EEE 321 LAB1-OFF LAB ASSIGMENT REPORT

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Part 1

1. A discrete time signal:

$$x_d[n] = A_d \cos[\hat{\omega} n + \phi_d],$$

where $A_d = 3,\ \hat{\omega} = \frac{2\pi}{15}\ , \phi_d = \frac{2\pi}{3}$ in the assignment.

a) With these values, the discrete signal becomes:

$$x_d[n] = 3\cos\left[\frac{2\pi}{15} n + \frac{2\pi}{3}\right]$$

The fundamental period of the cosine signal can be defined as N_c and the duration N of the discrete signal $x_d[n]$ was found as follows:

$$N_c = \frac{2\pi}{\frac{2\pi}{15}} = 15 \Longrightarrow N = 6 \cdot 15 = 90$$

b) The MATLAB code for the array can be seen belove:

```
n = 0:1:89;
xd1 = 3*cos((2*pi/15)*n+2*pi/3); %x_d[n]
```

c) The plot of the discrete signal was given in Figure 1 below:

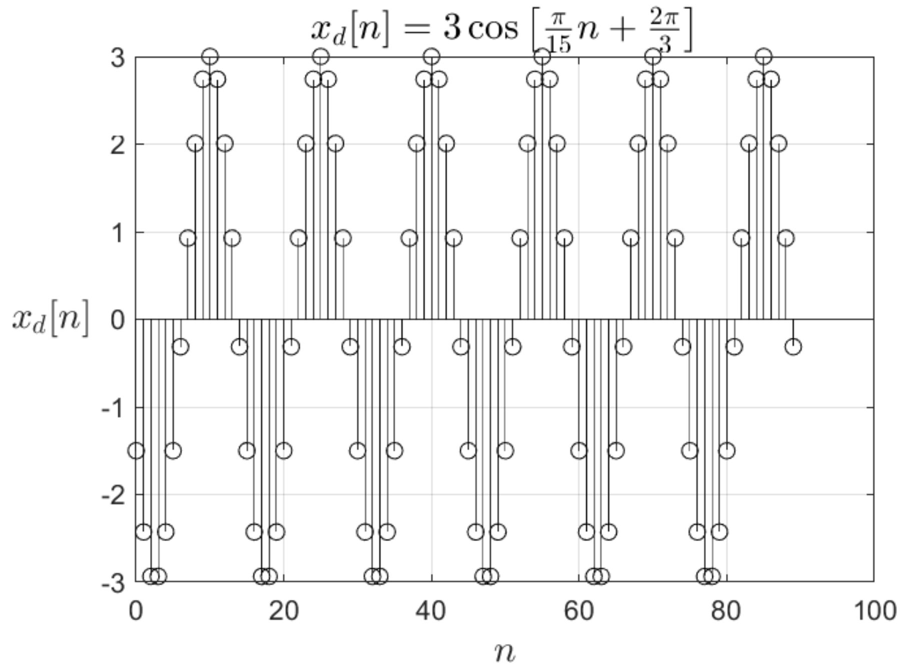

Figure 1: The Discrete Signal x[n]

2. A discrete time signal:

$$x_d[n] = A_d \cos[\widehat{\omega}n + \phi_d],$$

where $A_d = 6,\ \widehat{\omega} = \frac{\pi}{15}$, $\phi_d = \frac{\pi}{3}$ in this part.

a) With these values, the discrete signal becomes:

$$x_d[n] = 6\cos\left[\frac{\pi}{15}n + \frac{\pi}{3}\right]$$

The fundamental period of the cosine signal can be as N_c and the duration N of the discrete signal $x_d[n]$ was found as follows:

$$N_c = \frac{2\pi}{\frac{\pi}{15}} = 30 \Longrightarrow N = 6 \cdot 30 = 180$$

b) The MATLAB code for the array can be seen belove:

```
n = 0:1:179;
xd2 = 6*cos((pi/15)*n+pi/3); %x_d2[n]
```

c) The plot of the discrete signal was given in Figure 1 below:

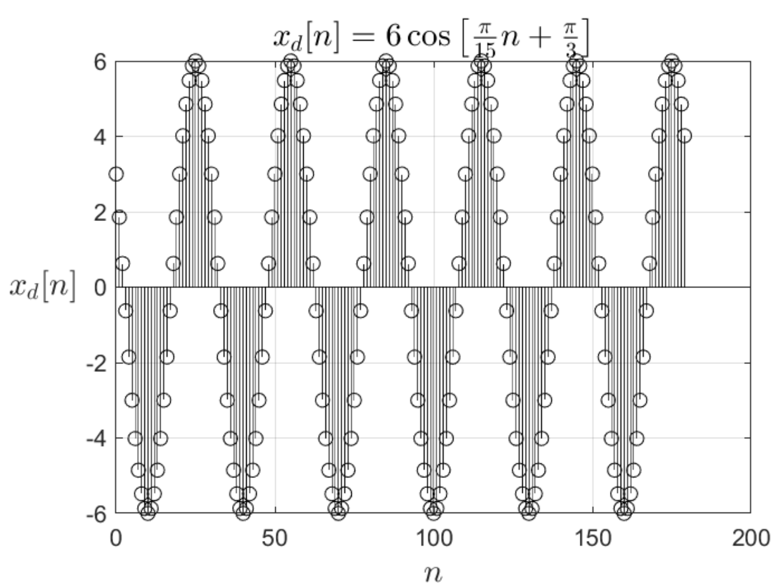

Figure 2: The Discrete Signal x[n]

d) The comparison between xd1 and xd2 can be seen in Figure 3 below:

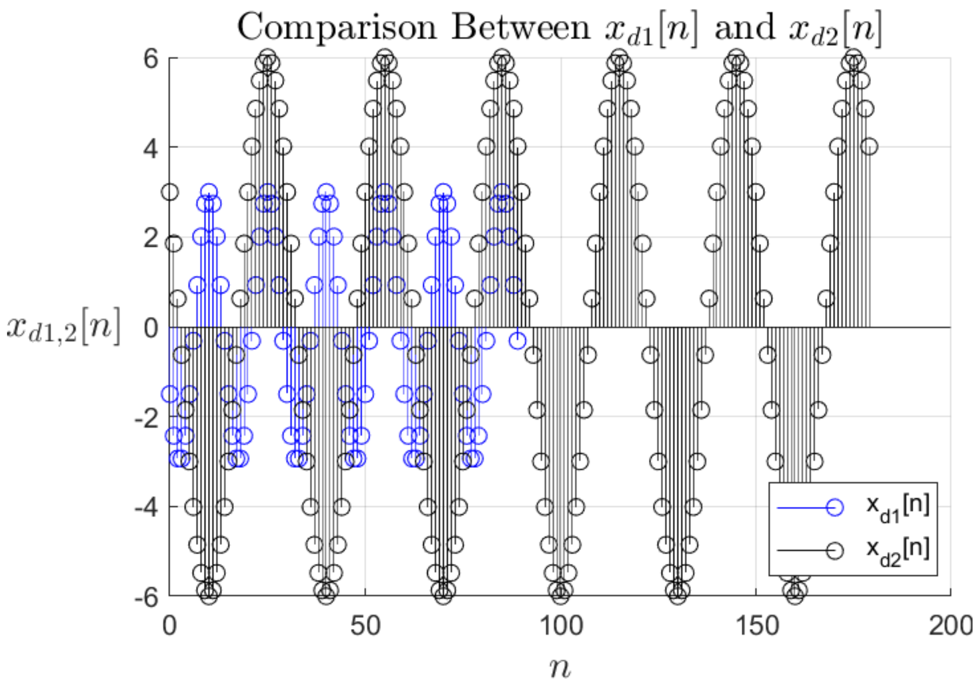

Figure 3: Comparison Between Discrete Signals

3. A decaying discrete-time cosine signal:

$$x_b[n] = \begin{cases} e^{-bn}x_d[n], & n \geq 0 \\ 0, & otherwise. \end{cases}$$

a) In an analytical manner, we can find the (b) coefficient as follows:

$$x_b[n] = 3e^{-bn}\cos\left[\frac{2\pi}{15}n + \frac{2\pi}{3}\right]$$

It is observed that the maximum point in the discrete signal $x_b[n]$ was located at the cartesian coordinates with $(x, y) = (10,3)$, and the maximum point of the signal in the sixth period was located at the cartesian coordinates with $(x, y) = (85,3)$. Multiplication with and exponential will not change the max points, only their amplitudes will change.

