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USAR
UNIVERSITY SCHOOL OF AUTOMATION AND ROBOTICS

# Principles of Communication Systems Lab

## COURSE CODE: ARI 353

2023-2024

**SUBMITTED TO:**

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# EXPERIMENT NO-2

# AMPLITUDE MODULATION & DEMODULATION

**AIM:** To study the function of Amplitude Modulation & Demodulation (under modulation, perfect modulation & over modulation) and also to calculate the modulation index.

**APPARATUS :**

1. Amplitude Modulation & De modulation trainer kit.
2. C.R.O (20MHz)
3. Function generator (1MHz).
4. Connecting cords & probes.
5. PC with windows(95/98/XP/NT/2000)
6. MATLAB Software with communication toolbox

**THEORY:** Modulation is defined as the process of changing the characteristics (Amplitude, Frequency or Phase) of the carrier signal (high frequency signal) in accordance with the intensity of the message signal (modulating signal). Amplitude modulation is defined as a system of modulation in which the amplitude of the carrier is varied in accordance with amplitude of the message signal (modulating signal).

The message signal is given by the expression.

$E_m(t) = E_m \cos Wmt$

Where, Wm is -----> Angular frequency

$E_m$ --------◊ Amplitude

Carrier voltage $E_c(t)= E_c \cos Wct$

$E(t)=E_c + K_aE_m \cos W_m t\ KaEm$

cosWmt -----◊ change in carrier amplitude

Ka-----◊ constant

The amplitude modulated voltage is given by E=E(t) cosWct From above two equations

$E= ( E_c+KaE_m \cos W_m t) \cos Wct.$

$E= (1+KaEm/Ec \cos W_m t)\ Ec \cos Wct$

$E= E_c(1+Ma \cos W_m t)\cos Wct$

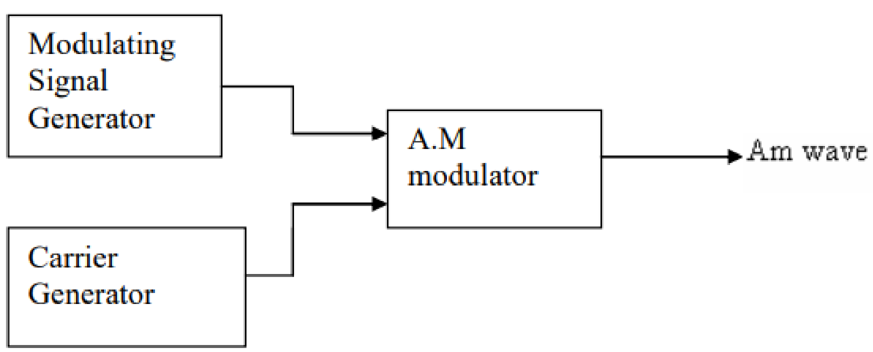
Where $M_a$-----◊ depth of modulation/ modulation index/modulation factor

$M_a=KaEm/Ec$

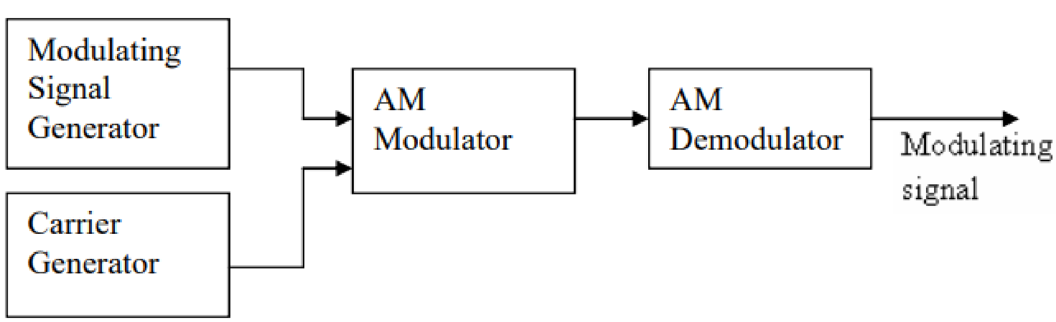
100* Ma gives the percentage of modulation.

