos~~ constant phase angle. θ_i may be neglected in the following analysis since it is insignificant in the modulation process. Hence the frequency modulate carrier voltage is given by.

$$v = V_c \sin\left[\omega_c t + k_f \frac{V_m}{\omega_m} \sin \omega_m t\right]$$

Instantaneous frequency of frequency modulated carrier voltage in Hz is given by,

$$f = \frac{\omega}{2\pi} = f_c + k_f \frac{V_m}{2\pi} \cos \omega_m t$$

The maximum value of frequency is given by,

$$f_{max} = f_c + k_f \frac{V_m}{2\pi}$$

The minimum value of frequency is given by,

$$f_{min} = f_c - k_f \frac{V_m}{2\pi}$$

Thus frequency deviation,

$$f_d = f_{max} - f_c = f_c - f_{min} = k_f \frac{V_m}{2\pi}$$

Modulation index m_f is the ratio of frequency deviation to modulation frequency and is also included by δ.

$$\delta = m_f = \frac{f_d}{f_m} = \frac{\omega_d}{\omega_m} = \frac{k_f \cdot V_m}{\omega_m}$$

Thus the expression for the frequency modulated voltage is given by.

$$v = V_c \sin(\omega_c t + m_f \sin \omega_m t).$$

Code: MATLAB code for Frequency Modulation is,

```
clc
clear all
close all
Vm=1;
Vc=1;
fm =2;
fc=50;
mf=15;
t=0:1/1000:1;
vm=Vm*cos(2*pi*fm*t);
subplot(3,1,1);
plot(t,vm);
xlabel('Time');
ylabel('Amplitude');
title('Message signal')
vc=Vc*sin(2*pi*fc*t);
subplot(3,1,2)
plot(t,vc);
xlabel('Time');
ylabel('Amplitude');
title('Carrier signal')
v=Vc*sin(2*pi*fc*t+(mf.*sin(2*pi*fm*t)));
subplot(3,1,3)
plot(t,v);
xlabel('Time');
ylabel('Amplitude');
title('Frequency Modulated signal');
```

Input & Output:

The carrier signal amplitude: 1

The message signal amplitude: 1

The carrier frequency: 50

The message frequency: 2

The modulation index: 15

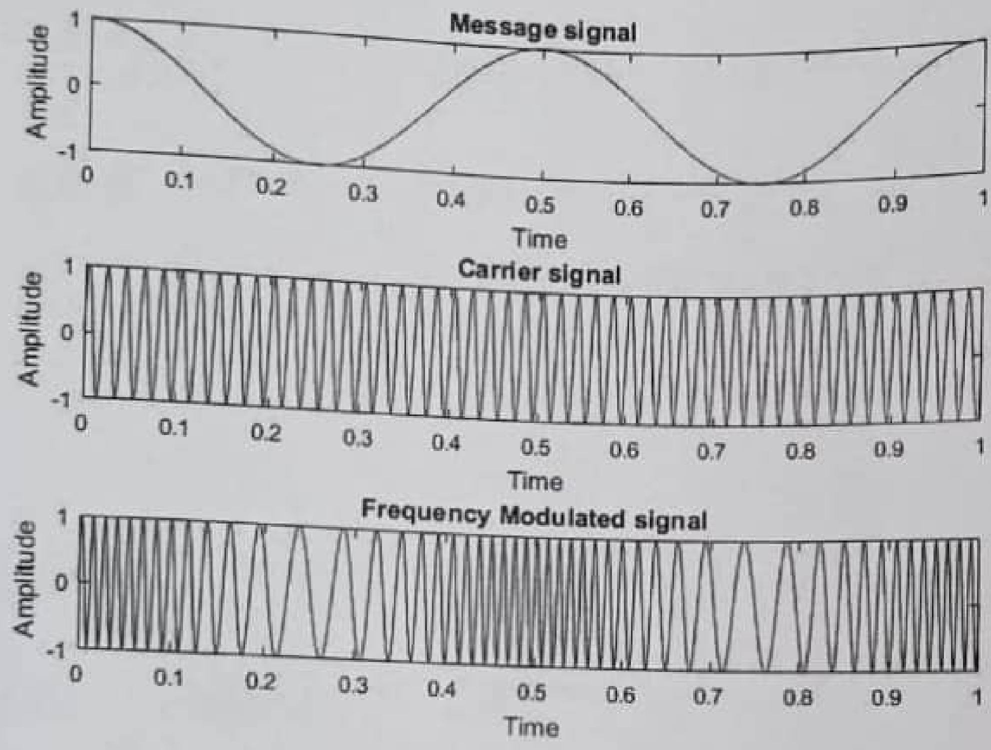


Fig 4: Frequency Modulation using MATLAB

Procedure: At first we open matlab. Take a new empty file. Then we generate the massege signal and carrier signal. Then we process those signal and produce modulated signal. Then we plot the figure and label the message, carrier, modulated signal.

