EXPERIMENT - 8 [U19CS012]

SINGLE SIDE BAND (SSB-SC) MODULATION SCHEME

AIM: Write and simulate a program for single side-band (SSB) modulation scheme. Draw the message / carrier waveforms and resultant modulated signal in time domain and frequency domain. Show input / output using matlab code in virtual mode.

APPARTUS: MATLAB

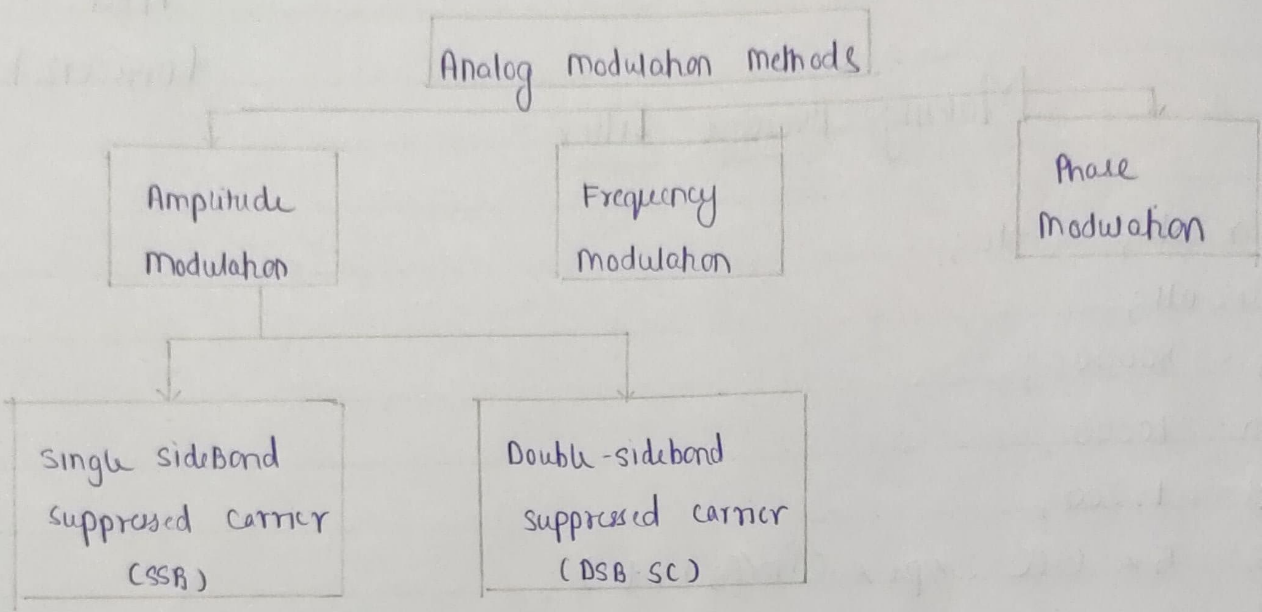
THEORY:

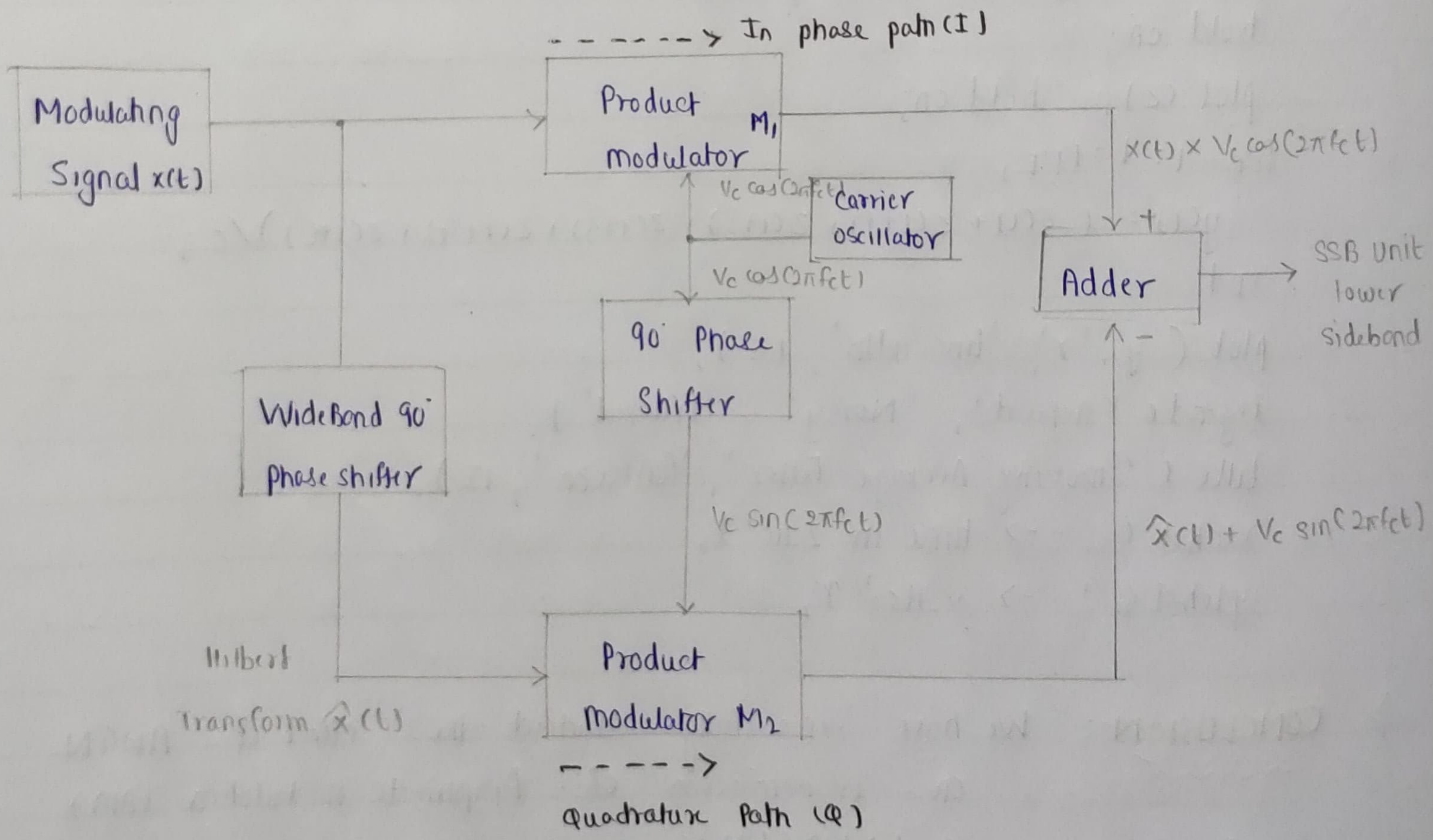
1.) Modulation: Modulation is a process by which some characteristics of a carrier wave is varied in accordance with a modulating (message) signal.

2) Analog modulation: It is a kind of modulation, where the message signal and the carrier wave both are analog in Nature.

3.) Single Side Band (SSB-SC) modulation:

- SSB-SC is a type of Amplitude Modulation
- In conventional A.M, we have two side band and the one carrier wave (no information is contained by the carrier)
- In SSB-SC modulation, only one side band is transmitted because





Generation of SSB-SC : By Hilbert Transform method both USB (upper side band) and LSB (lower side band) having the same information.

- Therefore, the transmission bandwidth is reduced to half and also required less power compare to other method of A.M.

4.) There are two methods of generation of SSB-SC :