## BLOCK DIAGRAM:

### 1.Modulation:




### 2.Demodulation:

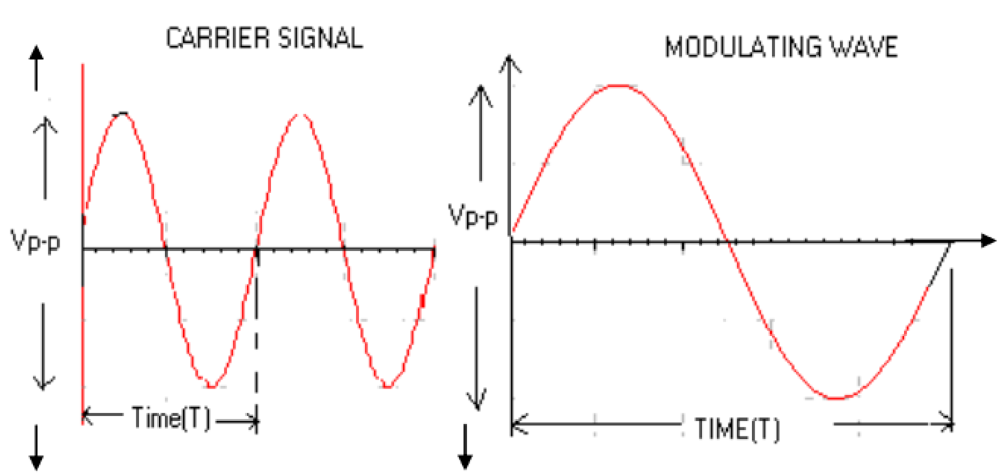


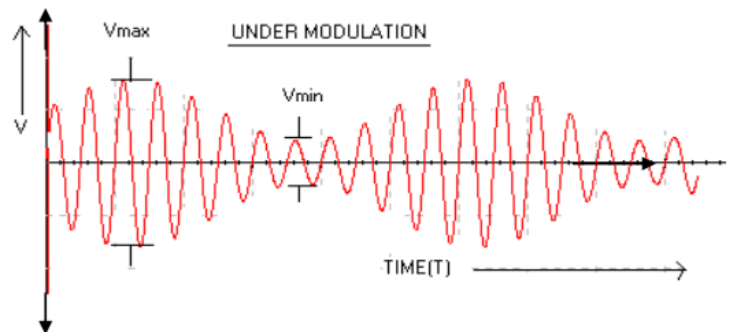
# CODE:

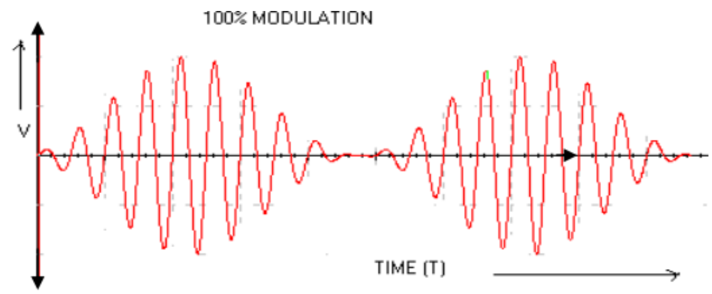
```
% program for AM modulation and demodulation
close all
clear all
clc fs=8000;
fm=20;
fc=500;
Am=1;
Ac=1;
t=[0:0.1*fs]/fs;
m=Am*cos(2*pi*fm*t);
c=Ac*cos(2*pi*fc*t);
ka=0.5; u=ka*Am;
s1=Ac*(1+u*cos(2*pi*fm*t)).*cos(2*pi*fc*t);
subplot(4,3,1:3);
plot(t,m);
title('Modulating or Message signal(fm=20Hz)');
subplot(4,3,4:6); plot(t,c);
title('Carrier signal(fc=500Hz)');
 subplot(4,3,7); plot(t,s1);
title('Under Modulated signal(ka.Am=0.5)');
Am=2;
 ka=0.5;
u=ka*Am;
s2=Ac*(1+u*cos(2*pi*fm*t)).*cos(2*pi*fc*t);
 subplot(4,3,8); plot(t,s2);
title('Exact Modulated signal(ka.Am=1)');
 Am=5;
 ka=0.5;
 u=ka*Am;
```

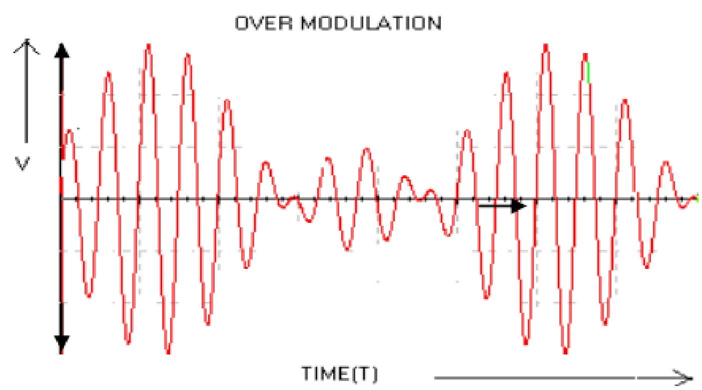
```
s3=Ac*(1+u*cos(2*pi*fm*t)).*cos(2*pi*fc*t);

subplot(4,3,9);

plot(t,s3);

title('Over Modulated signal(ka.Am=2.5)');

r1= s1.*c; [b a] = butter(1,0.01);

mr1= filter(b,a,r1);

subplot(4,3,10);

plot(t,mr1);

title(' deModulated signal for(ka.Am=0.5)');

r2= s2.*c; [b a] = butter(1,0.01);

mr2= filter(b,a,r2);

subplot(4,3,11);

plot(t,mr2);

title(' deModulated signal for(ka.Am=1)');

r3= s3.*c;

[b a] = butter(1,0.01);

mr3= filter(b,a,r3);

subplot(4,3,12);

plot(t,mr3);

title(' deModulated signal for(ka.Am=2.5)');
```

