LABORATORY RECORD COMMUNICATION ENGINEERING LAB (EC 2094) AUTUMN 2020

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SCHOOL OF ELECTRONICS ENGINEERING, KIIT Deemed to be University

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Experiment Number	01
Date of Experiment	03/08/2020
Date of Submission	17/08/2020
Name of the student	Debagnik Kar
Roll Number	1804373
Section	ETC-06

Aim of The Experiment :-

Generation and detection of Amplitude Modulation and Demodulation, DSBSC and SSB-SC modulation.

Equipment / Software Required:-

- Matlab R2018a

Theory:

Amplitude modulation: AM is a modulating technique which is generally used to transmit Radio signals over a carrier signal, where the amplitude of the modulated changes in response of the signal.

Mathematically,

If the carrier signal is,

$$c(t) = Ac.\cos(2\pi.fc.t)$$

And the message signal is,

$$m(t) = Am.cos(2\pi.fm.t)$$

Then the equation of the modulated signal is,

$$s(t) = [Ac + \cos(2.\pi.fm.t)].\cos(2.\pi.fc.t)$$

If we solve this equation further, we get,

$$s(t) = Ac\left[1 + \frac{Am}{Ac}.\cos(2.\pi.fm.t)\right].\cos(2.\pi.fc.t)$$

$$\boxed{s(t) = Ac[1 + \mu.\cos(2.\pi.fm.t)].\cos(2.\pi.fc.t), \quad Where,\ \mu = \frac{Am}{Ac}}$$

Modulating Index(μ), also known as modulation depth, of a modulation scheme describes by how much the modulated variable of the carrier signal varies around its unmodulated level. It is defined differently in each modulation scheme.

DSBSC: The transmission of a signal, which contains a carrier along with two sidebands can be termed as Double Sideband Full Carrier system or simply DSBSC.

Mathematically,

If the carrier Signal is,

$$c(t) = Ac.\cos(2.\pi.fc.t)$$

And the message signal is,

$$m(t) = Am.\cos\,(2.\pi.fm.t)$$

Then the modulating signal will be,

$$s(t) = m(t).c(t)$$

$$\boxed{or, \qquad s(t) = \; Am.Ac.\cos(2.\pi.fm.t)\,.\cos(2.\pi.fc.t)}$$

SSBSC: The process of suppressing one of the sidebands along with the carrier and transmitting a single sideband is called as Single Sideband Suppressed Carrier system or simply SSBSC.

Mathematically,

If the carrier Signal is,

$$c(t) = Ac.\cos(2.\pi.fc.t)$$

And the message signal is,

$$m(t) = Am.\cos\,(2.\pi.fm.t)$$

Then the modulating signal will be,

$$s(t) = \frac{Am.Ac}{2}\,.\cos[2.\pi.(fc\; + \; fm).t] \;\; for\ the\ upper\ Sideband$$

$$s(t) = \frac{Am.Ac}{2}\,.\cos[2.\pi.(fc\; - fm).t] \;\; For\ the\ lower\ Sideband$$

Code:-

<<<File: GenerateAM.m Comment: This code will amplitude modulate and then demodulate a sine wave.>>>

```
%generating user defined AM Signals
%Written By Debagnik Kar 1804373

clc;
clear all;
close all;

t = linspace(0,1,1000) %Time of 1 secs divided by 1000 times
%Carrier wave
fc = input('Enter fc = ')
ac = input('Enter ac = ')
xc= cos(2*pi*fc*t)

%Message signal
fm = input('Enter fm = ');
am = input('enter am = ');

xm = cos(2*pi*fm*t);

%AMplitude modulation

y = [ac + am*xm].*xc;

%plot AM
subplot(4,1,1)
plot(t,xc);
xlabel("Time -->")
ylabel("Amplitude -->")
title("Carrier Wave")
subplot(4,1,2)
plot(t,xm)
xlabel("Time -->")
ylabel("Amplitude -->")
title("Message Wave")
subplot(4,1,3)
plot(t,y)
xlabel("Time -->")
ylabel("Amplitude -->")
title("Modulated Wave")

%if else statement

mu = am/ac;

if mu==1
```

```
    disp('Critical modulation');
elseif mu>1
   disp('Over modulated signal');
elseif mu<1
   disp('under modulated signal');
end

%Demodutating The wave
dm = y.^2;
[b,a] = butter(10,0.1);
xd = filter(b,a,dm);

subplot(4,1,4)
plot(t,xd);
xlabel("Time -->")
ylabel("amplitude")
title("Demodulated Wave")
```

