Communications Lab

Experiment No. 1

Amplitude Modulation (AM) and Demodulation

190020039

a. Conventional AM technique

CODE:

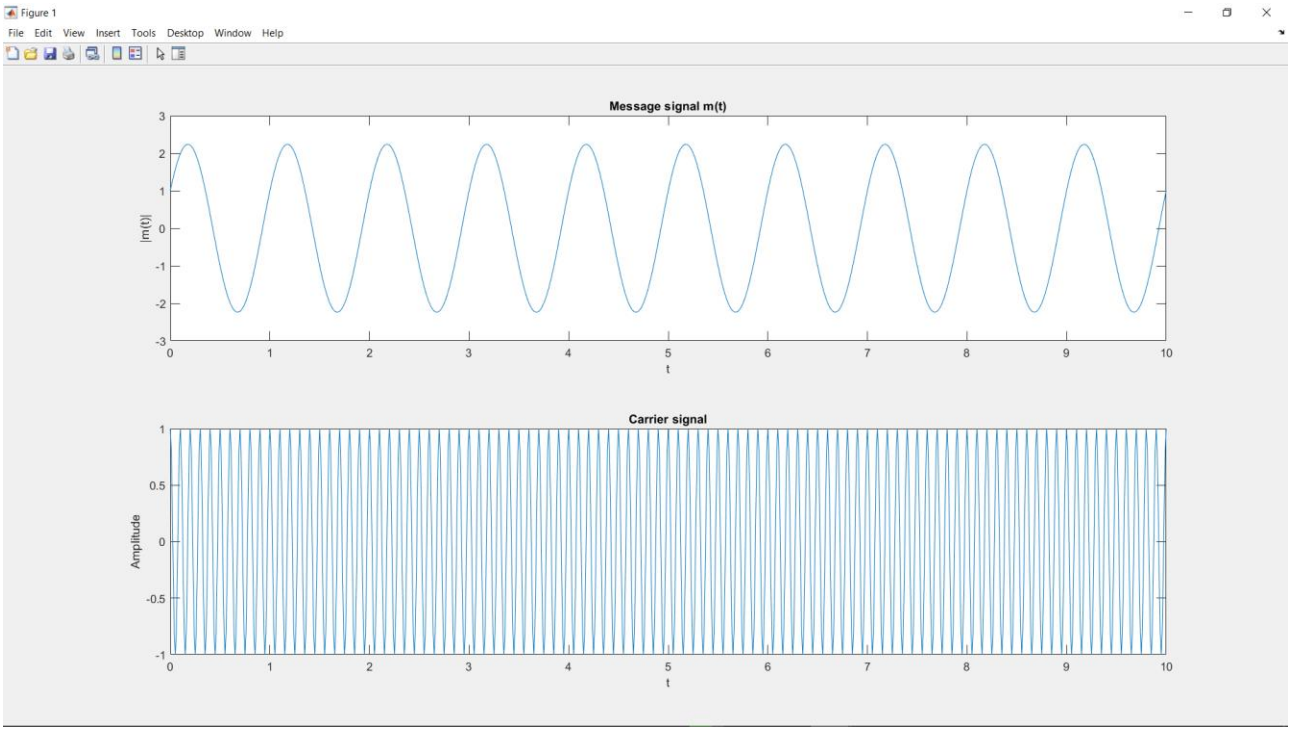
```
clear all
fs=100; %sampling freq
t=0:1/fs:10; %declaring time array
m=2*sin(2*pi*t)+cos(2*pi*t); %message signal

fc=10; %carrier freq
amod=0.8; %modulation index
Mo=abs(min(m)); %min t of m(t)
A=1;
Ac=A*Mo/amod;

uam=(A*m+Ac).*cos(2*pi*fc*t); %conventional AM signal

%conventional AM signal in FREQ domain
Uam1=fft(uam); %FT of AM sig (not centered around 0)
Uam=fftshift(Uam1);
n=length(uam);
f1=(-n/2:n/2-1)*fs/n; %freq array for AM signal

%demodulated signal
```

