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SCHOOL OF ELECTRICAL ENGINEERING

COMMUNICATION ENGINEERING (EEE2006)

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Experiment 3
Date : 24/09/21, 01/10/21

AIM :

1. Generate and demodulate FM modulation with and without the presence of noise using MATLAB.
2. Generate and demodulate PM modulation with and without the presence of noise using MATLAB.
3. Generate FM modulation using Pspice and calculate the modulation index.

THEORY QUESTIONS

1. What are the differences you observed between PM and FM.
2. What is the importance of modulation index in FM. Substantiate your claim.
3. List out the practical applications of FM and PM

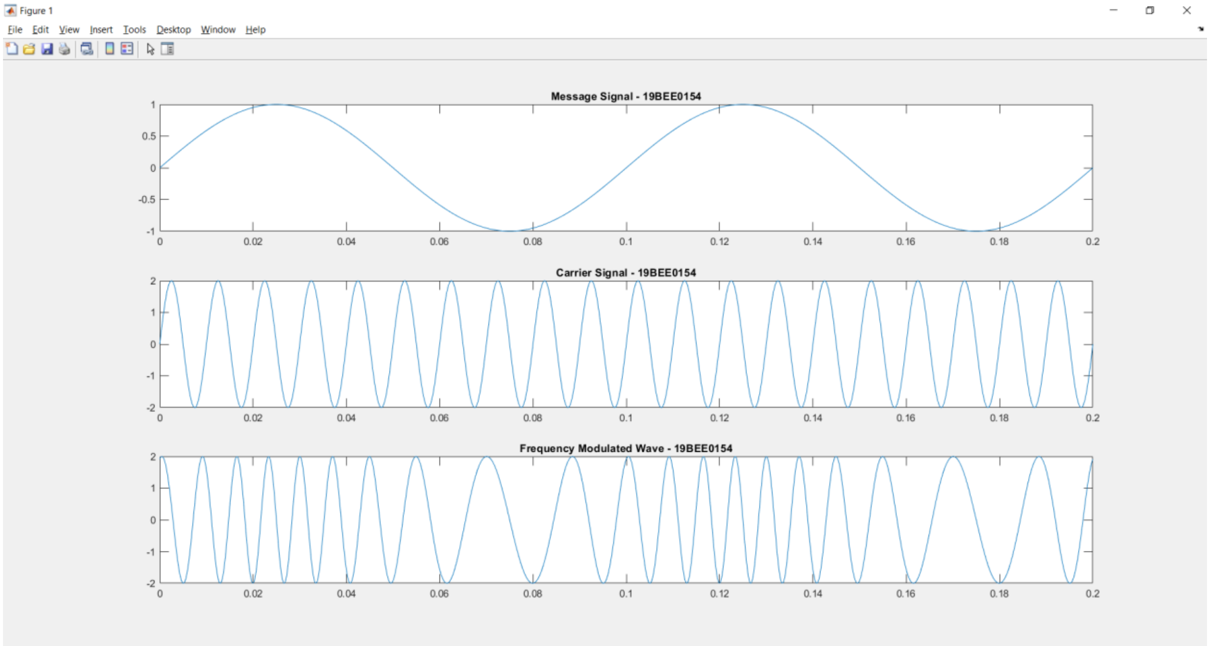
MATLAB Code

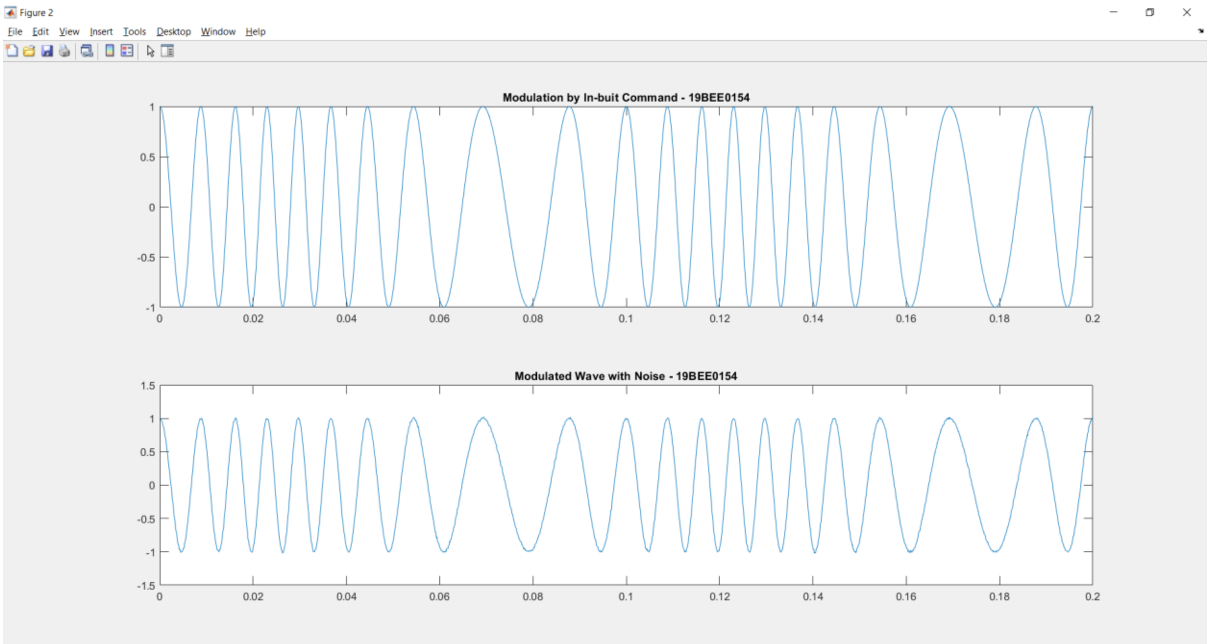
```
%19BEE0154 Shant Rakshit
clc
clear all;
close all;


%Frequency Modulation and Demodulation and Effects of Noise
Vm=1;
Vc=2;
fm=10;
fc=100;
fs=10000;
t=0:1/fs:2/fm;
wm=2*pi*fm;
wc=2*pi*fc;
Msg=Vm*sin(wm*t);

figure(1);
subplot(3,1,1);
plot(t,Msg);
title("Message Signal - 19BEE0154");
carrierWAVE=Vc*sin(wc*t);
figure(1);
subplot(3,1,2);
plot(t,carrierWAVE);
title("Carrier Signal - 19BEE0154");
Mf=5;
Vmodfm=Vc*sin(wc*t-Mf*cos(wm*t));
figure(1);
subplot(3,1,3);
plot(t,Vmodfm);
title("Frequency Modulated Wave - 19BEE0154");

y=fmmod(Msg,fc,fs,50);
figure(2)
subplot(2,1,1);
plot(t,y);
title('Modulation by In-buit Command - 19BEE0154')

y1=awgn(y,40);
figure(2);
subplot(2,1,2);
plot(t,y1);
title('Modulated Wave with Noise - 19BEE0154');
