Cairo University - Faculty of Engineering

Computer Engineering Department

Communication (ELC3252A6)

Project Report

Team 2

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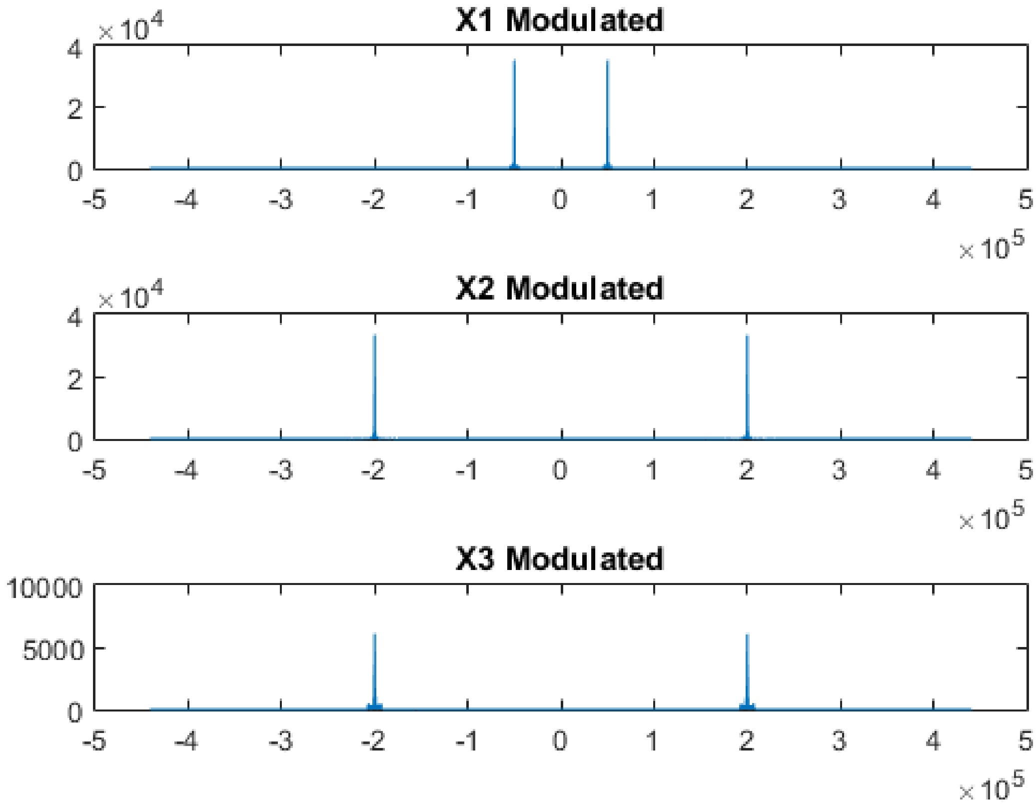
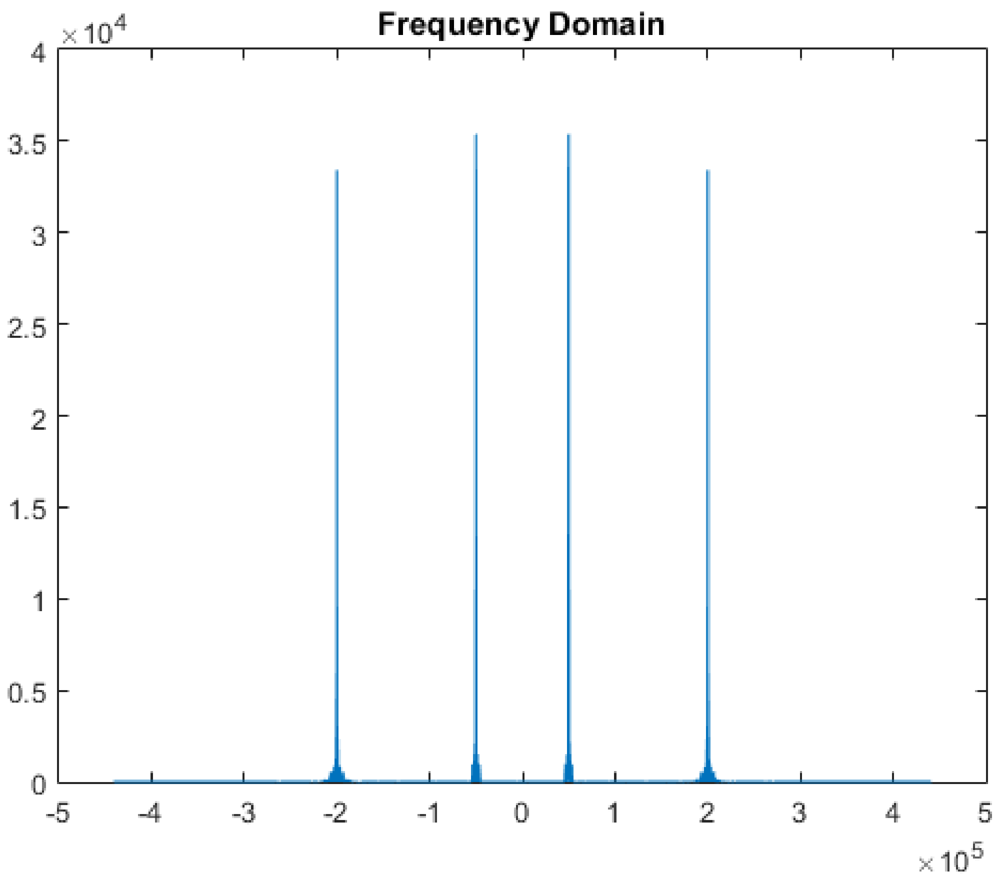
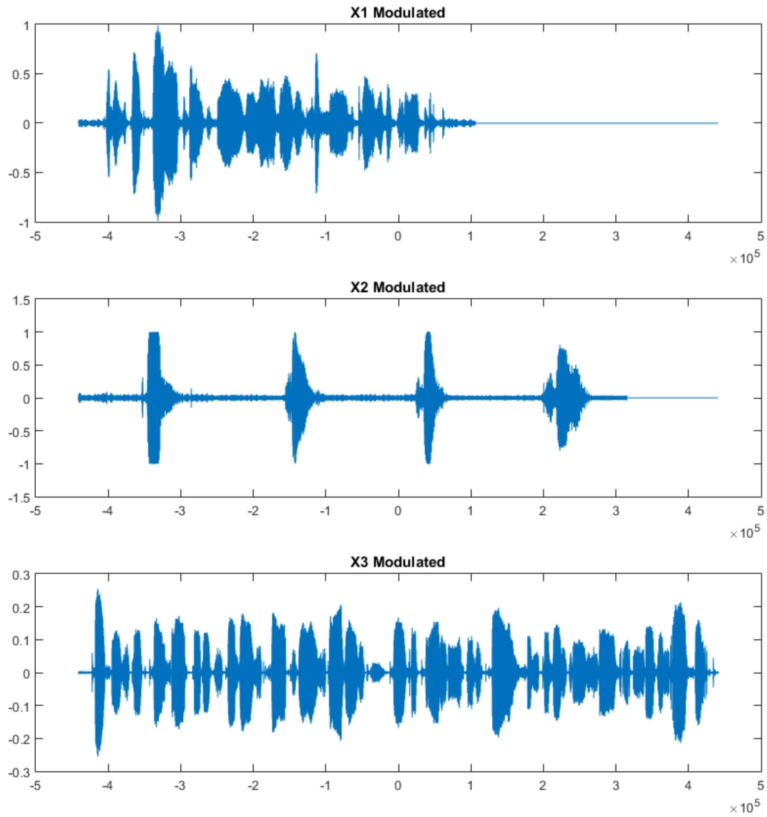
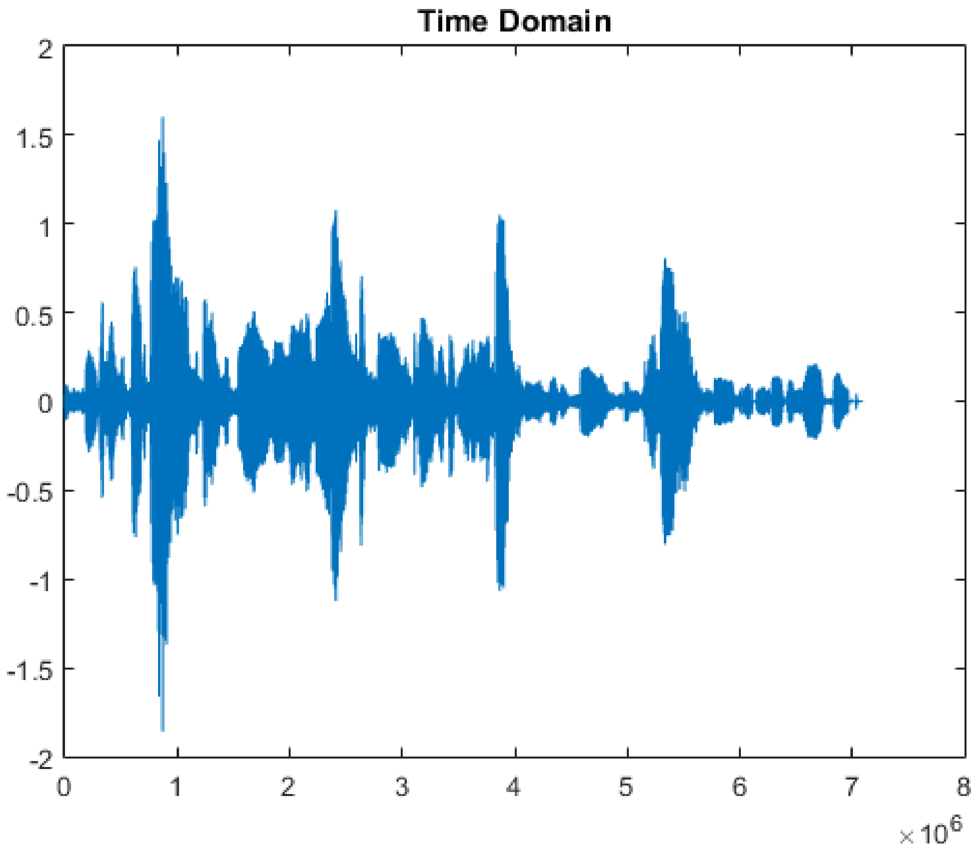
1- Modulated Signal






