LAB REPORT - 9

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Q1 $x = 2\cos\left(2\pi t + \frac{\pi}{4}\right)$, $t \in R$

a) $T_s = 0.2$ s/sample ; b) $T_s = 0.4$ s/sample

c) $T_s = 0.5$ s/sample ; d) $T_s = 1$ s/sample

Check whether the signal can be reconstructed for each case.

$$x(t) = 2\cos\left(2\pi t + \frac{\pi}{4}\right)$$

$$x(t+t_0) = 2\cos\left(2\pi(t+t_0) + \frac{\pi}{4}\right)$$

$$= 2\cos\left(2\pi t + \frac{\pi}{4} + 2\pi t_0\right)$$

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

when

$t_0 = 1$

$\Rightarrow$ Time period (fundamental) $T_0 = 1$ s

$\Rightarrow$ $f_m = \frac{1}{T_0} = 1$ Hz

(2)

$T_s = 0.2\ s/sample$

a) Nyquist condition:

$$f_s > 2 f_m$$

$f_s = \frac{1}{0.2}$, $f_m = 1$

$= 5$ $\quad f_s > 2f_m$ is true

Signal can be reconstructed

b) $T_s = 0.4\ s/sample$

$f_s = \frac{1}{0.4} = 2.5\ Hz$, $f_m = 1\ Hz$

$f_s > 2f_m$

⇒ Signal can be reconstructed

c) $T_s = 0.5\ s/sample$

$f_s = \frac{1}{0.5} = 2\ Hz$, $f_m = 1\ Hz$

Nyquist condition: $f_s \not> 2f_m$

$f_s > 2f_m$

⇒ Signal can be reconstructed.

d) $T_s = 1$ s/sample

$f_s = 1$ Hz, $f_m = 1$ Hz

$\Rightarrow f_s \not> 2f_m$

$\Rightarrow$ Signal can't be reconstructed

Q2 $x(t) = \cos(2000\pi t)$, check whether the signal can be reconstructed for both cases:

a) $f_s = 6000$ Hz b) 800 Hz

$x(t) = \cos(2000\pi t)$

Time period $T_0 = \frac{2\pi}{2000\pi} = \left(\frac{1}{1000}\right)$ s

$\Rightarrow f_0 = f_m = \frac{1}{T_0} = 1000$ Hz

a) $f_s = 6000$ Hz

According to Nyquist condition:

$f_s > 2f_m$

$\Rightarrow 2f_m = 2000$

Signal can be reconstructed.

(4)

b) $f_s = 800\ Hz$, $2f_m = 2000\ Hz$

$\Rightarrow f_s \ngeq 2f_m$

Signal cannot be reconstructed

Q3 Plot $x_r(t)$

$$x(t) = 2 - \cos(f_0 \pi t) - \sin(2 f_0 \pi t)$$

for $f_0 = 500\ Hz$, and

(i) for $f_s = 6000\ Hz$

(ii) for $f_s = 800\ Hz$

$$x(t) = 2 - \cos(f_0 \pi t) - \sin(2 f_0 \pi t)$$

Time period of cos $= T_1 = \frac{2\pi}{f_0 \pi} = \frac{2}{f_0}$ s

Time period of sin $= T_2 = \frac{2\pi}{2 f_0 \pi} = \frac{1}{f_0}$ s

Actual time period $= \left(\frac{2}{f_0}\right)$ s $= \left(\frac{1}{250}\right)$ s

(5)

(i) $f_s = 6000$ Hz (sample/s)

$f_m = 250$ sample/s

$f_s > 2f_m$ (follows Nyquist condition)

Signal can be reconstructed.

(ii) $f_s = 800$ Hz (sample/s)

$f_m = 250$ sample/s

$f_s > 2f_m$ (follows Nyquist condition)

Signal can be reconstructed.