```

```
modmsg = fmdemod(Vmodfm,fc,fs,50);
figure(3);
subplot(3,1,1)
plot(t,modmsg)
title('Demodulated Signal from the Mathematical derived Signal
- 19BEE0154');

modmsg = fmdemod(y,fc,fs,50);
figure(3);
subplot(3,1,2)
plot(t,modmsg)
title('Demodulated Signal - 19BEE0154');

modmsg = fmdemod(y1,fc,fs,50);
figure(3);
subplot(3,1,3)
plot(t,modmsg)
title('Demodulated Signal with Noise - 19BEE0154');




%Phase Modulation and Demodulation and Effects of Noise
mp=1.5;
dev=1.5;
Vmod_pm=Vc*sin((2*pi*fc*t)+mp*sin(2*pi*fm*t)); %Mathematical
exp
figure(4);
subplot(2,1,1);
plot(t,Vmod_pm);
title("PM Modulated signal by mathematical exression -
19BEE0154");
pm_mod=pmmod(Msg,fc,fs,dev); %using pmmod
figure(4);
subplot(2,1,2);
plot(t,pm_mod);
title("PM Modulated signal using pmmod - 19BEE0154");

sig21=awgn(Vmod_pm,25);
figure(5);
subplot(2,1,1);
plot(t,sig21);
title("Noise in PM Mathematical exp - 19BEE0154");
sig31=awgn(pm_mod,30);
figure(5);
subplot(2,1,2);
plot(t,sig31);
title("Noise in pmmod signal - 19BEE0154");
```

```
de_sig = pmdemod(Vmod_pm,fc,fs,0.5);
figure(6);
subplot(3,1,1);
plot(t,de_sig);
title("Demodulated mathematical PM signal using Mathematical
formula - 19BEE0154");


de_sig = pmdemod(pm_mod,fc,fs,0.5);
figure(6);
subplot(3,1,2);
plot(t,de_sig);
title("Demodulated mathematical PM signal using PMDEMOD -
19BEE0154");

de_sig = pmdemod(sig31,fc,fs,0.5);
figure(6);
subplot(3,1,3);
plot(t,de_sig);
title("Demodulated mathematical PM signal with noise using
PMDEMOD - 19BEE0154");
```

