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Section: 2

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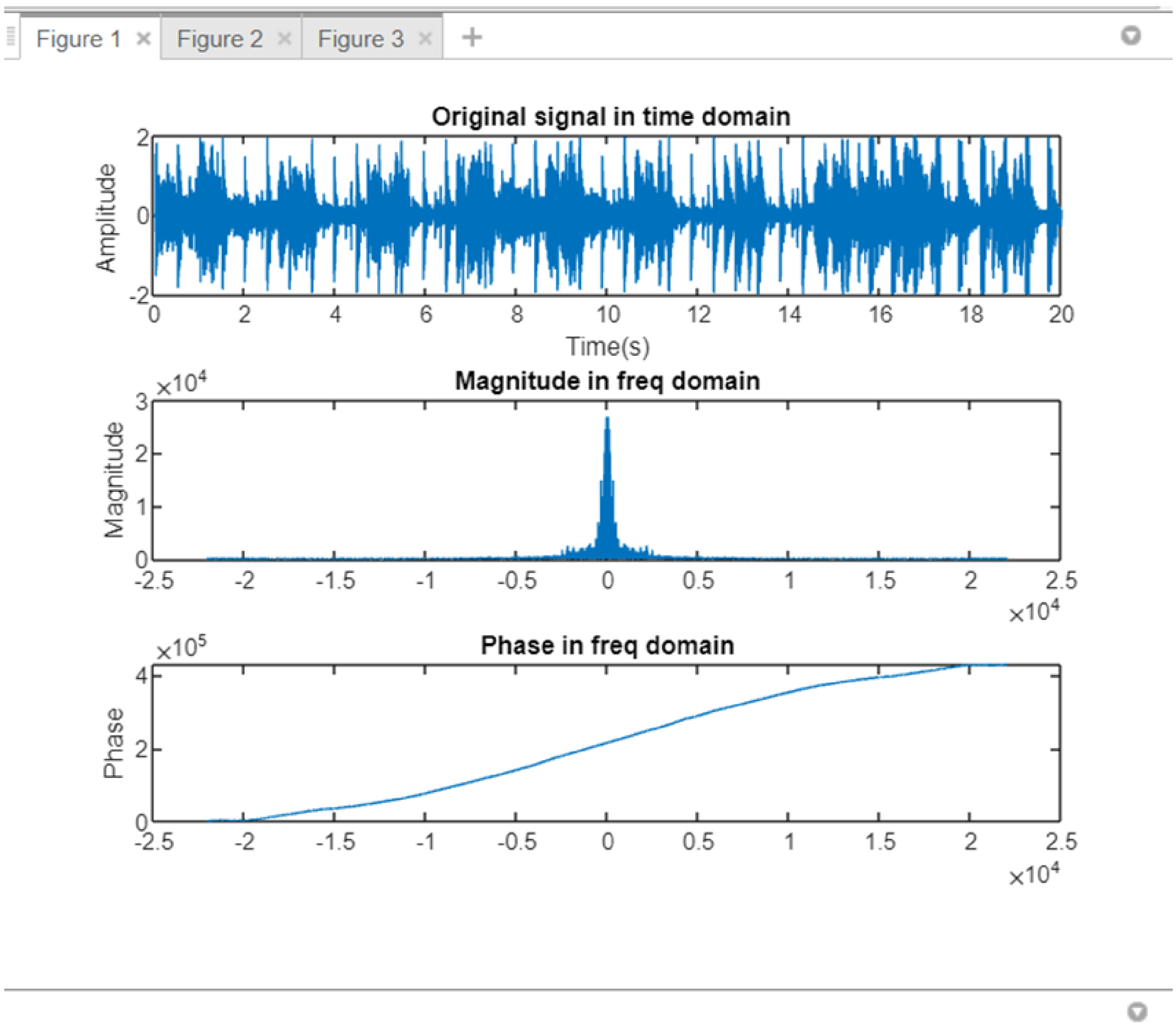
Communication Engineering

