LAB-2

$m(t) = \cos(2\pi f_m t)$ → message signal

$c(t) = \cos(2\pi f_c t)$ → carrier signal

$f_m = 50\,Hz, \quad f_c = 300\,Hz$

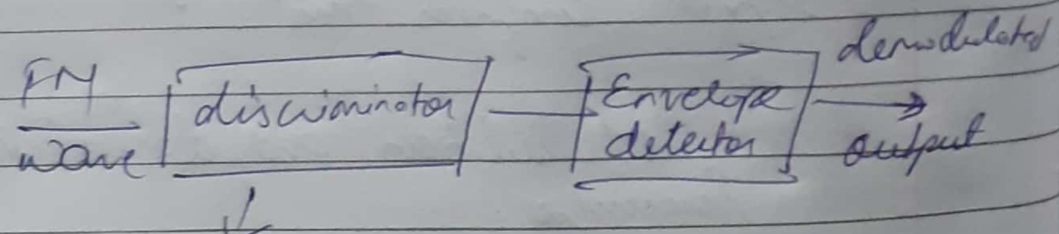
Frequency modulated signal:

$$y(t) = \cos\left(2\pi f_c t + \int_0^t \cos(2\pi f_m z)\,dz\right)$$

$$y(t) = \cos\left(2\pi f_c t + \beta \sin(2\pi f_m t)\right)$$

β = modulation index $= 10 = \frac{\Delta f}{f_m}$

The demodulation of FM is signal is done using frequency discrimination method where we differentiate the circuit and pass the resulting signal through an envelope detector which is just a low pass filter.



Used to convert FM wave into combination of AM wave and fm wave.

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Frequency domain of message signal is just two impulses at $\pm f_c$.

Frequency domain representation of FM signal has ~~impulses around~~ wide ~~range~~ impulses on both sidebands. This is ~~better~~ because modulation index in this case is 10 and thus it is a wide band FM.
The FM spectrum is ~~influenced~~. influenced by the modulation index as well as ~~to~~ by the ratio of the amplitude of the modulating signal to the frequency of modulating signal.
We will get impulses at $W_c + W_m$, $W_c + 2W_m$, $W_c + 3W_m$ . . . and similarly at $W_c - W_m$, $W_c - 2W_m$ . . .

The frequency plot of demodulated signal ~~is~~ consist of two impulse similar to frequency spectrum of message signal, which confirms that ~~the~~ message signal is modulated and demodulated successfully.

```
clc;
clear all;
close all;

fm=50; %modulating signal frequency(frequency of message signal)
fc=300; %carrier signal frequency
B=10; %modulation index
t=0:0.0001:0.5; %defining time period from 0 to 0.5s in 0.0001s interval


%considering amplitude of message and carrier signals to be 1
m=cos(2*pi*fm*t); %message signal
c=cos(2*pi*fc*t); %carrier signal
y=cos((2*pi*fc*t)+(B.*sin(2*pi*fm*t))); % frequency modulated signal(y=cos
(2*pi*fc*t+integralof(messagesignal))


%plotting message signal
figure;
subplot(6,1,1);
plot(t,m); %plotting message signal
xlabel('Time(sec)');
ylabel('Amplitude');
title('message signal');
grid on;


%plotting modulated signal
subplot(6,1,2);
plot(t,y); %plotting modulated signal
xlabel('Time(sec)');
ylabel('Amplitude');
title('modulated signal');
grid on;


%plotting demodulated signal(demodulation is done using envelope detection)
%for demodulation of fm signal it is first differentiated to get slope and
%then passed through an envelope detector circuit which is basically a
%lowpass filter
x=diff(y); %differentiating the message signals
ydemod=abs(x); %taking absolute value
[b,a]=butter(10,0.014); %implementing butterworth lowpass fiter of order 10 with
cutoff frequency 0.056
s1=filter(b,a,ydemod);  %using filter
subplot(6,1,3);
plot(s1); %plotting demodulated signal
xlabel('Time(sec)');
ylabel('Amplitude');
title('demodulated signal');
grid on;
```

```
%plotting frequency plot for message signal
ts=1/(10*fc);
fs=1/ts; %sampling frequency
mf=fftshift(fft(m))*ts; %calculating fourier transform of message signal using
inbuilt function fft
delta=fs/length(mf);
f=-fs/2:delta:fs/2-delta;  %defining the x range of frequencies
subplot(6,1,4);
plot(f,abs(mf));  %plotting frquency plot of message signal(taking absolute value)
xlabel('Time(sec)');
ylabel('Amplitude');
title('frequency plot of message signal');
grid on;


%plotting frequency plot for modulated signal
yf=fftshift(fft(y))*ts; %calculaing fourier transform of modulated signal using fft
delta=fs/length(yf);
f=-fs/2:delta:fs/2-delta;  %defining the x range of frequencies
subplot(6,1,5);
plot(f,abs(yf)); %plotting frquency plot of modulated signal(taking absolute value)
xlabel('Time(sec)');
ylabel('Amplitude');
title('frequency plot of modulated signal');
grid on;


%plotting frequency plot for demodulated signal
ydef=fftshift(fft(s1))*ts;  %calculaing fourier transform of demodulated signal
using fft
delta=fs/length(ydef);
f=-fs/2:delta:fs/2-delta;
subplot(6,1,6);
plot(f,abs(ydef)); %plotting frquency plot of demodulated signal(taking absolute
value)
xlabel('Time(sec)');
ylabel('Amplitude');
title('frequency plot of demodulated signal');
grid on;
```