MATLAB Simulation





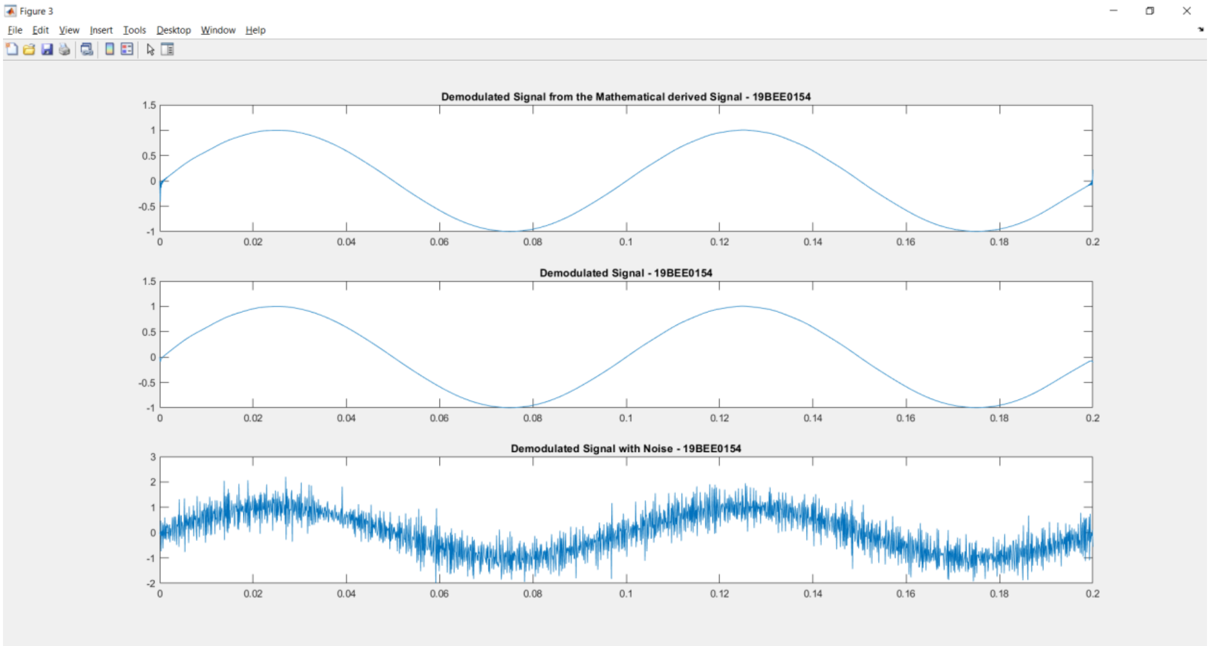


Figure 3
File Edit View Insert Tools Desktop Window Help
Demodulated Signal from the Mathematical derived Signal - 19BEE0154
Demodulated Signal - 19BEE0154
Demodulated Signal with Noise - 19BEE0154

