Date : 17-10-2022

Experiment No : 02

Experiment Name: Study of frequency Modulation.

Theory:

Frequency Modulation is a system in which the amplitude of the modulated carrier is kept constant , while its frequency and rate of change are varied by the modulating signal.

Let the message signal be given by , $v_m=V_m\sin(w_mt)$

Carrier signal is $v_c=V_c\sin(w_ct)$

Mathematical Representation of FM :

The frequency modulated wave is given by :

$f=fc+ kv_m$

$=fc + k(V_m\sin w_mt)$

Where fc is unmodulated carrier frequency , Kf is proportionality constant expressed in Hz/Volt and $V_m\sin w_mt$ is the is instantaneous modulating voltage.

The maximum deviation for this signal will occur when the sine term has its maximum value +-. Under this condition the instantenous frequency will be $f=f_c + KVm$. So the maximum deviation will be K_fV_m .

The instantenous amplitude of the FM signal will be given by a formula of the form

$V_{FM} = V_c \sin[f(w_c,w_m)]= V_c \sin\Theta$

To find this Θ we have to integrate w with respect to time.

$\Theta = \int wdt$

$= \int (wc\ (1+\mathrm{Kvm})$

$=\int wc(1 + KVm * Sin(wmt)\mathrm{dt}$

$=w_ct + \frac{K*Vm*wc}{wm} * \sin(w_mt)$

$=\mathrm{So,}\ V_{FM} =Vc \sin(wct + \frac{K*Vm*wc}{wm} *\sin(w_mt)$

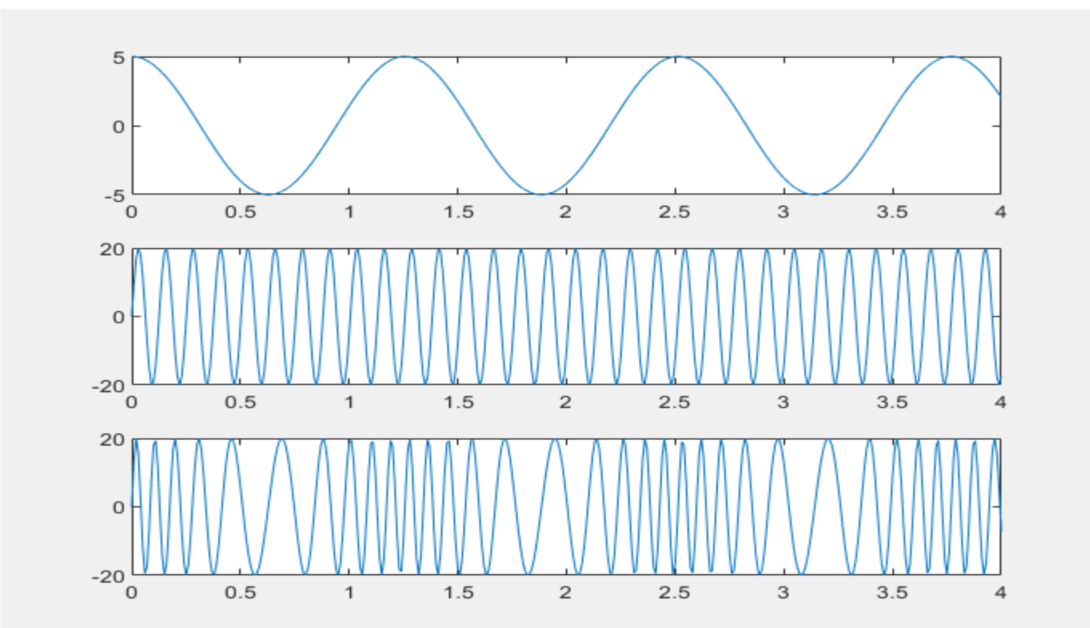
$=\frac{KVmFc}{Fm}$

= Modulation index

Code : When message signal is **`Vm=vm*cos(wm*t);`**

```
clc;
clear all;
vm=5;
vc=20;
wm=5;
wc=50;
k=0.1;
t=0:0.01:4


Vm=vm*cos(wm*t);
Vc=vc*sin(wc*t);
M=vc*sin(wc*t+((k*vm*wc)/wm)*sin(wm*t));

subplot(3,1,1);
plot(t,Vm);

subplot(3,1,2);
plot(t,Vc);

subplot(3,1,3);
plot(t,M);
```