As it is requested that the first max point should be 6 times bigger than the max point in the sixth period, the following expression is generated.

$$3e^{-b10}\cos\left[\frac{2\pi}{15}10 + \frac{2\pi}{3}\right] = 18e^{-b85}\cos\left[\frac{2\pi}{15}85 + \frac{2\pi}{3}\right]$$

$$1 = 6e^{-b75}$$

$$75b = \ln 6$$

$$b \cong 2.39 \cdot 10^{-2}$$

b) The MATLAB code for the array can be seen belove:

```
b = 2.39*10^(-2);
n1 = 0:1:89;
xb1 = 3*exp(-b*n1).*cos((2*pi/15)*n1+2*pi/3)
```

c) The plot of the discrete signal was given in Figure 4 below:
s

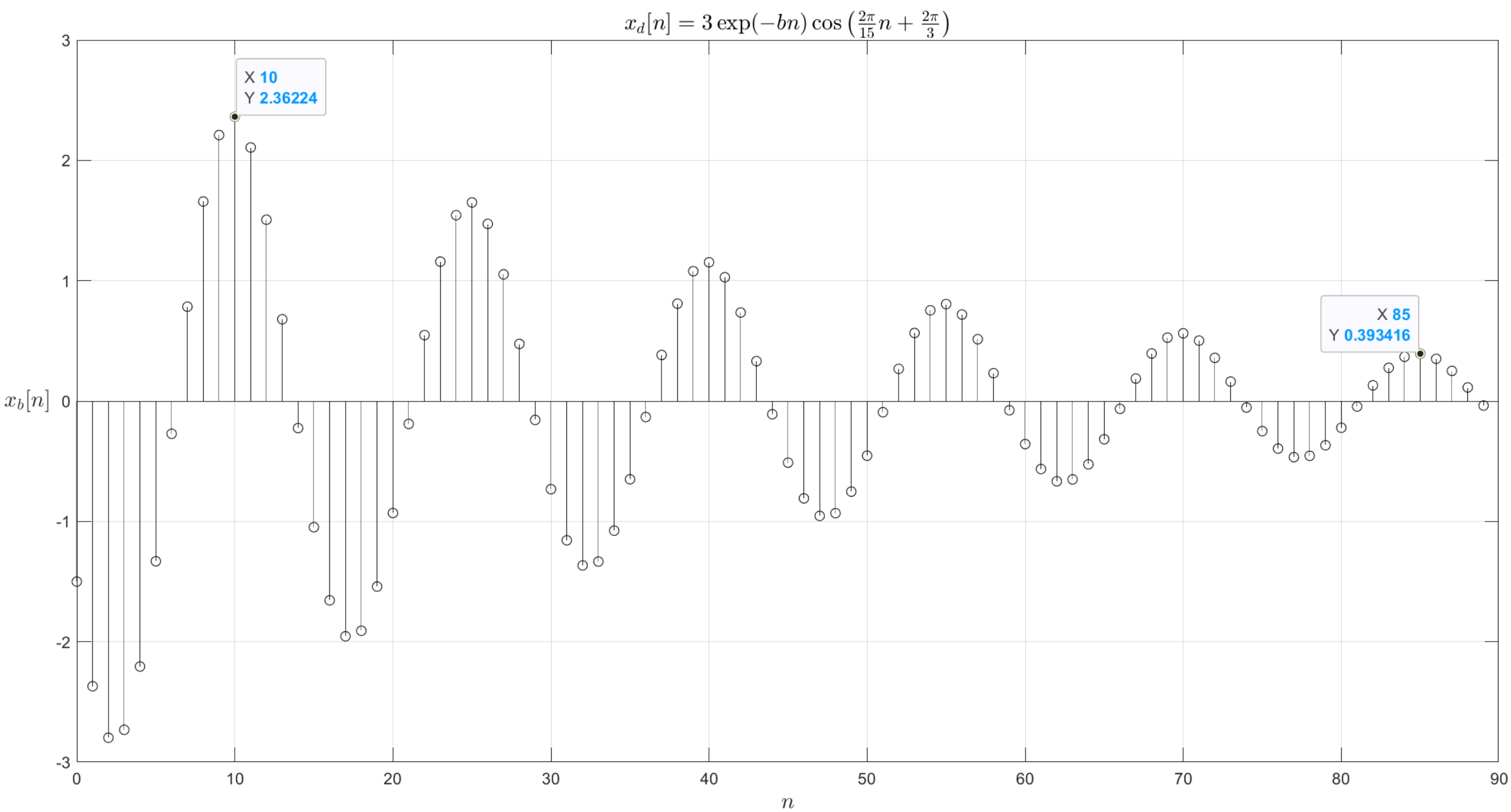

Figure 4: Damped Discrete Signal

From the values on the plot, it can be seen that the max points and the coefficient satisfies the requirements.

<u>Part 2</u>

$$x_c(t) = A_c \cos(\omega t + \phi_c)\,, A_c = 1$$

is the continuous time cosine signal.

1. The selected note is an A note with octave 5 that has frequency 880 Hz.

$$f = 880\ Hz, \omega = 5.53 \cdot 10^3\ rad/s$$

2. For Δt, first the period of the signal was determined as:

$$T = \frac{1}{f} = \frac{1}{880} \cong 1.14ms$$

Hence, in one period there will be 100 points, the $\Delta t = \frac{T}{100} = 0.114\mu s$

3. The MATLAB code for the x_{c1} array, sampling frequency and soundsc command configuration was given below:

```
samp_int = 1.14*10^(-5);
w = 2*pi*880;
A = 1;
phi = 0;
fs = 88000;

t = 0:sampl_int:20;
xc1 = A*cos(w*t+phi);
soundsc(xc1,fs);
```

Sampling frequency f_s was found by considering the discrete consecutive data points of the on the continuous time cosine signal. These data points actually generates the sound that MATLAB produces as their values of these points will be converted to voltages and will be fed to the speakers of the computers. Hence, the sampling frequency of the sound command is equal to the inverse of the Δt.

$$f_s = \frac{1}{\Delta t} = \frac{1}{0.114\mu s} = 88000Hz$$

4. The MATLAB code for x_{c1} that tried with different phases:

```
samp_int = 1.14*10^(-5);

t = 0:samp_int:20;

w = 2*pi*880;
A = 1;
%phi = pi/4;
%phi = pi/2;
phi = pi;
fs = 88000;

xc1 = A*cos(w*t+phi);
soundsc(xc1,fs);
```

5. There was no difference between sounds, it seem phase shift has no observable effect on the sound.

6. The plot for $x_{c1}(t)$ can be seen below:

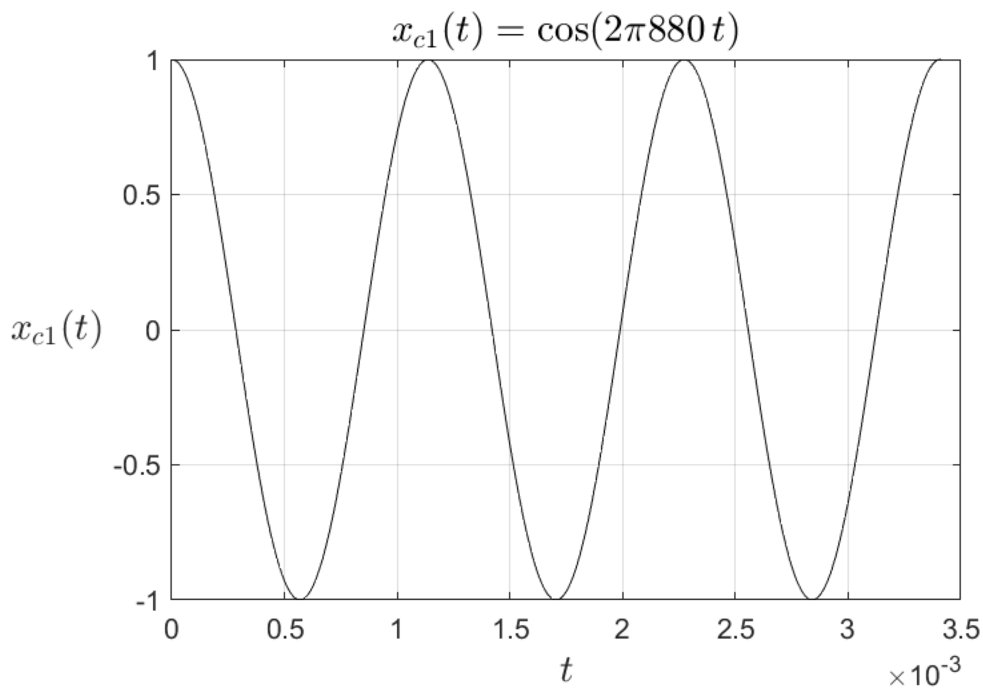

Figure 5: Approximated Continuous Time Cosine Signal xc1(t)