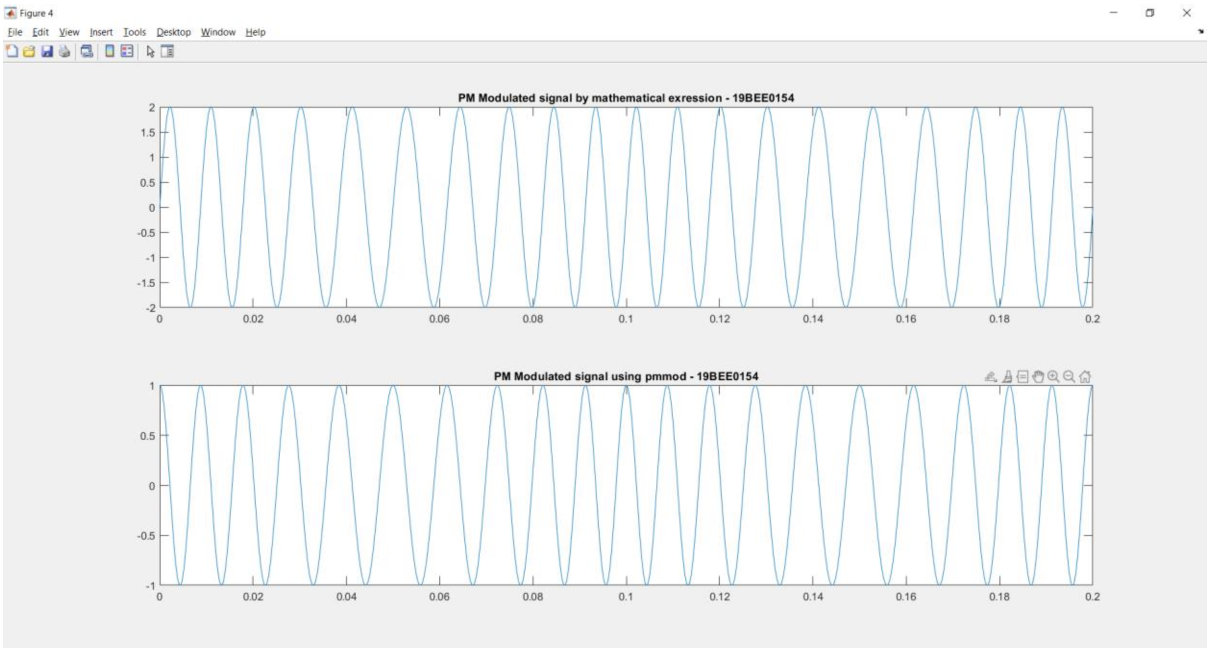


Figure 4
File Edit View Insert Tools Desktop Window Help
PM Modulated signal by mathematical exression - 19BEE0154
PM Modulated signal using pmmod - 19BEE0154