<<<File:DSBSC.m Comment: This code will generate a DSBCS Modulated signal>>>

```
%DSBCS Generation
%Written by Debagnik Kar 1804373
clc;
clear all;
close all;
t = linspace(0,4,1000);

fc = input('Enter the carrier frequency: ')
ac = input('Enter the carrier amplitude: ')
fm = input('Enter the message frequency: ')
am = input('Enter the message amplitude: ')

y = am*cos(2*pi*fm*t) %message signal
z = ac*cos(2*pi*fc*t) %carrier signal

w = ((am*ac)/2).*(cos(2*pi*(fc+fm)*t)+cos(2*pi*(fc-fm)*t))
%DSBSC Modulation
subplot(3,1,1)
plot(t,z)
xlabel("time -->")
ylabel("magnitude -->")
title("Carrier Signal")
subplot(3,1,2)
plot(t,y)
xlabel("time -->")
ylabel("magnitude -->")
title("Message Signal")
subplot(3,1,3)
plot(t,w)
xlabel("time -->")
ylabel("magnitude -->")
```

```
title("DSBSC Signal")
```

<<<File: SSBSC.m Comment: Generates an upper sideband, a lower side band SSBSC>>>

```
% Generation of SSB-SC Signal
% Written by Debagnik Kar
clear all
close all
clc

fc = input('Enter the frequency of Carrier: ')
ac = input('Enter the amplitude of Carrier: ')
fm = input('Enter the frequency of Message: ')
am = input('Enter the amplitude of Message: ')

t = linspace(0,1,1000)

m = am*cos(2*pi*fm*t) %Message signal
c = ac*cos(2*pi*fc*t) %carrier Signal

Susb = ((am*ac)/2).*cos(2*pi*(fc+fm)*t) %upper Sideband
Slsb = ((am*ac)/2).*cos(2*pi*(fc-fm)*t) %lower Sideband

subplot(4,1,1)
plot(t,c,'r')
xlabel("Time -->")
ylabel("Amplitude-->")
title("Carrier Wave")

subplot(4,1,2)
plot(t,m,'g')
xlabel("Time -->")
ylabel("Amplitude-->")
title("Message Wave")

subplot(4,1,3)
plot(t,Susb,'b')
xlabel("Time -->")
ylabel("Amplitude-->")
title("Upper Sideband SSB-SC Signal")

subplot(4,1,4)
plot(t,Slsb,'k')
xlabel("Time -->")
ylabel("Amplitude-->")
title("Lower Sideband SSB-SC Signal")
```

