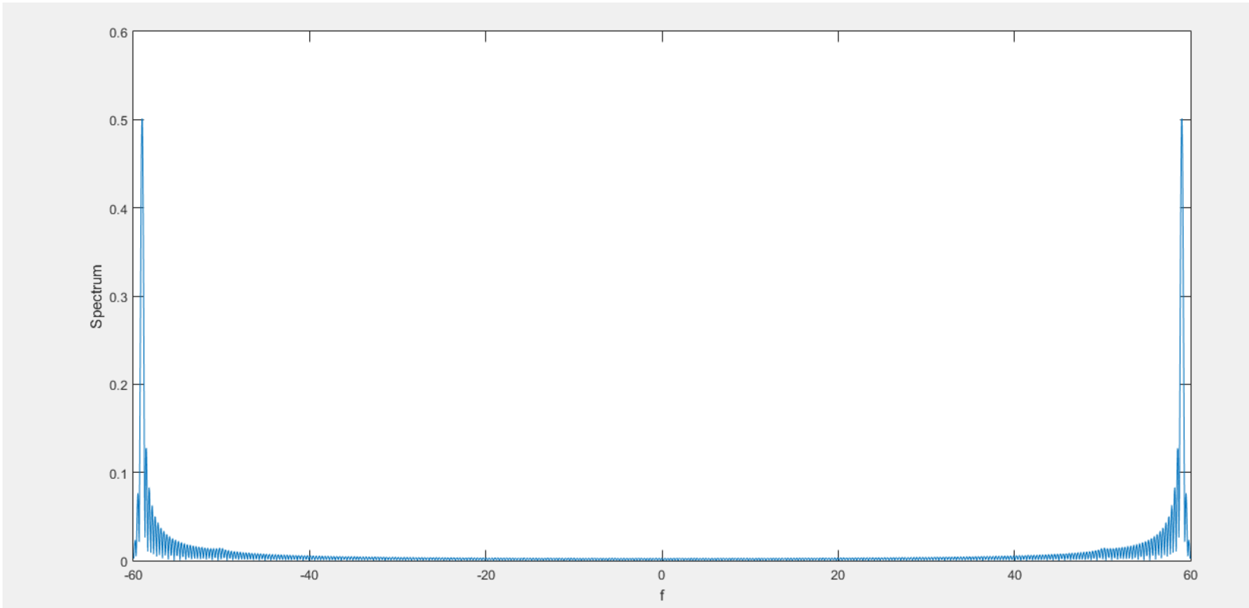
5-SSB:

MATLAB Code for this part :

```
fs = 120; %sample frequency
fc= 50 ;%carrier frequency
ts=1/fs;
t=0:ts:3 ;
m_t = cos(2*pi*9*t);% signal
c_t =cos(2*pi*fc*t);%carrier
c_t2=sin(2*pi*fc*t);
hil = hilbert(m_t);%heilbert transform
mh_t = imag(hil); %signal heilbert
usb=m_t.*c_t -(mh_t.*c_t2); %usb signal
usbzp=[usb zeros(1,2000)];
%Drawing usb in freq:
usbzpf = (ts/3).*fft(usbzp);
usbsh=abs(fftshift(usbzpf));
N = length(usbzp);
df=fs/(N-1);
f=-(fs/2):df:(fs/2);
figure
plot(f,usbsh)
xlabel  ('f');
```