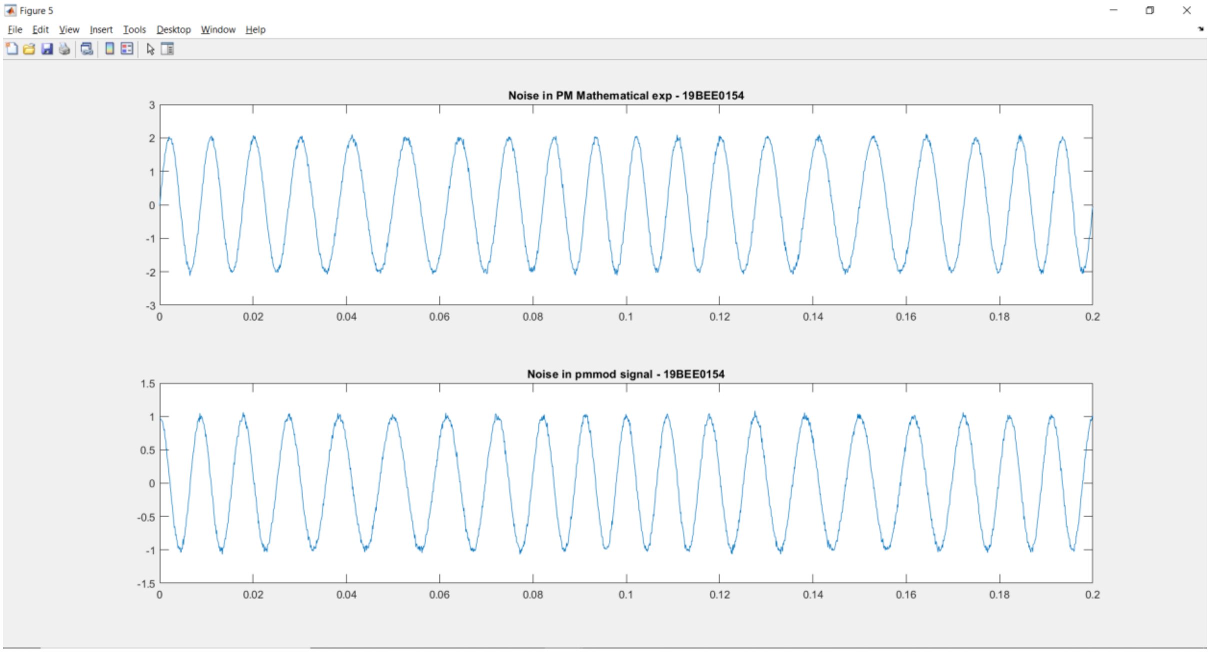


Figure 5
File Edit View Insert Tools Desktop Window Help
Noise in PM Mathematical exp - 19BEE0154
Noise in pmmod signal - 19BEE0154