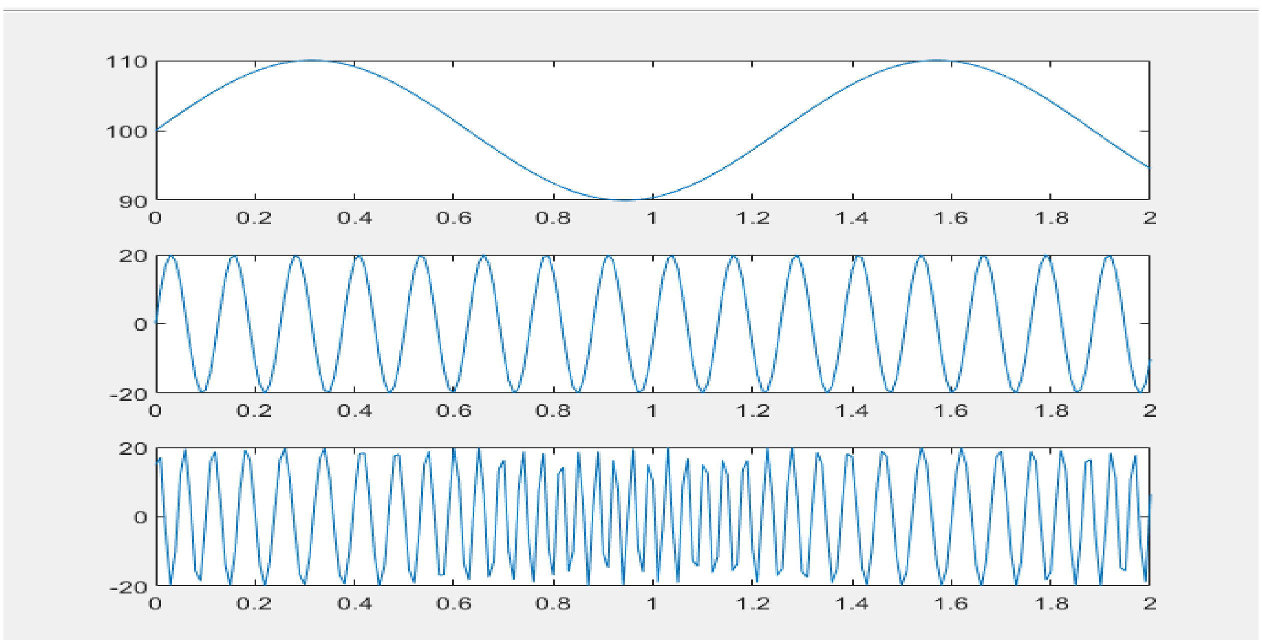
Output : The Waveshape is like -



Code: When message signal is **`Vm=100+vm*sin(wm*t)`**

```
clc;
clear all;
t=0:0.01:2
vm=10;
vc=20;
wm=5;
wc=50;
k=0.1;

Vm=100+vm*sin(wm*t);
Vc=vc*sin(wc*t);
M=vc*sin(wc+100*k*t*wc- ((k*vm*wc)/wm)*cos(wm*t));

subplot(3,1,1);
plot(t,Vm);

subplot(3,1,2);
plot(t,Vc);

subplot(3,1,3);
plot(t,M);
```

Output :