# EXPECTED WAVEFORMS:-

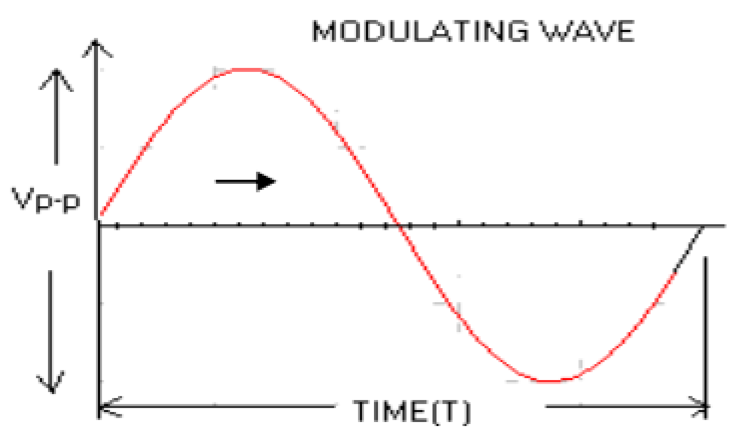




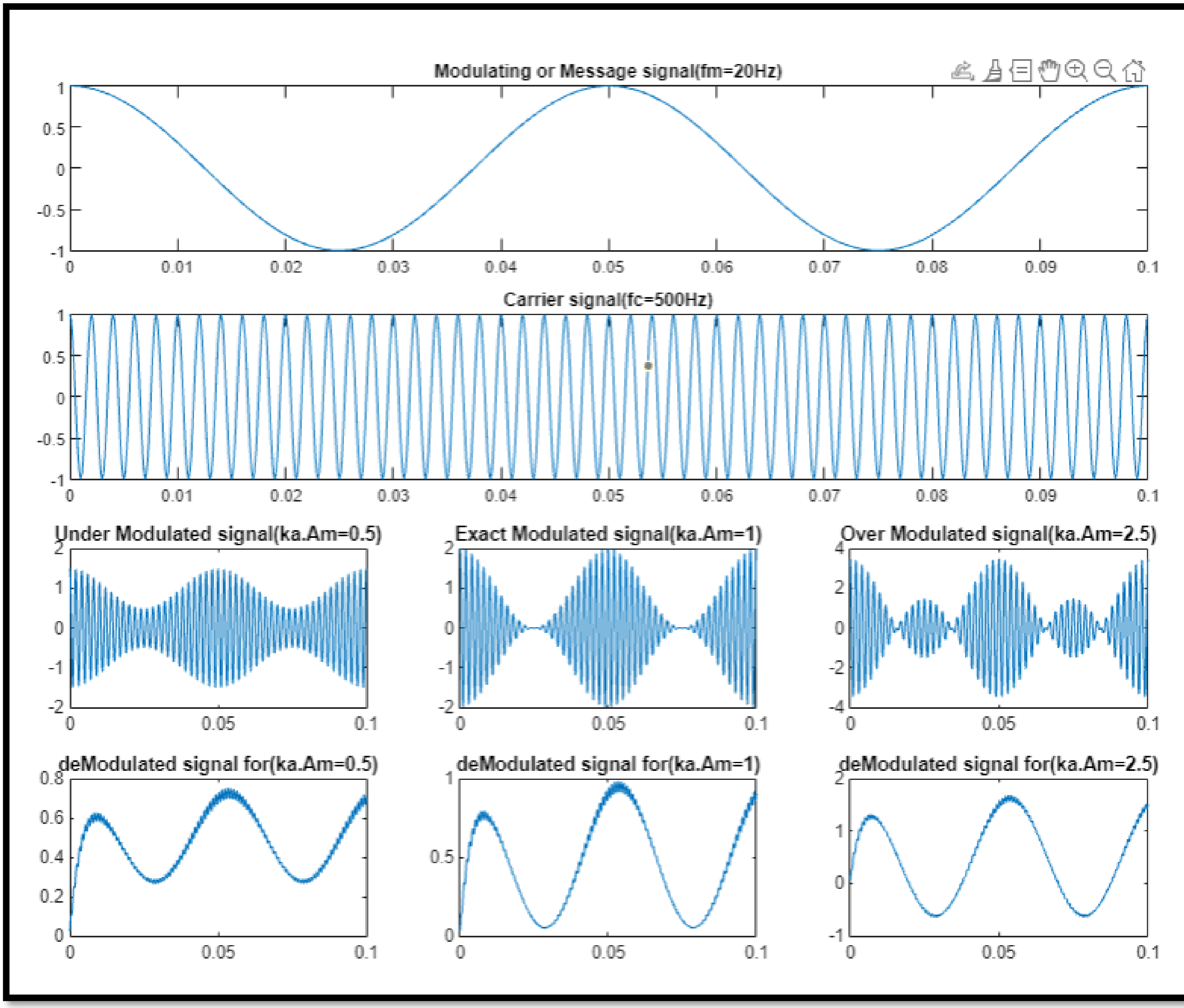




## Demodulated signal



**RESULT:**



Modulating or Message signal(fm=20Hz)
Carrier signal(fc=500Hz)
Under Modulated signal(ka.Am=0.5)
Exact Modulated signal(ka.Am=1)
Over Modulated signal(ka.Am=2.5)
deModulated signal for(ka.Am=0.5)
deModulated signal for(ka.Am=1)
deModulated signal for(ka.Am=2.5)

# EXPERIMENT NO-3

# DSB-SC MODULATOR & DETECTOR

**AIM:** To study the working of the Balanced Modulator and demodulator.

**APPARATUS:**

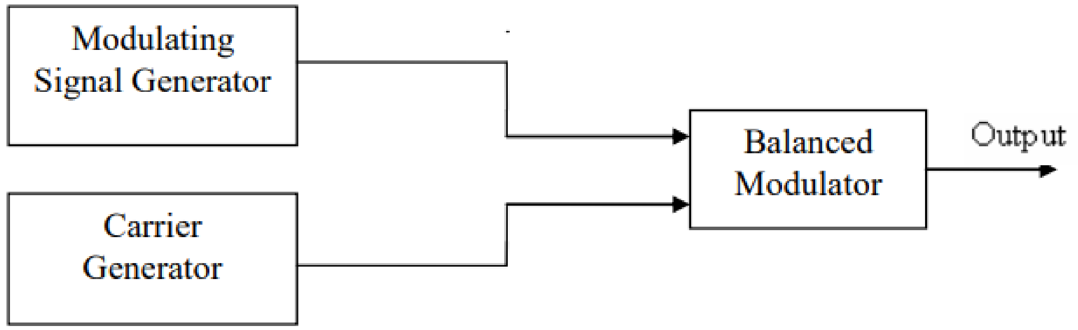
1. Balanced modulator trainer kit
2. C.R.O (20MHz)
3. Connecting cords and probes
4. Function generator (1MHz)
5. PC with windows (95/98/XP/NT/2000)
6. MATLAB Software with communication toolbox