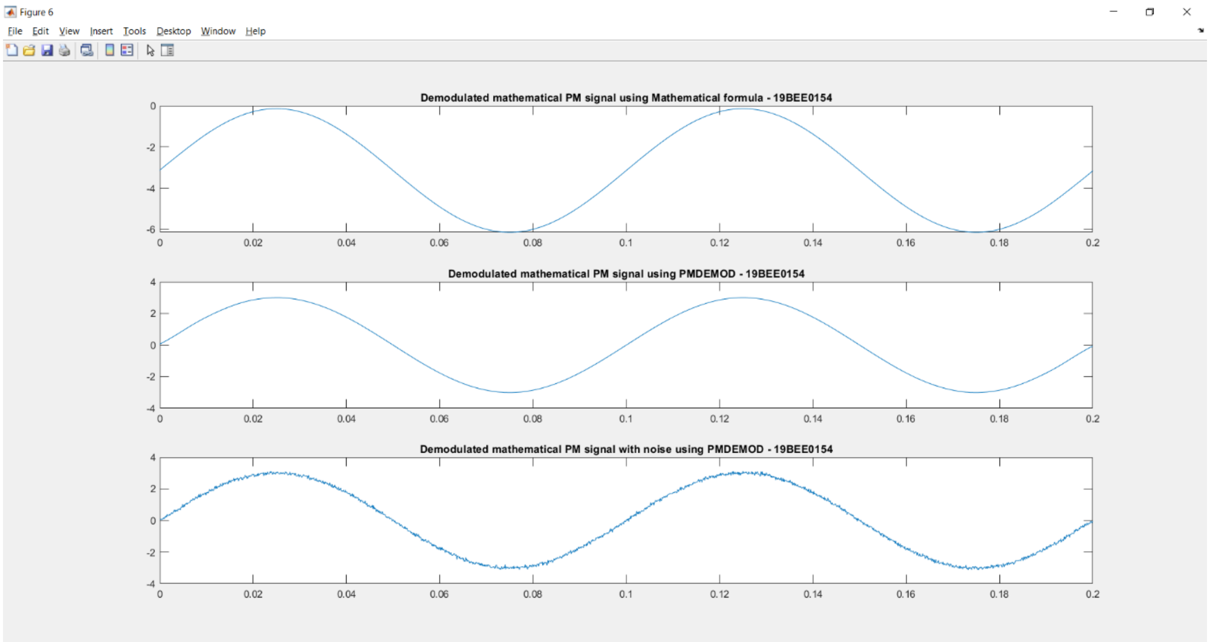
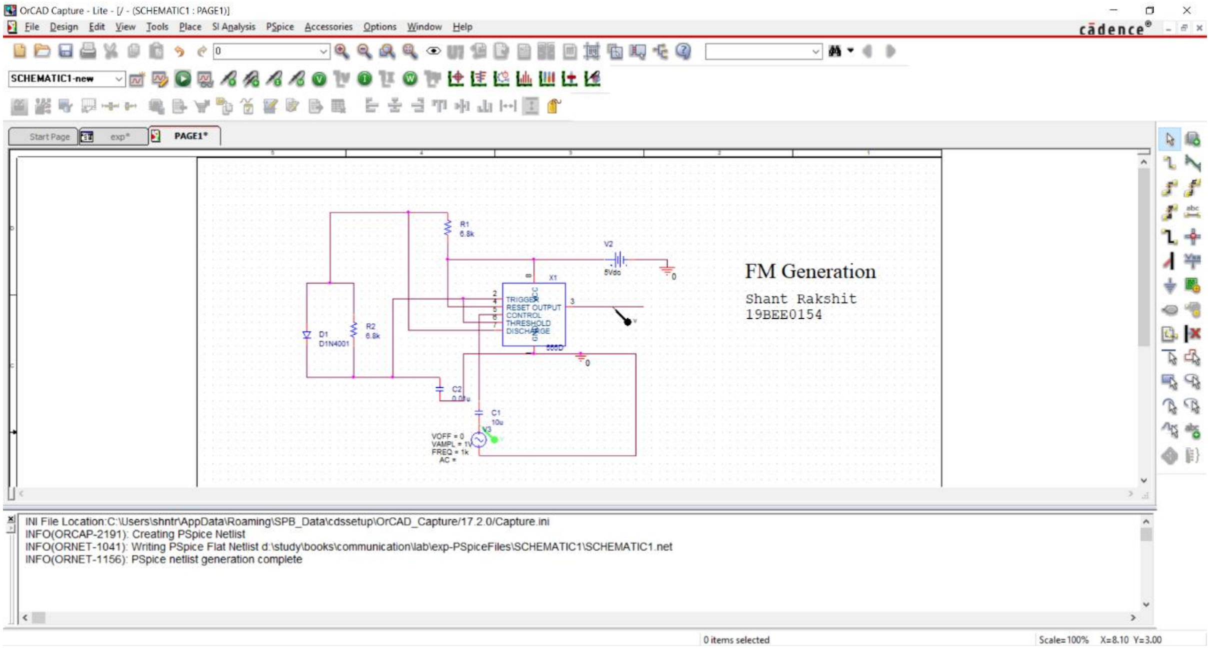


Figure 6
File Edit View Insert Tools Desktop Window Help
Demodulated mathematical PM signal using Mathematical formula - 19BEE0154
Demodulated mathematical PM signal using PMDEMOD - 19BEE0154
Demodulated mathematical PM signal with noise using PMDEMOD - 19BEE0154