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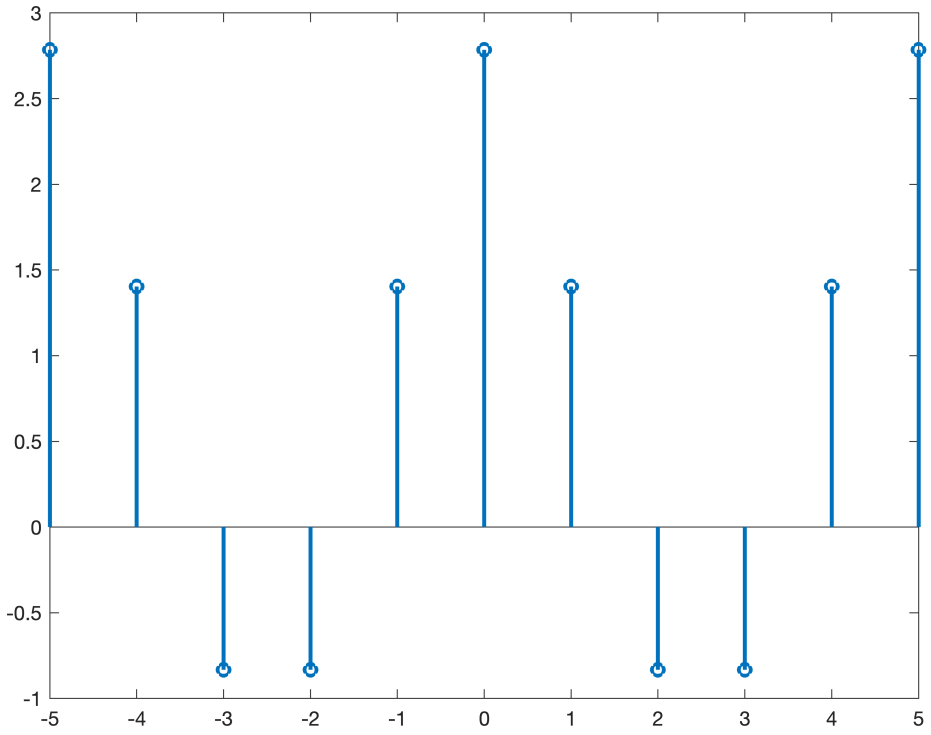
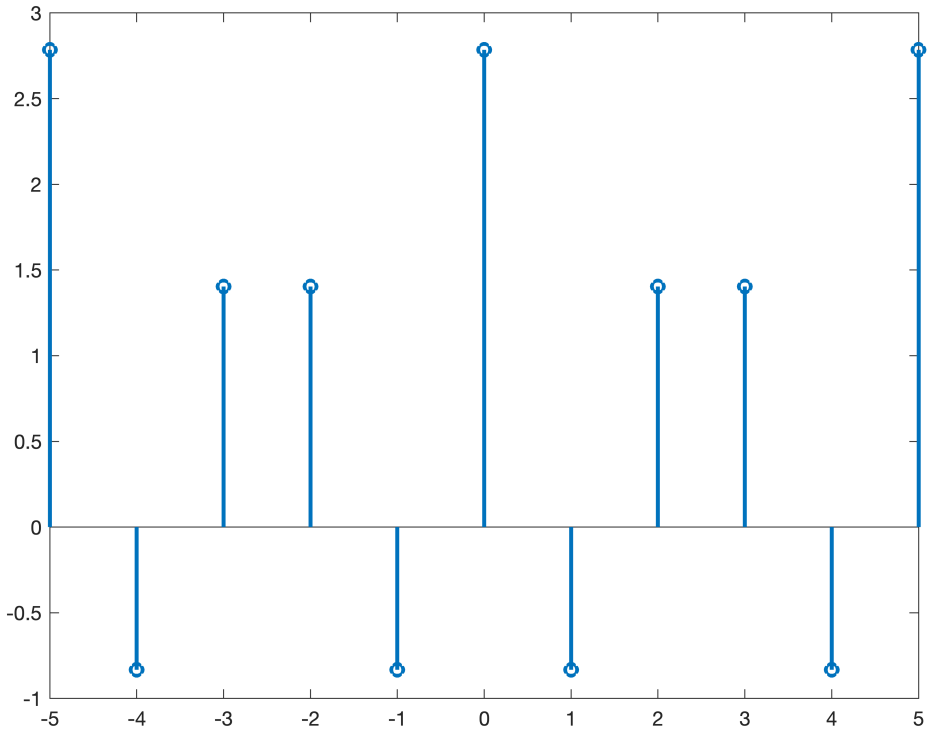
Q1

