Experiment 2-

Frequency Modulation

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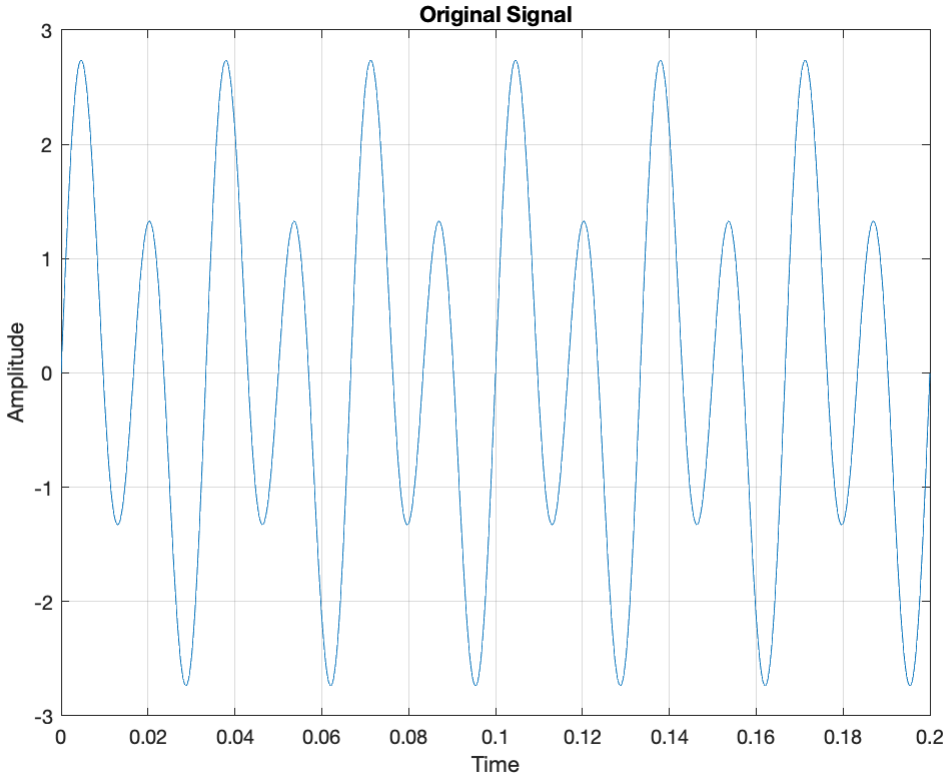
Initial Variables-

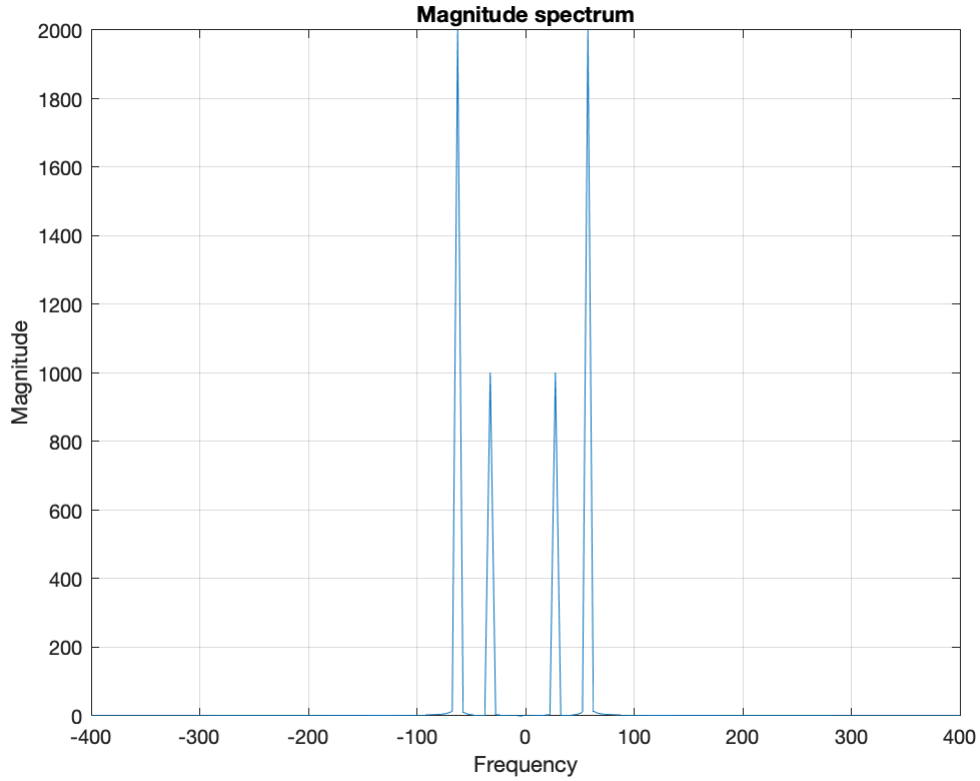
```
clear all;
close all;

fs = 10000;                                          %Sampling frequency
fc = 200;                                            %Carrier frequency
kf = 1;                                              %frequency Deviation
Ac = 3;                                              %Carrier Amplitude
```