7. The steps from 1 to 6 with different frequencies indicates that the high frequency sounds show high-pitched behavior while low frequency tones have the feature of bass. The MATLAB code for x_{c2} was given below:

```
samp_int = 3.21*10^(-
5);
t1 = 0:samp_int:20;

w = 2*pi*311.13;
A = 1;
phi = 0;
fs = 31113;
xc2 = A*cos(w*t1+phi);
soundsc(xc2,fs)
```

8. A decaying continuous signal:

$$x_a(t) = e^{-at} x_c(t),$$

$$\phi_c = 0, \qquad A_c = 1, \qquad \omega_1 = 2\pi \cdot 880, \qquad \omega_2 = 2\pi \cdot 311.13$$

a) The damped signal $x_a(t)$:

$$x_a(t) = A_c\, e^{-at} \cos(\omega t + \phi_c).$$

It has a maximum value at t = 0, it is requested that the value at t = 0 is 2 times of the value at t= 6.

$$\omega_1 = 2\pi \cdot 880, \qquad e^{-a0} \cos(\omega_1 0) = 2e^{-a6} \cos(\omega_1 6)$$
$$1 = 2e^{-a6}$$
$$\ln 0.5 = -6a$$
$$a = \frac{\ln 2}{6} \cong 0.115$$

b-c) The volume of the sound decreases as t goes gets bigger, namely, the signal exponentially decays. The MATLAB code and plot for the decaying signal was given below:

```
a = 0.115;

A = 1;
phi = 0;
w = 2*pi*880;

samp_int = 1.14*10^(-5);
t = 0:samp_int:20;
fs = 88000;

x_a = A*exp(-
a*t).*cos(w*t+phi);
soundsc(x_a,fs);
```

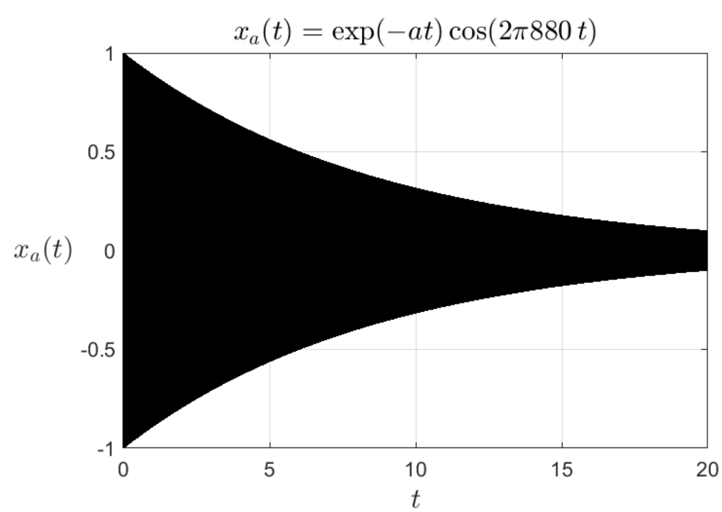

Figure 6: Exponentially Decaying Signal

Part 3

1. From the previous parts, frequencies ω_1 and ω_2 and the sampling intervals Δt were obtained as:

$$\omega_1 = 2\pi 880\frac{rad}{s}, \qquad \omega_2 = 2\pi 311.13\frac{rad}{s}, \qquad \Delta t = 0.114\mu s$$

The MATLAB code for the composite signal was given below:

```
t = 0:samp_int1:1000*samp_int1;

x1 = exp(1i*w1*t);
x2 = exp(1i*w2*t);

x3 = x1 + x2;
```

2. The plots for real and imaginary parts of the composite signal also absolute value of the complex amplitude and the phase of the signal were given below:

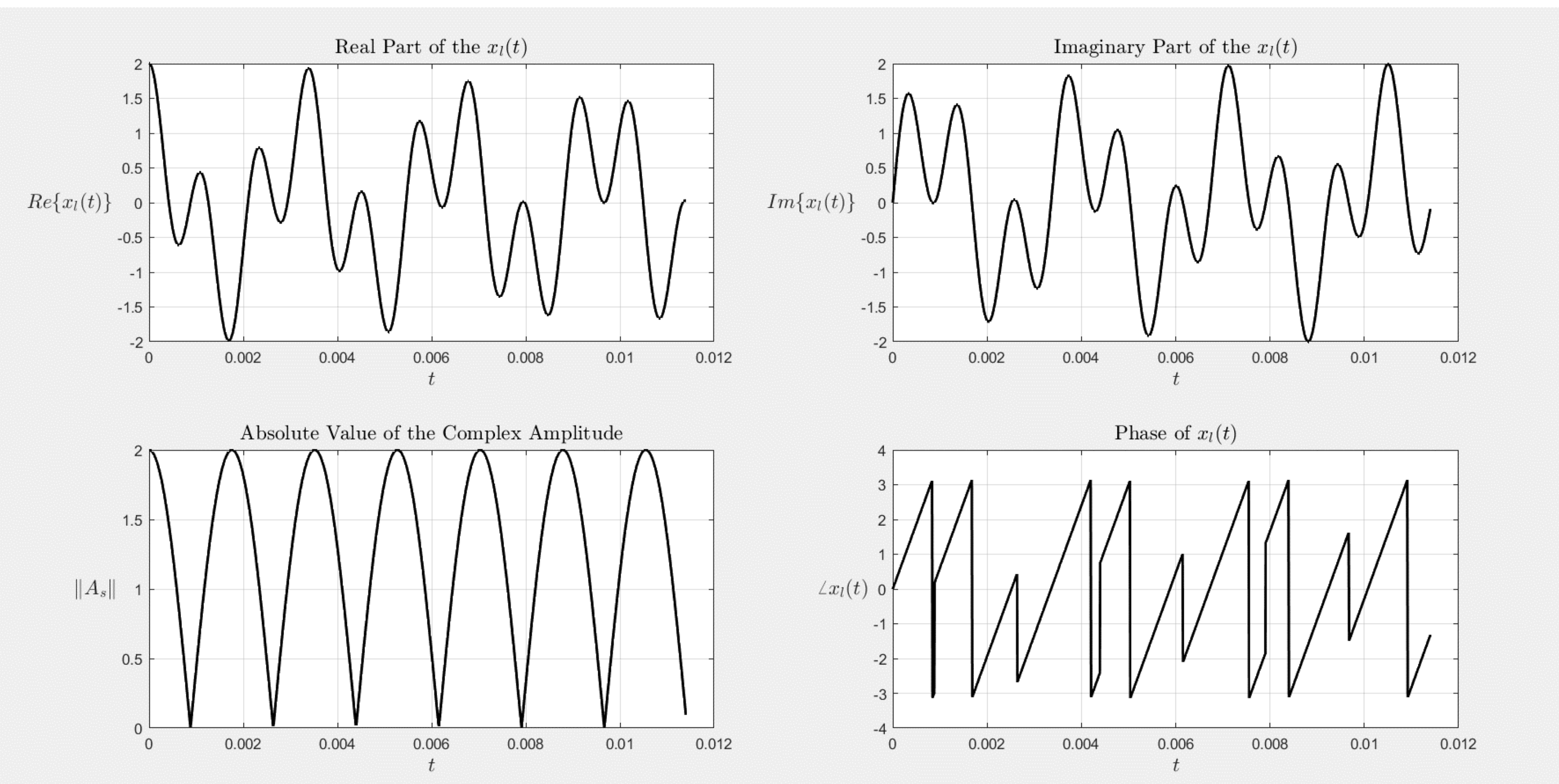

Figure 7: Requested Plots of The Composite Signal

3. To be able to see the signal properly, duration of the signal were taken much shorter than 20 seconds. From the plots, it can be said that the signal contains two different frequency components, while signal with higher frequency component takes the role of "envelope", the other one can be validated as information that is "carried".