1. Frequency discrimination method
2. Hilbert transform method or Phase discrimination method

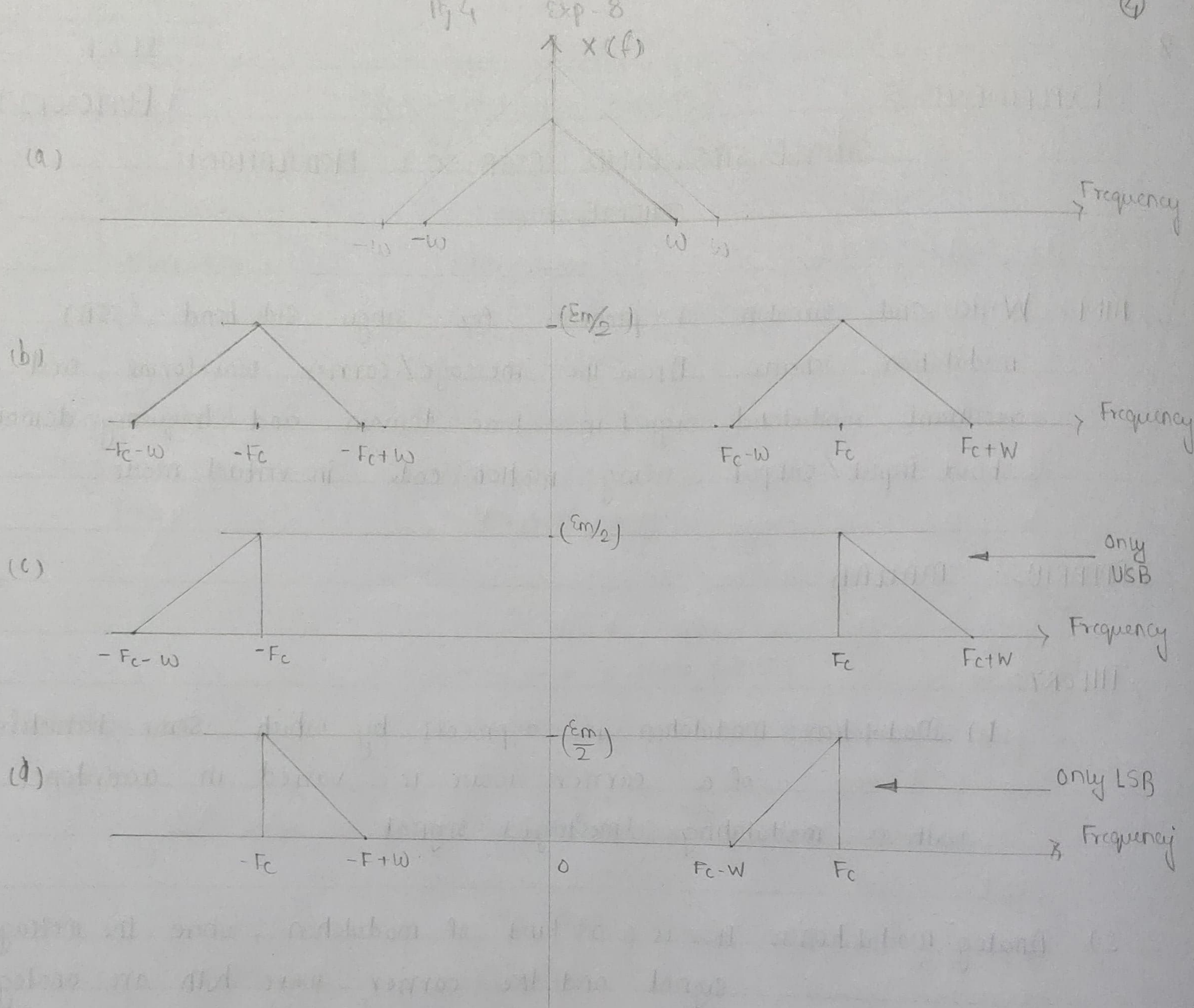
5.) Applications:

→ In point-to-point communications

→ Radar Communication

→ Where the power saving and low bandwidth requirements are important

→ In many voice applications.