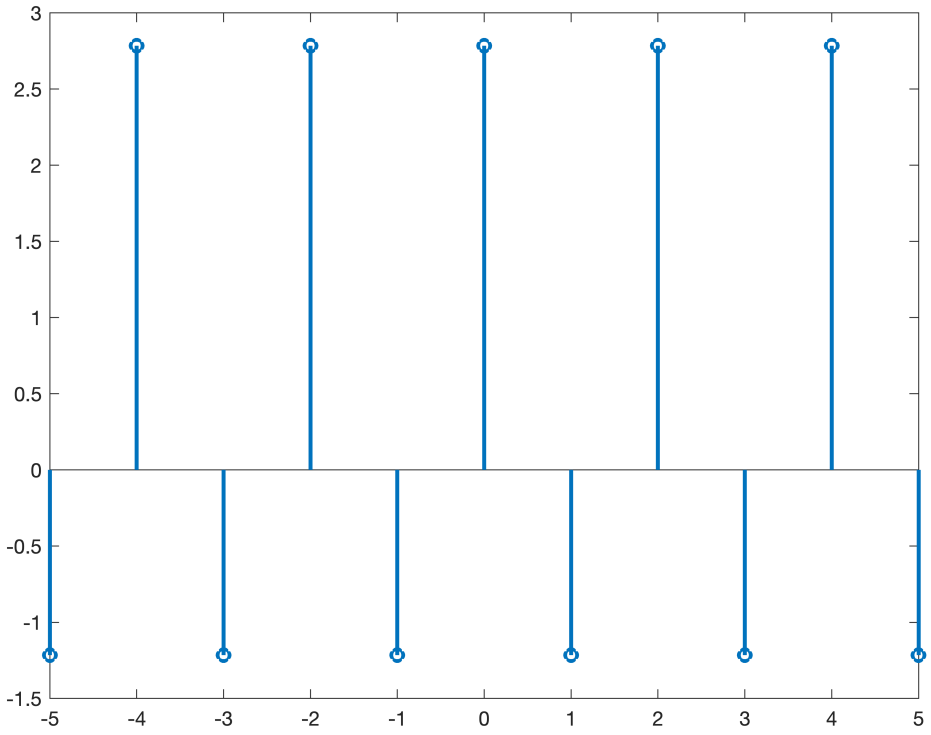
```
close all;
clear;
clc;

n = -5:5;
Ts1 = 0.2;
stem(n,2.*cos(2.*pi.*n.*Ts1)+(pi/4), "LineWidth", 2);
```



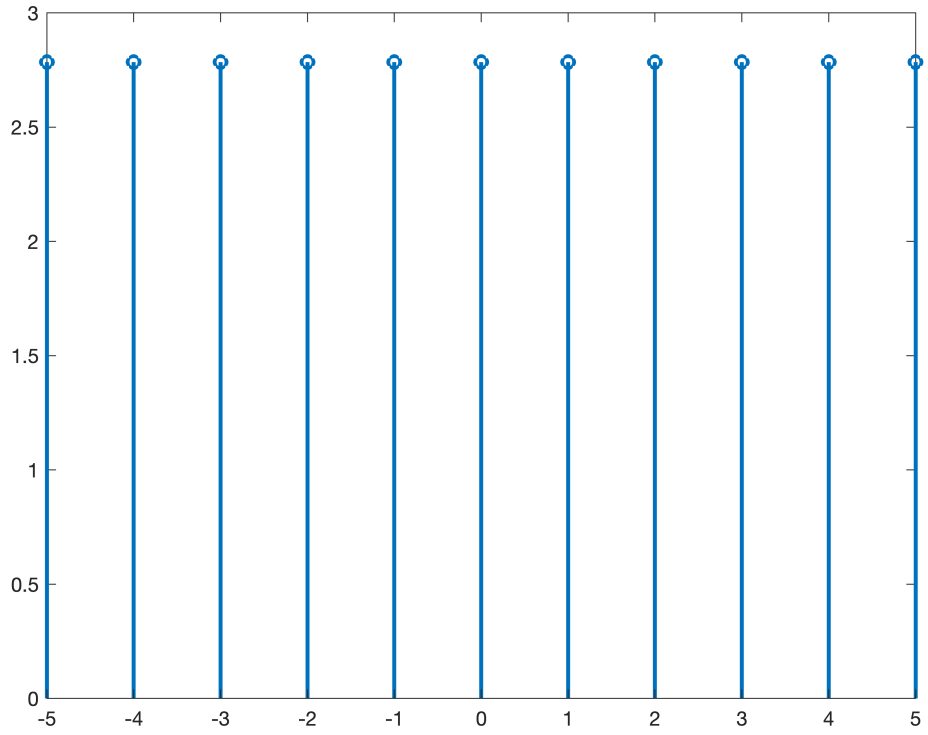

```
Ts2 = 0.4;
stem(n,2.*cos(2.*pi.*n.*Ts2)+(pi/4), "LineWidth", 2);
```




```
Ts3 = 0.5;
stem(n,2.*cos(2.*pi.*n.*Ts3)+(pi/4), "LineWidth", 2);
```