Message SIgnal-

```
t1 = [0:1/fs:0.2];
%Message Signal
msg = sin(2*pi*30*t1)+2*sin(2*pi*60*t1);


%Taking Fourier Transform of original signal-
n = length(msg);
Y = fft(msg);
Fmsg = fftshift(Y);
fshift = (-n/2:n/2-1)*(fs/n);               % zero-centered frequency range
freq = abs(Fmsg);

%Plotting Original signal-
plot(t1, msg);
title('Original Signal');
xlabel('Time');
ylabel('Amplitude');
grid on;
```




```
%Plotting Magnitude Spectrum of Original signal-
plot(fshift, freq);
title('Magnitude spectrum');
xlim([-2*fc,2*fc]);
xlabel('Frequency');
ylabel('Magnitude');
grid on;
```



Modulation of FM signal-

If our message signal is m(t) then-

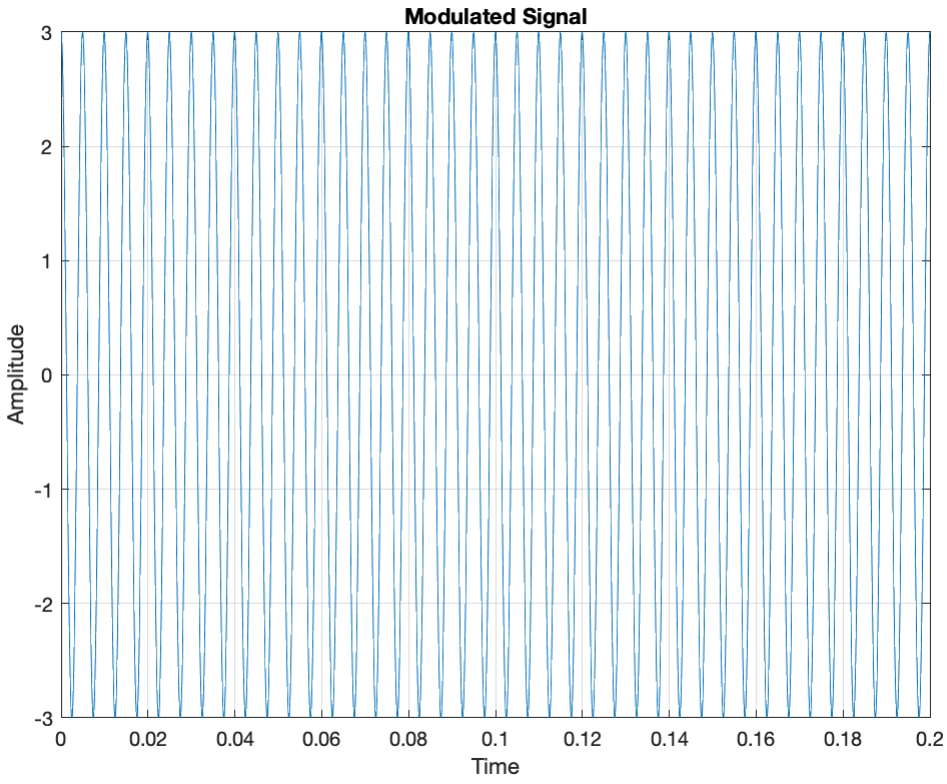
$$\theta(t) = \theta(0) + 2\pi k_f \int_0^t m(\tau)d\tau$$