Part 4

1. The continuous time signal:

$$x(t) = \cos(\omega_c t)$$

is periodic for any choice of ω_c.

2. The discrete signal:

$$x[n] = \cos[\widehat{\omega} n]$$

is periodic if the ratio of 2π and $\widehat{\omega}$ is rational; otherwise, the signal is not periodic.

$$N = m\frac{2\pi}{\widehat{\omega}};\ N, m \in \mathbb{Z}^+$$

3. Answers for various signals whether they are periodic or not.

a) $\cos(0.4\pi t)$; *It is a **periodic** signal as it does not matter the choice of fundamental frequency for a continuous time sinusoidal signal.*

b) $\cos[0.4\pi n]$; *It is a **periodic** signal with the following reasoning and fundamental period N.*

$$N = \frac{2\pi}{0.4\pi} = \frac{20}{4} = 5$$

c) $\cos(0.4t)$; *It is a **periodic** signal as it does not matter the choice of fundamental frequency for a continuous time sinusoidal signal.*

d) $\cos[0.4n]$; *It is **not a periodic** signal as the ratio of 2π and the fundamental frequency is not a rational number.*

$$\frac{2\pi}{0.4} = 5\pi \notin \mathbb{Q}$$

e) $\cos(0.4et)$; *It is a **periodic** signal as it does not matter the choice of fundamental frequency for a continuous time sinusoidal signal.*

f) $\cos[0.4en]$; *It is **not a periodic** signal as the ratio of 2π and the fundamental frequency is not a rational number.*

$$\frac{2\pi}{0.4e} \notin \mathbb{Q}$$

g) $\cos(0.2\pi t) + \sin(0.4\pi t)$; *It is a* ***periodic*** *signal; firstly, individual components of the composite signal are periodic and secondly, the ratio of two fundamental period is a rational number.*

$$\frac{T_1}{T_2} = \frac{\frac{2\pi}{0.4\pi}}{\frac{2\pi}{0.2\pi}} = \frac{1}{2} \Rightarrow T = 0.4\pi$$

h) $\cos[0.2\pi n] + \sin[0.4\pi n]$; *It is a* ***periodic*** *signal; firstly, individual components of the composite signal are periodic and secondly, the ratio of two fundamental period is a rational number.*

$$N_1 = \frac{2\pi}{0.2\pi} = 10, \qquad N_2 = \frac{2\pi}{0.4\pi} = 5 \Rightarrow \frac{N_1}{N_2} = 2 \Rightarrow N = 10$$

i) $\sin[0.2n] + \sin[0.4\pi n]$; *It is not a periodic signal because while* $\sin[0.4\pi n]$ *component is periodic,* $\sin[0.2n]$ *component is not periodic. Hence, the composite signal is* ***not a periodic*** *signal.*

j) $\cos(0.2t) + \cos(0.2et)$; *It is a* ***not a periodic*** *signal; although, individual components of the composite signal are periodic, the ratio of two fundamental period is not a rational number.*

$$T_1 = \frac{2\pi}{0.2} = 10\pi, \qquad T_2 = \frac{2\pi}{0.2e} = \frac{10\pi}{e} \Rightarrow \frac{T_1}{T_2} = e \notin \mathbb{Q}$$

4. Plots of signals from previous section.

a)

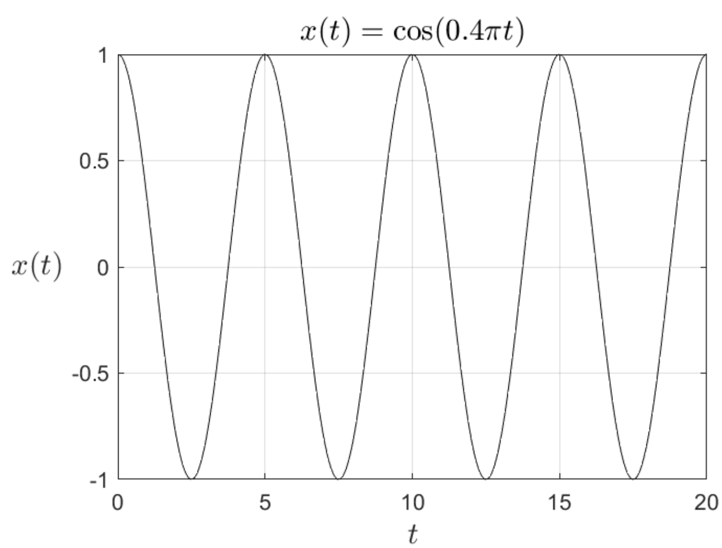

Figure 8

b)

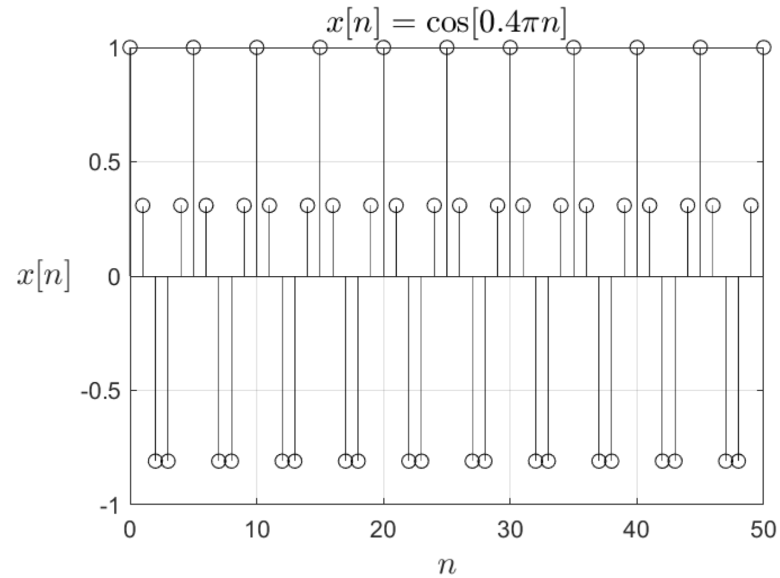

Figure 9

c)

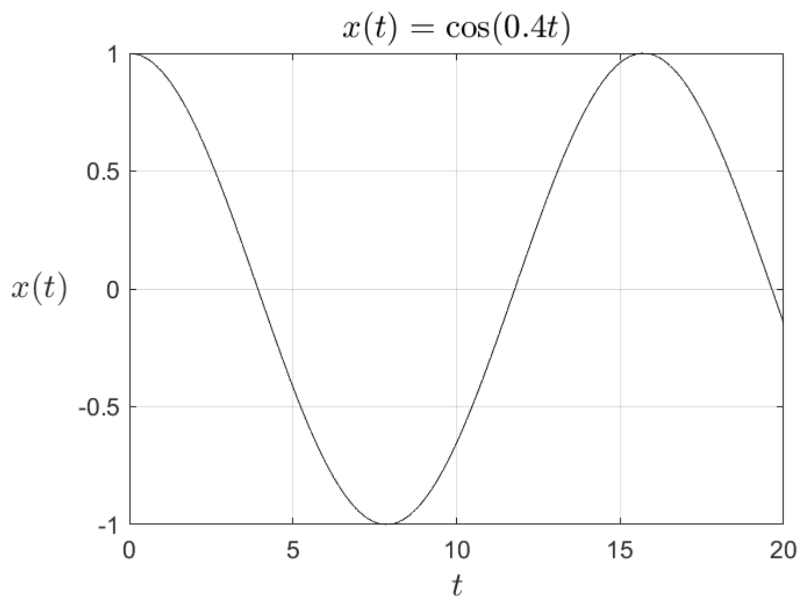

Figure 10

d)