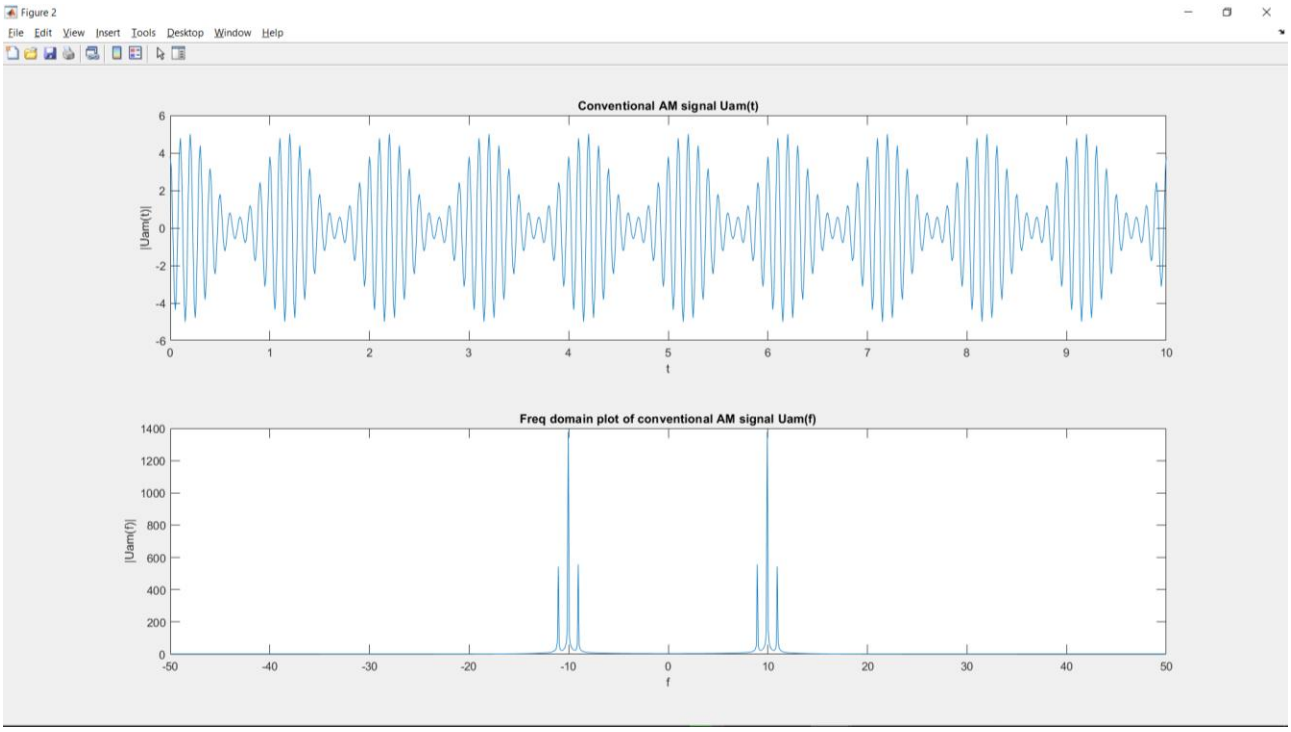
```
%envelope func detects the upper peak envelope
%Ac is subtracted to get original signal
dmd=envelope(uam,1,'peak')-Ac;

%demodulated signal in FREQ domain
Dmd1=fft(dmd); %FT of demodulated signal (not centered around 0)
Dmd=fftshift(Dmd1);
n=length(dmd);
f2=(-n/2:n/2-1)*fs/n; %freq array for demodulated signal

%plotting message signal
figure(1);
subplot(2,1,1);
plot(t,m)
title("Message signal m(t)")
xlabel("t")
ylabel("|m(t)|")

%plotting carrier signal
figure(1);
subplot(2,1,2);
plot(t,cos(2*pi*fc*t))
title("Carrier signal")
xlabel("t")
ylabel("Amplitude")
```

