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(a) Conventional AM :

The message Signal is $m(t) = A_m \cos(2\pi f_m t)$
and carrier $c(t) = A_c \cos(2\pi f_c t)$

$A_m = 5$, $f_m = 5$, $f_c = 500$

and modulation index (m) as 1.

$$A_c = \frac{A_m}{m} = 5/1 = 5$$

AM modulated Signal is :

$$y = A_c \cdot (1 + m \cos(2\pi f_m t)) \cdot \cos(2\pi f_c t)$$

The amplitude of Am ~~bodter~~ modulated Signal varies as $\cos(2\pi f_m t)$ with maximum value as $(A_c + A_m)$ and minimum value as $(A_c - A_m)$.

Upon demodulation we get ~~the~~ back the ~~mess~~ message Signal which is Same as the ~~am~~ message Signal.
For demodulation, modulated Signal is multiplied with $\cos(2\pi f_c t)$ and passed with low pass filter of order 2.

The frequency domain plots shows that we have equal impulse at (f_m+f_c), (f_m-f_c), ; (f_c-f_m), $-(f_m+f_c)$ and also at $\pm f_c$ which can clearly be seen from the plot.

Also, from the frequency domain plot of demodulated signal we have impulses at $\pm f_m$.
This shows that modulation and demodulation was done successfully.

(b) DSB-SC

Message signal is $m(t) = A_m \sin(2\pi f_m t)$

Carrier $c(t) = A_c \cos(2\pi f_c t)$

With $A_m = \frac{1}{2}$, $A_c = 1$, $f_m = 5$, $f_c = 520$;

DSB-SC modulated signal is:

$$y = A_m A_c \cos(2\pi f_c t) \sin(2\pi f_m t)$$

The amplitude of DSB-SC modulated signal varies between $\pm A_m A_c$ which can be seen from the plot.

Demodulation is done by multiplying the modulated signal by $\cos(2\pi f_c t)$ and passing it through a low pass filter centred at f_c and we get back the message signal which we can verify from plots.

$$U_{DSB}(f) = \frac{A}{2}\left[M(f-f_c) + M(f+f_c)\right]$$

From the plot it is clearly seen that message plot is shifted by $\pm f_c$.
And we can verify it through frequency domain plot of demodulated signal.
Hence, modulation and demodulation was done successfully.

(c) SSB-SC

Message signal $m(t) = A_m \cos(2\pi f_m t)$
$c(t) = A_c \cos(2\pi f_c t)$

$$A_m = \frac{1}{5},\ A_c = 1,\ f_m = 5,\ f_c = 50$$

Modulated signal is

$$y(t) = \frac{A_m A_c}{2} \cos\left[2\pi(f_c + f_m)t\right]$$

(Upper band)

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$$y(t) = \frac{A_m A_c}{2} \cos\left[2\pi (f_c - f_m) t\right]$$

(Lower sidebond)

From the plot it is clear that amplitude of SSB-SC modulated waveform varies with $\pm \frac{A_m A_c}{2}$ and this can be confirmed from plot.

Demodulation is ~~done~~ in a similar manner as $\frac{A_m A_c^2}{4}$ and its amplitude varies as $\pm \frac{A_m A_c^2}{4}$.

From the frequency domain plot of SSB SC modulated signal, the impulse are centred at $\pm f_c$ and also the frequency of demodulated signal confirms this.

∴ Modulation and demodulation is succesfull.

```
clc;
clear all;
close all;

m=1;   %modulation index
Am=5;  %Amplitude of modulating signal
fa=5; %frequency of modulating signal
Ta=1/fa;  %timeperiod
t=0:Ta/999:6*Ta; %creating values for x axis

%message signal
ym=Am*cos(2*pi*fa*t); %message signal
figure(1)
subplot(6,1,1)     %used to plot graphs on same figure
plot(t,ym)
title('Modulating signal')

%carrier signal
Ac=Am/m;  %carrier amplitude
fc=500;   %carrier frequency
Tc=1/fc;
yc=Ac*cos(2*pi*fc*t);  %carrier signal
subplot(6,1,2)
plot(t,yc)
grid on;
title('Carrier signal')

%Conventional AM Modulation
y = Ac * (1+m*cos(2*pi*fa*t)).*cos(2*pi*fc*t);  %conventional AM
subplot(6,1,3)
plot(t,y)
title('Amplitude Modulated Signal')
grid on;

%demodulation of conventional AM
d=y.*yc;              %multiplying the modulated signal with cos(2pifct)
[b,a]=butter(2,0.1);  %butterworth filter
d1=filter(b,a,d);     %implementing the filter passing the modulated signal through
filter
subplot(6,1,4)
plot(d1)
title('demodulated Signal')
grid on;


%frequency domain plots

%modulated signal
%Spectrum of modulated signal
N=length(t);
ymf=fftshift(fft(y,N)/N);    %using fft to calculate fourier transform and fftshift
is used to center the fourier transform
f=(-N/2:N/2-1);              %creating range for x axis
```

```
subplot(6,1,5)
plot(f,real(ymf),'b')  %plotting the real part of fourier transform of modulating
signal
hold on;
plot(f,imag(ymf),'r')   %plotting the imagfinary part of fourier transform of
modulating signal
title('frequency plot of AM modulated signal')


%demodulated signal

%Spectrum of demodulated signal
N=length(t);
ydf=fftshift(fft(d1,N)/N);   %using fft to calculate fourier transform and fftshift
is used to center the fourier transform
f=(-N/2:N/2-1);               %creating range for x axis
subplot(6,1,6)
plot(f,real(ydf),'b')  %plotting the real part of fourier transform of demodulating
signal
hold on;
plot(f,imag(ydf),'r')    %plotting the imagfinary part of fourier transform of
demodulating signal
title('frequency plot of AM demodulated signal')
```