So our modulated signal-

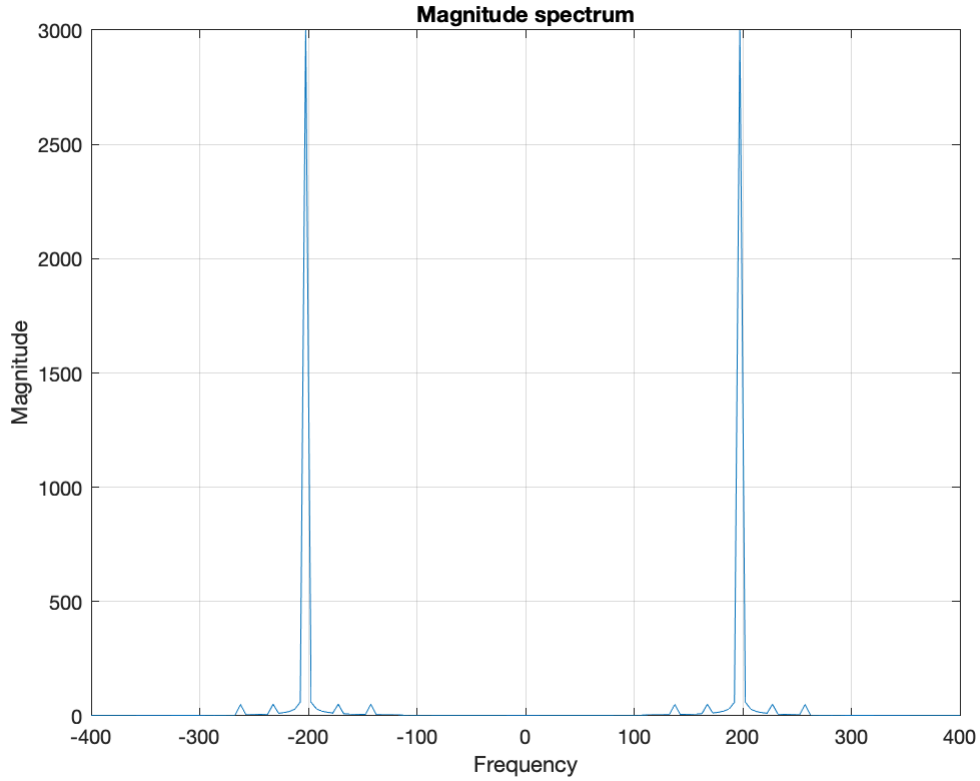
$$u(t) = Ac \times cos(2\pi f_c t + \theta(t))$$

```
%Modulation using FM-
 int_msg = cumsum(msg)/fs;              %Finding integral using cumsum()
 mod_fm = Ac*cos(2*pi*fc*t1 + 2*pi*kf*int_msg);

%Taking Fourier Transform of modulated signal-
n = length(mod_fm);
Y = fft(mod_fm);                        %Fourier Transform
Fam = fftshift(Y);                      %Shifting Fourier Transform around 0
fshift = (-n/2:n/2-1)*(fs/n);           % zero-centered frequency range
freq = abs(Fam);

%Plotting Modulated signal-

plot(t1, mod_fm);
title('Modulated Signal');
xlabel('Time');
```

```
ylabel('Amplitude');
grid on;
```

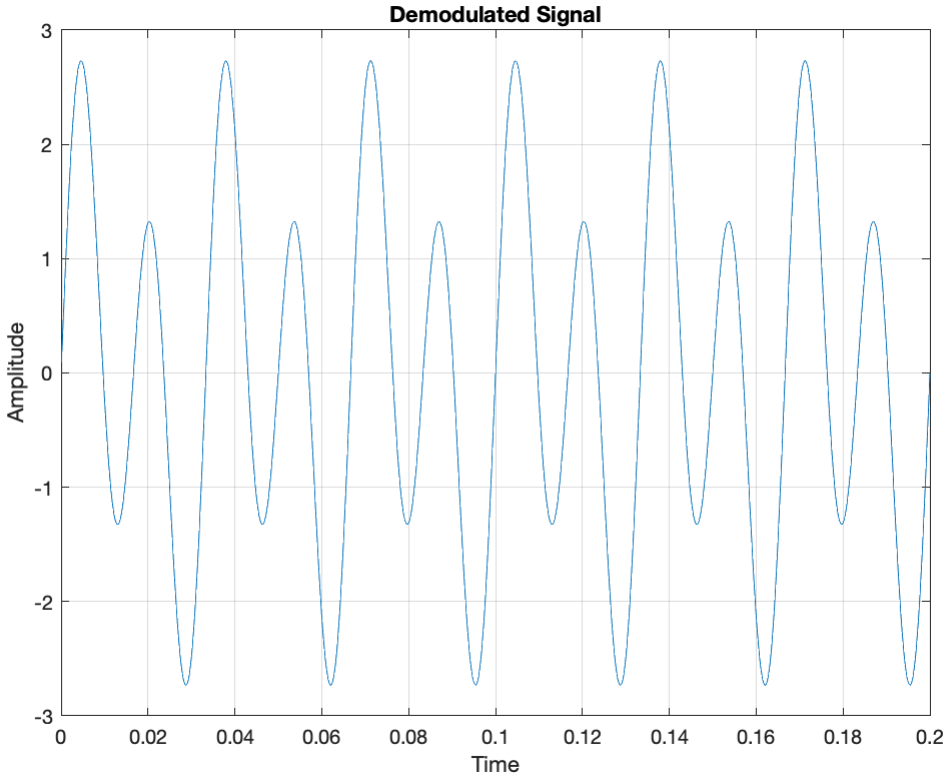



```
%Plotting magnitude spectrum(Modulated Signal)-

plot(fshift, freq);
title('Magnitude spectrum');
xlim([-2*fc,2*fc]);
xlabel('Frequency');
ylabel('Magnitude');
grid on;
```