Result: From the figure, we can see the carrier signal, message signal, frequency modulated signal. The output amplitude frequency modulated signal is as expected. So, the experiment is correct.

Discussion: The output of our experiment and the theoritical expected value exactly same. So, the experiment is correct.

Precaution: i) Write code in Matlab correctfully.

ii) Input perfect value to get perfect output.

Experiment No. : 3

Experiment Name: To design and Observe the phase modulation in Matlab.

Objective: i) Observe the wave form of phase modulation modulated signal

Theory: Modulation is defined as the process by which some characteristics. usually amplitude, frequency or phase, of voltage (usually sinusoidal voltage) is varied in accrodance with the instanteneous value of some other voltage called the modulating voltage. The term carrier is applied to the voltage whose characteristic is varied and the term modulating voltage is for the voltage in accrodance with which the variation is made.

Scanned with CamScanner

Accordingly modulation process may be classified as

i) Amplitude modulation

ii) Frequency modulation

iii) phase modulation.

In phase modulation, the phase of the carrier voltage varies in accordance with the instantaneous value of the modulating voltage.

Expression for phase modulation voltage:

Let, the carrier voltage be,

$$v_c = V_c \sin(\omega_c t + \theta_0)$$

and the modulating voltage be,

$$v_m = V_m \sin \omega_m t$$

Instanteneous phase of the carrier before modulation is given by

$$\phi_c = \omega_c t + \theta_0$$

After phase modulation, the instanteneous phase of the carrier is given by

$$\theta(t) = \omega_c t + \theta_0 + k_p V_m$$

$$= \omega_c t + \theta_0 + k_p V_m \sin \omega_m t$$

The phase modulated carrier voltage is then given by

$$v = V_c \sin[\omega_c t + \theta_0 + k_p V_m \sin \omega_m t]$$

In phase modulation process, the constant phase angle θ_0 plays no part and hance for the sake of simplification θ_0 may be omitted. Then the modulated carrier voltage given by

$$v = V_c \sin[\omega_c t + k_p V_m \sin \omega_m t]$$

The maximum phase deviation obviously is $k_p \cdot V_m$ and may be indicated by ϕ_m. Then the modulated voltage may be.

$$v = V_c \sin[\omega_c t + \phi_m \sin \omega_m t]$$

$$v = V_c \sin[\omega_c t + m_p \sin \omega_m t]$$

Code: MATLAB code for Phase Modulation is,

```
clc
clear all
close all
Vm=1;
Vc=1;
fm =2;
fc=50;
mf=15;
t=0:1/1000:1;
vm=Vm*cos(2*pi*fm*t);
subplot(3,1,1);
plot(t,vm);
xlabel('Time');
ylabel('Amplitude');
title('Message signal')
vc=Vc*sin(2*pi*fc*t);
subplot(3,1,2)
plot(t,vc);
xlabel('Time');
ylabel('Amplitude');
title('Carrier signal')
v=Vc*sin(2*pi*fc*t+(mf.*sin(2*pi*fm*t)));
subplot(3,1,3)
plot(t,v);
xlabel('Time');
ylabel('Amplitude');
title('Phase Modulated signal');
```

Input & Output:

The carrier signal amplitude: 1

The message signal amplitude: 1

The carrier frequency: 50

The message frequency: 2

The modulation index: 15

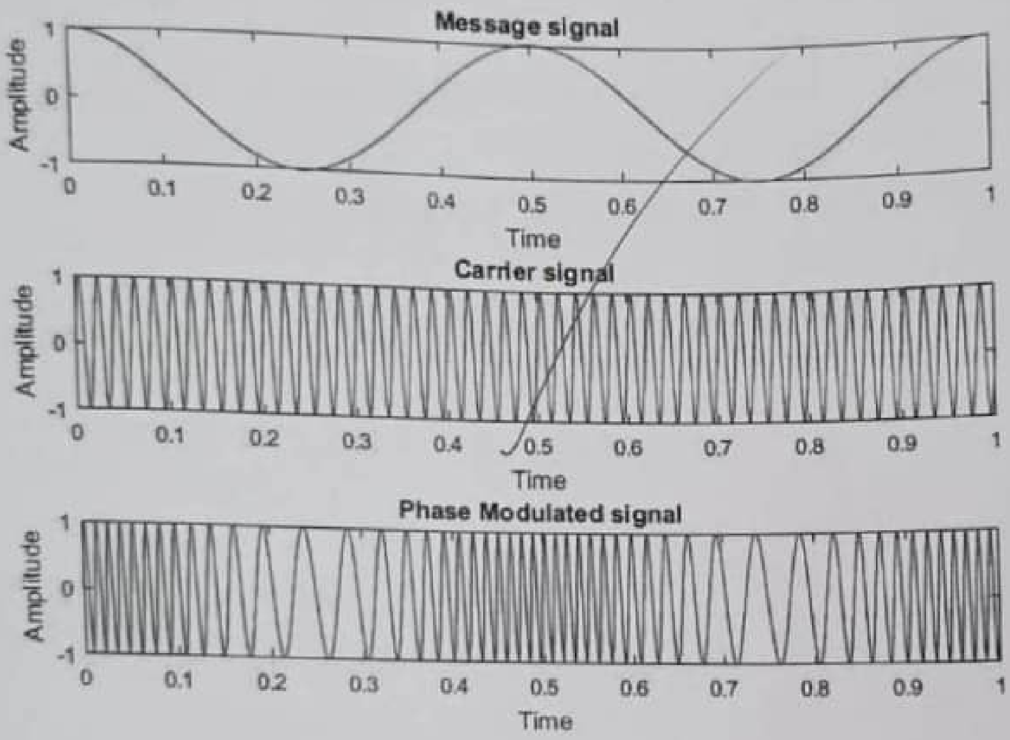


Fig 6: Phase Modulation using MATLAB

Procedure: At first we open matlab. Take a new empty file. Then we generate the massege signal, and carrier signal. Then we process those signal and produce modulated signal. Then we plot the figure and label the message, carrier, modulated signal.

Result: From the figure we can see the carrier signal, message signal phase modulated signal. The output is as same as the expected phase modulated signal.

Discussion: The output of our experiment and the theoritical expected value exactly same. So, the experiment is correct.

Precaution: i) Write code in Matlab correctly

ii) Input perfect value to get perfect output.

Experiment No: 4

Experiment Name: To generate amplitude demodulation signal using MATLAB.

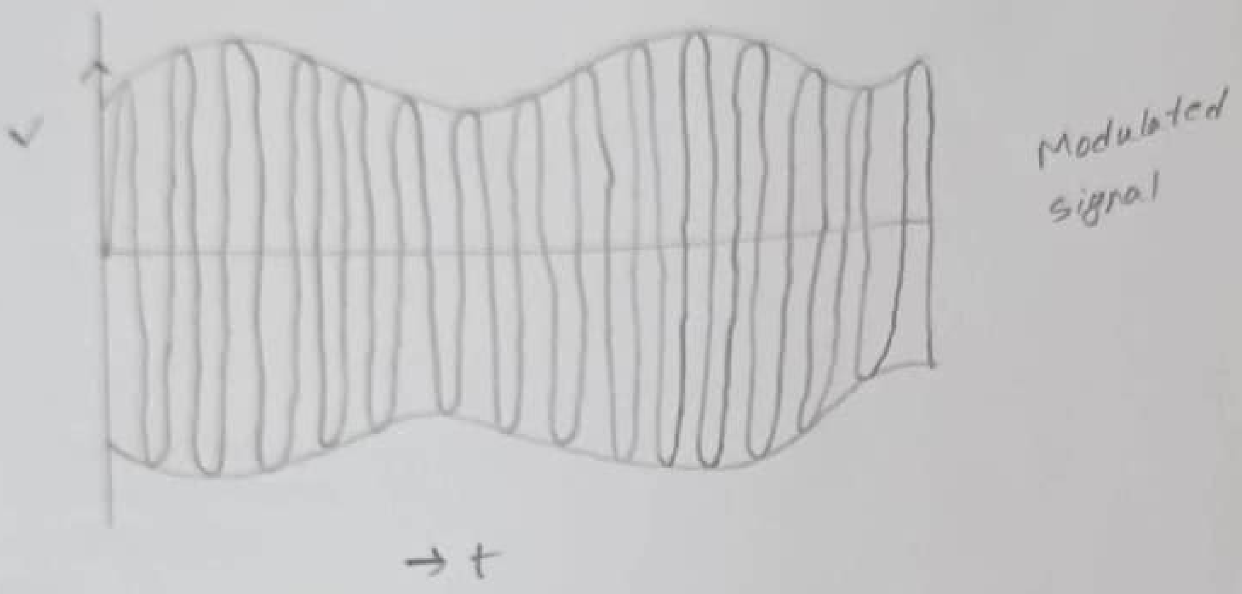
Theory:

Amplitude Demodulation: The process to detection provides a means of recovering the modulating signal from modulating signal. Demodulation is the reverse process of modulation. The detector circuit is employed to separate the carrier wave and eliminate the side bands. Since the envelope of an AM wave has the same shape as the message, independent of the carrier frequency and phase. Demodulation can be accomplished by extracting envelope.

An increased time constant R_c results in a marginal output follows the modulation envelope. A further increase in time constant the discharging curve become horizontal than the rate of modulation. envelope during negative half cycle of the modulation voltage

The modulation is faster than the rate of voltage Re combination. The output fails to follow the modulation resulting distorted output is called as digonal clipping. This will occur even high modulation index.

The depth of modulation at the detector output greater than unity and circuit impedance is less than circuit load $(R_l > Z_m)$ results in clipping of negative peaks of modulating signal. It is called negative clipping.



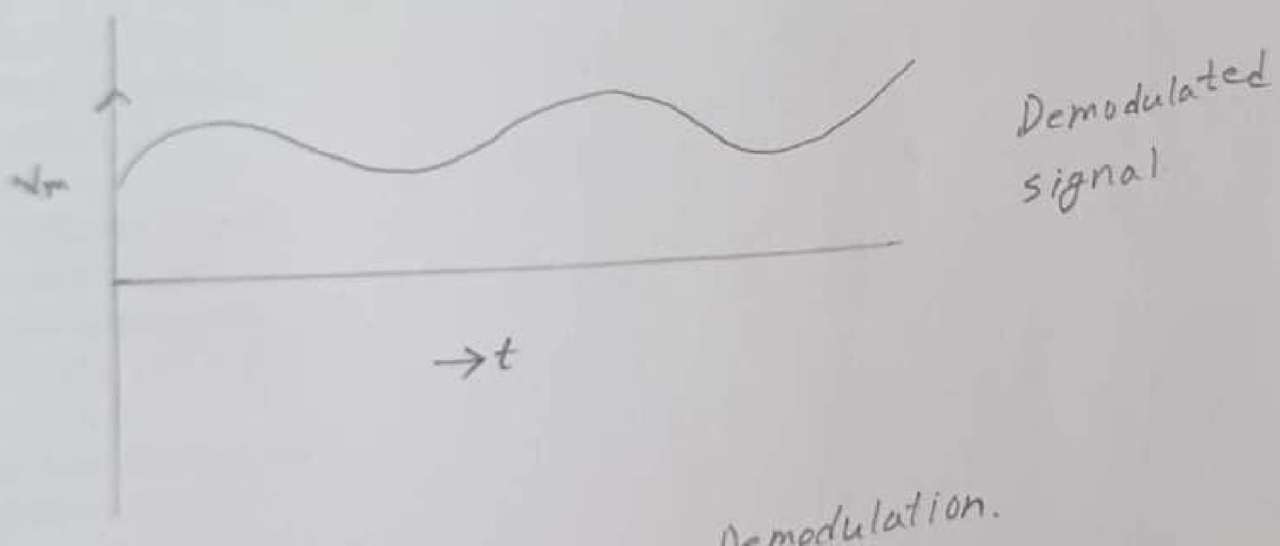


Fig: Amplitude Demodulation.