(a) Spectrum of message Signal

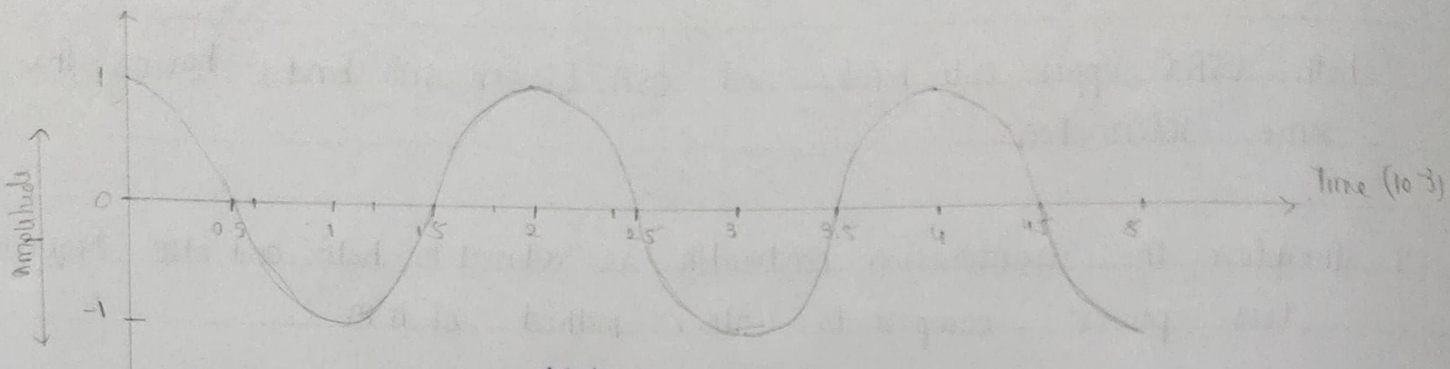
(b) Spectrum of DSB-SC wave

(c) spectrum of DSB-SC with only USB Transmission

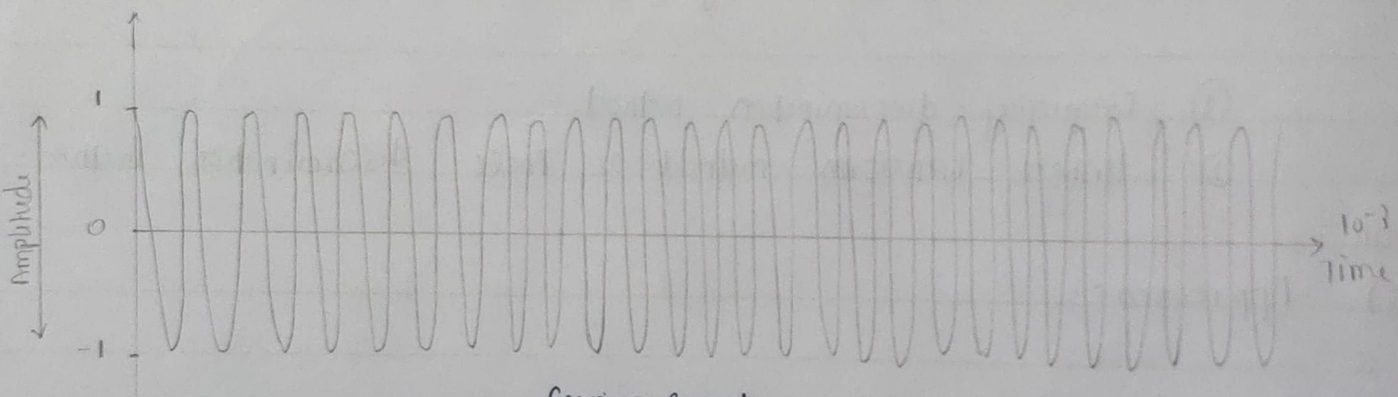
(d) Spectrum of DSB-SC with only LSB Transmission

MATLAB Code :

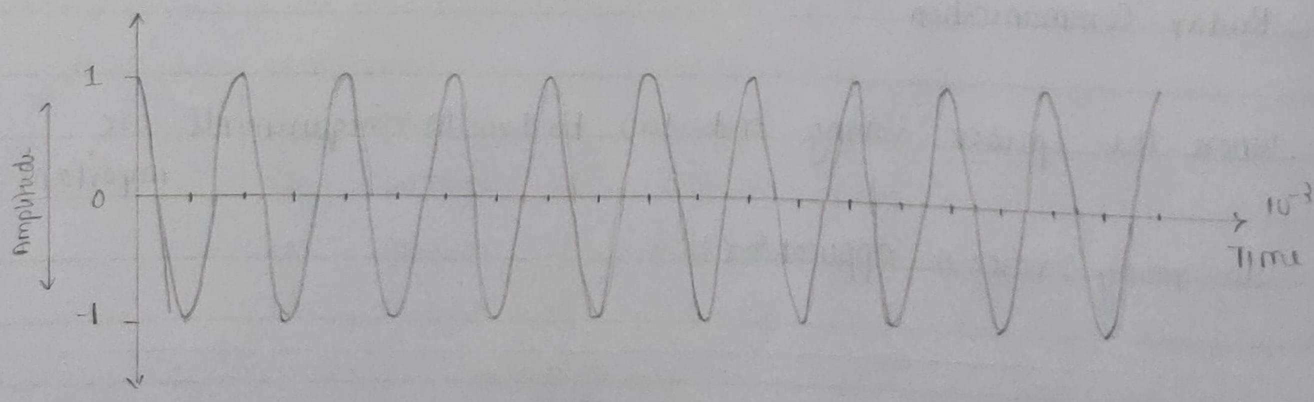
```
clc;
clear all;
close all;
am = 1 ;                          % amplitude of modulating signal
ac = 1 ;                          % amplitude of carrier signal
fm = 500;                         % modulating signal frequency
fc = 5000;                        % carrier frequency
fs = 100000;                      % sampling frequency
ts = 1/fs;                        % sampling interval
N = 10000;                        % no. of samples
t = (-N/2 : 1 : (N/2-1))*ts;      % time interval
m = am * cos(2*pi* fm*t);         % modulating signal
mh = am * sin(2*pi* fm*t);        % hilbert transformation of message signal
c = ac * cos(2*pi* fc*t);         % carrier signal
ch = ac * sin(2*pi* fc*t);        % hilbert transform of carrier signal
st = m.*c - mh.*ch;               % SSB-SC signal

% time domain of all signals
subplot (3,2,1)
plot( t,m, 'red', 'linewidth', 1.5 );
axis ( [0 0.005 -2.5 2.5] );
xlabel ( 'time' );
ylabel ( 'amplitude' );
title ( 'modulating signal' );
grid on;
```



