AMERICAN INTERNATIONAL UNIVERSITY–BANGLADESH (AIUB)

FACULTY OF ENGINEERING

Course name: Data Communication

Course code: COE 3201

Section: H

Semester: Spring 2023-24

Group-04

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Experiment No : 08

Experiment name: **Study of Frequency Division Multiplexing (FDM) using MATLAB**

Submission date: April 26th, 2024

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.

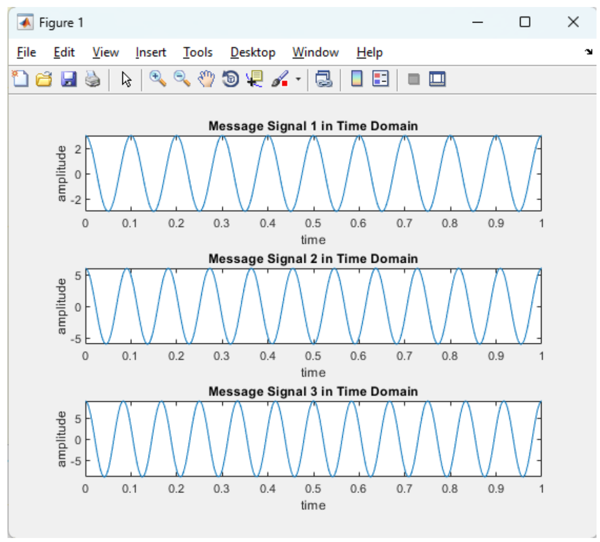
*** Write a code that can modulate and multiplex the four given message signals in transmitting side (use appropriate carrier signals for amplitude modulation as required) and de-multiplex (use appropriate cut-off frequencies in your bandpass filters) and de-modulate (use appropriate cut-off frequencies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

