# AMERICAN INTERNATIONAL UNIVERSITY BANGLADESH

Faculty of Engineering

# Laboratory Report Cover Sheet

***Students must complete all details except the faculty use part.***

Please submit all reports to your subject supervisor or the office of the concerned faculty.

Lab Title: **Frequency Division Multiplexing using MATLAB**

Experiment Number: **09** Due Date: **03 /05/2024** Semester: **Spring 2023-2024** Subject Code: **COE3103** Subject Name: **DATA COMMUNICATION** Section: **E** Course Instructor: **NOWSHIN ALAM** Degree Program: **B.Sc. CSE**

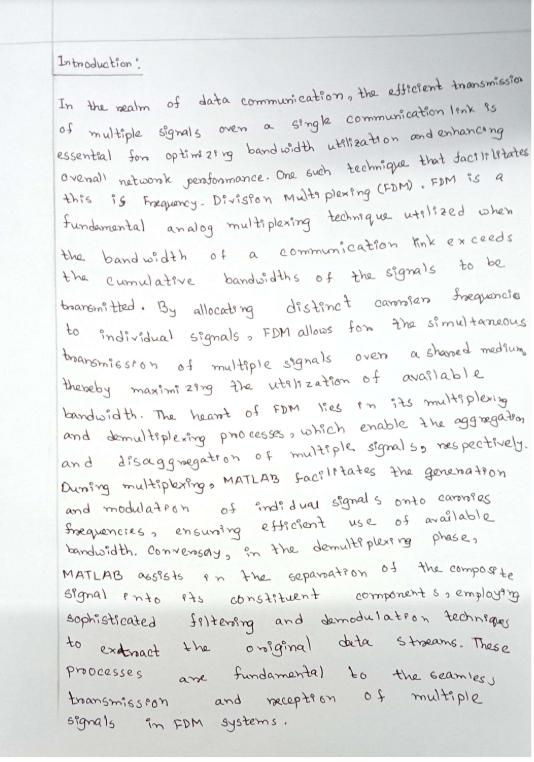
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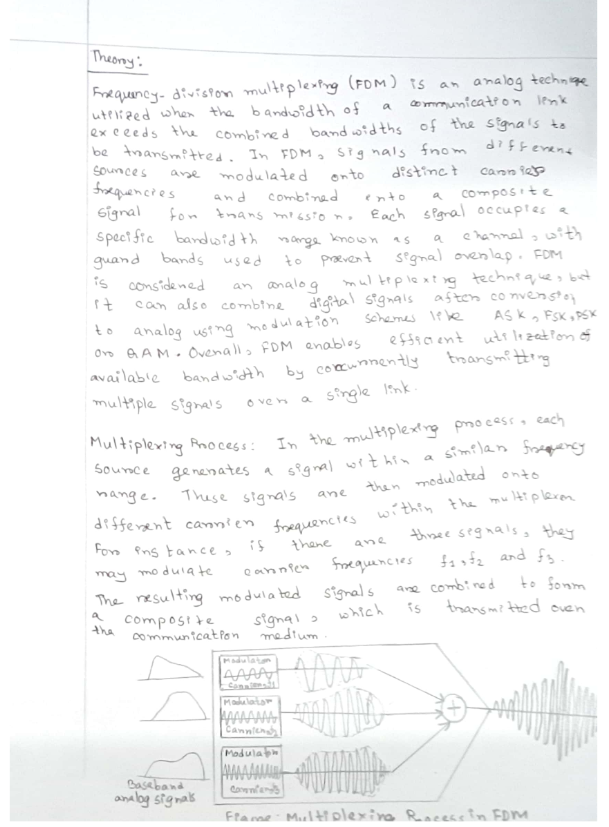
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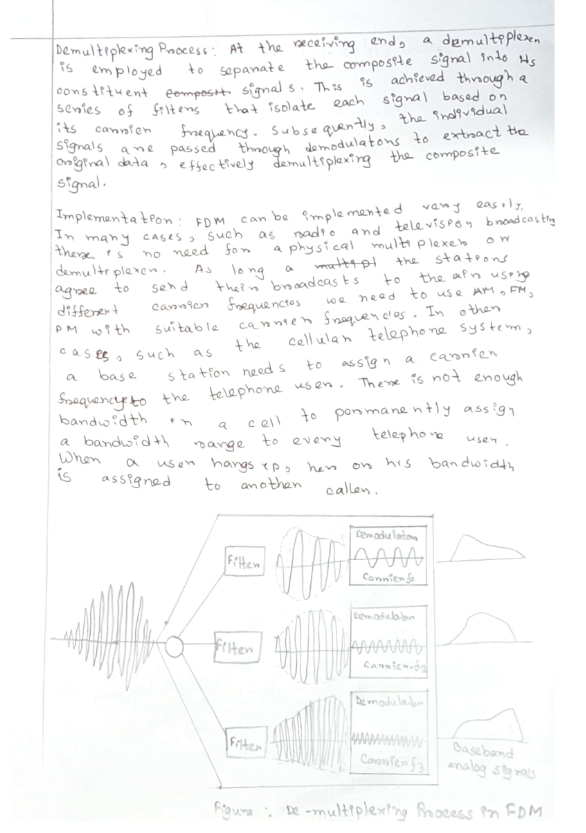
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| Group Number (if applicable): 8 | | | Individual Submission | | |  | Group Submission | | |  |  |  |
|  | | | | | | | | | | |  |
| **No.** |  | **Student Name** | | **Student Number** |  |  | **Student Signature** |  | **Date** | |  |
| **Submitted by:** | | | | | | | | | | |  |
| **1** | | **KHUSHBU ALAM RAHI** | | **22-46947-1** | |  | | |  | |  |
| ***For faculty use only:*** | | | | **Total Marks: Marks Obtained:** | | | | | | |  |  |
| **Faculty comments** | | | | | | | | | | |  |
|  | | | | | | | | | |  |  |