OrCAD Circuit

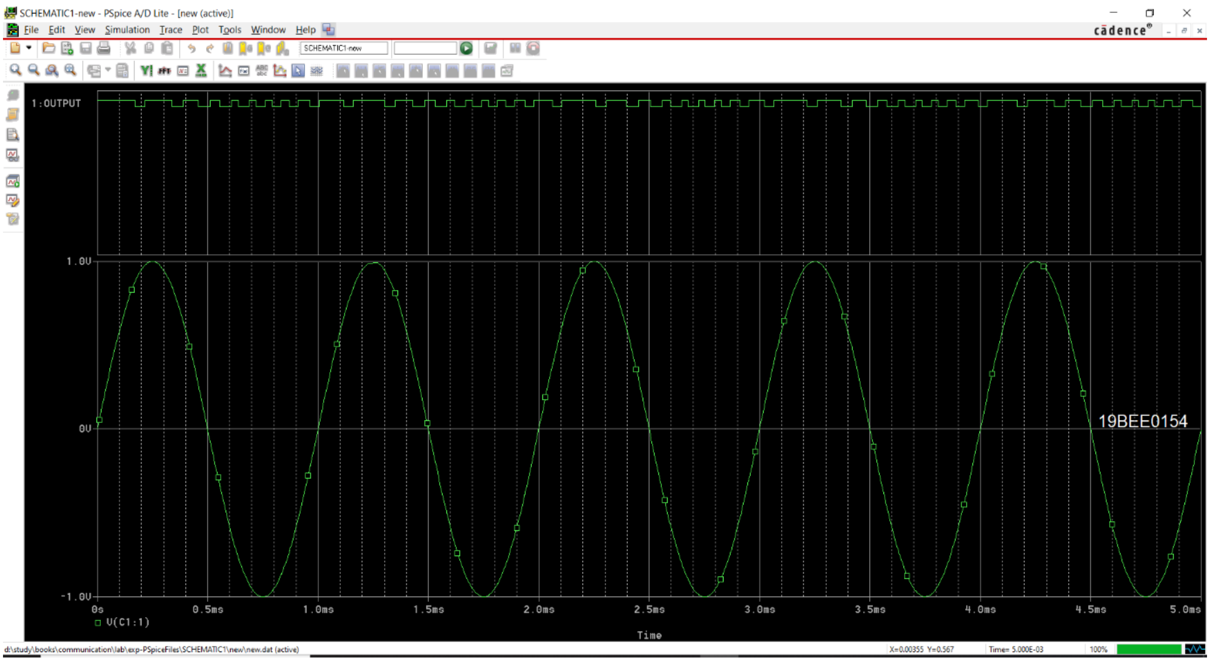


Stimulation settings

Mode : Time Domain (Transient)

Run Time : 5ms

Simulation



Manual Calculation of Modulation Index

Manual Calculation

Modulation Index for FM generator.

$f_m = 1k\,Hz = 1000\,Hz$

from the plot,

time period for high amplitude $= (2.2591 - 2.1048)\,ms$

$= 0.1543\,ms$

$\therefore f_{min} = \frac{1}{t} = 6480.88\,Hz$

time period for low amplitude $= (2.6785 - 2.6480)\,ms$

$= 0.0305\,ms$

$\therefore f_{max} = \frac{1}{t} = 32786.88\,Hz$

$\therefore \Delta f = 2(f_{max} - f_{min})$

$= 2(32786.88 - 6480.88)$

$= 2 \times 26306 = 52612\,Hz$

$\therefore$ Modulation Index $= \frac{\Delta f}{f_m}$

$= \frac{52612}{1000} = 52.6$

Hence the modulation index at frequency of 1kHz with amplitude of 1V is 52.6.

Result

The experiment was performed. The information for carrier wave and messenger wave was given as input and modulated signal were obtained using mathematical as well as in built commands, furthermore the effect of noise was observer by using the noise in the modulated signal. then demodulation was performed for modulated signal with and without noise.

Then circuit for FM generation was designed on ORCAD and simulated, the message waveform and modulated carrier waveform were observed and modulation index for the design circuit was calculated.