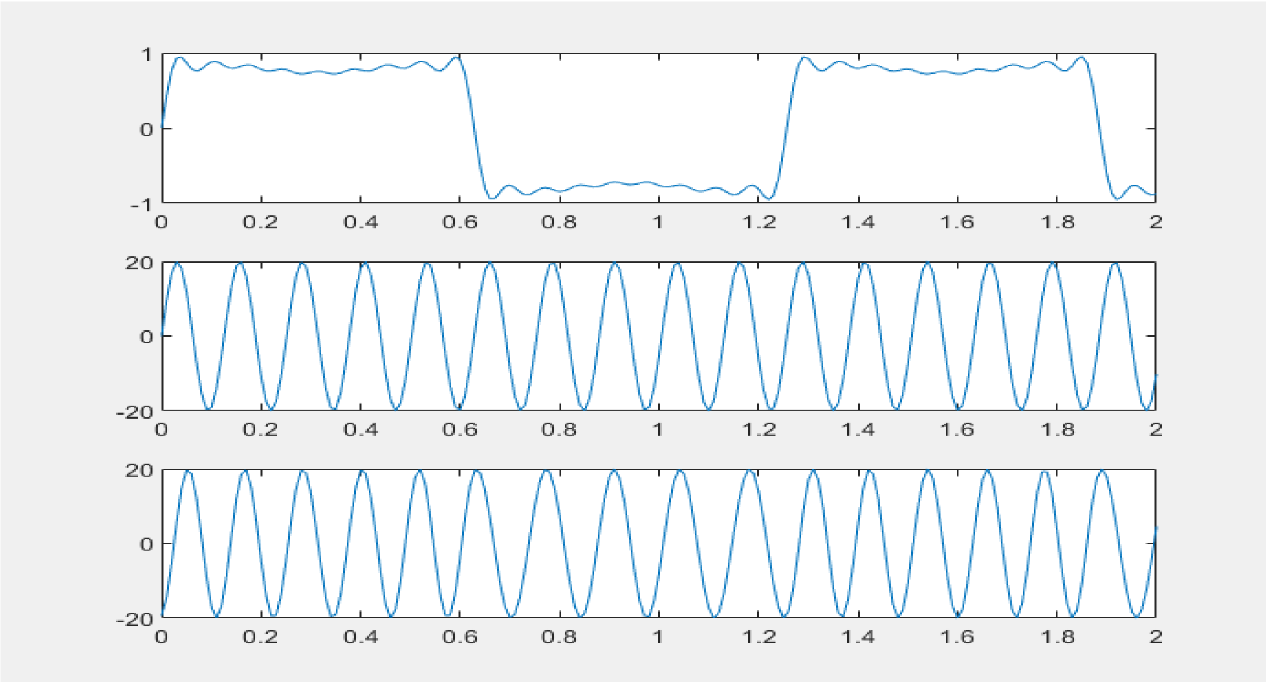


Code: When input wave is - **`Vm=sin(wm*t)+(sin(3*wm*t))/3 +(sin(5*wm*t))/5+`**.........................**`+(sin(3*wm*t))/19`**

We have taken 10 elements of the signal equation

```
clc;
clear all;
t=0:0.01:2
vc=20;
wm=5;
wc=50;
k=0.1;


Vm=sin(wm*t)+(sin(3*wm*t))/3 +(sin(5*wm*t))/5
+(sin(7*wm*t))/7 +(sin(9*wm*t))/9+(sin(11*wm*t))/11
+(sin(13*wm*t))/13+(sin(15*wm*t))/15+(sin(17*wm*t))/17+(si
n(3*wm*t))/19;
Vc=vc*sin(wc*t);
M=vc*sin(wc*t-((wc*k)/wm)*cos(wm*t)-
((wc*k)/(9*wm))*cos(3*wm*t) -
((wc*k)/(25*wm))*cos(5*wm*t)-((wc*k)/(9*wm))*cos(3*wm*t)-
((wc*k)/(49*wm))*cos(7*wm*t)-((wc*k)/(81*wm))*cos(9*wm*t)-
((wc*k)/(121*wm))*cos(11*wm*t)-
((wc*k)/(169*wm))*cos(13*wm*t)-
((wc*k)/(225*wm))*cos(15*wm*t)-
((wc*k)/(289*wm))*cos(17*wm*t)-
((wc*k)/(361*wm))*cos(19*wm*t));

subplot(3,1,1);
plot(t,Vm);

subplot(3,1,2);
plot(t,Vc);
```

Output:



Discussion :

We can see in the first case , for positive half cycle of the message signal, the frequency is higher comparing negative half cycle where frequency is less. It happenes as a result of phase shift in message signal . when message signal is going from positive to negative and negative to positive , modulated signals amplitude decreases slightly .

case 2 , we add a dc signal with the message signal to over come this problem.

For square wave as message signal ,We get a fine sinusoidal wave . we can see that the frequency of the carrier signal and the modulated signal is of same frequency all over the wave.

So when the message signal is square wave , we get the best modulated signal.

Conclusion:

The wave shape was exactly like we expected. We learnt the frequency modulation for 3 different types of waves. We first a used a sinusoidal wave , and then used a dc source to overcome the disadvantages. We at last found that , square wave is the best sort of message signal for getting fine sinusoidal modulated wave.

Department of Electrical & Computer Engineering

Course No: ECE 3208

Course Title: Communication Engineering Sessional

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