**THEORY:** Balanced modulator circuit is used to generate only the two side bands DSB-SC. The balanced modulation system is a system is a system of adding message to carrier wave frequency there by only the side bands are produced. It consists of two AM modulators arranged in a balanced configuration. The AM modulator is assumed to be identical. The carrier input to the two modulators is same. If we eliminate or suppress the carrier then the system becomes suppressed carrier DSB-SC. In this we need reinsert the carrier is complicated and costly. Hence the suppressed carrier DSB system may be used in point-to-point communication system. Generation of suppressed carrier amplitude modulated volt balanced modulator may be of the following types.

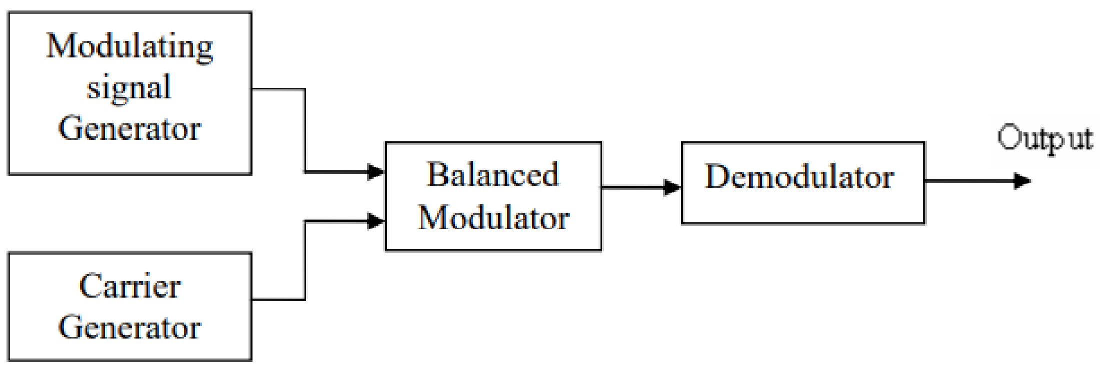
1. Using transistors or FET.
2. Using Diodes