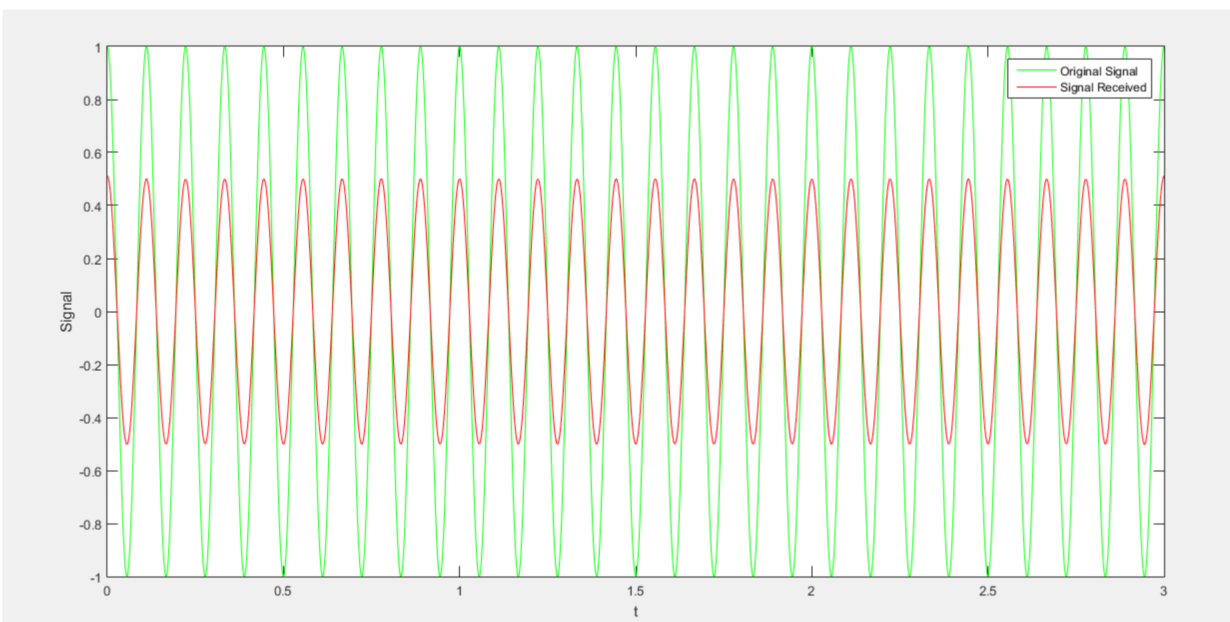
```
ylabel ('Spectrum');
%demodulation
%After coherent detector
N1 = length(usb);
df1=fs/(N1-1);
f1=-(fs/2):df1:(fs/2);
signal=usb.*c_t;
signalf=(ts/3)*fftshift(fft(signal));
LPF=rectangularPulse(-10,10,f1);
signalfn=signalf.*LPF;
mt=3*fs*ifft(ifftshift(signalfn));
figure
plot(t,m_t,'color','g')
hold on
plot(t,mt,'color','r')
hold off
legend('Original Signal','Signal Received')
xlabel  ('t');
ylabel ('Signal');
```

a)the spectrum of the USB modulated signal:



Estimated BW = W = 9 HZ

b)YES it can be demodulated :

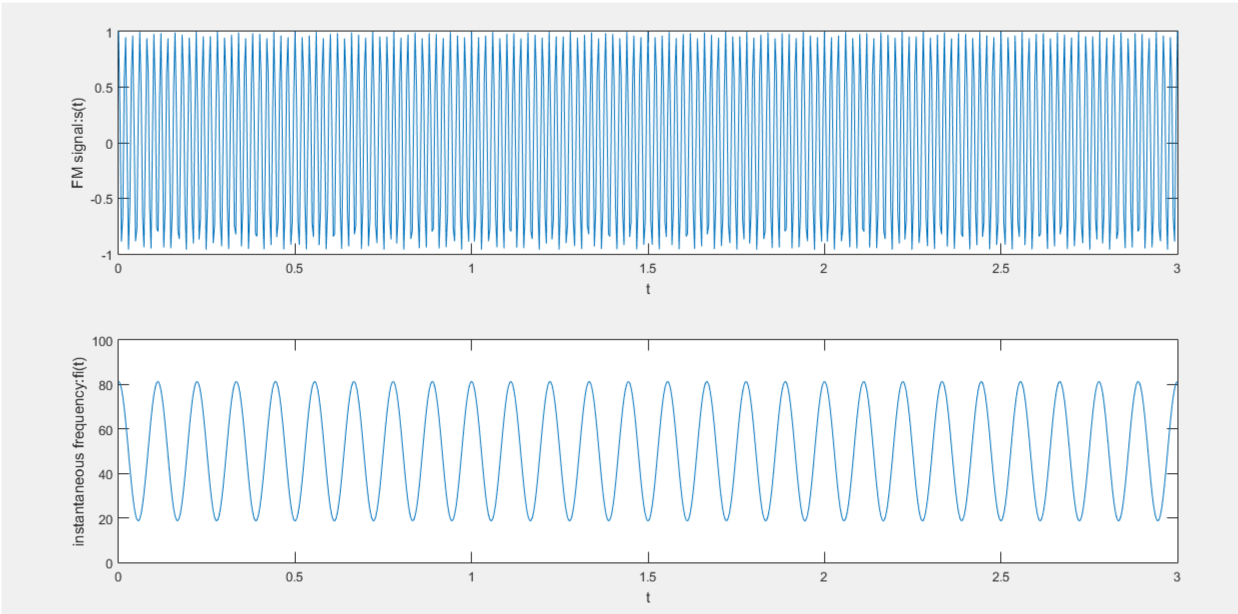


8-FM:

MATLAB code:

```
fc = 50 ; % carrier-frequancy = 50 HZ
Kf = 20 ; % sensitivity = 10 Hz/V
fm = 9 ; %signal_frequancy = 9 Hz
t =0:0.004:3 ;
m = cos (2*pi*fm.*t);%signal
m_integ =0.004*cumtrapz(m) ;%signal integral
plot(t,m_integ)
c= cos ( 2*pi*fc.*t);%carrier
s =cos(2*pi*fc.*t +(Kf).*m_integ);%modulated signal
fi= fc + (Kf/2*pi)*m ; %instantaneous frequency
figure
subplot(2,1,1)
plot(t,s);
xlim([0 3])
xlabel  ('t');
ylabel ('FM signal:s(t)');
subplot(2,1,2)
plot (t,fi);
xlabel  ('t');
ylabel ('instantaneous frequency:fi(t)');
```

Plots:



FM signal:s(t)
1
0.5
0
-0.5
-1
0
0.5
1
1.5
2
2.5
3
t
instantaneous frequency:fi(t)
100
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3
t

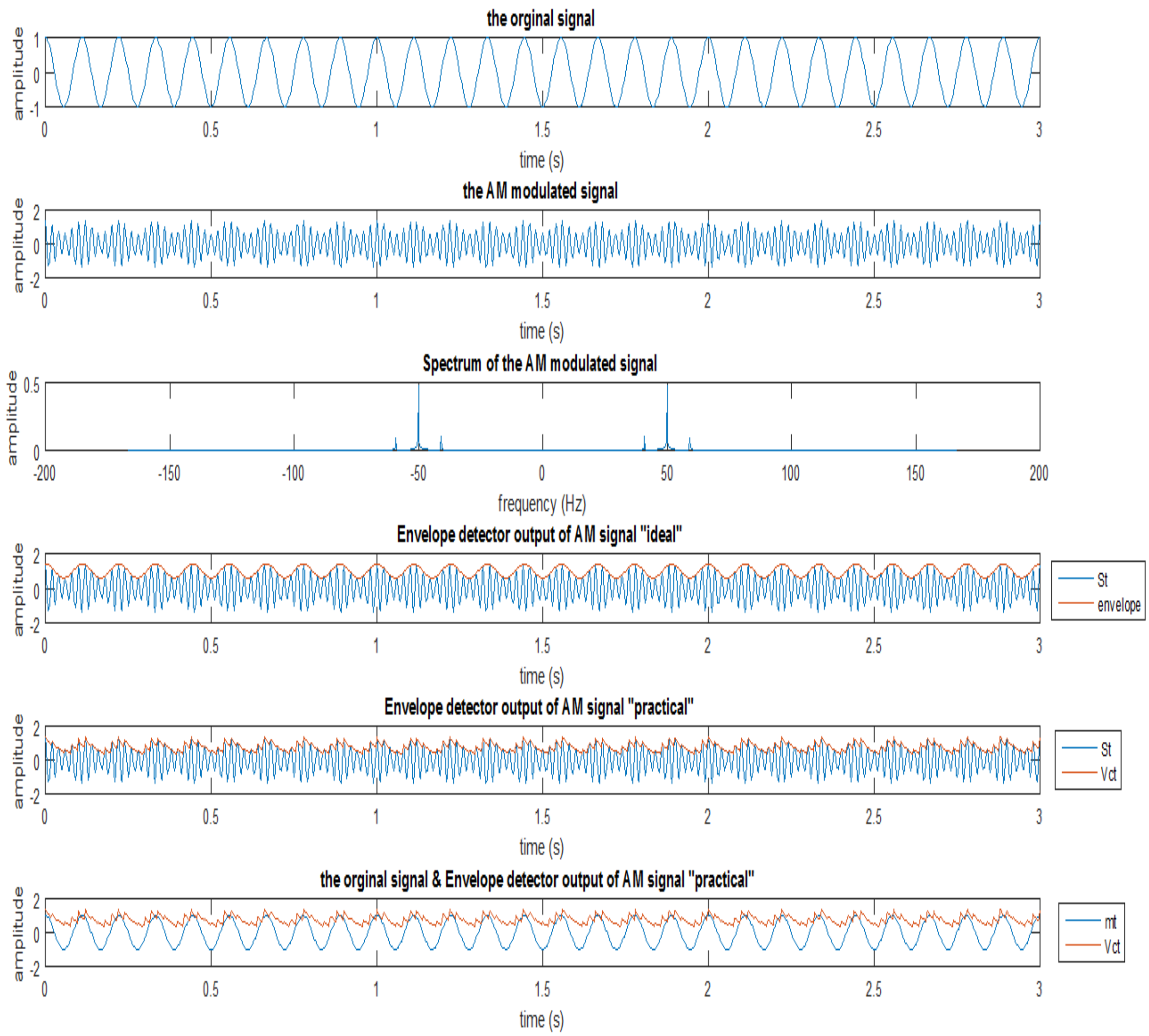
6. Conventional AM (DSB-LC) modulation:

Matlab code:

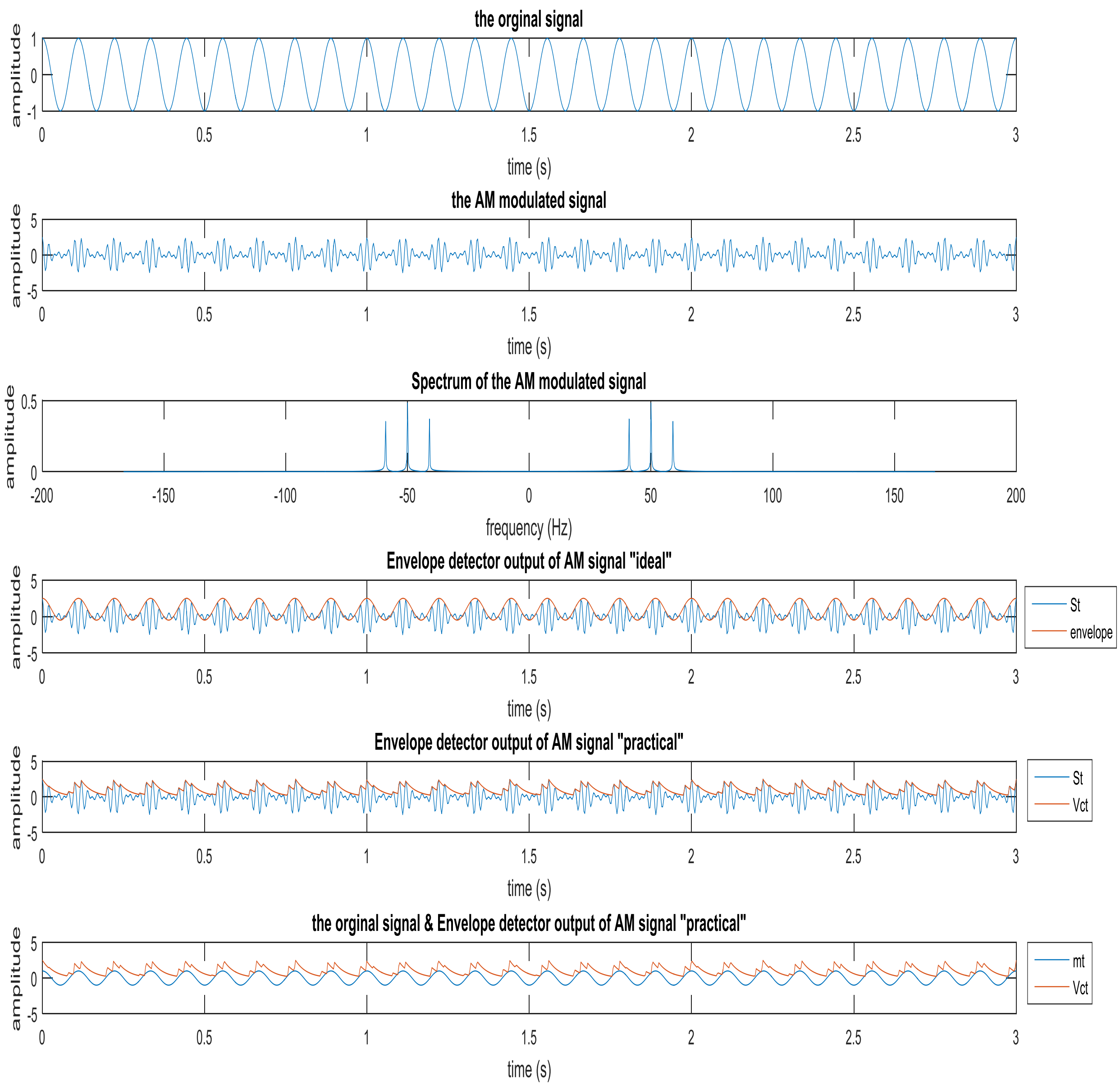
```
clear
clc
close all
ts = 0.003;
fs = 1/ts;
t = 0:ts:3;
ka = 1.5;
fm = 9;
fc = 50;
R = 10^4*4;
C = 10^-6;
mt = cos(2*pi*fm*t);
V = length(mt);
%mt = [mt zeros(1,200)];
ct = cos(2*pi*fc*t);
St = (1+ka*mt).*ct;
N = length(t);
%x = [x zeros(1,200)];
y =(1/3*ts).*fftshift(fft(St));
M = length(y);
df = fs/(V-1);
f = -fs/2:df:fs/2;
z =(1/3*ts).*fftshift(fft(mt));
envelope = (1+ka*mt);
%Vc = (1+ka1*mt).*(1-(t/RC));
Vct(1) = St(1);
for i=2:length(St)
        if St(i)>Vct(i-1)
        Vct(i)=St(i);
        else
        %Vct(i)= Vct(i-1).*(exp(-ts/(R*C)));
        Vct(i)= Vct(i-1).*(1-(ts/(R*C)));
        end
end
v =(1/3*ts).*fftshift(fft(Vct));
subplot(6,1,1)
plot(t,mt)
title('the orginal signal');
xlabel('time (s)');
ylabel('amplitude');
subplot(6,1,2)
plot (t,St)
title('the AM modulated signal');
xlabel('time (s)');
ylabel('amplitude');
subplot(6,1,3)
plot (f,abs(y))
title('Spectrum of the AM modulated signal');
xlabel('frequency (Hz)');
ylabel('amplitude');
subplot(6,1,4)