**Simulated Results:**ID=AB-CDEFG-H  
ID=22-46947-1  
  
There are 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);  
**Code and Simulations:**Simultaneous transmission of these four signals through a single data link supporting a frequency range of 50 Hz to 250 Hz is achieved by employing frequency division multiplexing (FDM).

clc

clear all

close all

%ID=AB-CDEFG-H

%ID=22-46947-1

fs = 4001; %Sampling Frequency

t = 0:1/fs:1-1/fs; %Generating Time axis

%am1 = (F+2)

%am1=(4+2)=6

am1 = 6; %Amplitude of First Message Signal

%fm1 = (G+1)=(7+1)=8;

fm1 = 8; %Frequency of First Message Signal

m1 = am1\*cos(2\*pi\*fm1\*t); % First Message Signal

%am2 = (F+5)=(4+5)=9;

am2 = 9; %Amplitude of Second Message Signal

%fm2 = (G+2)=(7+2)=9;

fm2 = 9; %Frequency of Second Message Signal

m2 = am2\*cos(2\*pi\*fm2\*t); % Second Message Signal

%am3 = (F+8)=(4+8)=12;

am3 = 12; %Amplitude of Third Message Signal

%fm3 = (G+3)=(7+3)=10;

fm3 = 10; %Frequency of Third Message Signal

m3 = am3\*cos(2\*pi\*fm3\*t); % Third Message Signal

%am4 = (F+11)=(4+11)=15;

am4=15;

%fm4 = (G+4)=(7+4)=11;

fm4=11;

m4 = am4\*cos(2\*pi\*fm4\*t); % Fourth Message Signal

%%

%% Carrier Signal Generation

Cm1 = 1; %Amplitude of First Carrier Signal

fc1 = 80; %Frequency of First Carrier Signal

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

Cm2 = 1; %Amplitude of Second Carrier Signal

fc2 = 130; %Frequency of Second Carrier Signal  
c2 = Cm2\*cos(2\*pi\*fc2\*t); % Second Carrier Signal

Cm3 = 1; %Amplitude of Third Carrier Signal

fc3 = 180; %Frequency of Third Carrier Signal

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

Cm4 = 1; %Amplitude of Fourth Carrier Signal

fc4 = 220; %Frequency of Fourth Carrier Signal

c4 = Cm4\*cos(2\*pi\*fc4\*t); % Fourth 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(4,1,1)

plot(t,m1)

xlabel('time')

ylabel('amplitude')

title('Message Signal 1 in Time Domain')

ylim([-am1 am1])

subplot(4,1,2)

plot(t,m2)

xlabel('time')

ylabel('amplitude')

title('Message Signal 2 in Time Domain')

ylim([-am2 am2])

subplot(4,1,3)

plot(t,m3)

xlabel('time')

ylabel('amplitude')

title('Message Signal 3 in Time Domain')

ylim([-am3 am3])

subplot(4,1,4)

plot(t,m4)

xlabel('time')

ylabel('amplitude')

title('Message Signal 4 in Time Domain')

ylim([-am4 am4])

