**AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH**

**Faculty of Science and Technology**



**Course Title: Data Communication[G]**

**Lab Report-7**

**Exp. Title: Frequency Division Multiplexing using MATLAB**

***Submitted by:* [Group-2]**

|  |  |
| --- | --- |
| **Name** | **ID** |
| Shadril Hassan Shifat | 20-42451-1 |
| Sadia Sultana Ali | 20-42386-1 |
| Abu Shaleh Md. Kaium | 20-42475-1 |
| Md. Ali Ahnaf | 20-42378-1 |

***Submitted to:* Tanjil Amin**

**Date of Submission:** 19 **March, 2022**

**Performance Task for Lab Report: (your ID = AB-CDEFG-H)**You have four message signals:  
a) mt1 = am1\*cos(2\*pi\*fm1\*t);  
b) mt2 = am2\*cos(2\*pi\*fm2\*t);  
c) mt3 = am3\*cos(2\*pi\*fm3\*t);  
d) mt4 = am4\*cos(2\*pi\*fm4\*t);  
where,  
am1 = (F+2);  
am2 = (F+5);  
am3 = (F+8);  
am4 = (F+11);  
and  
fm1 = (G+1);  
fm2 = (G+2);  
fm3 = (G+3);  
fm4 = (G+4);  
We want to simultaneously transmit these four signals through a single data link that can support a frequency range of 50 Hz to 250 Hz.

\*\*\* Write a code that can modulate and multiplex the four given message signals in transmitting side (use appropriate carrier signals for amplitude modulation as required) and de-multiplex (use appropriate cutoff frequencies in your bandpass filters) and de-modulate (use appropriate cut-off frequencies in your lowpass filters) to recover the four message signals in receiving side.

**MATLAB Code:**

%ID=20-42451-1

clc;

clear all;

close all;

A=2;

B=0;

C=4;

D=2;

E=4;

F=5;

G=1;

H=1;

fs=4001;

t=0:1/fs:1-1/fs;

am1=(F+2);

fm1=(G+1);

mt1=am1\*cos(2\*pi\*fm1\*t);

am2 = (F+5);

fm2= (G+2);

mt2=am2\*cos(2\*pi\*fm2\*t);

am3 = (F+8);

fm3 = (G+3);

mt3 = am3\*cos(2\*pi\*fm3\*t);

am4 = (F+11);

fm4 = (G+4);

mt4 = am4\*cos(2\*pi\*fm4\*t);

%% Carrier Signal Generation

Cm1 = 1; %Amplitude of First Carrier Signal

fc1 = 100; %Frequency of First Carrier Signal

c1 = Cm1\*cos(2\*pi\*fc1\*t); % First Carrier Signal

Cm2 = 1; %Amplitude of Second Carrier Signal

fc2 = 150; %Frequency of Second Carrier Signal

c2 = Cm2\*cos(2\*pi\*fc2\*t); % Second Carrier Signal

Cm3 = 1; %Amplitude of Third Carrier Signal

fc3 = 200; %Frequency of Third Carrier Signal

c3 = Cm3\*cos(2\*pi\*fc3\*t); % Third Carrier Signal

Cm4 = 1; %Amplitude of Forth Carrier Signal

fc4 = 230; %Frequency of Forth Carrier Signal

c4 = Cm4\*cos(2\*pi\*fc4\*t); % Forth Carrier Signal

%% Composite Signal Generation

x = (mt1).\*c1+(mt2).\*c2+(mt3).\*c3+(mt4).\*c4;

%%figure of signals in time domain

figure; %1

subplot(4,1,1);

plot(t,mt1);

xlabel('time');

ylabel('amplitude');

title('Message Signal 1 in Time Domain');

ylim([-am1 am1]);

subplot(4,1,2);

plot(t,mt2);

xlabel('time');

ylabel('amplitude');

title('Message Signal 2 in Time Domain');

ylim([-am2 am2]);

subplot(4,1,3);

plot(t,mt3);

xlabel('time');

ylabel('amplitude');

title('Message Signal 3 in Time Domain');

ylim([-am3 am3]);

subplot(4,1,4);

plot(t,mt4);

xlabel('time');

ylabel('amplitude');

title('Message Signal 4 in Time Domain');

ylim([-am4 am4]);