plot(t,St)
hold on
subplot(6,1,4)
```

```
plot (t,envelope)
title('Envelope detector output of AM signal "ideal"');
xlabel('time (s)');
ylabel('amplitude');
legend('St','envelope')
hold on
subplot(6,1,5)
plot(t,St)
hold on
subplot(6,1,5)
plot(t,Vct)
title('Envelope detector output of AM signal "practical"');
xlabel('time (s)');
ylabel('amplitude');
legend('St','Vct')
subplot(6,1,6)
plot(t,mt)
hold on
%plot(t,envelope)
subplot(6,1,6)
hold on
subplot(6,1,6)
plot(t,Vct)
title('the orginal signal & Envelope detector output of AM signal
"practical"');
xlabel('time (s)');
ylabel('amplitude');
legend('mt','Vct')
figure
subplot(2,1,1)
plot(t,mt)
hold on
subplot(2,1,1)
plot(t,Vct)
title('the orginal signal & Envelope detector output of AM signal
"practical"');
xlabel('time (s)');
ylabel('amplitude');
legend('mt','Vct')
subplot(2,1,2)
plot (f,abs(z))
hold on
subplot(2,1,2)
plot (f,abs(v))
title('Spectrum of the orginal signal & Envelope detector output');
xlabel('frequency (Hz)');
ylabel('amplitude');
legend('abs(z)','abs(v)')
```