Output/Graph:-

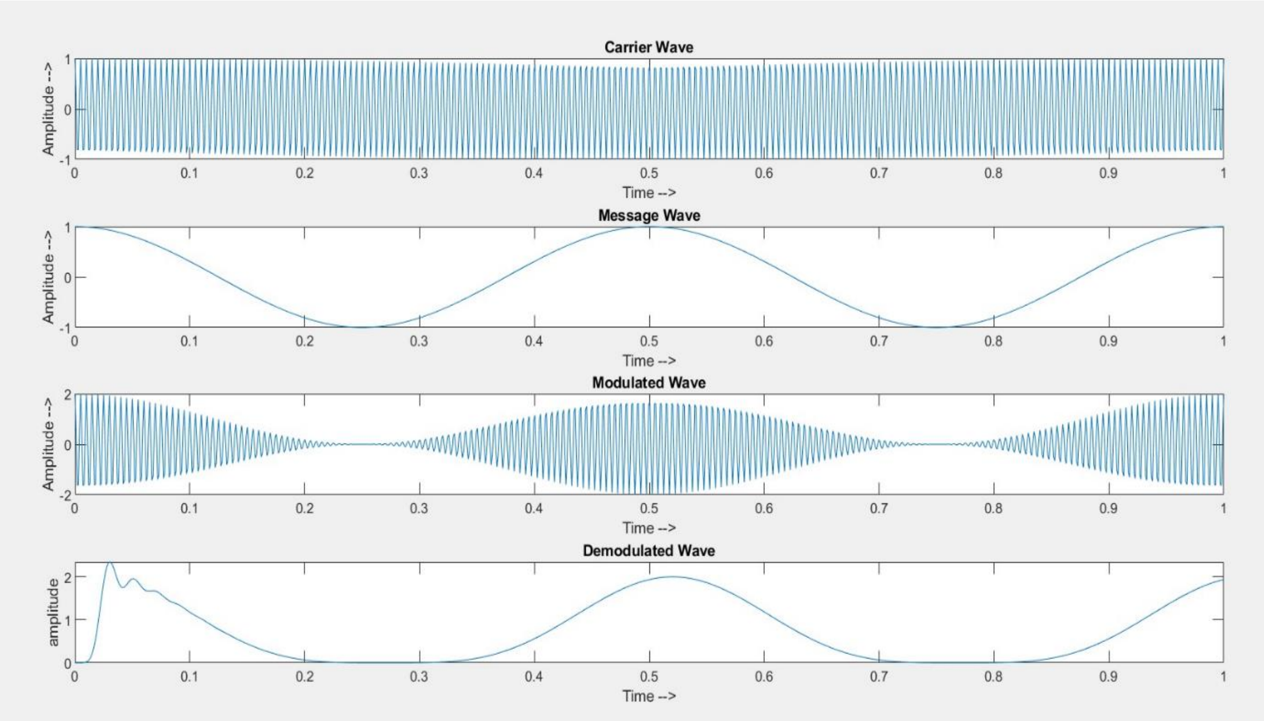

Fig 1 : Amplitude modulating and Demodulating a Sine wave of 2Hz

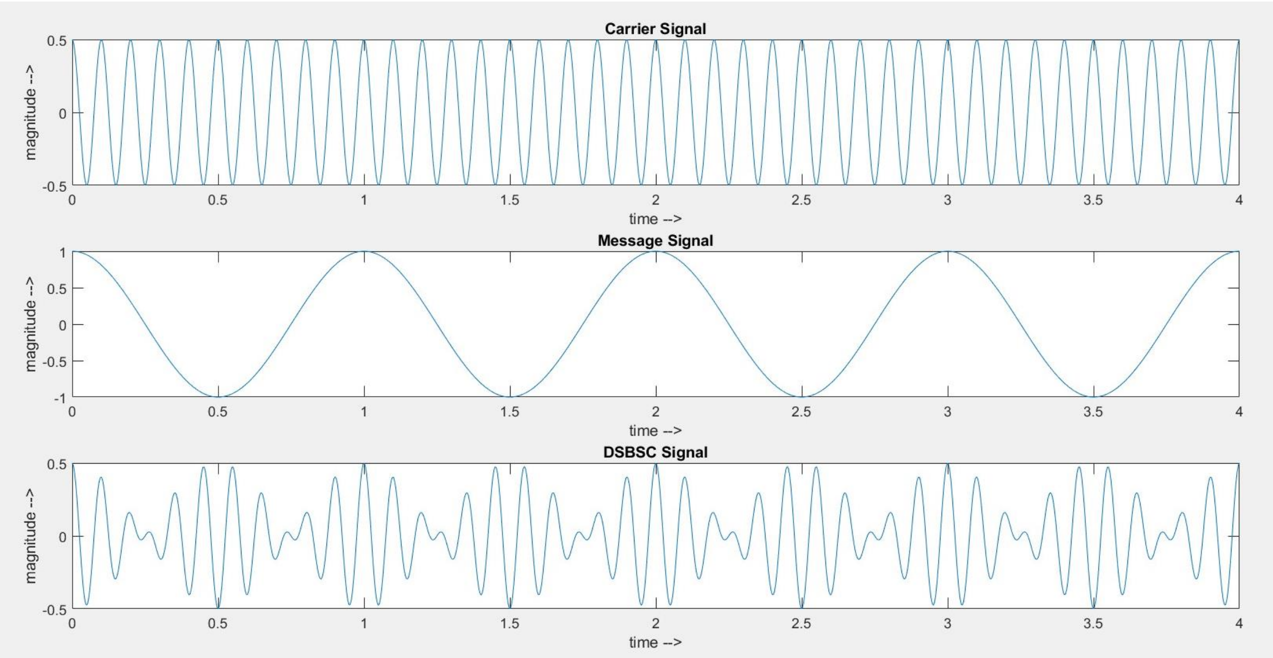

Fig 2: Generation of DSBSC Signal

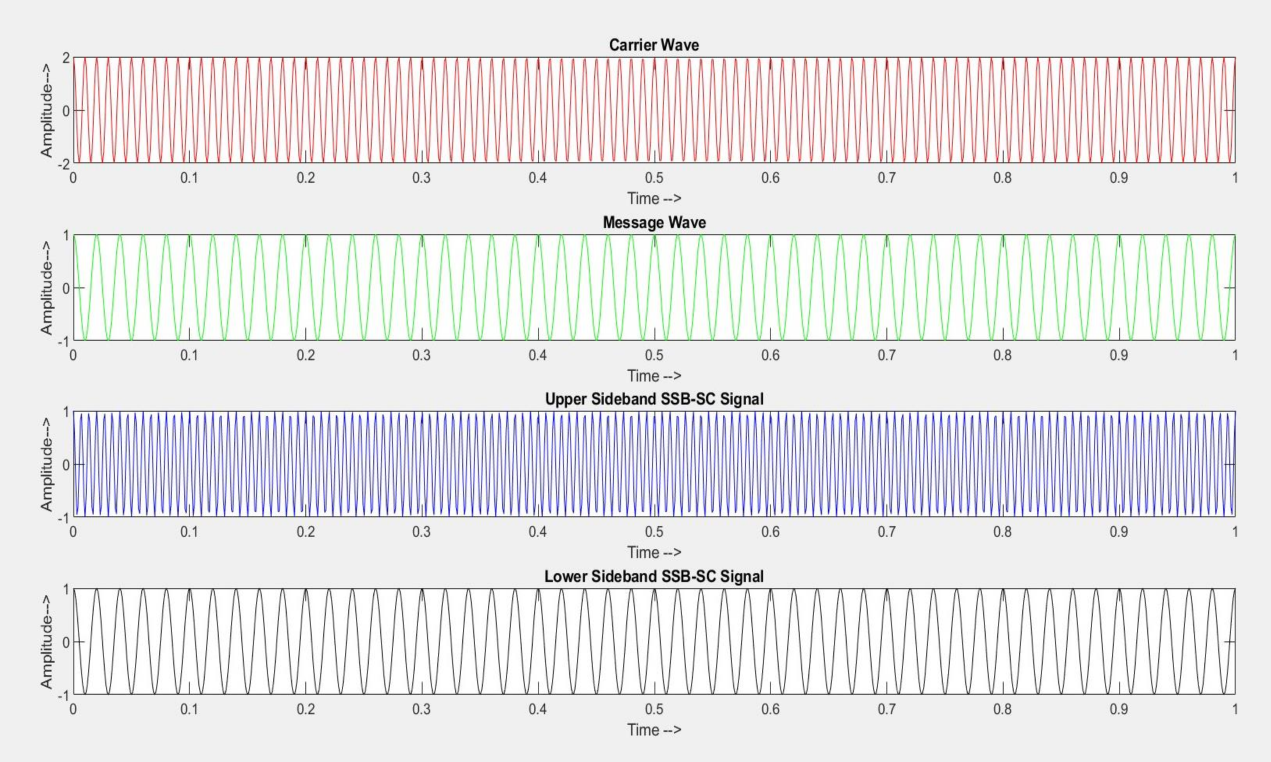

Fig 3: Generation of SSBSC Signal

Discussion or Inference of the experiment

This experiment taught me about different kind of amplitude modulation and demodulation techniques that is practiced in analog radio communication technology. It also helped me visualize the difference between the different techniques of transmission

Conclusion:-

The simulation of experiment is done successfully using MATLAB Software.

Experiment Number	02
Date of Experiment	10/08/2020
Date of Submission	17/08/2020
Name of the student	Debagnik Kar
Roll Number	1804373
Section	ETC-06

Aim of The Experiment :-

Study of Frequency modulation and Demodulation Techniques.

Equipment / Software Required:-

- MATLAB R2018a

Theory

Frequency Modulation (FM) is a form of modulation in which changes in the carrier wave frequency correspond directly to changes in the baseband signal.