%freq. domain conversion

M1 = abs(fftshift(fft(mt1)))/(fs/2); %Fourier Transformation of mt1

M2 = abs(fftshift(fft(mt2)))/(fs/2); %Fourier Transformation of mt2

M3 = abs(fftshift(fft(mt3)))/(fs/2); %Fourier Transformation of mt3

M4= abs(fftshift(fft(mt4)))/(fs/2); %Fourier Transformation of mt4

X = abs(fftshift(fft(x)))/(fs/2); %Fourier Transformation of x (composite sig.)

f = fs/2\*linspace(-1,1,fs);

figure; %2

subplot(4,1,1);

%%plot(f,M1)

stem(f,M1);

xlabel('frequency');

ylabel('amplitude');

title('Message Signal 1 in Frequency Domain');

axis([-10 10 0 9]);

subplot(4,1,2);

%%plot(f,M2)

stem(f,M2);

xlabel('frequency');

ylabel('amplitude');

title('Message Signal 2 in Frequency Domain');

axis([-10 10 0 12]);

subplot(4,1,3);

%%plot(f,M3)

stem(f,M3);

xlabel('frequency');

ylabel('amplitude');

title('Message Signal 3 in Frequency Domain');

axis([-10 10 0 15]);

subplot(4,1,4);

stem(f,M4);

xlabel('frequency');

ylabel('amplitude');

title('Message Signal 4 in Frequency Domain');

axis([-10 10 0 20]);

figure %3

subplot(2,1,1);

plot(t,x);

xlabel('time');

ylabel('amplitude');

title('Composite Signal in Time Domain');

subplot(2,1,2);

stem(f,X);

xlabel('frequency');

ylabel('amplitude');

title('Composite Signal in Frequency Domain');

axis([-270 270 0 7]);

%% Passing the Composite Signal Through Bandpass Filter

[num1, den1] = butter(5, [(fc1-fm1-6)/(fs/2),(fc1+fm1+6)/(fs/2)]);

%Butterworth Filter Window Determining for Bandpass Filter

bpf1 = filter(num1,den1,x); %Filtering is done here

[num2, den2] = butter(5, [(fc2-fm2-6)/(fs/2),(fc2+fm2+6)/(fs/2)]);

bpf2 = filter(num2,den2,x);

[num3, den3] = butter(5, [(fc3-fm3-6)/(fs/2),(fc3+fm3+6)/(fs/2)]);

bpf3 = filter(num3,den3,x);

[num4, den4] = butter(5, [(fc4-fm4-6)/(fs/2),(fc4+fm4+6)/(fs/2)]);

bpf4= filter(num4,den4,x); %Filtering is done here

%% Mixing

z1 = 2\*bpf1.\*c1;

z2 = 2\*bpf2.\*c2;

z3 = 2\*bpf3.\*c3;

z4= 2\*bpf4.\*c4;

%%

%% Passing the Mixed Signals Through Lowpass Filter

[num5, den5] = butter(5, (fm1+3)/(fs/2)); %Low pass filter is made here

rec1 = filter(num5,den5,z1); %Filtering is done here

[num6, den6] = butter(5, (fm2+3)/(fs/2));

rec2 = filter(num6,den6,z2);

[num7, den7] = butter(5, (fm3+3)/(fs/2));

rec3 = filter(num7,den7,z3);

[num8, den8] = butter(5, (fm4+3)/(fs/2));

rec4 = filter(num8,den8,z4);