Modulating signal



Carrier signal



Modulated Signal

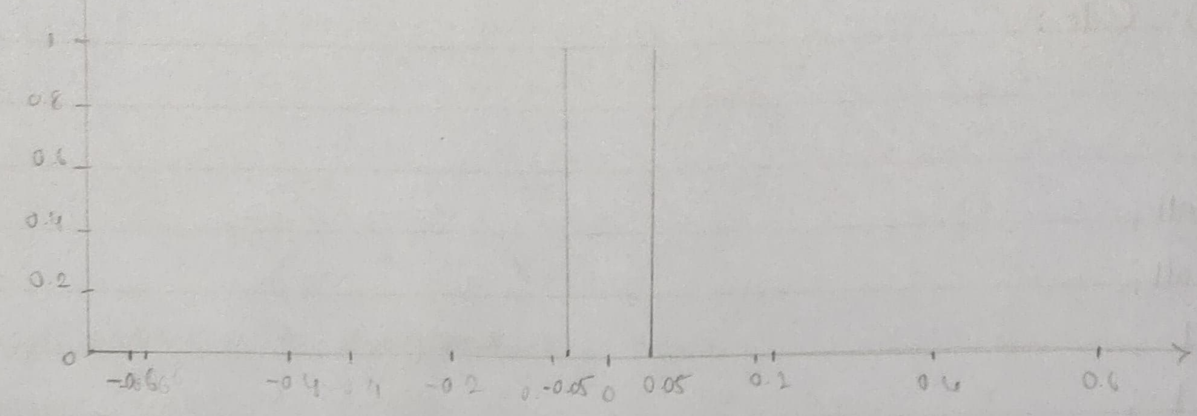
```
subplot ( 3, 2, 3)
plot ( t, c, 'black', 'line width', 1.5 );
axis ( [ 0 0.005 -2.5 2.5] );
xlabel ('time');
ylabel ('amplitude');
title ('carrier signal');
grid on;
```

```
subplot (3, 2, 5)
plot ( t, st, 'blue', 'linewidth', 1.5 );
axis ( [ 0 0.005 -2.5 2.5])
xlabel ('time');
ylabel ('amplitude');
title ('modulated signal');
grid on;
```