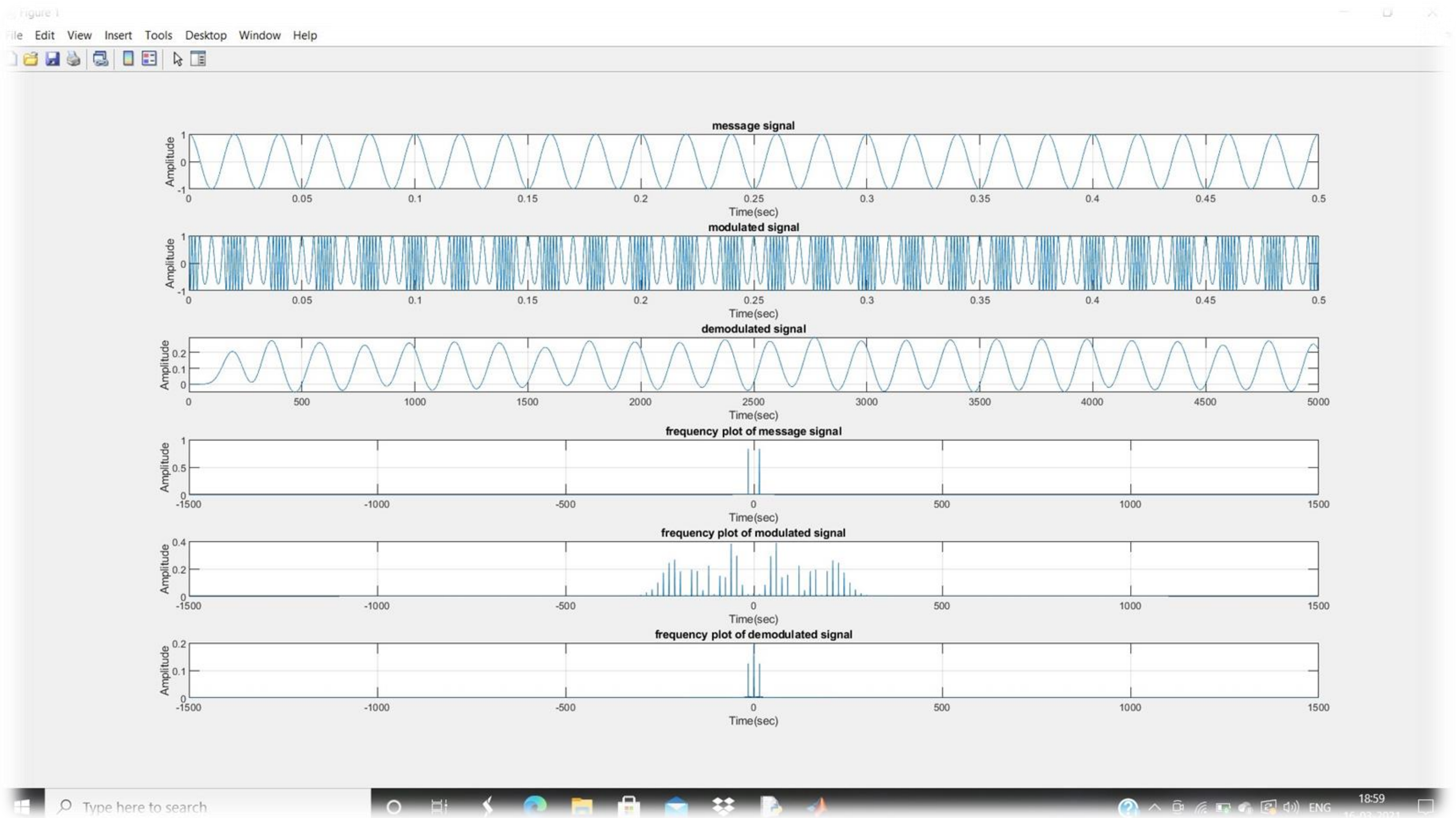
Figure 1
File Edit View Insert Tools Desktop Window Help
message signal
Amplitude
Time(sec)
modulated signal
Amplitude
Time(sec)
demodulated signal
Amplitude
Time(sec)
frequency plot of message signal
Amplitude
Time(sec)
frequency plot of modulated signal
Amplitude
Time(sec)
frequency plot of demodulated signal
Amplitude
Time(sec)
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