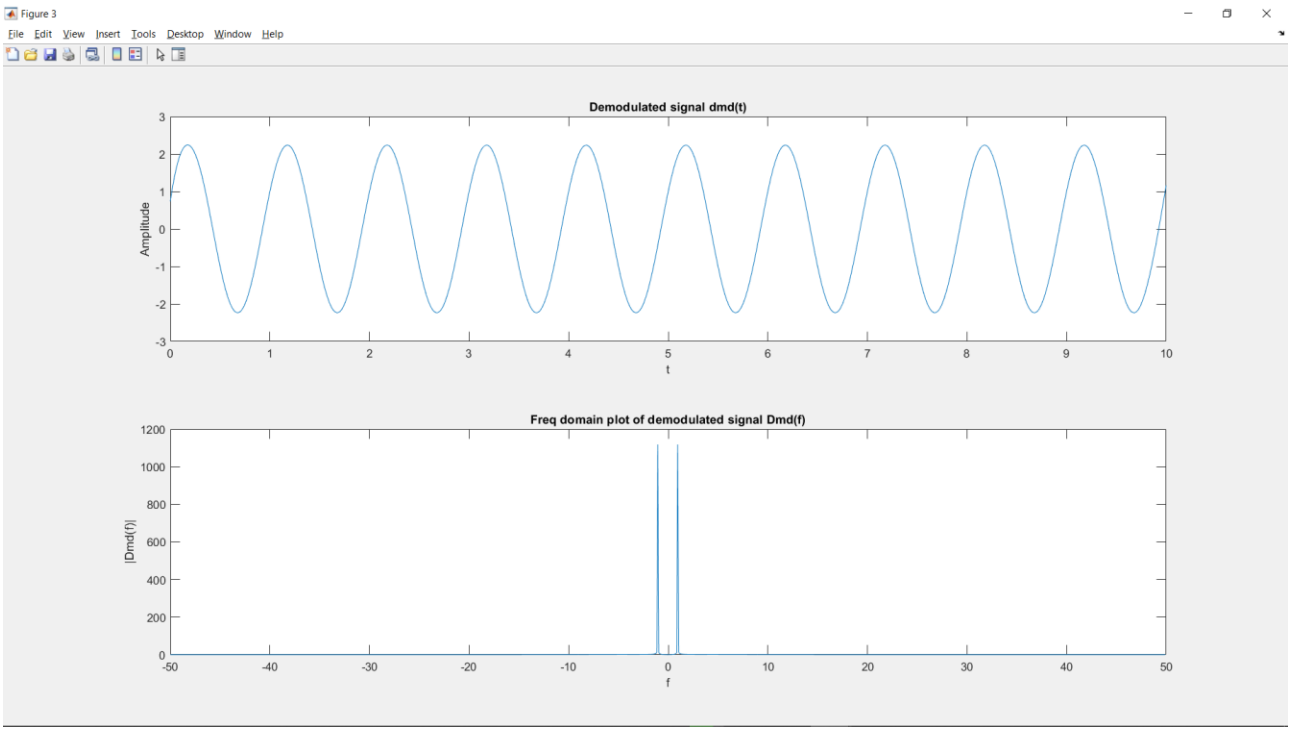
```
%plotting conventional AM signal in time domain
figure(2);
subplot(2,1,1);
plot(t,uam)
title("Conventional AM signal Uam(t)")
xlabel("t")
ylabel("|Uam(t)|")

%plotting freq domain plot of conventional AM signal
figure(2);
subplot(2,1,2);
plot(f1,abs(Uam))
title("Freq domain plot of conventional AM signal Uam(f)")
xlabel("f")
ylabel("|Uam(f)|")

%plotting Demodulated signal in time domain
figure(3);
subplot(2,1,1);
plot(t,dmd)
title("Demodulated signal dmd(t)")
xlabel("t")
ylabel("Amplitude")

%plotting freq domain plot of demodulated signal
figure(3);
```

```
subplot(2,1,2);
plot(f2,abs(Dmd))
title("Freq domain plot of demodulated signal Dmd(f)")
xlabel("f")
ylabel("|Dmd(f)|")
```

OUTPUT PLOTS:







Inferences/Observations:

Shape of message signal can be seen in Amplitude envelope of AM signal.

The demodulated signal is same as the message signal.

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b. Double Sideband Suppressed Carrier (DSB SC) modulation technique