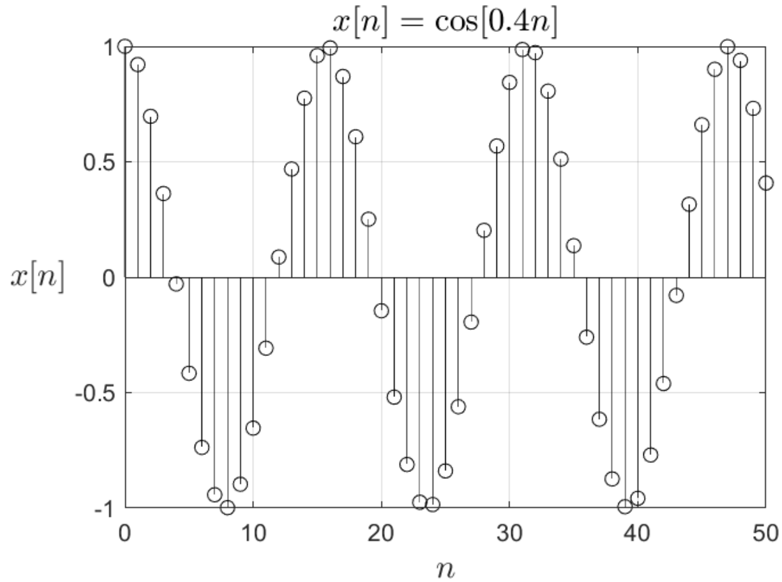

Figure 11

e)

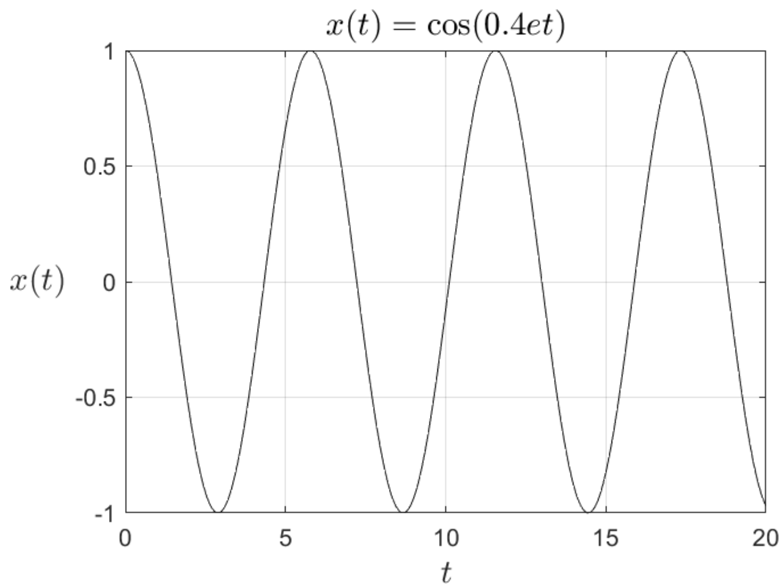

Figure 12

f)

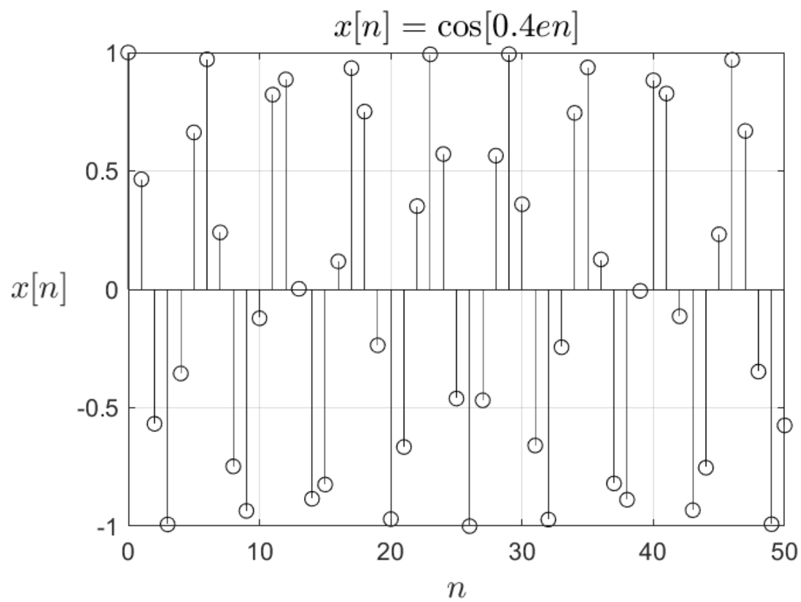

Figure 13

g)

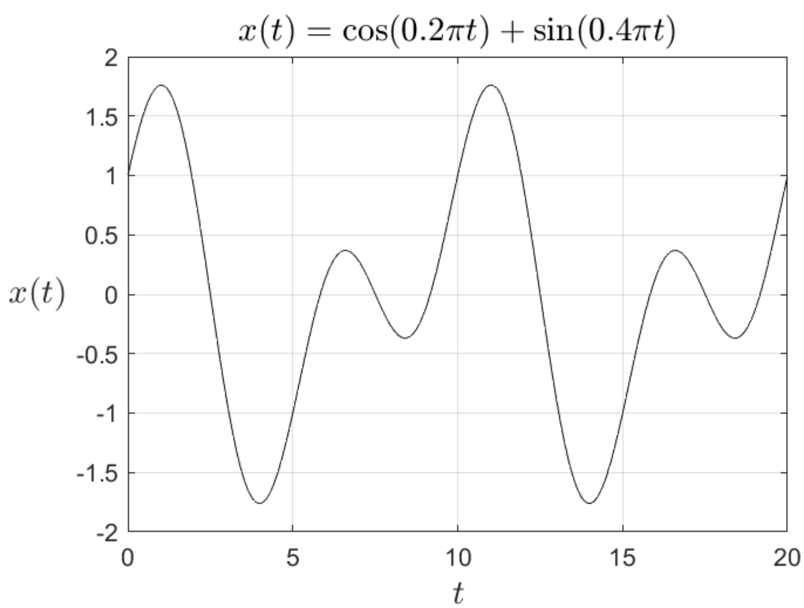

Figure 14

h)

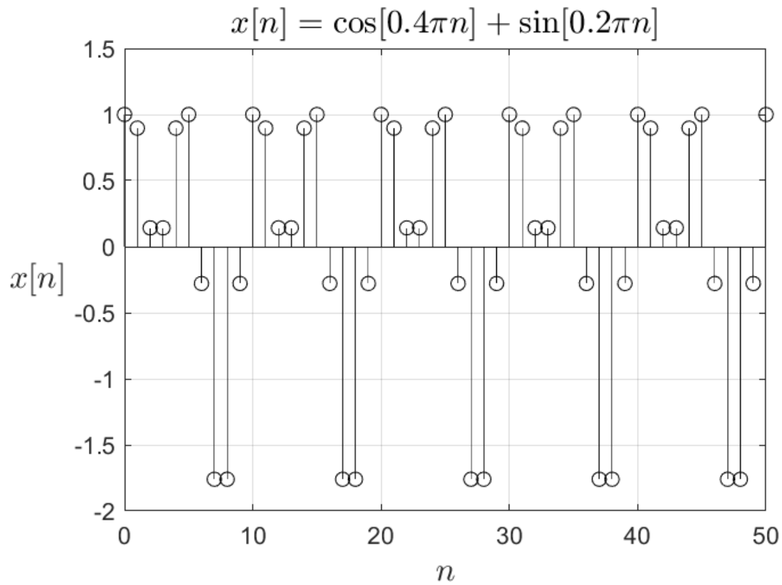

Figure 15

i)