figures: for Ka=0.4

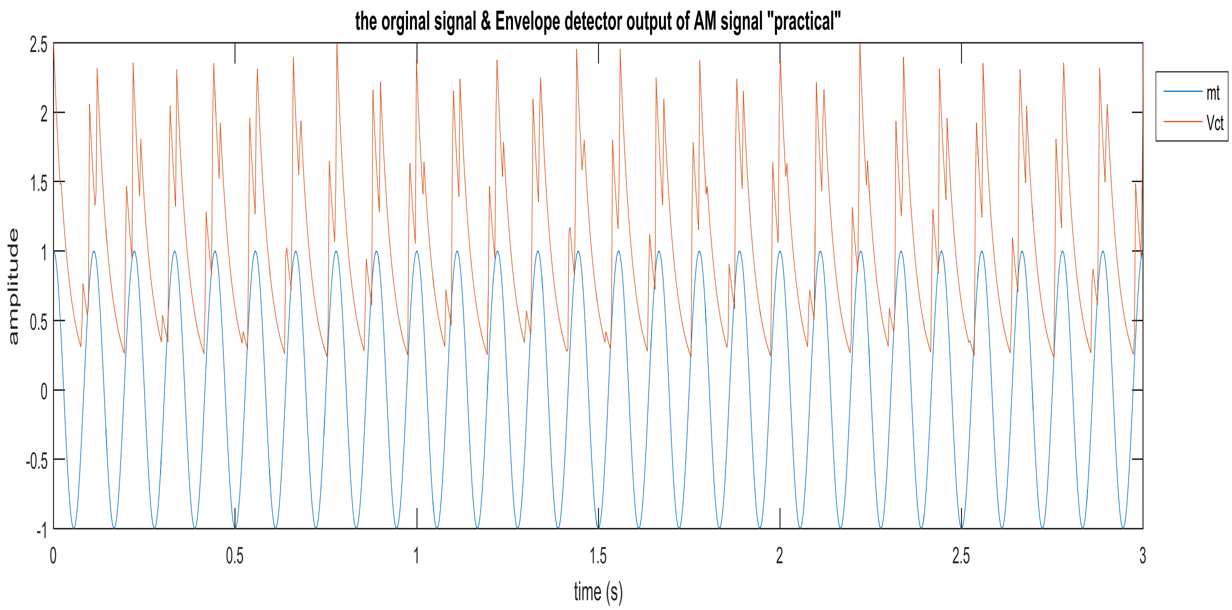


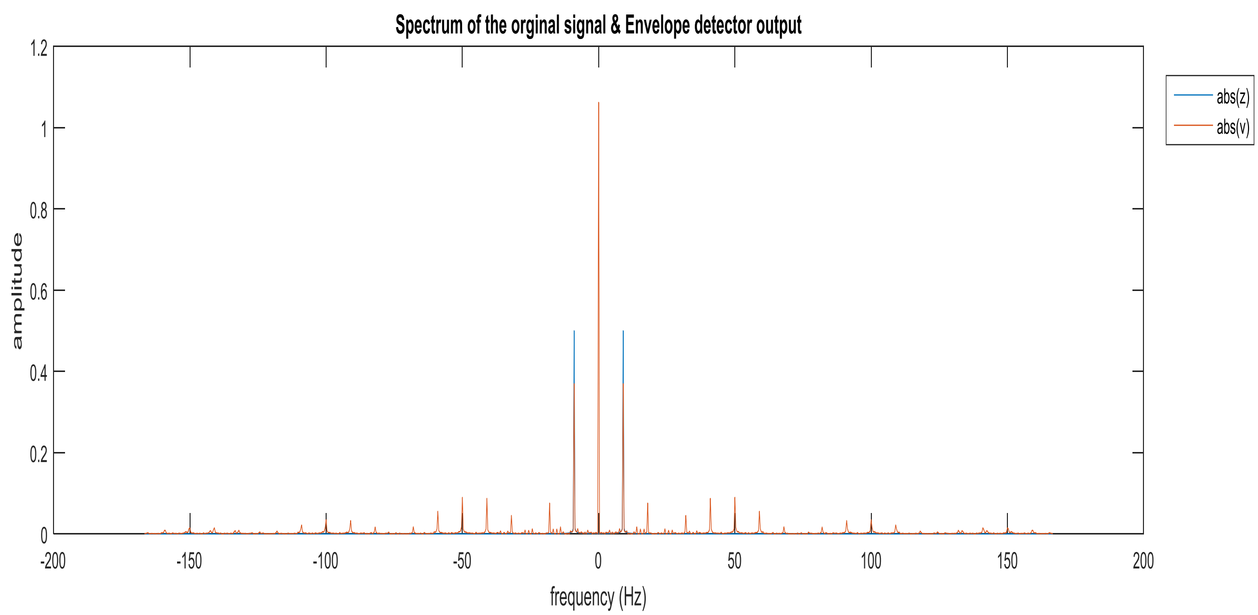
for Ka=0.4



comment:
as Ka>1, the demodulated signal is not correct ,due to phase revasals

Plot the demodulated signal and the original message on one graph both in time domain and in frequency domain.





by using lowpass filter to enhance the demodulated signal such that it resembles the original message.

Determine the best relaxation time (t) of the envelop detector such that demodulated signal is very close to the original message :

$$\frac{1}{\omega_c} \leq RC \leq \frac{1}{\omega_m} \times \frac{\sqrt{1-\mu^2}}{\mu}, where: \mu = Ac * Ka, Ac = 1, Ka = 0.4, so: 0.003 \leq RC \leq 0.04$$