Mathematically,

If the Carrier signal is

$$c(t) = \cos(2.\pi.fc.t)$$

And the message signal is

$$m(t) = \sin(2.\pi.fm.t)$$

Then the modulating signal will be,

$$s(t) = \cos[2.\pi.fc.t - \{\mu.\sin(2.\pi.fm.t)\}]$$

$$Where\ \mu = \frac{Am}{Ac}$$

Code:-

<<<File:FMModDemod.m Comment: This code generates a FM signal and Demodulates it>>

```
%Generating a FM Signal and Demodulating it
%Written by Debagnik Kar 1804373

clc;
clear all;
close all;

fc=input('Enter the carrier signal: ');
fm=input('Enter the message signal: ');
mu=input('Modulation index ');

t=linspace(0,1,1000);

c=cos(2*pi*fc*t);%carrier signal
m=sin(2*pi*fm*t);%message signal

subplot(4,1,1);
plot(t,c,'r'); %plotting the carrier signal
ylabel('amplitude');
xlabel('time');
title('Carrier signal');

subplot(4,1,2);
plot(t,m,'g'); %plotting the message signal
ylabel('amplitude');
xlabel('time');
title('Message signal');

y=cos(2*pi*fc*t-(mu*cos(2*pi*fm*t))); % FM Generation

subplot(4,1,3);
plot(t,y,'b'); % Plotting the FM Generation
ylabel('amplitude');
xlabel('time');
title('Frequency Modulated signal');

%FM Demodulation
dem = diff(y);
dem = [0,dem];
rect_dem = abs(dem)
b,a]=butter(10,0.06);
rec = filter(b,a,rect_dem);
subplot(4,1,4)
plot(t,rec,'k')
xlabel('Time')
ylabel('Amplitude')
title('Demodulated Signal')
```

Output/Graph:-

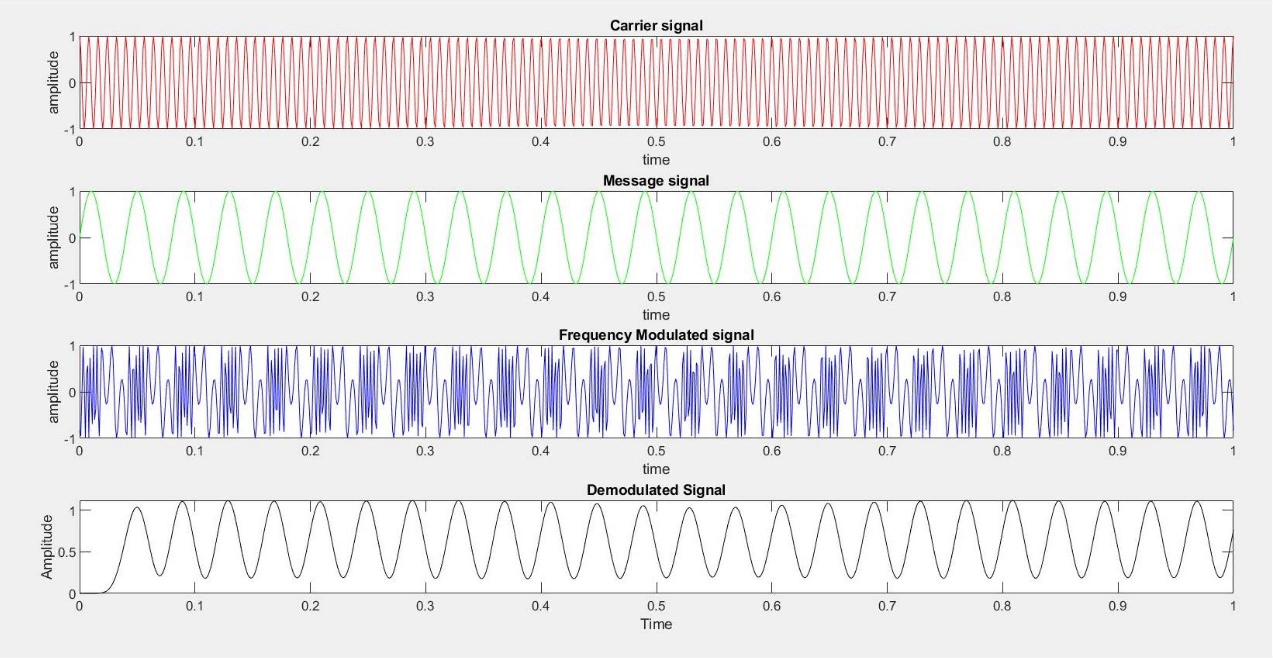

Fig 1: Generation of FM Signal and demodulating it.

Discussion or Inference of the experiment

This experiment taught me techniques of radio transmission that are currently being practiced. It also taught me the reasons that FM is better than AM in radio signal transmissions. I also learnt to demodulate a FM signal.

Conclusion:-

Simulation of experiment is done successfully