%%

%%

%% Plotting the Received Signals in Time-Domain and Frequency Domain

figure; %3

subplot(4,1,1);

plot(t,rec1);

xlabel('time');

ylabel('amplitude');

title('received signal 1 in time domain');

ylim([-am1 am1]);

subplot(4,1,2);

plot(t,rec2);

xlabel('time');

ylabel('amplitude');

title('received signal 2 in time domain');

ylim([-am2 am2]);

subplot(4,1,3);

plot(t,rec3);

xlabel('time');

ylabel('amplitude');

title('received signal 3 in time domain');

subplot(4,1,4);

plot(t,rec4);

xlabel('time');

ylabel('amplitude');

title('received signal 4 in time domain');

ylim([-am4 am4]);

%freq. domain conversion

R1 = abs(fftshift(fft(rec1)))/(fs/2); %Fourier Transformation is done here

R2 = abs(fftshift(fft(rec2)))/(fs/2);

R3 = abs(fftshift(fft(rec3)))/(fs/2);

R4 = abs(fftshift(fft(rec4)))/(fs/2);

figure;%5

subplot(4,1,1);

stem(f,R1);

xlabel('frequnecy');

ylabel('amplitude');

title('received signal 1 in frequnecy domain');

axis([-10 10 0 9]);

subplot(4,1,2);

stem(f,R2);

xlabel('frequnecy');

ylabel('amplitude');

title('received signal 2 in frequnecy domain');

axis([-10 10 0 12]);

subplot(4,1,3);

stem(f,R3);

xlabel('frequnecy');

ylabel('amplitude');

title('received signal 3 in frequnecy domain');

axis([-10 10 0 15]);

subplot(4,1,4);

stem(f,R4);

xlabel('frequnecy');

ylabel('amplitude');

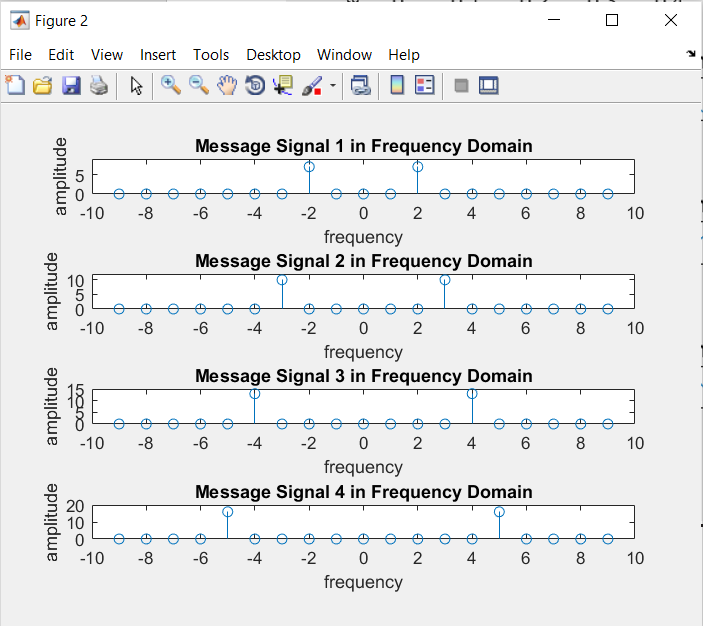
title('received signal 4 in frequnecy domain');

