**Lab Report:** *07*

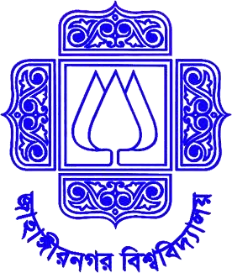
**Title:** *Amplitude and Frequency*

*Modulation and Demodulation (AM and FM)*

***Course Title:*** *Data and Telecommunication Laboratory*

***Course Code:*** *CSE-260*

*2nd Year 2nd Semester Examination 2023*



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Date of Submission: 01/02/2025

**Lab Report:** Amplitude and Frequency Modulation and Demodulation (AM and FM)

**Objective:**

The objective of this experiment is to study and implement **Amplitude Modulation (AM)** and **Frequency Modulation (FM)** techniques, including their modulation and demodulation processes. The experiment also involves analyzing the time-domain and frequency-domain characteristics of the modulated signals.

**Theory:**

**Amplitude Modulation (AM)**

* **Definition**: AM is a modulation technique where the amplitude of the carrier signal is varied in proportion to the message signal. It is widely used in radio broadcasting.

**Frequency Modulation (FM)**

* **Definition**: FM is a modulation technique where the frequency of the carrier signal is varied in proportion to the message signal. It is commonly used in high-fidelity radio broadcasting and television sound.

**Experimental Setup:**

Tools and Software:

* MATLAB
* Python (with libraries: numpy, matplotlib, scipy)

Signals Used:

1. **Message Signal**:
   * For AM: (sinusoidal signal).
   * For FM:  (sinusoidal signal).
2. **Carrier Signal**:
   * For AM:  (high-frequency sinusoidal signal).
   * For FM: Carrier frequency  Hz.

%Modulation

t = 0:0.01: 5;

y1 = cos(pi\*t); %message

y2 = sin(10\*pi\*t); %carrier

m=0.8; % modulation index

ym=(1+m\*y1).\*y2; %Modulated wave

subplot(3,1,1)

plot(t,y1, 'r')

xlabel('t')

ylabel('m(t)')

title('Message')

grid on

subplot(3,1,2)

plot(t,y2, 'r')

xlabel('t')

ylabel('yc(t)')

title('Carrier')

grid on

subplot(3,1,3)

plot(t,ym, 'r')

xlabel('t')

ylabel('ym(t)')

title('Modulated Wave')

grid on

For m=1

Demodulation:

%Demodulation

z = ym.\*y2; %multiply by carrier then filter it

[b,a]=butter(8, 0.1); %Butterworth filter with cut off 0.1

and order 8

r = filter(b, a, z);

plot(r)

title('Filtered signal');

grid on



Audio Signal:

AM Modulation

% AM modulator and demodulator

load mtlb

in=mtlb;

x=in(1:500); %500 samples of speech

Fs=18000; %sampling rate of plot

Fc=8000; %carrier frequency

in\_phase = 0;%initial phase angle

y=ammod(x,Fc,Fs,in\_phase);

%AM with double sideband suppressed carrier

subplot(2,2,1)

plot(x, 'k'); %base band signal

title('Base band signal');

grid on

subplot(2,2,2)

plot(y, 'k') % AM signal

title('AM signal');

grid on

z=demod(y,Fc,Fs,'am'); %demodulated signal

subplot(2,2,3)

plot(z, 'k') % demodulated signal

grid on

title('Demodulated signal');

subplot(2,2,4)

****[b,a]=butter(8, 0.1); %Butterworth filter with cut off 0.1 and order 8

r=filter(b, a, z);

plot(r)

title('Filtered signal');

grid on

periodogram(y,[],512,Fs**);**

FM Modulation:

%FM modulation

fs = 1000; % Sample rate (Hz)

ts = 1/fs; % Sample period (s)

fd = 25; % Frequency deviation (Hz)

t = 0:ts:2;

t=t';

x = sin(2\*pi\*2\*t);

M\_s = comm.FMModulator('SampleRate',fs,'FrequencyDeviation',fd);

y = step(M\_s, x);

subplot(3,1,1)

plot(t,[x real(y)]) %plot both x and y

% Demodulation

DEMOD = comm.FMDemodulator('SampleRate',fs,'FrequencyDeviation',fd);

z = step(DEMOD,y);

subplot(3,1,2)

plot(t,z,'r')

xlabel('Time (s)')

ylabel('Amplitude')

title('Demodulated signal')

grid on

%psd of FM

subplot(3,1,3)

periodogram(real(y),[],512,fs);