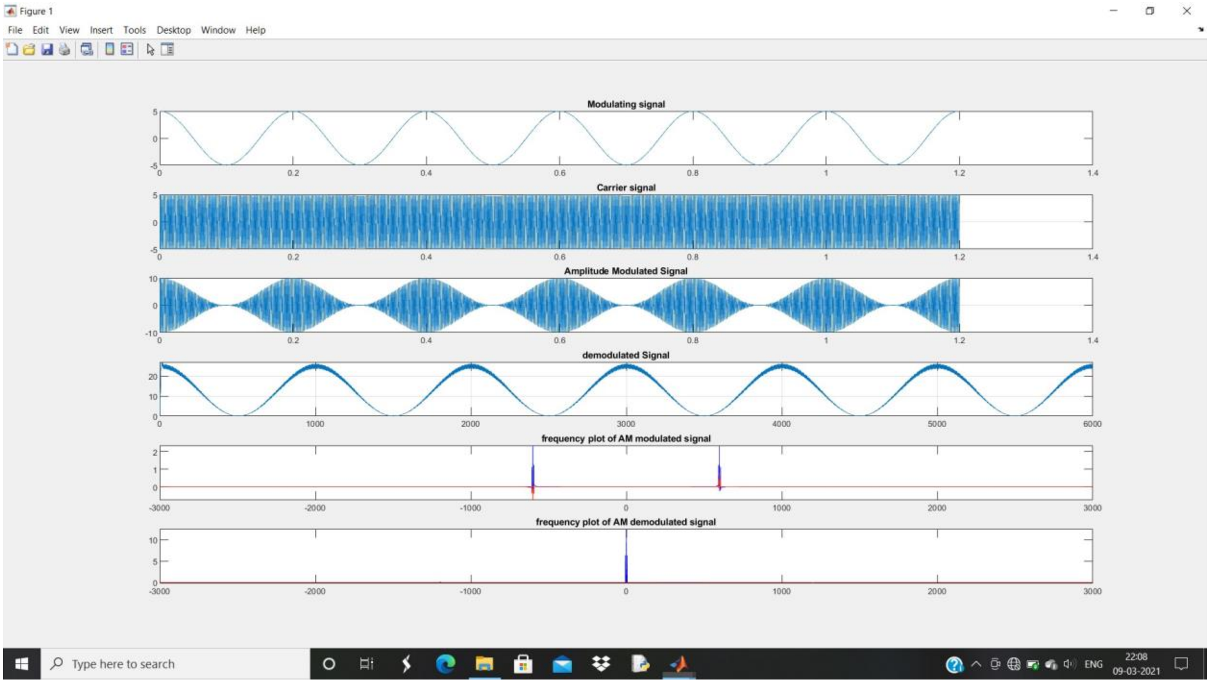
```
clc;
clear all;
close all;

t=0:0.001:1; %creating values for x axis
Am=1/2;     %amplitude of message signal
Ac=1;       %amplitude of carrier signal
fm=5;       %frequency of modulating signal
fc=500;      %frequency of carrier signal

%message signal
ym=Am*sin(2*pi*fm*t);   %message signal
figure(1)
subplot(6,1,1)
plot(t,ym)              %plotting message signal
title('Modulating signal')

%carrier signal
yc=Ac*cos(2*pi*fc*t);    %carrier signal
subplot(6,1,2)
plot(t,yc)               %plotting carrier signal
grid on;
title('Carrier signal')

%Conventional DSB-SC Modulation
y = ym.*yc;       %multiplying message signal with carrier
subplot(6,1,3)
plot(t,y)         %plotting DSB-SC modulated signal
title('Amplitude Modulated DSB-SC Signal')
grid on;

%demodulation of DSB-SC
d=y.*yc;                %multiplying the modulated signal with cos(2pifct)
[b,a]=butter(5,0.1);     %butterworth filter
d1=filter(b,a,d);       %implementing the filter passing the modulated signal ↙
through filter
subplot(6,1,4)
plot(d1)                  %plotting demodulated signal
title('demodulated Signal')
grid on;

%frequency domain plots

%modulated signal
%Spectrum of modulated signal
N=length(t);
ymf=fftshift(fft(y,N)/N);       %using fft to calculate fourier transform and↙
fftshift is used to center the fourier transform
f=(-N/2:N/2-1);                 %creating range for x axis
subplot(6,1,5)
plot(f,real(ymf),'b')          %plotting the real part of fourier transform of↙
modulating signal
hold on;
```

```
plot(f,imag(ymf),'r')           %plotting the imagfinary part of fourier transform ↙
of modulating signal
title('frequency modulated signal')

%demodulated signal
%Spectrum of demodulated signal
N=length(t);
ydf=fftshift(fft(d1,N)/N);     %using fft to calculate fourier transform and↙
fftshift is used to center the fourier transform
f=(-N/2:N/2-1);                 %creating range for x axis
subplot(6,1,6)
plot(f,real(ydf),'b')         %plotting the real part of fourier transform of↙
modulating signal
hold on;
plot(f,imag(ydf),'r')          %plotting the imagfinary part of fourier transform of↙
modulating signal
title('frequency demodulated signal')
```