THEORY QUESTIONS

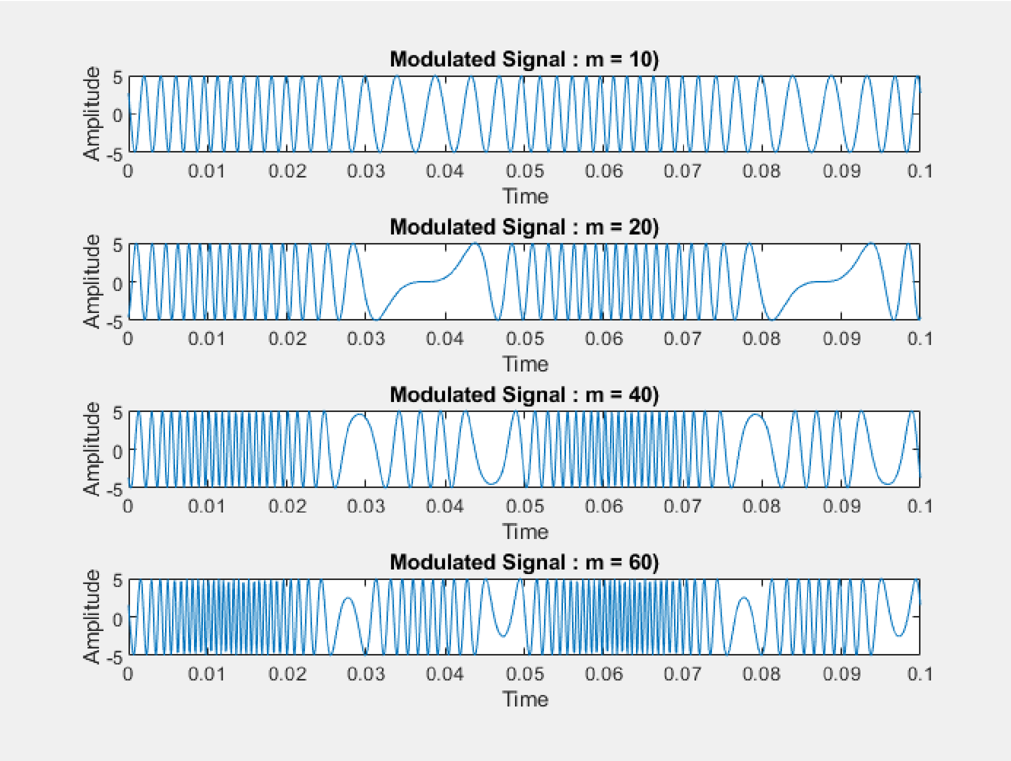
1. Differences between FM and PM observed

   A phase difference of π/2 between the two is observed. The frequency derivation is proportional to the modulating voltage only IN FM, whereas in PM, the frequency derivation is proportional to the modulating voltage as well as modulating frequency.

2. Importance of modulation index in FM.

   We observed the changes in the modulated signal by observing the graphs for different values of modulation index. As the value of index increases, the distortion of modulated signal also increases. It decides the bandwidth of the FM wave. The modulation index also decides the number of side bands having significant amplitudes.

   MATLAB Plot



3. Practical Applications of FM and PM

The applications of frequency modulation include FM radio broadcasting, radar, seismic prospecting, telemetry, & observing infants for seizure through EEG, music synthesis, two-way radio systems, magnetic tape recording systems, video broadcast systems, etc.

Phase modulation is widely used for transmitting radio waves and is an integral element of many digital transmission coding schemes that support an ample range of wireless technologies such as GSM, Satellite television, and Wi-Fi. PM is used for signal and waveform generation in digital synthesizers like Yamaha DX7 for phase modulation synthesis implementation, and Casio CZ for sound synthesis which is known as phase distortion.
This modulation is very useful in radio waves transmission, and it is an essential element in several digital transmission coding schemes. Phase modulation is used in digital synthesizers for generating waveform and signal