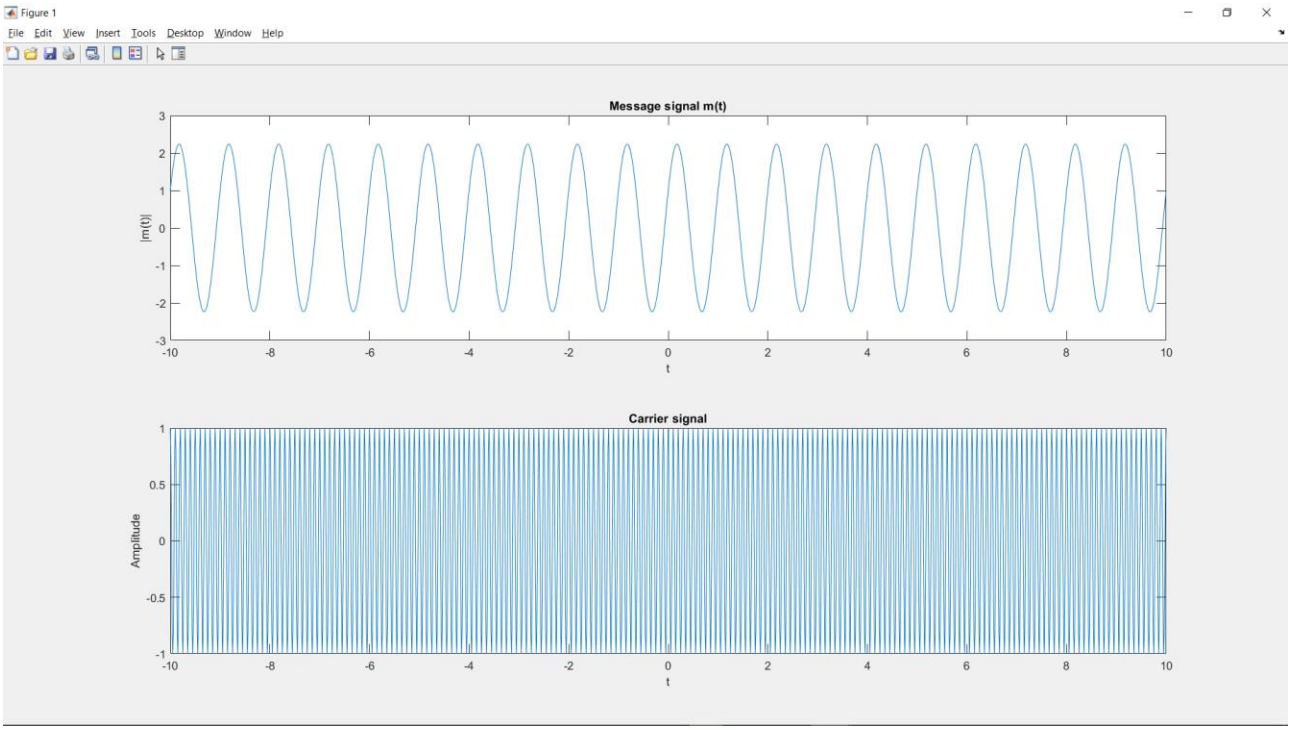
CODE:

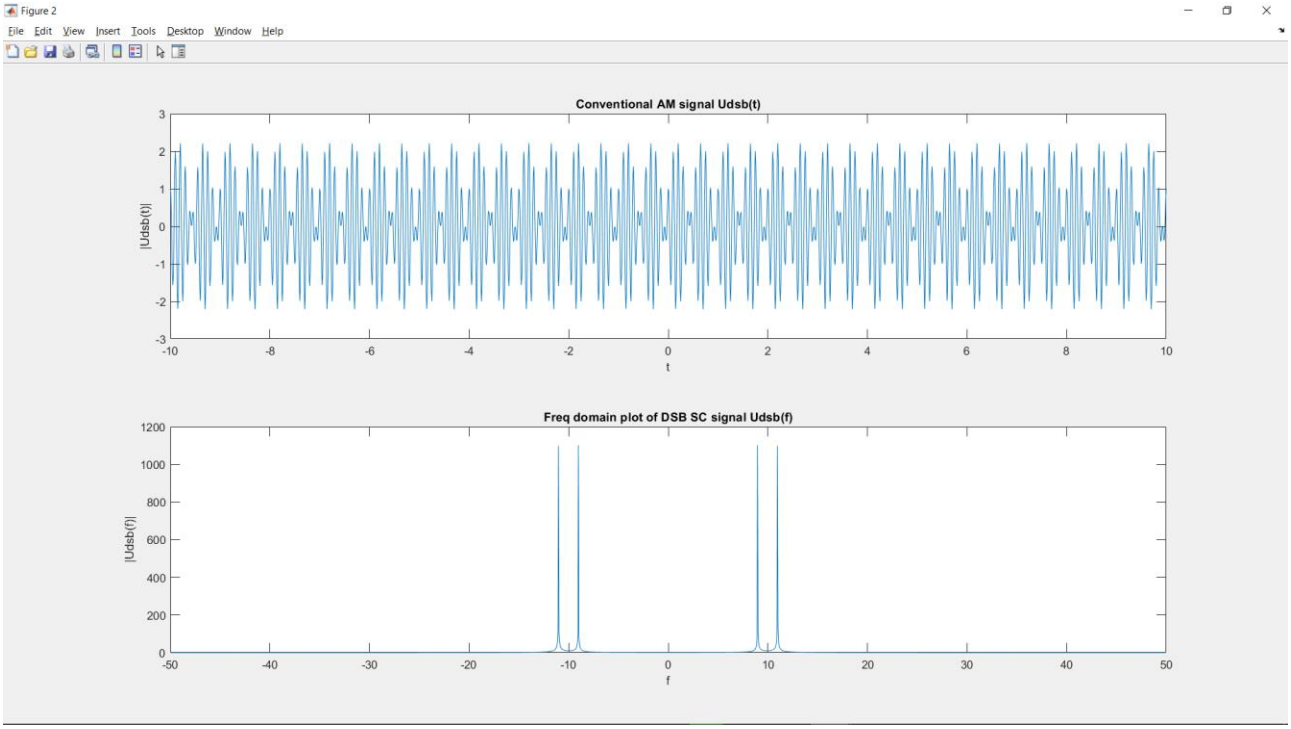
```
clear all

fs=100; %sampling freq

t=-10:1/fs:10; %declaring time array

m=2*sin(2*pi*t)+cos(2*pi*t); %message signal


fc=10; %carrier freq

A=1;


udsb=A*m.*cos(2*pi*fc*t); %DSB SC signal


%DSB SC signal in FREQ domain

Udsb1=fft(udsb); %FT of DSB SC sig (not centered around 0)

Udsb=fftshift(Udsb1);

n=length(Udsb);

f1=(-n/2:n/2-1)*fs/n; %freq array for DSB SC signal


%demodulated signal

dmd1=2*udsb.*cos(2*pi*fc*t);

dmd=lowpass(dmd1,fc/3,fs);


%demodulated signal in FREQ domain

Dmd1=fft(dmd); %FT of demodulated signal (not centered around 0)
```