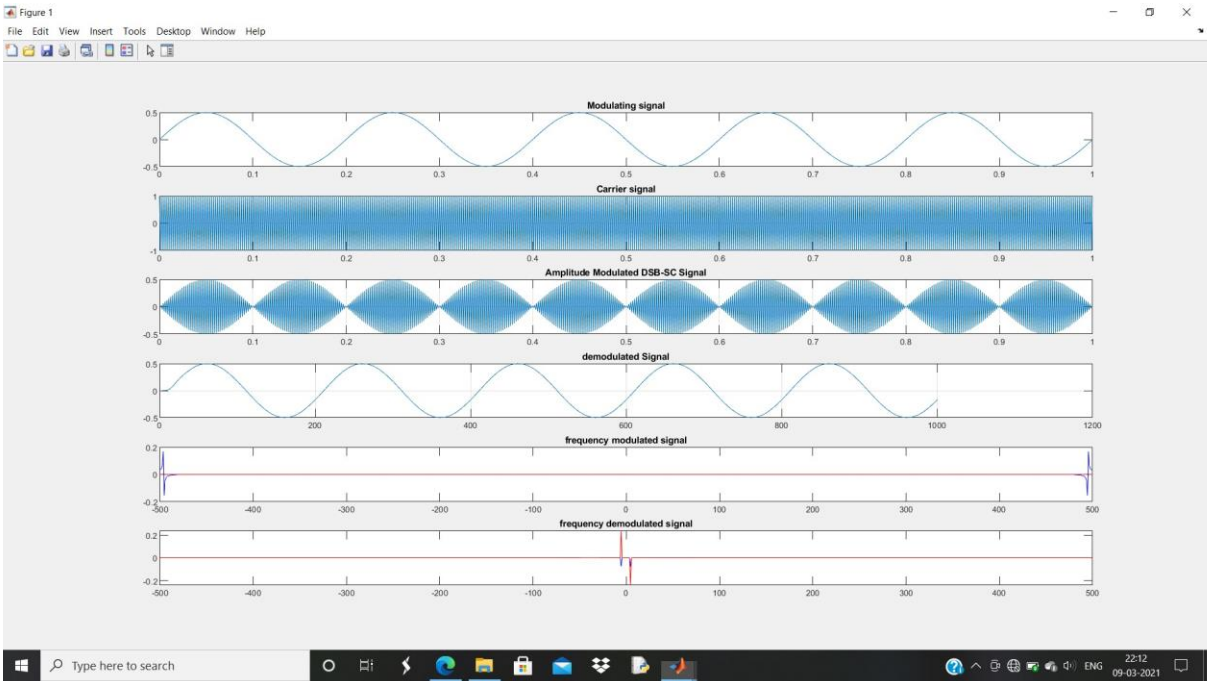
```
clc;
clear all;
close all;

t=0:0.001:1; %creating values for x axis
Am=1;      %amplitude of message signal
Ac=1;        %amplitude of carrier signal
fm=5;        %frequency of modulating signal
fc=250;       %frequency of carrier signal
%message signal

ym=Am*cos(2*pi*fm*t);   %message signal
figure(1)
subplot(6,1,1)
plot(t,ym)
title('Modulating signal')

%carrier signal
yc=Ac*cos(2*pi*fc*t);        %carrier signal
subplot(6,1,2)
plot(t,yc)
grid on;
title('Carrier signal')

%SSB-SC AM Modulation
y = (Am*Ac)/2*cos(2*pi*(fc+fm)*t);   %multiplying message signal with carrier
subplot(6,1,3)
plot(t,y)
title('Amplitude Modulated SSB-SC Signal')    %plotting SSB-SC modulated signal
grid on;

%demodulation of SSB-SC
d=y.*yc;                     %multiplying the modulated signal with cos(2pifct)
[b,a]=butter(5,0.1);         %butterworth filter
d1=filter(b,a,d);            %implementing the filter passing the modulated signal ↙
through filter
subplot(6,1,4)
plot(d1)
title('demodulated Signal')
grid on;

%frequency domain plots
%modulated signal
%Spectrum of modulated signal
N=length(t);
ymf=fftshift(fft(y,N)/N);       %using fft to calculate fourier transform and ↙
fftshift is used to center the fourier transform
f=(-N/2:N/2-1);                 %creating range for x axis
subplot(6,1,5)
plot(f,real(ymf),'b')          %plotting the real part of fourier transform of ↙
modulating signal
hold on;
plot(f,imag(ymf),'r')          %plotting the imagfinary part of fourier transform ↙
```

```
of modulating signal
title('frequency plot of SSB-SC modulated signal')

%demodulated signal
%Spectrum of demodulated signal
N=length(t);
ydf=fftshift(fft(d1,N)/N);     %using fft to calculate fourier transform and
fftshift is used to center the fourier transform
f=(-N/2:N/2-1);                %creating range for x axis
subplot(6,1,6)
plot(f,real(ydf),'b')          %plotting the real part of fourier transform of
modulating signal
hold on;
plot(f,imag(ydf),'r')         %plotting the imagfinary part of fourier transform of
modulating signal
title('frequency plot of  demodulated signal')
```