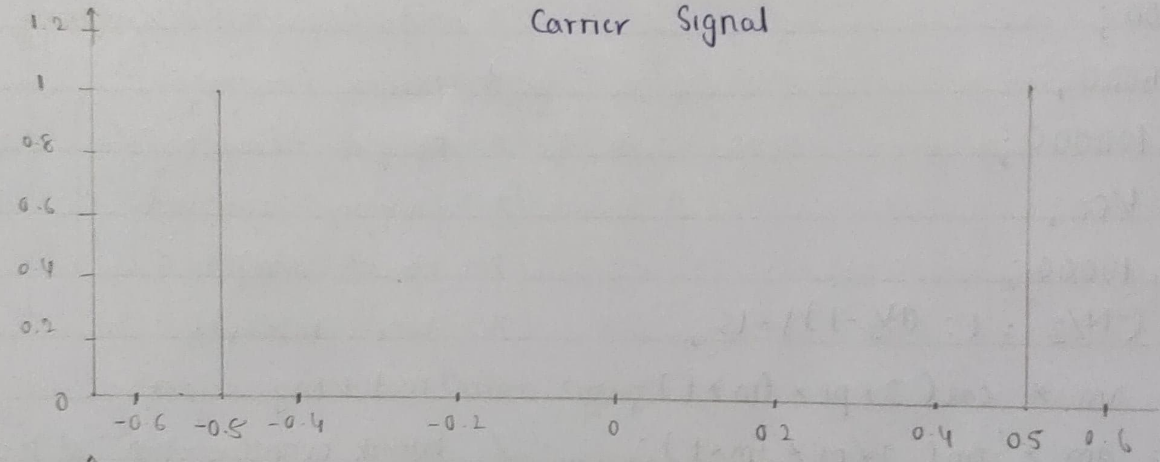
```
% spectrum of all signals
f = ( -N/2 : 1: (N/2 -1)) * fs/N;
M = abs ( (2/N) * fftshift ( fft(m)) );
C = abs ( (2/N) * fftshift ( fft (c)) );
SF = abs ( (2/N) * fftshift ( fft (st)) );
subplot (3, 2, 2);
plot ( f, M/max(M), 'red', 'linewidth', 1.5 );
axis ( [ -2*fc 2*fc -0.1 1.1] );
xlabel ('frequency');
ylabel ('amplitude');
title ('modulating signal');
grid on;
```

```
subplot ( 3, 2, 4);
plot( f, C/max(C), 'black', 'linewidth', 1.5);
axis ( [ -2*fc 2*fc -0.1 1.1];
xlabel ( 'frequency');
ylabel ( ~~carrier~~ 'amplitude');
title ( 'carrier signal');   grid on;
```

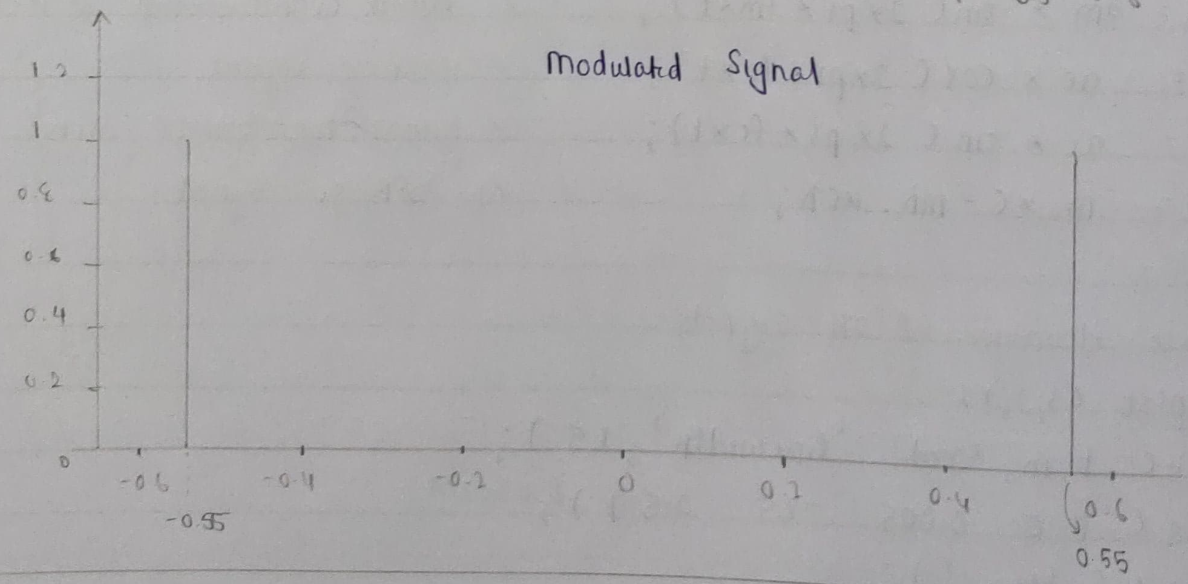
Modulating Signal



Carrier Signal



Modulated Signal



[U19CS012]

```
subplot (3,2,6);
plot ( f, SF/ max (SF) , 'blue', 'linewidth' , 1.5);
axis ( [ -2*fc   2*fc   -0.1  1.1 ]);
xlabel ( 'frequency');
ylabel ( 'amplitude');
title ( 'modulating signal');
grid on;
```

CONCLUSION : We successfully observed single side Band (SSB-SC) Modulation scheme and as we come to know that here low Bandwidth is required for transmission. Hence, we also save power.

—x—