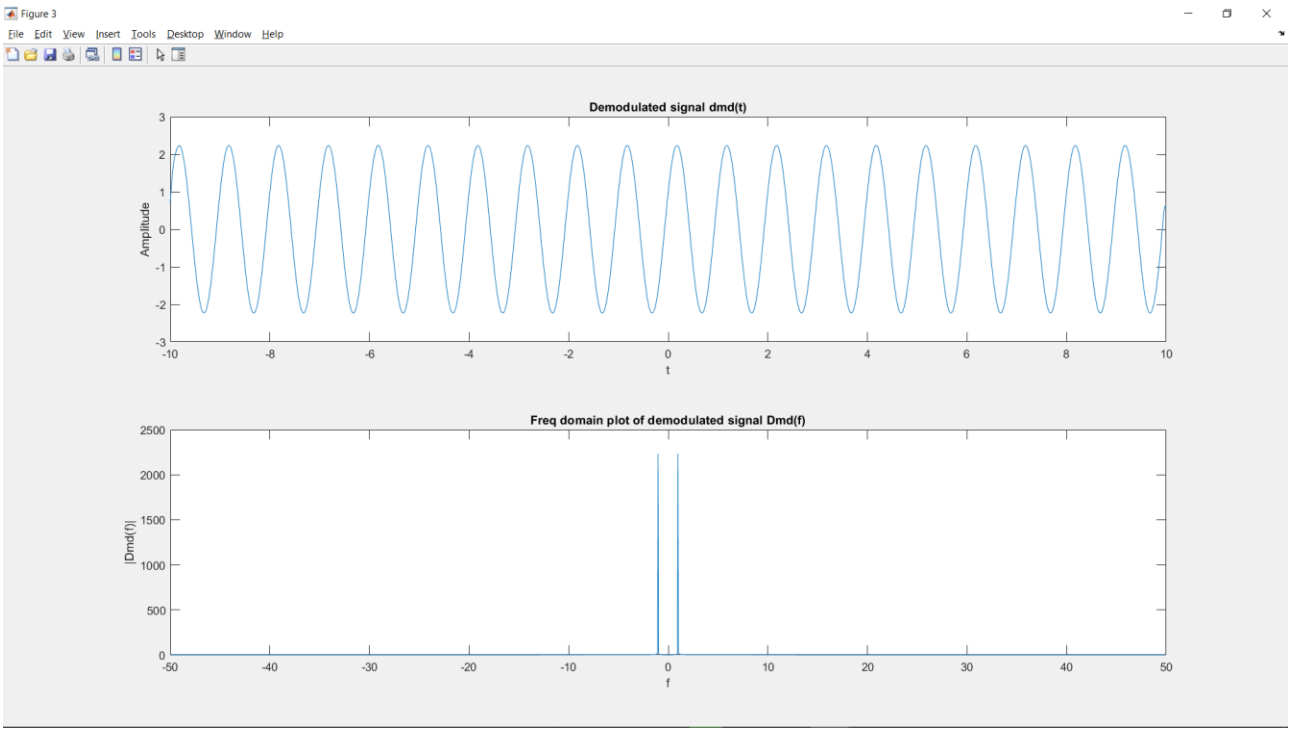
```
Dmd=fftshift(Dmd1);
n=length(dmd);
f2=(-n/2:n/2-1)*fs/n; %freq array for demodulated signal

%plotting message signal
figure(1);
subplot(2,1,1);
plot(t,m)
title("Message signal m(t)")
xlabel("t")
ylabel("|m(t)|")

%plotting carrier signal
figure(1);
subplot(2,1,2);
plot(t,cos(2*pi*fc*t))
title("Carrier signal")
xlabel("t")
ylabel("Amplitude")

%plotting DSB SC signal
figure(2);
subplot(2,1,1);
plot(t,udsb)
title("Conventional AM signal Udsb(t)")
xlabel("t")
```

```
ylabel("|Udsb(t)|")

%plotting freq domain plot of DSB SC signal
figure(2);
subplot(2,1,2);
plot(f1,abs(Udsb))
title("Freq domain plot of DSB SC signal Udsb(f)")
xlabel("f")
ylabel("|Udsb(f)|")

%plotting Demodulated signal in time domain
figure(3);
subplot(2,1,1);
plot(t,dmd)
title("Demodulated signal dmd(t)")
xlabel("t")
ylabel("Amplitude")

%plotting freq domain plot of demodulated signal
figure(3);
subplot(2,1,2);
plot(f2,abs(Dmd))
title("Freq domain plot of demodulated signal Dmd(f)")
xlabel("f")
ylabel("|Dmd(f)|")
```