X1 Modulated
1
0.5
0
-0.5
-1
-5 -4 -3 -2 -1 0 1 2 3 4 5
× 10^5
X2 Modulated
1.5
1
0.5
0
-0.5
-1
-1.5
-5 -4 -3 -2 -1 0 1 2 3 4 5
× 10^5
X3 Modulated
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-5 -4 -3 -2 -1 0 1 2 3 4 5
× 10^5

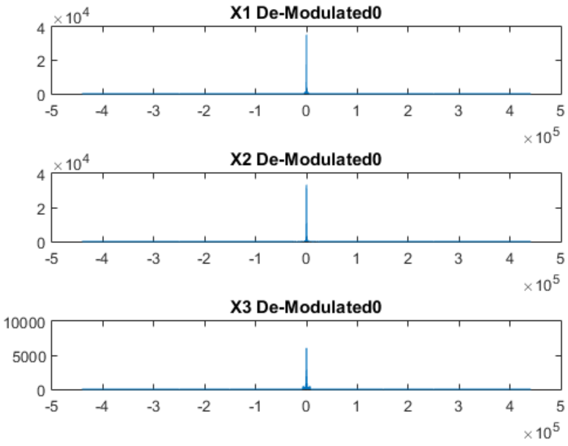

Time Domain
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0 1 2 3 4 5 6 7 8
× 10^6

2- Demodulated Signals

The phase error may cause attenuation of the output signal without causing distortion as long as it is constant.

e(t)=1/2*m(t)*cos(α) , where α is the phase shift.

a. phase shift 0 degree



Restored signals have half magnitude of the original ones.

b. phase shift 10 degrees

For signal 1 it's almost the same as the original.

For signal 2 and 3 because they are modulated on the same frequency but one by sin and the other by cos, then an overlapping will happen with low interference from the other signal.

c. phase shift 30 degrees

For signal 1 it's almost the same as the original.

For signal 2 and 3 because of the previous reason an overlapping will happen, but with higher interference from the other signal than the case of phase 10.

d. phase shift 90 degrees

For signal 1 it'll mute because cos(90)=0.

For signal 2 and 3 they will be switched, because cos(α+90)=sin(α) and vice versa.