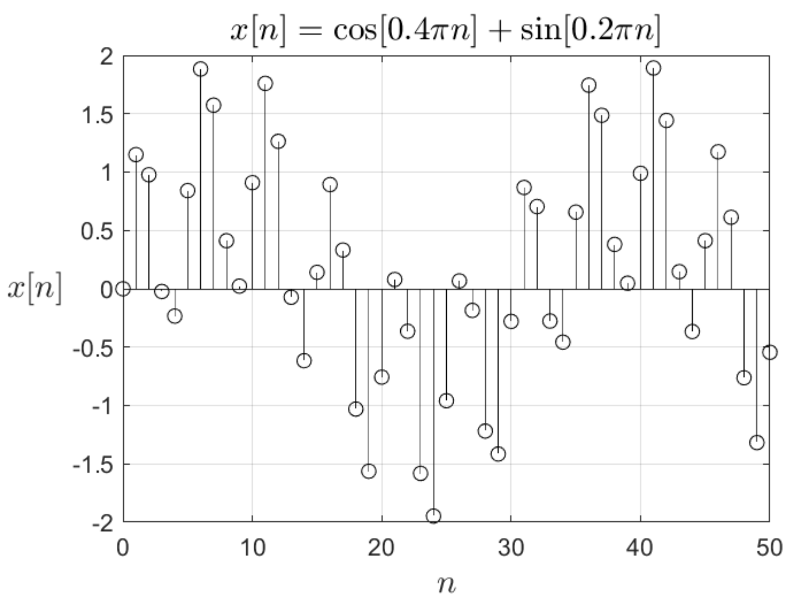

Figure 16

j)

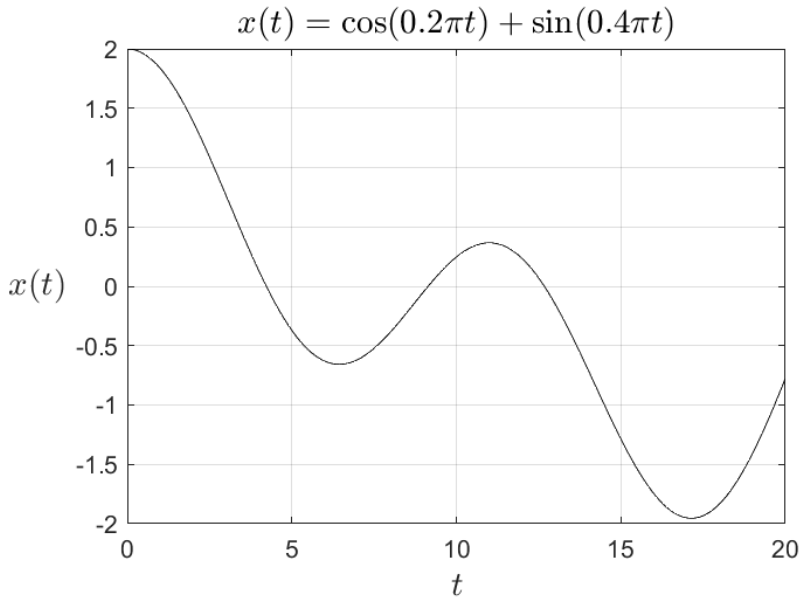

Figure 17

5. For a signal x(t) to be periodic in general it should satisfy the general expression below:

$$x(t) = x(t + t_0)$$

for some t_0. Hence:

$$\begin{aligned} x(t) &= \cos(\alpha t^2) = \cos(\alpha(t + t_0)^2) \\ &\Rightarrow \cos(\alpha t^2) = \cos(\alpha t^2 + 2\alpha t t_0 + \alpha t_0^2) \\ &\Rightarrow 2\alpha t t_0 + \alpha t_0^2 = 0\ ;\ 2\alpha t t_0 + \alpha t_0^2 = 2\pi \\ &\Rightarrow \alpha = \ 0\ or\ \alpha = \frac{2\pi}{2tt_0 + t_0^2}, (t \vee t_0) \neq 0 \end{aligned}$$

Therefore, the signal x(t) is periodic with any period if α = 0. As α is a constant not a function of time, second value of the α was discarded.

6. For a signal x[n] to be periodic in general it should satisfy the general expression below:

$$x[n] = x[n + n_0]$$

for some n_0. Hence:

$$\begin{aligned} x[n] &= \cos[\alpha n^2] = \cos[\alpha(n + n_0)^2] \\ &\Rightarrow \cos[\alpha n^2] = \cos[\alpha n^2 + 2\alpha n n_0 + \alpha n_0^2] \\ &\Rightarrow 2\alpha n n_0 + \alpha n_0^2 = 0\ ;\ 2\alpha n n_0 + \alpha n_0^2 = 2\pi \end{aligned}$$

$$\Rightarrow \alpha = 0;\ \alpha = \frac{2\pi}{2nn_0 + n_0^2}, (n \vee n_0) \neq 0$$

Therefore, the signal x(t) is periodic with some T which is at least 1 as it is the minimum period for a discrete signal if α = 0. Again as α is a constant, the second choice of α was discarded.

EEE 321 LAB1-ON LAB ASSSIGNMENT REPORT

Name/Surname: Muhammet Melih Çelik ID:22003836

1. The sinusoidal signal,

$$x_m(t) = 2\cos(\omega_1 t)\cos(\omega_2 t)$$

can be written as follows with the help of the hint given, let it be said that there are two signals one of them has the frequency as $\omega_1 + \omega_2$ and the other one has $\omega_1 - \omega_2$. If we sum these two signals, the result gives the signal $x_m(t)$.

$$\cos\big((\omega_1 + \omega_2)t\big) + \cos\big((\omega_1 - \omega_2)t\big)$$

$$= \cos(\omega_1 t)\cos(\omega_2 t) - \sin(\omega_1 t)\sin(\omega_2 t) + \cos(\omega_1 t)\cos(\omega_2 t) + \sin(\omega_1 t)\sin(\omega_2 t)$$

$$= 2\cos(\omega_1 t)\cos(\omega_2 t)$$

Hence, the signal can be shown as sum of two signals as below:

$$x_m(t) = \cos\big((\omega_1 + \omega_2)t\big) + \cos\big((\omega_1 - \omega_2)t\big)$$

2. To analyze the periodicity of the $x_m(t)$, separate cosines can be investigated. As they are clearly periodic for any choice of frequency pairs, (ω_1, ω_2). Secondly, the ratio of the frequencies should be rational; otherwise, the composite signal cannot be considered as periodic.

$$\frac{(\omega_1 + \omega_2)}{(\omega_1 - \omega_2)} = k, \qquad k \in \mathbb{Q} \;\Rightarrow\; x_m(t)\ is\ periodic.$$

3. ID:22003836, ABC = 836; $\omega_1 = 836\pi, \omega_2 = 4\omega_1$. The MATLAB code for the signal was given below:

```
t = 0:samp_int:1;
x_m = cos(5*w1*t) + cos(3*w1*t);
```

4. The sampling rate f_s is actually inverse of the sampling interval used during the construction the signal with a 100 sample in just one period. Therefore, it is necessary to find the fundamental period of the $x_m(t)$ signal.

$$\omega_1 = 836\pi, \omega_2 = 4\omega_1.$$

$$x_m(t) = \cos\big((\omega_1 + \omega_2)t\big) + \cos\big((\omega_1 - \omega_2)t\big)$$

$$= \cos(5\omega_1 t) + \cos(3\omega_1 t)$$

$$T_1 = \frac{2\pi}{5\omega_1}, \qquad T_2 = \frac{2\pi}{3\omega_1} \Rightarrow \frac{T_1}{T_2} = \frac{3}{5}$$

$$T = 5T_1 = 3T_2 \Rightarrow T = \frac{2\pi}{\omega_1} = \frac{2\pi}{836\pi} \cong 2.39 \cdot 10^{-3} s$$

$$\Delta t = \frac{T}{100} = 2.39 \cdot 10^{-5} s$$

$$f_s = \frac{1}{\Delta t} = 41800 Hz$$

The MATLAB code for the listening part was given below:

```
abc = 836;

w1 = pi*abc;
w2 = 4*w1;

T = 2.39*10^(-3);
samp_int = T/100;
fs = 41800;

t = 0:samp_int:1;
x_m = cos(5*w1*t) + cos(3*w1*t);

t2 = 0:samp_int:5*T;
x_m2 = cos(5*w1*t2) + cos(3*w1*t2);

soundsc(x_m,fs);
```