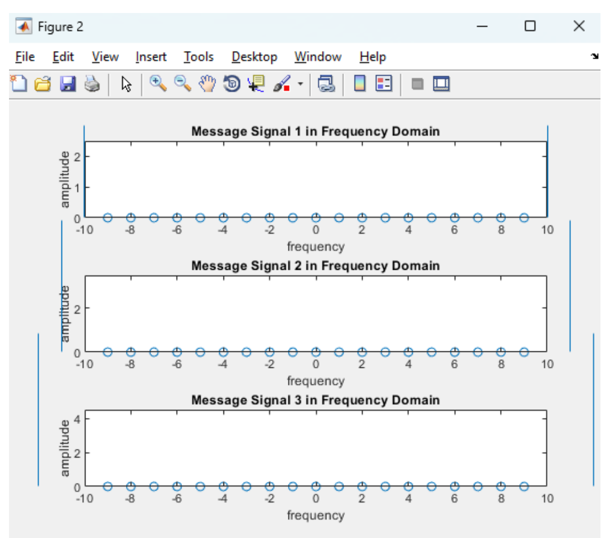
ANSWER OF QUESTION 1

A	B	-	C	D	E	F	G	-	H
2	2	-	4	7	0	1	9	-	1

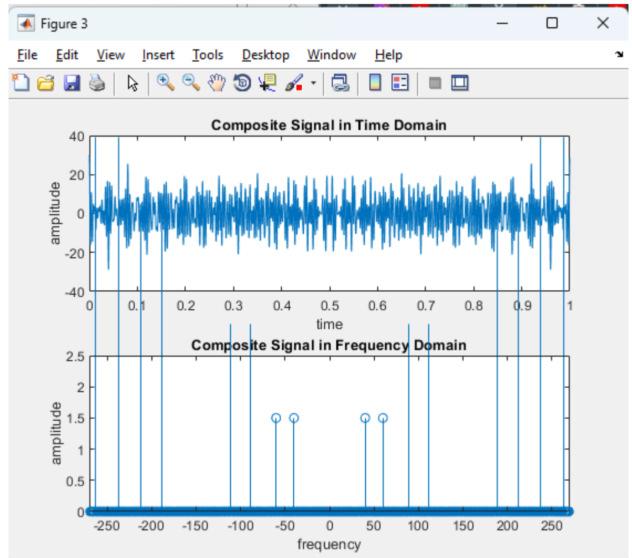
MATLAB Code	Output Figure

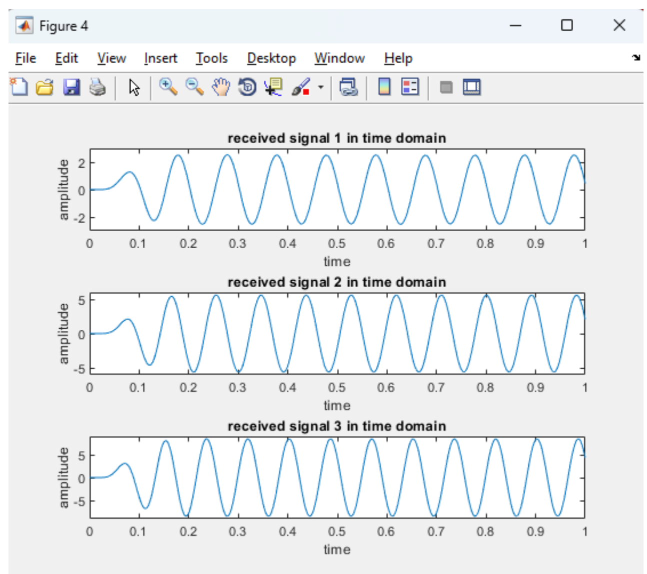
```
%HERE, F = 1, G = 9
clc;
clear all;
close all;

%% Message Signal Generation
fs = 4001; %Sampling Frequency
t = 0:1/fs:1-1/fs; %Generating Time axis

Am1 = 3; %Amplitude of First Message Signal
fm1 = 10; %Frequency of First Message Signal
m1 = Am1*cos(2*pi*fm1*t); % First Message Signal

Am2 = 6; %Amplitude of Second Message Signal
fm2 = 11; %Frequency of Second Message Signal
m2 = Am2*cos(2*pi*fm2*t); % Second Message Signal

Am3 = 9; %Amplitude of Third Message Signal
fm3 = 12; %Frequency of Third Message Signal
m3 = Am3*cos(2*pi*fm3*t); % Third Message Signal

Am4 = 12; %Amplitude of Fourth Message Signal
fm4 = 13; %Frequency of Fourth Message Signal
m4 = Am4*cos(2*pi*fm4*t);
%% Carrier Signal Generation
Cm1 = 1; %Amplitude of First Carrier Signal
fc1 = 50; %Frequency of First Carrier Signal
c1 = Cm1*cos(2*pi*fc1*t); % First Carrier Signal

Cm2 = 1; %Amplitude of Second Carrier Signal
fc2 = 100; %Frequency of Second Carrier Signal
c2 = Cm2*cos(2*pi*fc2*t); % Second Carrier Signal

Cm3 = 1; %Amplitude of Third Carrier Signal
```