3- Code

```
% %***********************************************************************************
% %******************************** TIME DOMAIN ******************************
% %***********************************************************************************
%
clc ;
clear all;
%
% % ================================
% % ======== reading audios ========
% % ================================
%
[x1,fs1]=audioread('Team2_ speechsignal_1.wav');
[x2,fs2]=audioread('Team2_ speechsignal_2.wav');
[x3,fs3]=audioread('Team2_ speechsignal_3.wav');

L1 = length(x1);
L2 = length(x2);
L3 = length(x3);
x1=([x1' zeros(1,L3-L1)])';
x2=([x2' zeros(1,L3-L2)])';
x3=([x3' zeros(1,L3-L3)])';

x1=interp(x1,20);
x2=interp(x2,20);
x3=interp(x3,20);

fs1=fs1*20;
TS1 = 1/fs1;
N1 = [0:(length(x1)-1)];
L1 = length(x1);
f1 = [-L1/2:L1/2-1]*(fs1/L1);

fs2=fs2*20;
TS2 = 1/fs2;
N2 = [0:(length(x2)-1)];
L2 = length(x2);
f2 = [-L2/2:L2/2-1]*(fs2/L2);

fs3=fs3*20;
TS3 = 1/fs3;
N3 = [0:(length(x3)-1)];
L3 = length(x3);
f3 = [-L3/2:L3/2-1]*(fs3/L3);

% % ================================
% % ========== Modulating ==========
% % ================================
Fc1=50000;
```

```
carrier1 = cos(2*pi*Fc1*TS1*N1);
x1_modulated = x1'.* carrier1;
Fc2=200000;
carrier2 = cos(2*pi*Fc2*TS2*N2);
x2_modulated = x2'.*carrier2;
Fc3=200000;
carrier3 = sin(2*pi*Fc3*TS3*N3);
x3_modulated = x3'.*carrier3;

% figure();
% subplot(3,1,1);
% plot(f1,abs(fftshift(fft(x1_modulated))));
% title('X1 Modulated')
% subplot(3,1,2);
% plot(f2,abs(fftshift(fft(x2_modulated))));
% title('X2 Modulated')
% subplot(3,1,3);
% plot(f3,abs(fftshift(fft(x3_modulated))));
% title('X3 Modulated')



% %******************************************************************************
% %******************************** COMBINED SIGNAL *******************************
% %******************************************************************************
signal = x1_modulated + x2_modulated + x3_modulated ;
figure();
plot(signal);
title('Time Domain')
figure();
plot(f3,abs(fftshift(fft(signal))));
title('Frequency Domain')

[C1,R1]=size(x1);
[C2,R2]=size(x2);
[C3,R3]=size(x3);

% %******************************************************************************
% %******************************** Demodulate ************************************
% %******************************************************************************

for i = [0 pi/18 pi/6 pi/2]
    carrier1 = cos(2*pi*Fc1*TS1*N1 + i);
    x1_new = signal(1:R1, 1:C1) .* carrier1;
    lp = designfilt('lowpassfir', 'FilterOrder',128, 'CutoffFrequency',22*10^3, 'Sam-
pleRate', fs1);%lowpassfilter
    x1_new=filter(lp,x1_new);
    OUTPUT1=downsample(x1_new,20);
    audiowrite(strcat('audio1Out',int2str(i*180/pi),'.wav'),OUTPUT1,fs1/20);


    carrier2 = cos(2*pi*Fc2*TS2*N2 + i);
```

```
    x2_new = signal(1:R2, 1:C2) .* carrier2;
    lp = designfilt('lowpassfir', 'FilterOrder',64, 'CutoffFrequency',44*10^3, 'Sam-
pleRate', fs2);%lowpassfilter
    x2_new=filter(lp,x2_new);
    OUTPUT2=downsample(x2_new,20);
    audiowrite(strcat('audio2Out',int2str(i*180/pi),'.wav'),OUTPUT2,fs2/20);

    carrier3 = sin(2*pi*Fc3*TS3*N3 + i);
    x3_new = signal(1:R3, 1:C3) .* carrier3;
    lp = designfilt('lowpassfir', 'FilterOrder',64, 'CutoffFrequency',44*10^3, 'Sam-
pleRate', fs3);%lowpassfilter
    x3_new=filter(lp,x3_new);
    OUTPUT3=downsample(x3_new,20);
    audiowrite(strcat('audio3Out',int2str(i*180/pi),'.wav'),OUTPUT3,fs3/20);

%     figure();
%     subplot(3,1,1);
%     plot(f1,abs(fftshift(fft(x1_new))));
%     title(strcat('X1 De-Modulated ',int2str(i*180/pi)))
%     subplot(3,1,2);
%     plot(f2,abs(fftshift(fft(x2_new))));
%     title(strcat('X2 De-Modulated ',int2str(i*180/pi)))
%     subplot(3,1,3);
%     plot(f3,abs(fftshift(fft(x3_new))));
%     title(strcat('X3 De-Modulated ',int2str(i*180/pi)))

end;
```