5. The signal was plotted, the plot can be seen in Figure 1 on the next page.

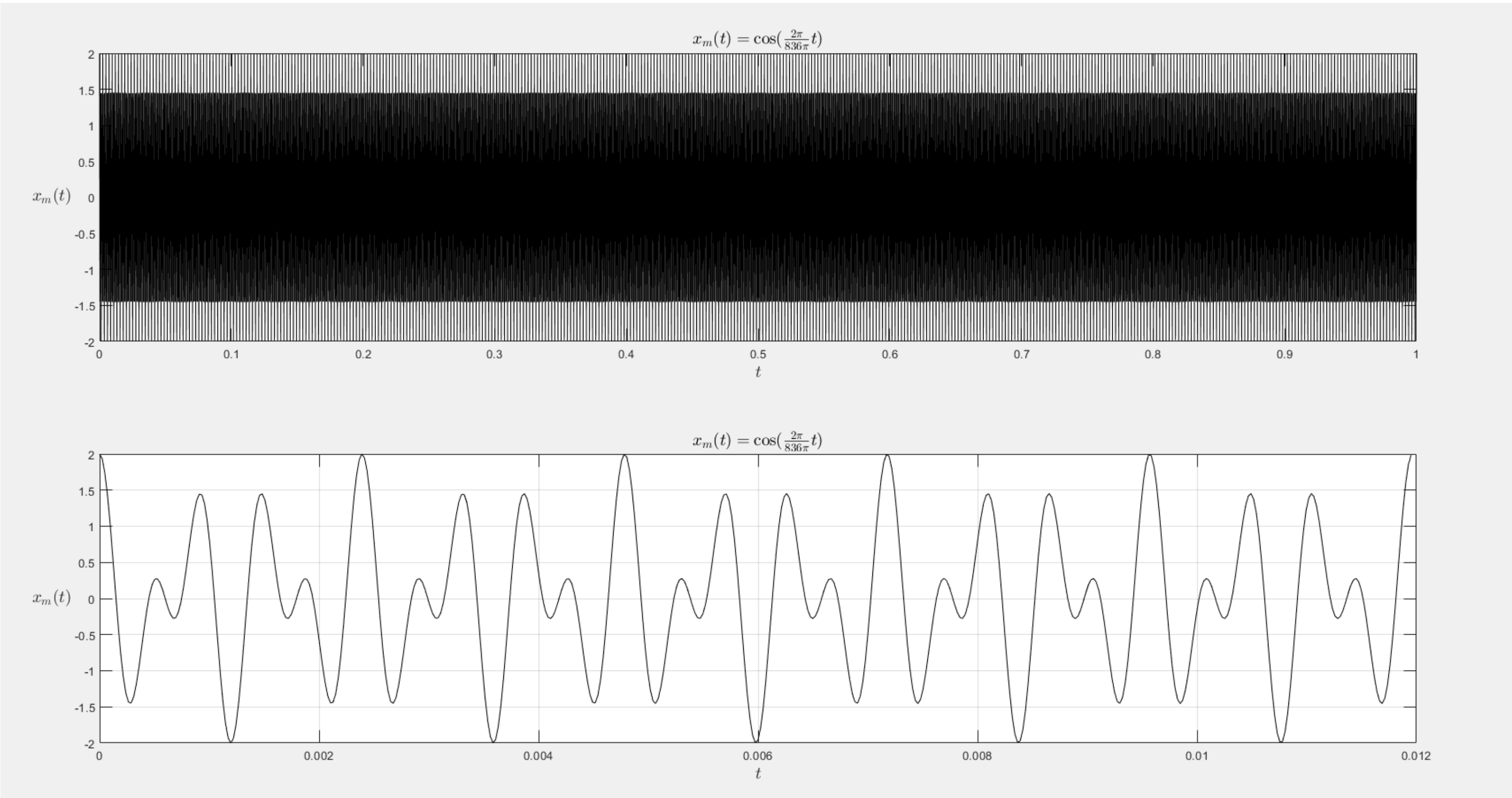

Figure 1

```
%---------------------------EEE321 LAB1 OFFLAB-------------------------------
%PART 1---------------------------------------------------------------------
%1)

clf;
n = 0:1:89;
xd1 = 3*cos((2*pi/15)*n+2*pi/3); %x_d1[n]
stem(n,xd1,"k");
ylabel ('$x_d[n]$','Interpreter','latex',FontSize=14);
xlabel ('$n$','Interpreter','latex',FontSize=14);
title(['$x_d[n] = 3 \cos\left[\frac{\pi}{15} n +' ...
    ' \frac{2\pi}{3}\right]$'], 'Interpreter', 'latex', 'FontSize', 14);
grid on
ax = gca;
ax.YLabel.Rotation = 360;

%2)
n = 0:1:179;
xd2 = 6*cos((pi/15)*n+pi/3); %x_d2[n]
stem(n,xd2,"k");

ylabel ('$x_d[n]$','Interpreter','latex',FontSize=14);
xlabel ('$n$','Interpreter','latex',FontSize=14);
title(['$x_d[n] = 6 \cos\left[\frac{\pi}{15} n +' ...
    ' \frac{\pi}{3}\right]$'], 'Interpreter', 'latex', 'FontSize', 14);
grid on;
ax = gca;
ax.YLabel.Rotation = 360;

%2-d comparison
n1 = 0:1:89;
xd1 = 3*cos((2*pi/15)*n1+2*pi/3); %x_d1[n]

n2 = 0:1:179;
xd2 = 6*cos((pi/15)*n2+pi/3); %x_d2[n]
clf;
hold on
stem(n1,xd1,"b");
stem(n2,xd2,"k");

ylabel ('$x_{d1,2}[n]$','Interpreter','latex',FontSize=14);
xlabel ('$n$','Interpreter','latex',FontSize=14);
title ('Comparison Between $x_{d1}[n]$ and $x_{d2}[n]$',...
    'Interpreter','latex','FontSize',14);
legend('x_{d1}[n]', 'x_{d2}[n]', 'Location', 'best');
grid on
ax = gca;
ax.YLabel.Rotation = 360;

%3-b

clf;
b = 2.39*10^(-2);
```

```
n1 = 0:1:89;
xb1 = 3*exp(-b*n1).*cos((2*pi/15)*n1+2*pi/3);
stem(n1,xb1,"k");

ylabel ('$x_b[n]$','Interpreter','latex',FontSize=14);
xlabel ('$n$','Interpreter','latex',FontSize=14);
title(['$x_d[n] = 3\exp(-bn) \cos\left(\frac{2\pi}{15} n +' ...
    ' \frac{2\pi}{3}\right)$'], 'Interpreter', 'latex', 'FontSize', 14);
grid on;
ax = gca;
ax.YLabel.Rotation = 360;

%PART 2---------------------------------------------------------------------
%1-2-3
samp_int1 = 1.14*10^(-5);
t1 = 0:samp_int1:20;

w = 2*pi*880;
A = 1;
phi = 0;
fs = 88000;

xc1 = A*cos(w*t1+phi);
soundsc(xc1,fs);

%4
%samp_int1 = 1.14*10^(-5);
t1 = 0:samp_int1:20;

w = 2*pi*880;
A = 1;
%phi = pi/4;
%phi = pi/2;
phi = pi;
fs = 88000;

xc1 = A*cos(w*t1+phi);
soundsc(xc1,fs);

%6
%samp_int1 = 1.14*10^(-5);
d = 3*1.14*10^(-3);
t1 = 0:samp_int1:d;

w1 = 2*pi*880;
A = 1;
phi = 0;

xc1 = A*cos(w1*t1+phi);
plot(t1,xc1,"k");
ylabel ('$x_{c1}(t)$','Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
title('$x_{c1}(t) = \cos(2\pi 880 \, t)$', ...
    'Interpreter', 'latex', 'FontSize', 14);
grid on
```

```
ax = gca;
ax.YLabel.Rotation = 360;

%7
samp_int2 = 3.21*10^(-5);
t2 = 0:samp_int2:20;

w2 = 2*pi*311.13;
A = 1;
phi = 0;
fs = 31113;
xc2 = A*cos(w2*t2+phi);
soundsc(xc2,fs)

%8
a = 0.115;
A = 1;
phi = 0;
w1 = 2*pi*880;

samp_int1 = 1.14*10^(-5);
t1 = 0:samp_int1:20;
fs1 = 88000;

x_a = A*exp(-a*t1).*cos(w1*t1+phi);
%soundsc(x_a,fs);

plot(t1,x_a,"k");
ylabel ('$x_a(t)$','Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
title('$x_a(t) = \exp(-a t)\cos(2\pi880 \, t)$', ...
    'Interpreter', 'latex', 'FontSize', 14);
grid on
ax = gca;
ax.YLabel.Rotation = 360;

%PART3---------------------------------------------------------------------
%1
clf;
t = 0:samp_int1:1000*samp_int1;
x1 = exp(1i*w1*t);
x2 = exp(1i*w2*t);

x3 = x1 + x2;
Re_x3 = real(x3);
Im_x3 = imag(x3);
Amplt = abs(x3);
Phase = angle(x3);

subplot(2,2,1); %Real part of the signal
plot(t,Re_x3,"k",LineWidth=1.5);
title ('Real Part of the $x_1(t)$','Interpreter','latex',FontSize=14)
ylabel ('$Re\{x_1(t)\}$','Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
grid on
```

```
ax = gca;
ax.YLabel.Rotation = 360;

subplot(2,2,2); %Imaginary part of the signal
plot(t,Im_x3,"k",LineWidth=1.5);
title ('Imaginary Part of the $x_l(t)$','Interpreter','latex',FontSize=14)
ylabel ('$Im\{x_l(t)\}$','Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
grid on
ax = gca;
ax.YLabel.Rotation = 360;

subplot(2,2,3); %absolute value of the complex amplitude
plot(t,Amplt,"k",LineWidth=1.5);
title ('Absolute Value of the Complex
Amplitude','Interpreter','latex',FontSize=14)
ylabel ('$\|A_s\|$','Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
grid on
ax = gca;
ax.YLabel.Rotation = 360;

subplot(2,2,4);
title_str = '$\angle x_l(t)$';
plot(t,Phase,"k",LineWidth=1.5);
title('Phase of $x_l(t)$','Interpreter','latex',FontSize=14);
ylabel (title_str,'Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