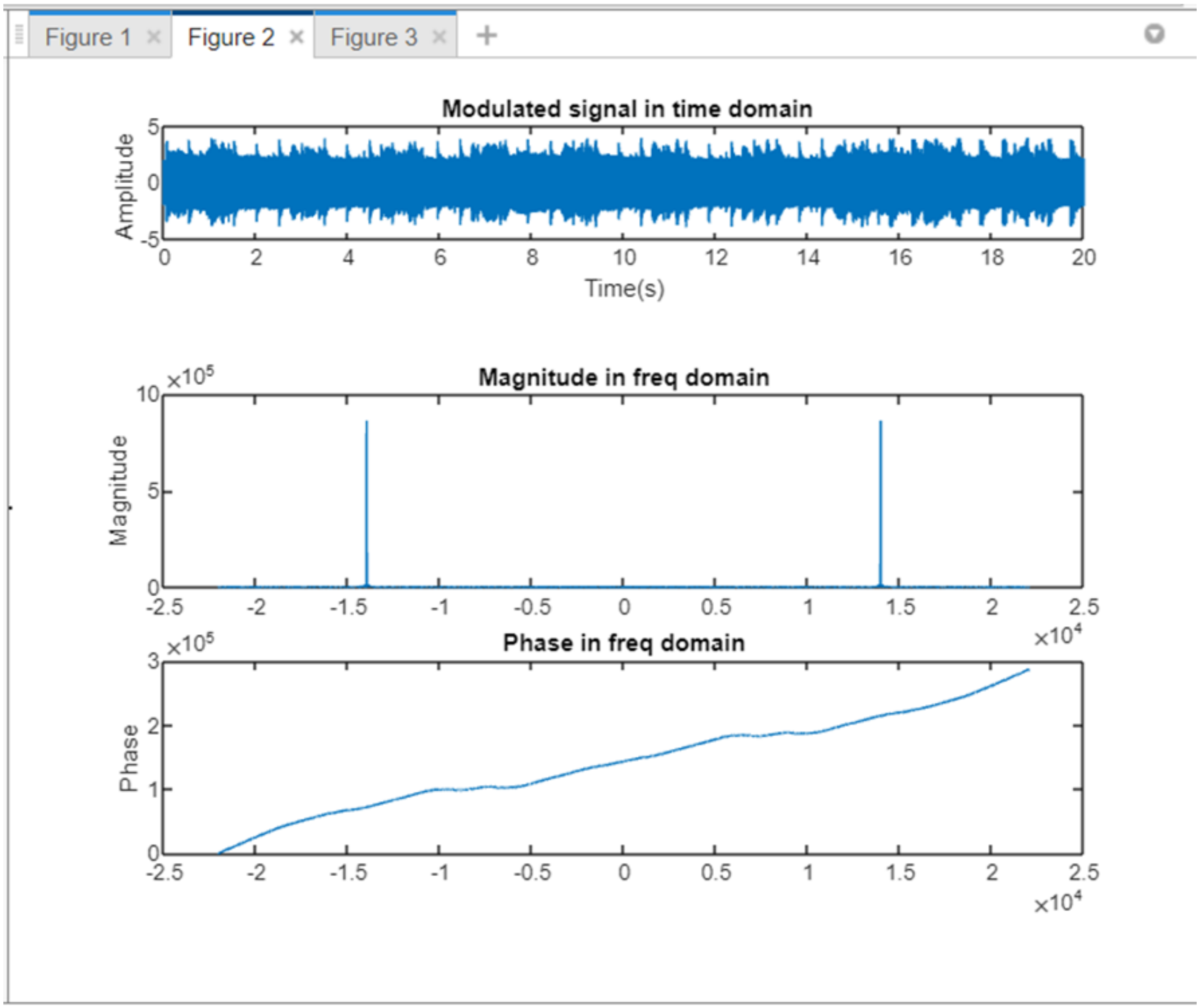
Lab 1

Simulation results:

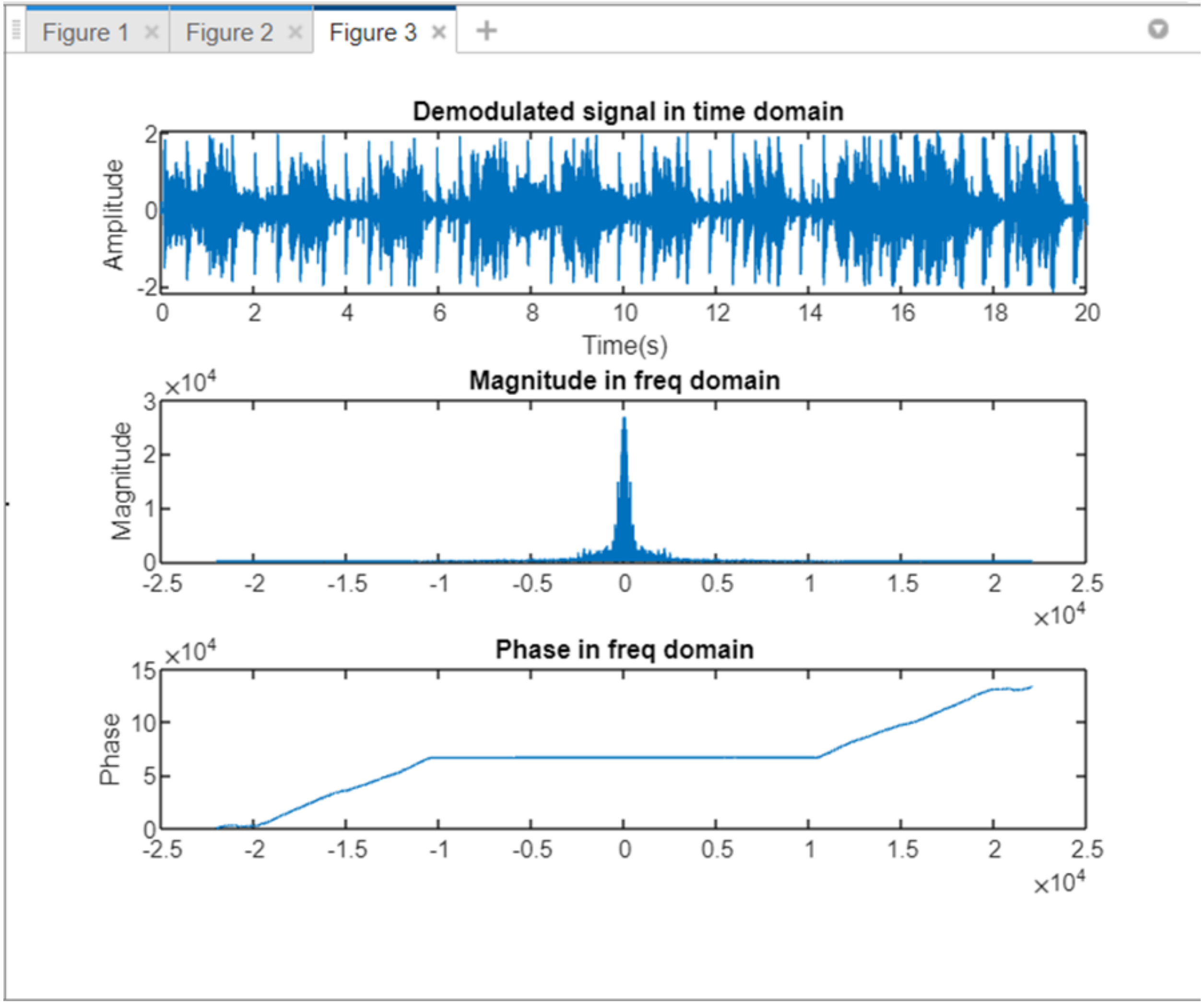
Modulating Signal:



Modulated Signal:



Demodulated Signal:



Code:

```
% Read the audio signal

clear;

[y,fs] = audioread('myaudio.mp3');

% sound(y,fs);

y =y(:,1) + y(:,2);


%time domain

t = (0:length(y) - 1)*20/length(y);


% Plot signal in time domain

subplot(3,1,1);

plot(t,y);

title(" Original signal in time domain");

xlabel('Time(s)');

ylabel('Amplitude ');


 %  freq domain

Y = fft(y);

Y_shift = fftshift(Y);

dfs=fs/length(y);

f=-fs/2:dfs:fs/2-dfs;
```

```
% Plot signal in frequency domain
subplot(3,1,2);
plot(f,abs(Y_shift));
title("Magnitude in freq domain");
ylabel('Magnitude');

subplot(3,1,3);
plot(f,unwrap(angle(Y)));
title("Phase in freq domain");
ylabel('Phase');

% Modulation ------------------------------------
BW=bandwidth(y)./(2.*pi);
fc=(fs/2)-BW;
wc=2*pi*fc;
Ac = abs(min(y));
c= cos(wc*t).';
y_mod = (y+Ac).*c;

% Plot signal in time domain
fig=figure();
subplot(4,1,1);
plot(t,y_mod);
title(" Modulated signal in time domain");
xlabel('Time(s)');
```

```
ylabel('Amplitude ');

%  freq domain
Y_mod = fft(y_mod);
Y_shift_mod = fftshift(Y_mod);

% Plot signal in frequency domain
subplot(3,1,2);
plot(f,abs(Y_shift_mod));
title("Magnitude in freq domain");
ylabel('Magnitude');

subplot(3,1,3);
plot(f,unwrap(angle(Y_mod)));
title("Phase in freq domain");
ylabel('Phase');

% Demodulation ------------------------------------
y_demod =  y_mod.*c;
y_demod_lpf = lowpass(y_demod,10000,fs);
y_demod_lpf=y_demod_lpf*2;
y_demod_lpf = y_demod_lpf -Ac;

% Plot signal in time domain
fig1=figure();
```

```
subplot(3,1,1);

plot(t,y_demod_lpf);

title(" Demodulated signal in time domain");

xlabel('Time(s)');

ylabel('Amplitude ');


%  freq domain

Y_demod = fft(y_demod_lpf);

Y_shift_demod = fftshift(Y_demod);


% Plot signal in frequency domain

subplot(3,1,2);

plot(f,abs(Y_shift_demod));

title("Magnitude in freq domain");

ylabel('Magnitude');


subplot(3,1,3);

plot(f,unwrap(angle(Y_demod)));

title("Phase in freq domain");

ylabel('Phase');


sound(y_demod_lpf,fs);
```

Comments:

- **How I chose Ac and Omega_c:**

Ac as is the maximum amplitude value in the modulating signal in time domain.

Miu = Am/Ac <= 1, Ac>=Am

Min Ac = Am (max amplitude) to achieve max efficiency.

fc=(fs/2)-BW -> fc should be less than fs, BW: signal bandwidth

omega_c=2*pi*fc

- **What do you think is a carrier's minimum Amplitude (A) to avoid over modulation?**

  Over modulation happens when miu=Am/Ac more than 1

  So, to avoid that miu <=1, Ac >= Am

  Min Ac=Am=max amplitude value in modulating signal in time domain

- **What is the problem with the AM signal when it is over-modulated?**

  Over modulation means Ac < Am

  so, there is a part of the signal is still in negative part

  It will cause information loss

  We can't obtain the same original signal in demodulating.

- **Compare between the bandwidth of the audio signal and the modulated one by plotting both signals in the frequency domain.**

  Bandwidth of modulated signal = 2* Bandwidth of modulating signal

  (The positive part in the magnitude part in freq domain)

- **Hear the demodulated signal and compare it with the original one. Are the two signals the same? Explain why?**

  Demodulated signal is almost the same as the modulating(original) signal,

  We almost returned to our original signal

  y=signal

  y_modulated=y*cos(2*pi*fc*t)

  y_demodulated= y*cos(2*pi*fc*t) *cos(2*pi*fc*t)

  = y(0.5+0.5cos(2*2*pi*fc*t))

  = 0.5 y + 0.5 y cos (2*2*pi*fc*t)

  Then the signal enters a low pass filter, then multiply by 2 and subtract Ac