Conventional AM



DSB-SC AM



SSB-SC

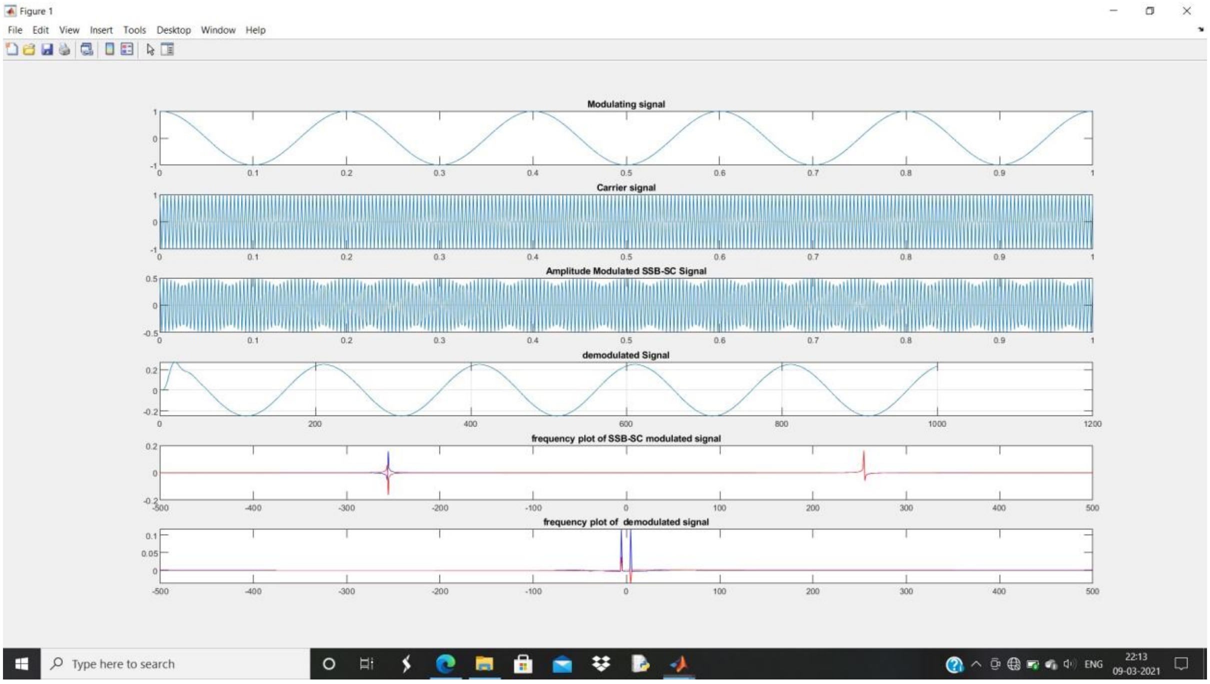


Figure 1
File Edit View Insert Tools Desktop Window Help
Modulating signal
Carrier signal
Amplitude Modulated SSB-SC Signal
demodulated Signal
frequency plot of SSB-SC modulated signal
frequency plot of demodulated signal
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