# BLOCK DIAGRAM:

## 1.Modulation:




## 2.Demodulation:

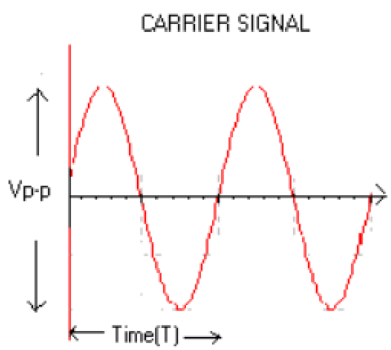


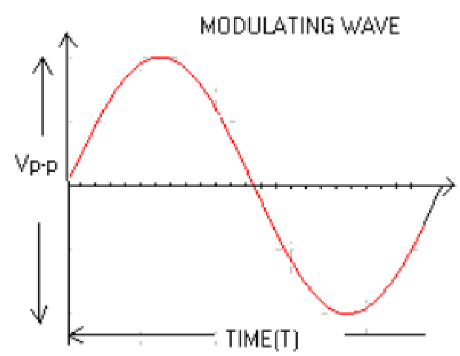

# CODE:

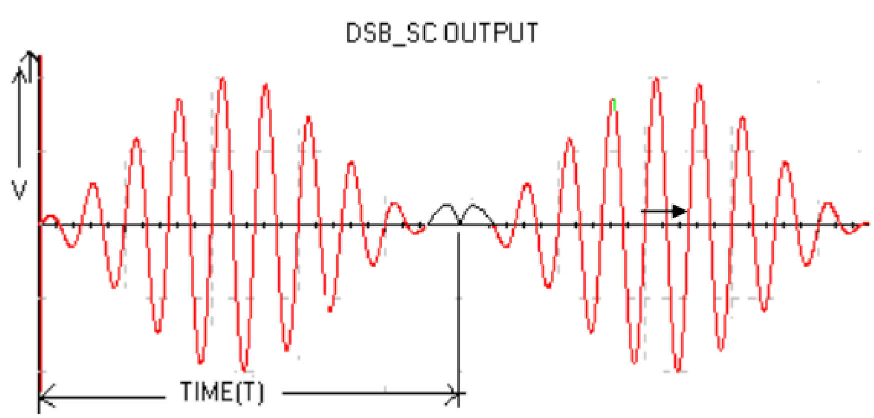
```
% program for dsbsc modulation and demodulation
close all
clear all clc
 t =0:0.000001:.001;
 Vm= 1;
 Vc= 1;
fm = 2000;
fc= 50000;
m_t = Vm*sin(2*pi*fm*t);
subplot(4,1,1);
plot(t,m_t);
```

```
c_t = Vc*sin(2*pi*fc*t);
subplot(4,1,2);
plot(t,c_t);
subplot(4,1,3);
s_t = m_t.*c_t;
hold on;
plot(t,s_t);
plot(t,m_t,'r:');
plot(t,-m_t,'r:');
hold off;
r = s_t.*c_t;
[b a] = butter(1,0.01);
mr= filter(b,a,r);
subplot(4,1,4);
```

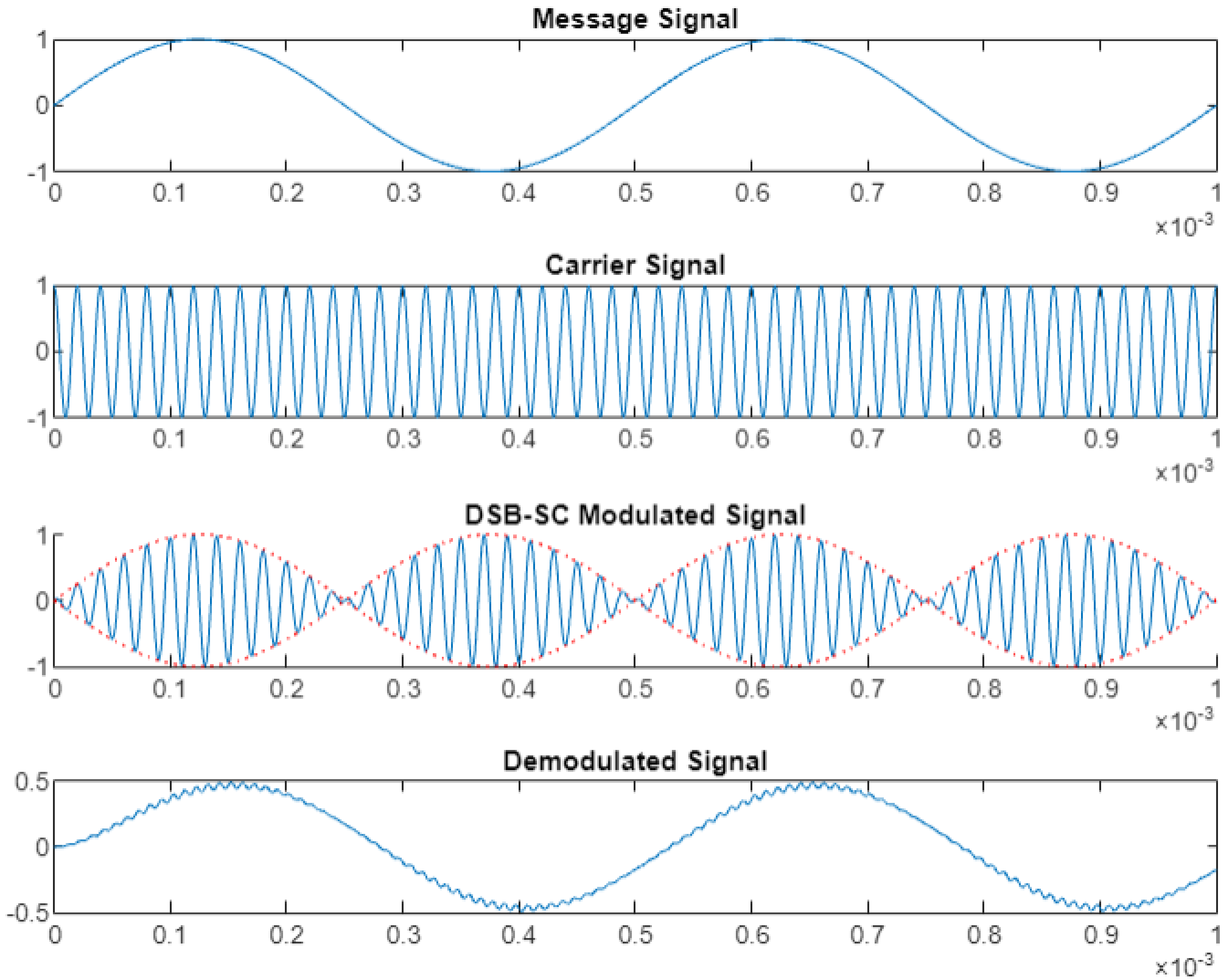
## EXPECTED WAVEFORM:



## RESULT:



Message Signal
Carrier Signal
DSB-SC Modulated Signal
Demodulated Signal
1
0
-1
0.5
-0.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
×10^-3

# EXPERIMENT.NO-4

# SSB-SC MODULATOR & DETECTOR

# (PHASE SHIFT METHOD)

**AIM:-** To generate SSB using phase method and detection of SSB signal using Synchronous detector.

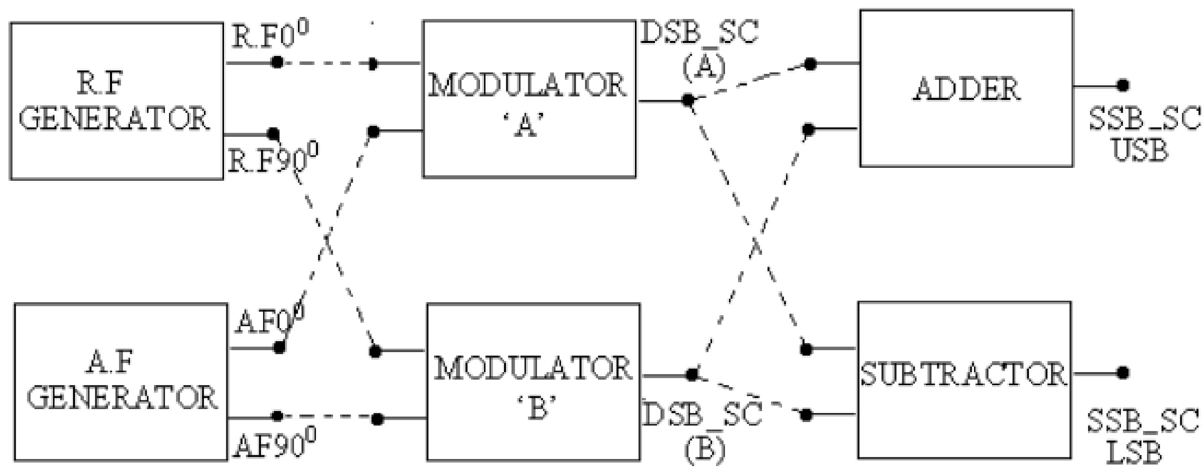
**APPARATUS:-**

1. SSB trainer kit
2. C.R.O (20MHz)
3. Patch cards
4. CRO probes

**THEORY:** AM and DSBSC modulation are wasteful of band width because they both require a transmission bandwidth which is equal to twice the message bandwidth In SSB only one side band and the carrier is used. The other side band is suppressed at the transmitter, but no information is lost. Thus the communication channel needs to provide the same band width, when only one side band is transmitted. So the modulation system is referred to as SSB system. The base band signal may not be recovered from a SSB signal by the Use of a diode modulator. The bae band signal can be recovered if the spectral component of the output i.e either the LSB or USB is multiplied by the carrier signal. Consider the modulating signal M(t)=Am cos Wmt C(t)=Ac cosWct M(t)c(t)= AcAm cosWmt cosWct The above signal when passed through a filter, only one of the above component is obtained which lays the SSB signal.