OUTPUT PLOTS:







Inferences/Observations:

The freq domain plot of DSB SC signal has both USB and LSB component but no component at fc.

The demodulated signal is same as message signal.

———

c. Single Sideband Suppressed Carrier (SSB SC) modulation technique

CODE:

```
clear all

fs=100; %sampling freq

t=-10:1/fs:10; %declaring time array

m=2*sin(2*pi*t)+cos(2*pi*t); %message signal

mh=imag(hilbert(m)); %hilbert transform of m(t)


fc=10; %carrier freq


ussb=m.*cos(2*pi*fc*t)-mh.*sin(2*pi*fc*t); %DSB signal
```

```
%SSB SC signal in FREQ domain
Ussb1=fft(ussb); %FT of DSB SC sig (not centered around 0)
Ussb=fftshift(Ussb1);
n=length(Ussb);
f1=(-n/2:n/2-1)*fs/n; %freq array for DSB SC signal

%demodulated signal
dmd1=2*ussb.*cos(2*pi*fc*t);
dmd=lowpass(dmd1,fc/3,fs);

%demodulated signal in FREQ domain
Dmd1=fft(dmd); %FT of demodulated signal (not centered around 0)
Dmd=fftshift(Dmd1);
n=length(dmd);
f2=(-n/2:n/2-1)*fs/n; %freq array for demodulated signal

%SSB SC in freq domain
Ussb1=fft(ussb); %FT of AM sig (not centered around 0)
Ussb=fftshift(Ussb1);
n=length(ussb);
f=(-n/2:n/2-1)*fs/n; %freq array

%plotting message signal
figure(1);
subplot(2,1,1);
```

```
plot(t,m)
title("Message signal m(t)")
xlabel("t")
ylabel("|m(t)|")

%plotting carrier signal
figure(1);
subplot(2,1,2);
plot(t,cos(2*pi*fc*t))
title("Carrier signal")
xlabel("t")
ylabel("Amplitude")

%plotting SSB SC signal Ussb(t)
figure(2);
subplot(2,1,1);
plot(t,ussb)
title("SSB SC signal Ussb(t)")
xlabel("t")
ylabel("|Ussb(t)|")

%plotting freq domain SSB SC signal Ussb(f)
figure(2);
subplot(2,1,2);
plot(f,abs(Ussb))
title("SSB SC signal Ussb(f)")
```

```
xlabel("f")
ylabel("|Ussb(f)|")

%plotting Demodulated signal in time domain
figure(3);
subplot(2,1,1);
plot(t,dmd)
title("Demodulated signal dmd(t)")
xlabel("t")
ylabel("Amplitude")

%plotting freq domain plot of demodulated signal
figure(3);
subplot(2,1,2);
plot(f2,abs(Dmd))
title("Freq domain plot of demodulated signal Dmd(f)")
xlabel("f")
ylabel("|Dmd(f)|")
```

OUTPUT PLOT:

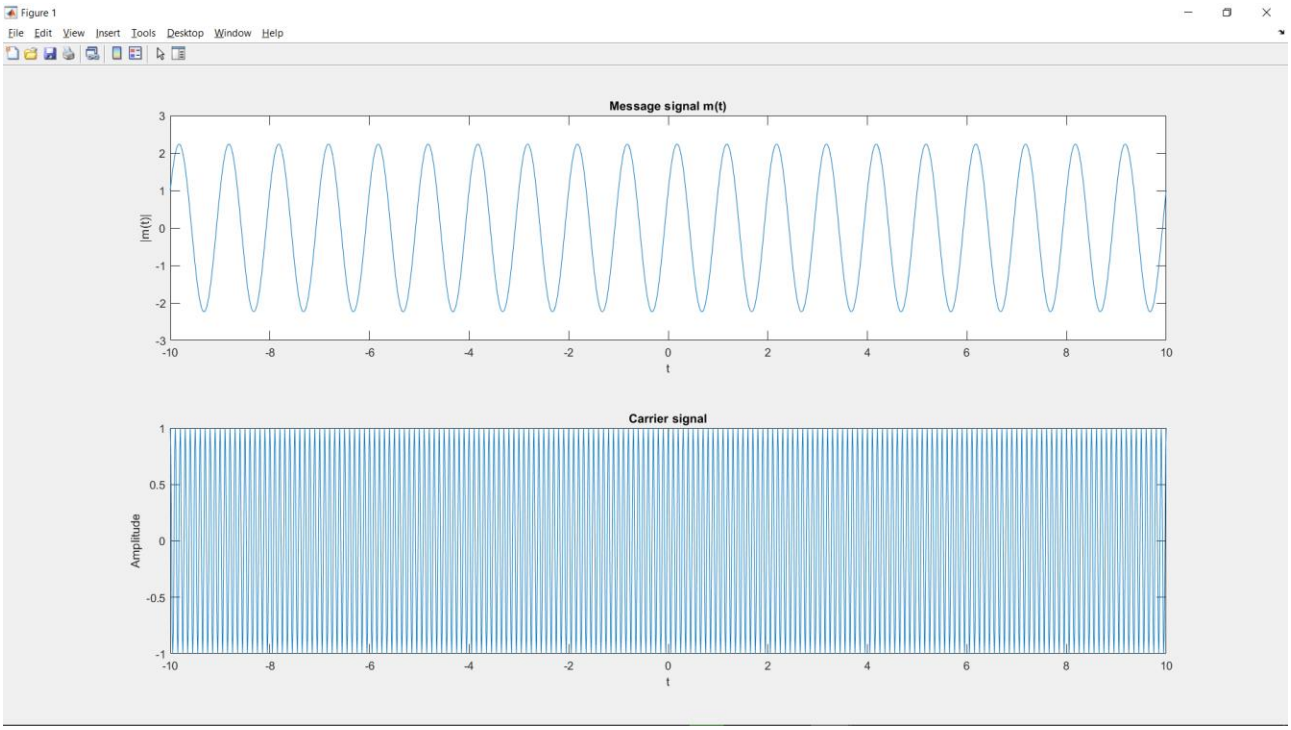


Figure 1
File Edit View Insert Tools Desktop Window Help
Message signal m(t)
|m(t)|
t
Carrier signal
Amplitude
t