Code: MATLAB code for Amplitude Demodulation is,

```
clc
clear all;
close all
Fc = 20;
Fs = 160;
Fm = 0.4;
Vc=1;
Vm=1;
t = 0:1/Fs:10;
c = Vc*cos(2*pi*Fc*t);
m =Vm* cos(2*pi*Fm*t);
y = ammod(m,Fc,Fs);
subplot(5,1,1);
plot(t, m);
title('Modulating Signal');
xlabel('time (s)');
ylabel('amplitude');
subplot(5,1,2);
plot(t, c);
title('Carrier Signal');
xlabel('time (s)');
ylabel('amplitude');
subplot(5,1,3);
plot(t,y);
title('Modulated Signal');
xlabel('time (s)');
ylabel('amplitude');

Vd(1) = 0;
for i = 2:length(y)
  if y(i) > Vd(i-1)
     Vd(i) = y(i);
  else
     Vd(i) = Vd(i-1) - 0.023*Vd(i-1);
```

```
    end
end
h = fir1(100, 0.0125, 'low');
foutputc = filter(h,1,Vd);
subplot(5,1,4);
plot(t, Vd);
title('Envelope detector output of modulating signal');
xlabel('time (s)');
ylabel('amplitude');
subplot(5,1,5);
plot(t, foutputc);
title('Demodulated  signal');
xlabel('time (s)');
ylabel('amplitude');
```

Input & Output:

The carrier signal amplitude: 1

The message signal amplitude: 1

The carrier frequency: 20

The message frequency: 0.4

The sampling rate: 160

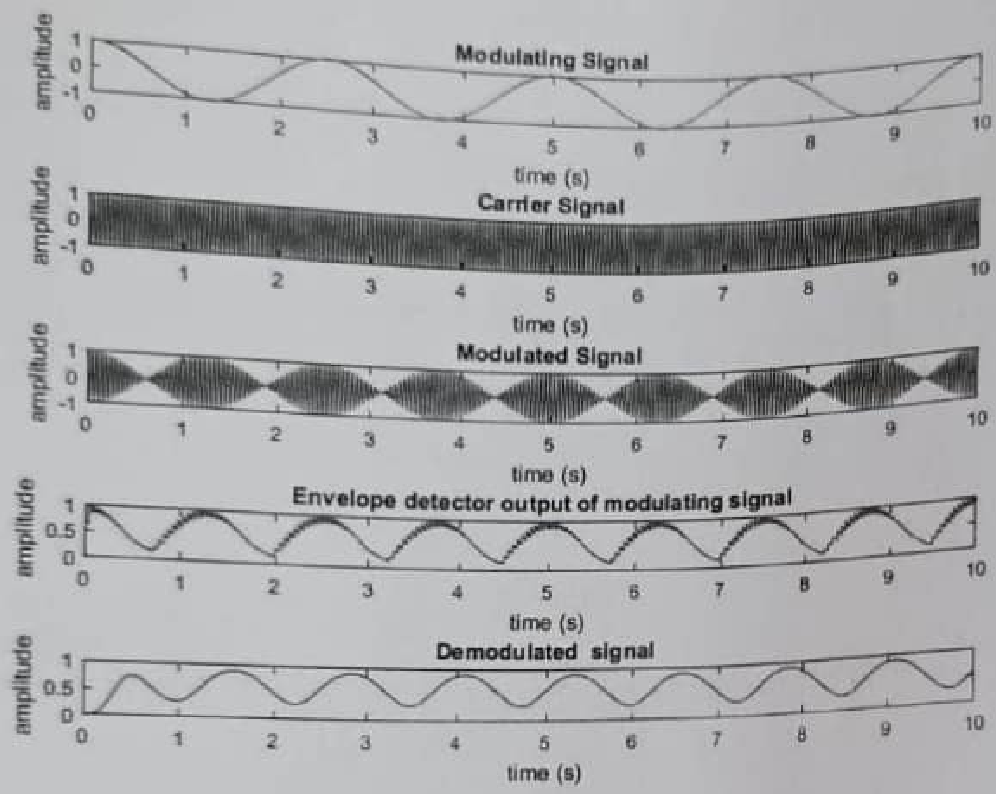


Fig 6: Amplitude Demodulation using MATLAB

Discussion: The output of our experiment and the theoritical expected value exactly same. So, the experiment is may be correct.

precaution: i) Write code in Matlab correctly

ii) Input perfect value to get perfect output.