## BLOCK DIAGRAM: -

SSB MODULATION



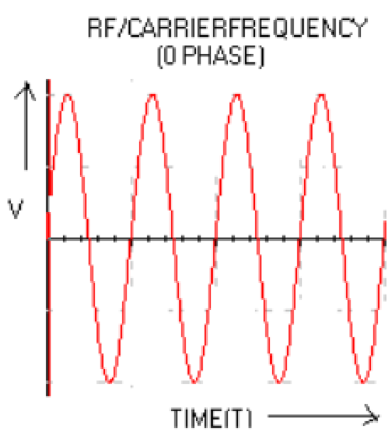

SSB DEMODULATION/SYNCHRONOUS DETECTOR

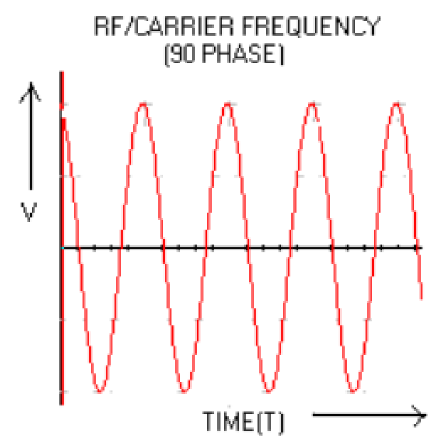

## CODE:

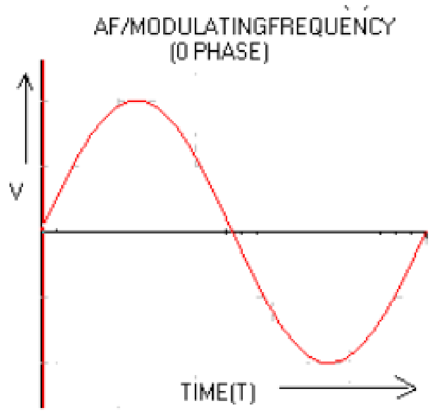
```
% program for ssb modulation and demodulation
close all
clear all
clc fs=8000;
fm=20;
fc=50; Am=1; Ac=1;
t=[0:0.1*fs]/fs;
subplot(5,1,1);
m1=Am*cos(2*pi*fm*t);
plot(t,m1);
title('Message Signal');
```

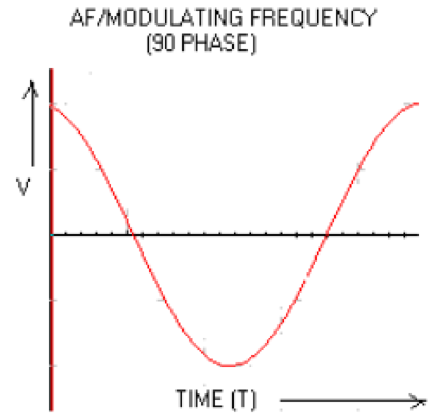
```
m2=Am*sin(2*pi*fm*t);

subplot(5,1,2)

c1=Ac*cos(2*pi*fc*t);

 plot(t,c1) title('Carrier Signal');

c2=Ac*sin(2*pi*fc*t);

subplot(5,1,3)

 % Susb=0.5* Am*cos(2*pi*fm*t).* Ac*cos(2*pi*fc*t) -- 0.5* Am*sin(2*pi*fm*t).* 
Ac*sin(2*pi*fc*t);

Susb=0.5*m1.*c1-0.5*m2.*c2;

plot(t,Susb);

 title('SSB-SC Signal with USB');

 subplot(5,1,4);

Slsb=0.5*m1.*c1+0.5*m2.*c2; plot(t,Slsb);

title('SSB-SC Signal with LSB');

 r = Susb.*c1;

 subplot(5,1,5);

 [b a] = butter(1,0.0001);

mr= filter(b,a,r);

plot(t,mr);
```