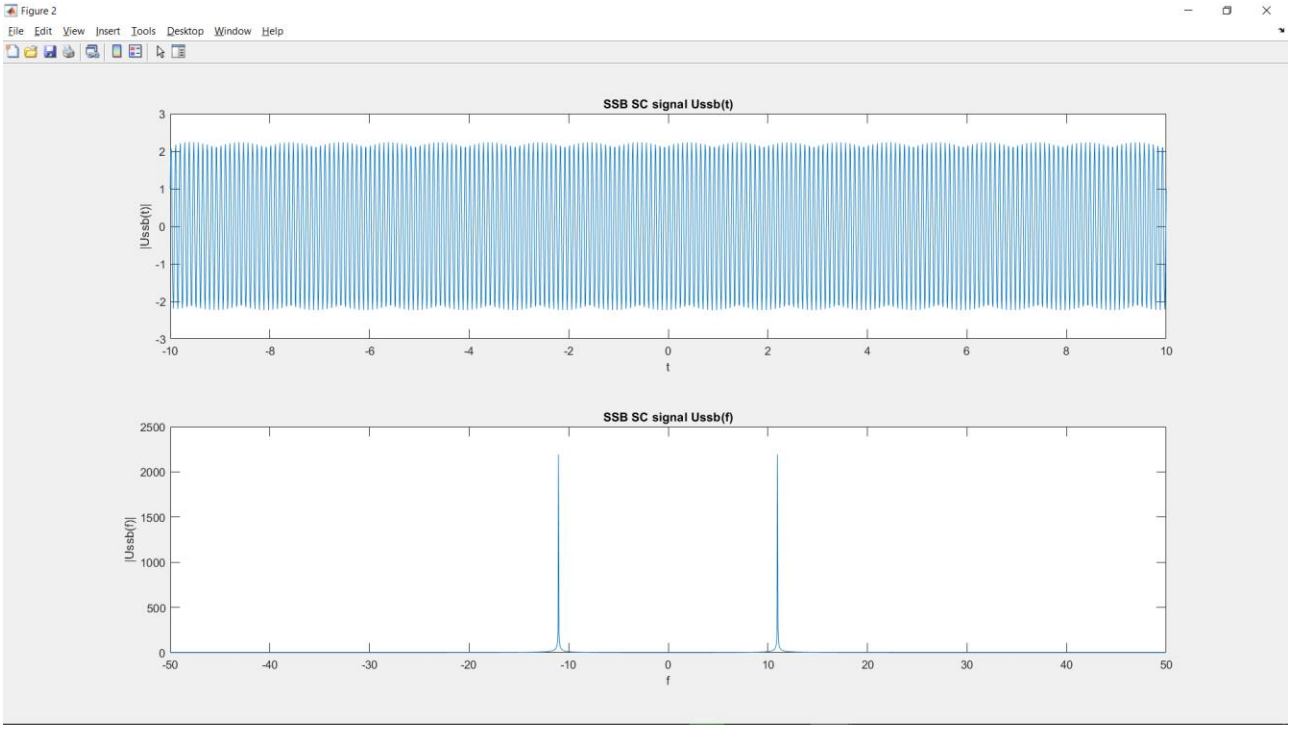
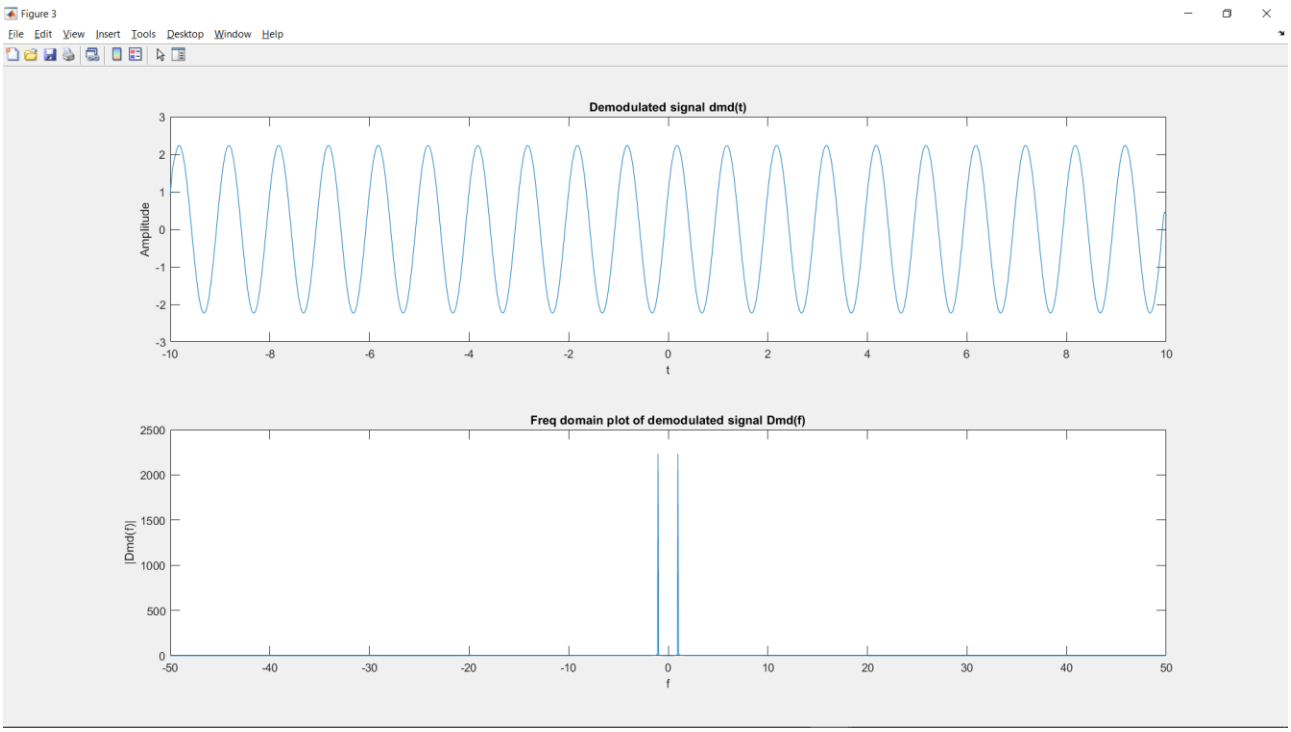


Figure 2
File Edit View Insert Tools Desktop Window Help
SSB SC signal Ussb(t)
|Ussb(t)|
t
SSB SC signal Ussb(f)
|Ussb(f)|
f



Inferences/Observations:

The freq domain plot of SSB SC signal has freq only in the USB and no component at fc.

The demodulated signal is same as message signal.