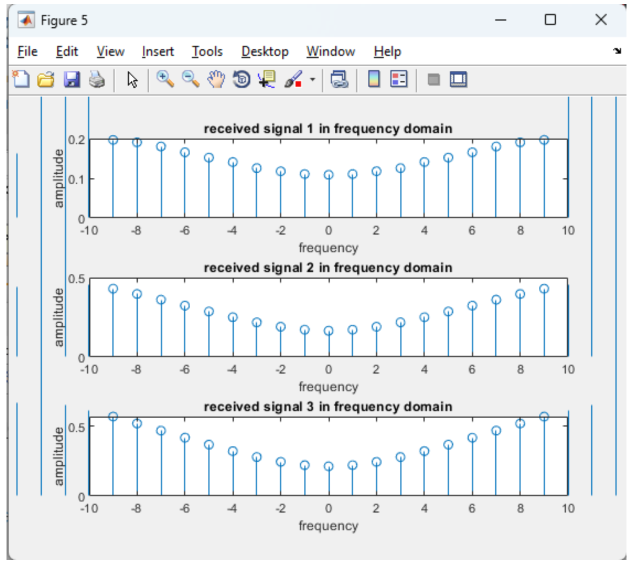


```
fc3 = 200; %Frequency of Third
Carrier Signal
c3 = Cm3*cos(2*pi*fc3*t); % Third
Carrier Signal


Cm4 = 1; %Amplitude of Third Carrier
Signal
fc4 = 250; %Frequency of Third
Carrier Signal
c4 = Cm4*cos(2*pi*fc4*t); % Third
Carrier Signal


%% Composite Signal Generation
x =
(m1).*c1+(m2).*c2+(m3).*c3+(m4).*c4;

% Plotting the Signals in Time-Domain
and Frequency-Domain
figure
subplot(3,1,1)
plot(t,m1)
xlabel('time')
ylabel('amplitude')
title('Message Signal 1 in Time
Domain')
ylim([-Am1 Am1])
subplot(3,1,2)
plot(t,m2)
xlabel('time')
ylabel('amplitude')
title('Message Signal 2 in Time
Domain')
ylim([-Am2 Am2])
subplot(3,1,3)
plot(t,m3)
xlabel('time')
ylabel('amplitude')
title('Message Signal 3 in Time
Domain')
ylim([-Am3 Am3])

M1 = abs(fftshift(fft(m1)))/(fs/2);
%Fourier Transformation of m1
M2 = abs(fftshift(fft(m2)))/(fs/2);
%Fourier Transformation of m2
M3 = abs(fftshift(fft(m3)))/(fs/2);
%Fourier Transformation of m3
X = abs(fftshift(fft(x)))/(fs/2);
%Fourier Transformation of x
f = fs/2*linspace(-1,1,fs);
figure
subplot(3,1,1)
stem(f,M1)
xlabel('frequency')
ylabel('amplitude')
title('Message Signal 1 in Frequency
Domain')
axis([-10 10 0 2.5])
subplot(3,1,2)
stem(f,M2)
xlabel('frequency')
```





```
ylabel('amplitude')
title('Message Signal 2 in Frequency
Domain')
axis([-10 10 0 3.5])
subplot(3,1,3)
stem(f,M3)
xlabel('frequency')
ylabel('amplitude')
title('Message Signal 3 in Frequency
Domain')
axis([-10 10 0 4.5])
figure
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 2.5])

%% 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)]);
%Butterworth Filter Window
Determining for Bandpass Filter
bpf2 = filter(num2,den2,x);
%Filtering is done here

[num3, den3] = butter(5, [(fc3-fm3-
6)/(fs/2),(fc3+fm3+6)/(fs/2)]);
%Butterworth Filter Window
Determining for Bandpass Filter
bpf3 = filter(num3,den3,x);
%Filtering is done here

% Mixing
z1 = 2*bpf1.*c1;
z2 = 2*bpf2.*c2;
z3 = 2*bpf3.*c3;

%% Passing the Mixed Signals Through
Lowpass Filter

[num4, den4] = butter(5,
(fm1+3)/(fs/2)); %Low pass filter is
made here
rec1 = filter(num4,den4,z1);
%Filtering is done here
```



```
[num5, den5] = butter(5,
(fm2+3)/(fs/2)); %Low pass filter is
made here
rec2 = filter(num5,den5,z2);
%Filtering is done here

[num6, den6] = butter(5,
(fm3+3)/(fs/2)); %Low pass filter is
made here
rec3 = filter(num6,den6,z3);
%Filtering is done here

% Plotting the Received Signals in
Time-Domain and Frequency Domain
figure
subplot(3,1,1)
plot(t,rec1)
xlabel('time')
ylabel('amplitude')
title('received signal 1 in time
domain')
ylim([-Am1 Am1])

subplot(3,1,2)
plot(t,rec2)
xlabel('time')
ylabel('amplitude')
title('received signal 2 in time
domain')
ylim([-Am2 Am2])

subplot(3,1,3)
plot(t,rec3)
xlabel('time')
ylabel('amplitude')
title('received signal 3 in time
domain')
ylim([-Am3 Am3])

R1 = abs(fftshift(fft(rec1)))/(fs/2);
%Fourier Transformation is done here
R2 = abs(fftshift(fft(rec2)))/(fs/2);
%Fourier Transformation is done here
R3 = abs(fftshift(fft(rec3)))/(fs/2);
%Fourier Transformation is done here

figure
subplot(3,1,1)
stem(f,R1)
xlabel('frequency')
ylabel('amplitude')
title('received signal 1 in frequency
domain')
xlim([-10 10])

subplot(3,1,2)
stem(f,R2)
xlabel('frequency')
ylabel('amplitude')
title('received signal 2 in frequency
domain')
xlim([-10 10])
```

``subplot(3,1,3)``` ```stem(f,R3)``` ```xlabel('frequency')``` ```ylabel('amplitude')``` ```title('received signal 3 in frequency domain')``` ```xlim([-10 10])```	