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

M4 = abs(fftshift(fft(m4)))/(fs/2); %Fourier Transformation of m4

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

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

figure

subplot(4,1,1)

stem(f,M1)

xlabel('frequency')

ylabel('amplitude')

title('Message Signal 1 in Frequency Domain')

axis([-15 15 0 10])

subplot(4,1,2)

stem(f,M2)

xlabel('frequency')

ylabel('amplitude')

title('Message Signal 2 in Frequency Domain')

axis([-15 15 0 10])

subplot(4,1,3)

stem(f,M3)

xlabel('frequency')

ylabel('amplitude')

title('Message Signal 3 in Frequency Domain')

axis([-15 15 0 16])

subplot(4,1,4)

stem(f,M4)

xlabel('frequency')

ylabel('amplitude')

title('Message Signal 4 in Frequency Domain')

axis([-15 15 0 18])

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 4.5])

%%

%% 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

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

%Butterworth Filter Window Determining for Bandpass Filter

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)); %Low pass filter is made here

rec2 = filter(num6,den6,z2); %Filtering is done here

[num7, den7] = butter(5, (fm3+3)/(fs/2)); %Low pass filter is made here

rec3 = filter(num7,den7,z3); %Filtering is done here

[num8, den8] = butter(5, (fm4+3)/(fs/2)); %Low pass filter is made here

rec4 = filter(num8,den8,z4); %Filtering is done here

%%

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

figure

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')

ylim([-am3 am3])

subplot(4,1,4)

plot(t,rec4)

xlabel('time')

ylabel('amplitude')

title('received signal 4 in time domain')

ylim([-am4 am4])

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

R4 = abs(fftshift(fft(rec4)))/(fs/2); %Fourier Transformation is done here

figure

subplot(4,1,1)

stem(f,R1)

xlabel('frequency')

ylabel('amplitude')

title('received signal 1 in frequency domain')

xlim([-10 10])

subplot(4,1,2)

stem(f,R2)

xlabel('frequency')

ylabel('amplitude')

title('received signal 2 in frequency domain')

xlim([-10 10])

subplot(4,1,3)

stem(f,R3)

xlabel('frequency')

ylabel('amplitude')

title('received signal 3 in frequency domain')

xlim([-10 10])

subplot(4,1,4)

stem(f,R4)

xlabel('frequency')

ylabel('amplitude')

title('received signal 4 in frequency domain')