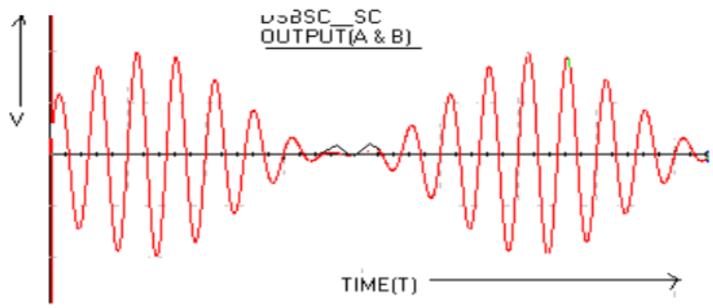
## EXPECTED WAVE FORMS: -

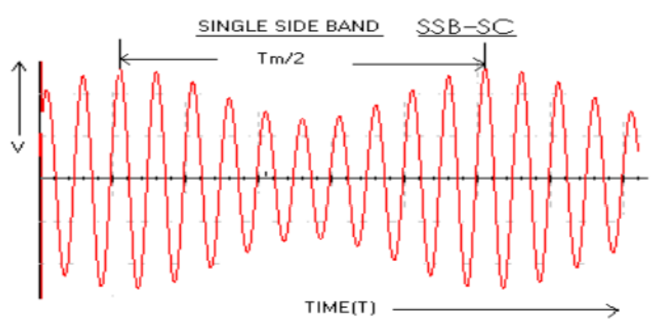


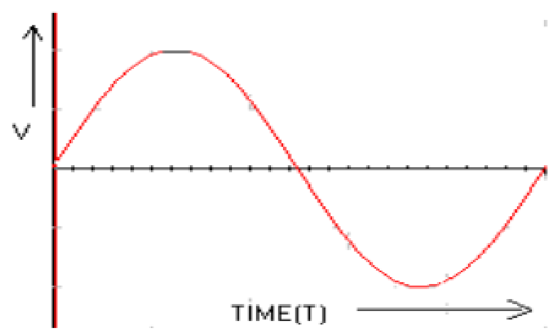


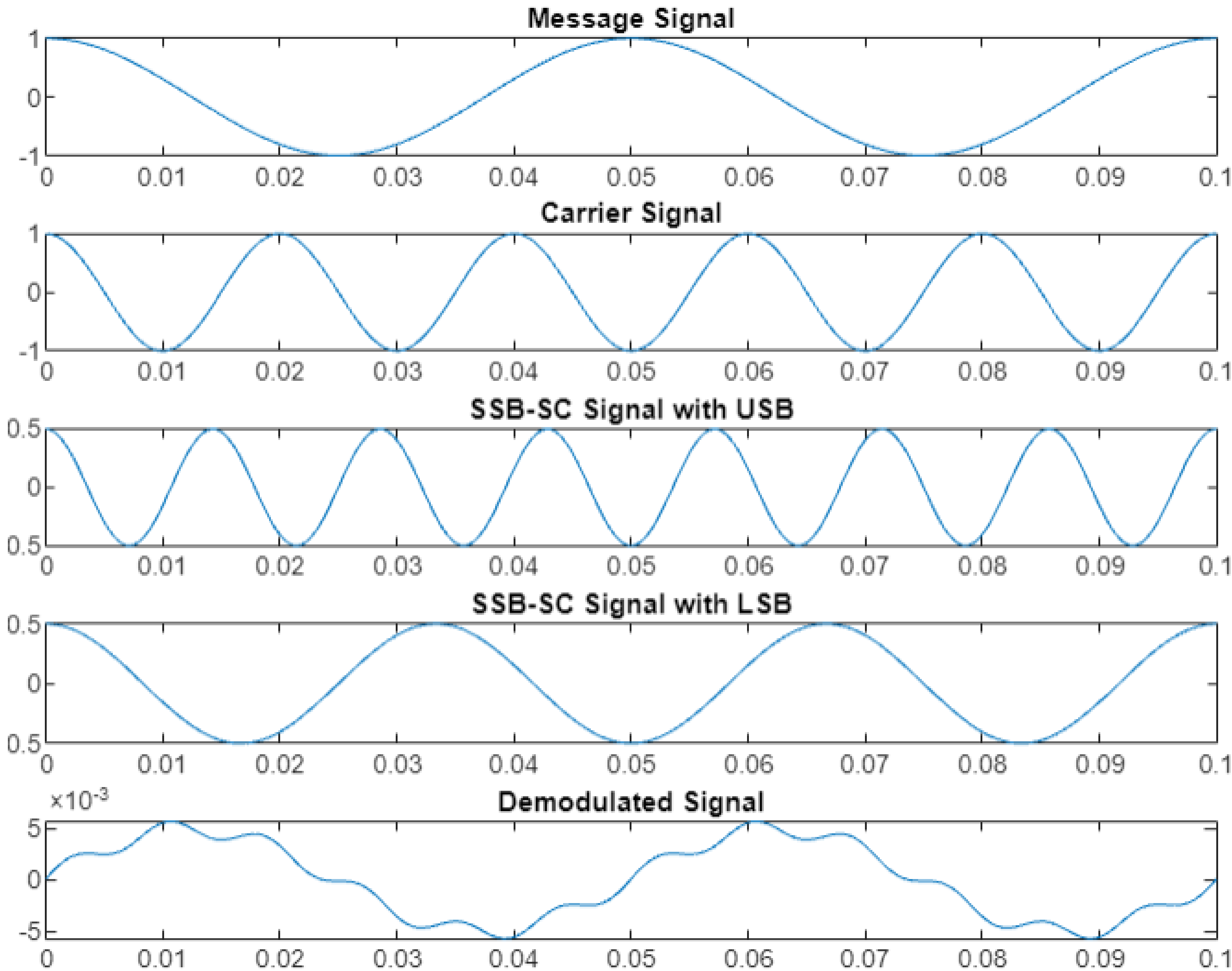




**SSB DEMODULATED OUTPUT**



**RESULT:**



Message Signal
Carrier Signal
SSB-SC Signal with USB
SSB-SC Signal with LSB
Demodulated Signal
×10-3