grid on
ax = gca;
ax.YLabel.Rotation = 360;

%PART 4-----------------------------------------------------------------------
%4-Plots of various signals
%a----------------------------------------------------------------------------
t = 0:0.05:20;
n = 0:1:50;

clf;
y1 = cos(0.4*pi*t);
plot(t,y1,"k");
ylabel ('$x(t)$','Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
title('$x(t) = \cos(0.4\pi t)$','Interpreter', 'latex', 'FontSize', 14);
grid on;
ax = gca;
ax.YLabel.Rotation = 360;

%b----------------------------------------------------------------------------

clf;
y2 = cos(0.4*pi*n);
stem(n,y2,"k");
ylabel ('$x[n]$','Interpreter','latex',FontSize=14);
```

```
xlabel ('$n$','Interpreter','latex',FontSize=14);
title('$x[n] = \cos[0.4\pi n]$','Interpreter', 'latex', 'FontSize', 14);
grid on;
ax = gca;
ax.YLabel.Rotation = 360;

%c--------------------------------------------------------------------------

clf;
y3 = cos(0.4*t);
plot(t,y3,"k");
ylabel ('$x(t)$','Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
title('$x(t) = \cos(0.4 t)$','Interpreter', 'latex', 'FontSize', 14);
grid on;
ax = gca;
ax.YLabel.Rotation = 360;

%d--------------------------------------------------------------------------

clf;
y4 = cos(0.4*n);
stem(n,y4,"k");
ylabel ('$x[n]$','Interpreter','latex',FontSize=14);
xlabel ('$n$','Interpreter','latex',FontSize=14);
title('$x[n] = \cos[0.4 n]$','Interpreter', 'latex', 'FontSize', 14);
grid on;
ax = gca;
ax.YLabel.Rotation = 360;

%e--------------------------------------------------------------------------

clf;
y5 = cos(0.4*exp(1)*t);
plot(t,y5,"k");
ylabel ('$x(t)$','Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
title('$x(t) = \cos(0.4e t)$','Interpreter', 'latex', 'FontSize', 14);
grid on;
ax = gca;
ax.YLabel.Rotation = 360;

%f--------------------------------------------------------------------------

clf;
y6 = cos(0.4*exp(1)*n);
stem(n,y6,"k");
ylabel ('$x[n]$','Interpreter','latex',FontSize=14);
xlabel ('$n$','Interpreter','latex',FontSize=14);
title('$x[n] = \cos[0.4e n]$','Interpreter', 'latex', 'FontSize', 14);
grid on;
ax = gca;
ax.YLabel.Rotation = 360;
```

```
%g-------------------------------------------------------------------------

clf;
y7 = cos(0.2*pi*t)+sin(0.4*pi*t);
plot(t,y7,"k");
ylabel ('$x(t)$','Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
title('$x(t) = \cos(0.2\pi t) + \sin(0.4\pi t)$',...
    'Interpreter', 'latex', 'FontSize', 14);
grid on;
ax = gca;
ax.YLabel.Rotation = 360;

%h-------------------------------------------------------------------------

clf;
y8 = cos(0.4*pi*n)+sin(0.2*pi*n);
stem(n,y8,"k");
ylabel ('$x[n]$','Interpreter','latex',FontSize=14);
xlabel ('$n$','Interpreter','latex',FontSize=14);
title('$x[n] = \cos[0.4\pi n] + \sin[0.2\pi n]$',...
    'Interpreter', 'latex', 'FontSize', 14);
grid on;
ax = gca;
ax.YLabel.Rotation = 360;

%i

clf;
y9 = sin(0.2*n)+sin(0.4*pi*n);
stem(n,y9,"k");
ylabel ('$x[n]$','Interpreter','latex',FontSize=14);
xlabel ('$n$','Interpreter','latex',FontSize=14);
title('$x[n] = \cos[0.4\pi n] + \sin[0.2\pi n]$',...
    'Interpreter', 'latex', 'FontSize', 14);
grid on;
ax = gca;
ax.YLabel.Rotation = 360;

%j

clf;
y10 = cos(0.2*t)+cos(0.2*exp(1)*t);
plot(t,y10,"k");
ylabel ('$x(t)$','Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
title('$x(t) = \cos(0.2\pi t) + \sin(0.4\pi t)$',...
    'Interpreter', 'latex', 'FontSize', 14);
grid on;
ax = gca;
ax.YLabel.Rotation = 360;
```

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```
%--------------------------EEE 321 ON-LAB CODE-----------------------------
%ID = 22003836, ABC = 836;
abc = 836;
w1 = pi*abc;
w2 = 4*w1;

T = 2.39*10^(-3);
samp_int = T/100;
fs = 41800;

t = 0:samp_int:1;
x_m = cos(5*w1*t) + cos(3*w1*t);

t2 = 0:samp_int:5*T;
x_m2 = cos(5*w1*t2) + cos(3*w1*t2);

soundsc(x_m,fs);

subplot(2,1,1);
plot(t,x_m,"k");
ylabel ('$x_m(t)$','Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
title('$x_m(t) = \cos(\frac{2\pi}{836 \pi}  t)$', ...
    'Interpreter', 'latex', 'FontSize', 14);
ax = gca;
ax.YLabel.Rotation = 360;


subplot(2,1,2);
plot(t2,x_m2,"k");
ylabel ('$x_m(t)$','Interpreter','latex',FontSize=14);
xlabel ('$t$','Interpreter','latex',FontSize=14);
title('$x_m(t) = \cos(\frac{2\pi}{836 \pi}  t)$', ...
    'Interpreter', 'latex', 'FontSize', 14);
grid
ax = gca;
ax.YLabel.Rotation = 360;
```

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