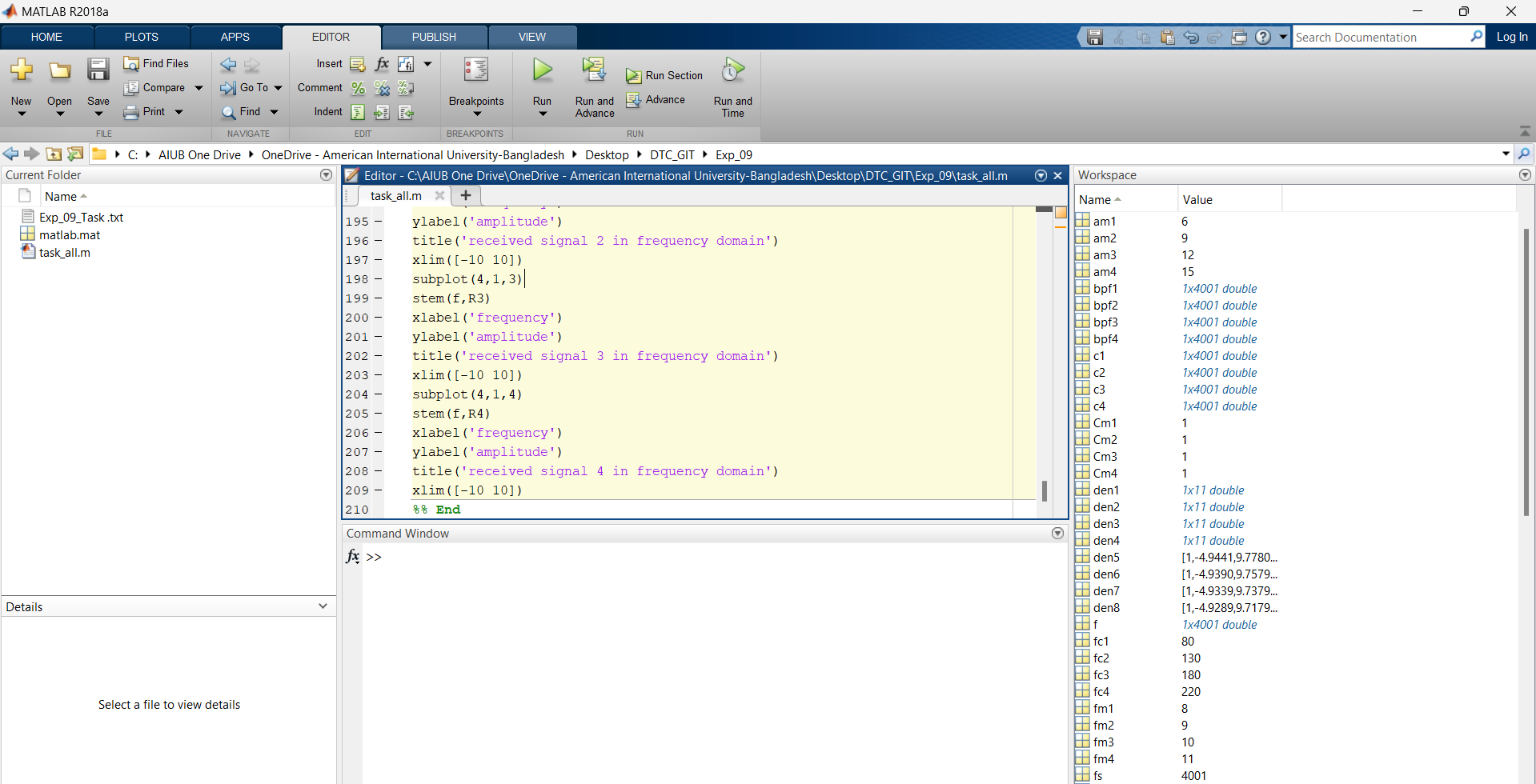
xlim([-10 10])

%% End

**Workspace:**

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**Plots:** Figure 1: Message Signals in Time Domain

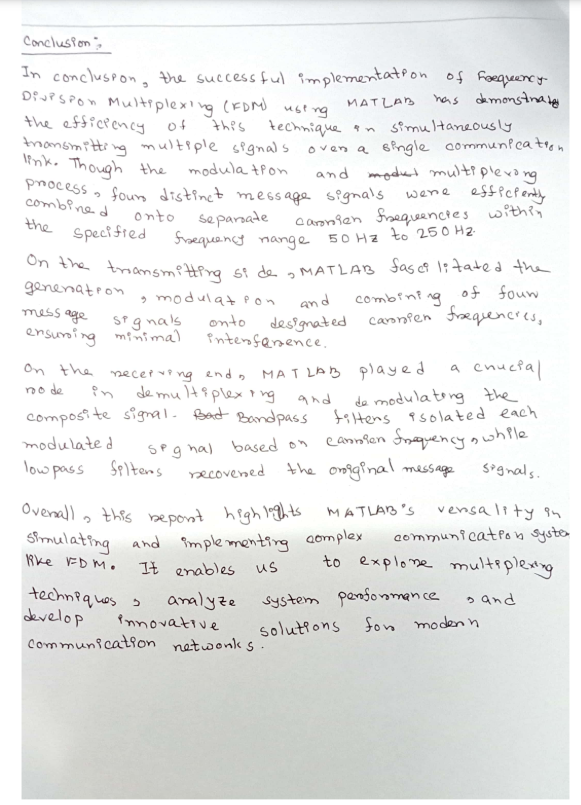
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Figure 2: Message Signals in Frequency Domain

Figure 3: Composite Signal in Time Domain  
 and  
 Composite Signal in Frequency Domain  
  
 Figure 4: Received Signals in Time Domain  
 Figure 5: Received Signals in Frequency Domain   
  


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