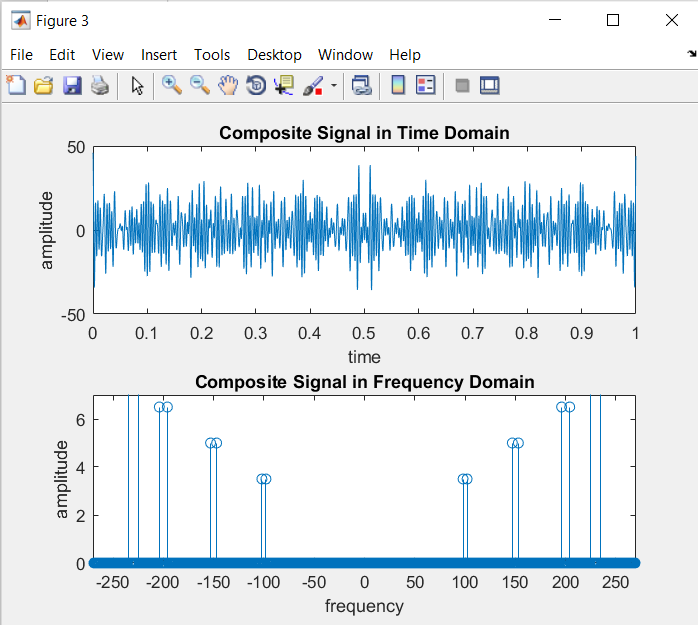
axis([-10 10 0 20]);

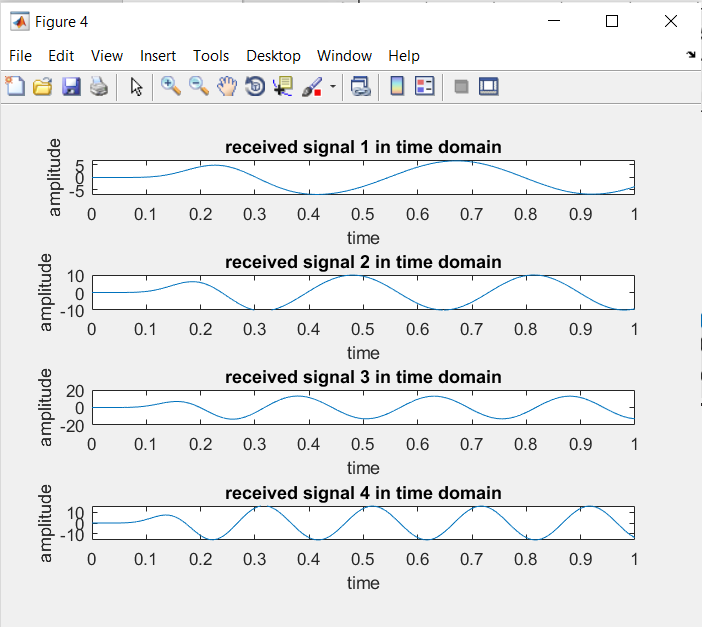
%% End

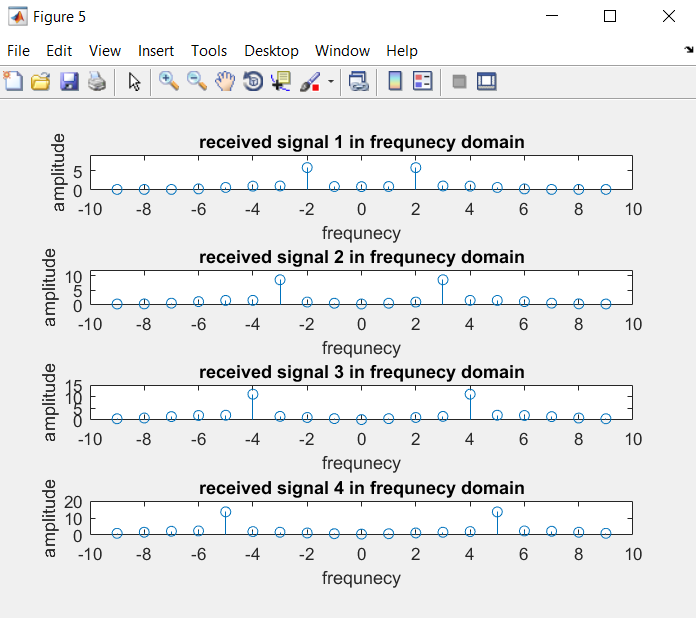
**Output:**

****

****

****

****

****