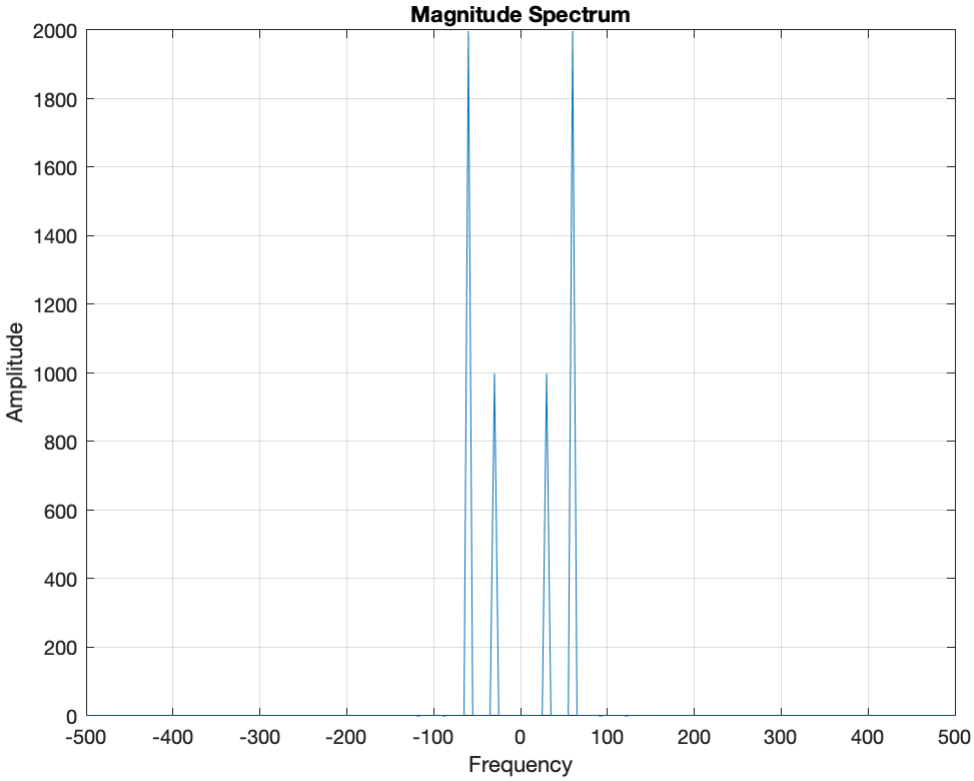


Demodulation of modulated signal-

```
dif_mod = diff(mod_fm)*fs; %taking differentiation of modulated signal
env = envelope(dif_mod);   %finding envelope of differentiated signal
env1 = env - mean(env);    %Removing DC value from envelope
demod = env1/(2*pi*Ac*kf);

%As diff() removes first element from array so redefining time axis
t2 = [1/fs:1/fs:0.2];

%Taking Fourier Transform of modulated signal-
n = length(demod);
Y = fft(demod);
Fam = fftshift(Y);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
freq = abs(Fam);

%Plotting Demodulated signal-

plot(t2, demod);
title('Demodulated Signal');
xlabel('Time');
ylabel('Amplitude');
grid on;
```




```
%Plotting magnitude spectrum of Demodulated signal-

plot(fshift, freq);
title('Magnitude Spectrum');
xlim([-2.5*fc,2.5*fc]);
xlabel('Frequency');
ylabel('Amplitude');
grid on;
```


Magnitude Spectrum
Amplitude
Frequency
2000
1800
1600
1400
1200
1000
800
600
400
200
0
-500
-400
-300
-200
-100
0
100
200
300
400
500

THE END