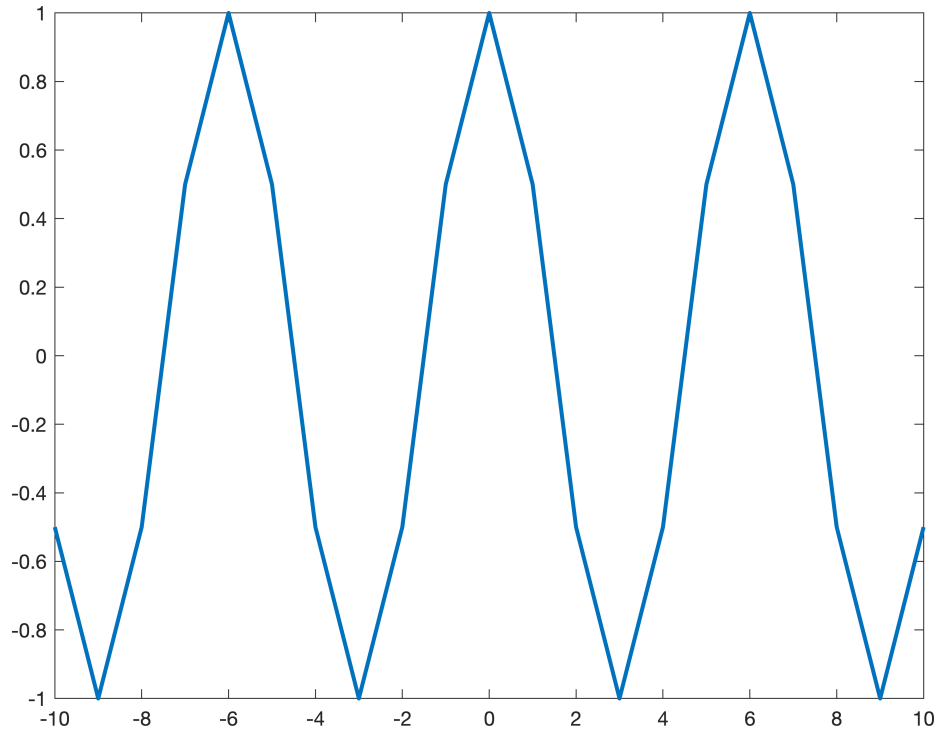


```
Ts4 = 1;
stem(n,2.*cos(2.*pi.*n.*Ts4)+(pi/4), "LineWidth", 2);
```

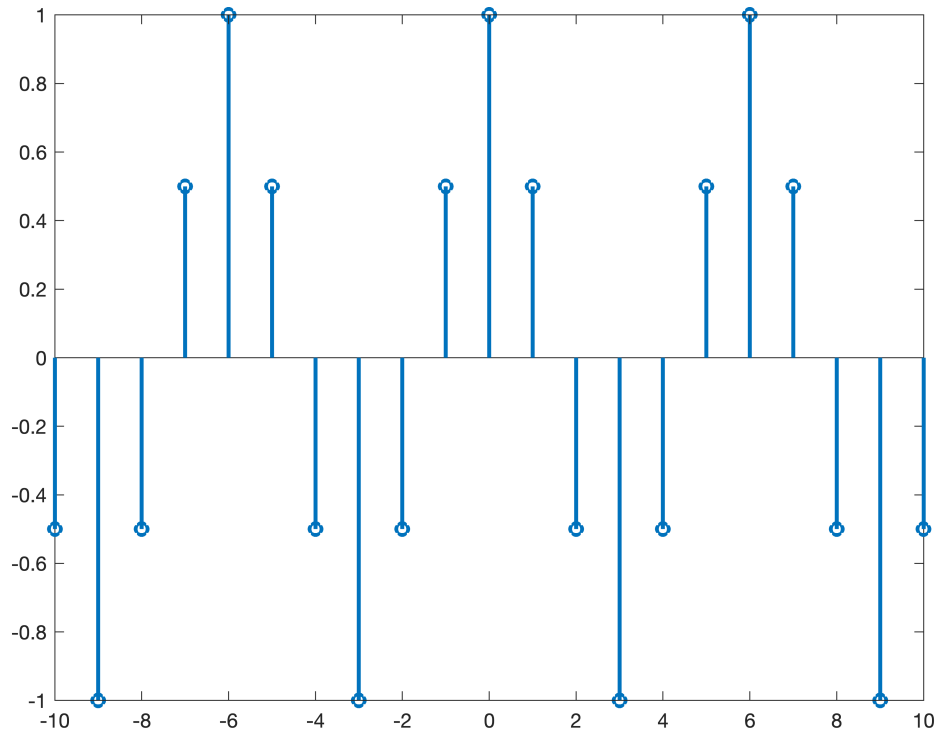


Q2

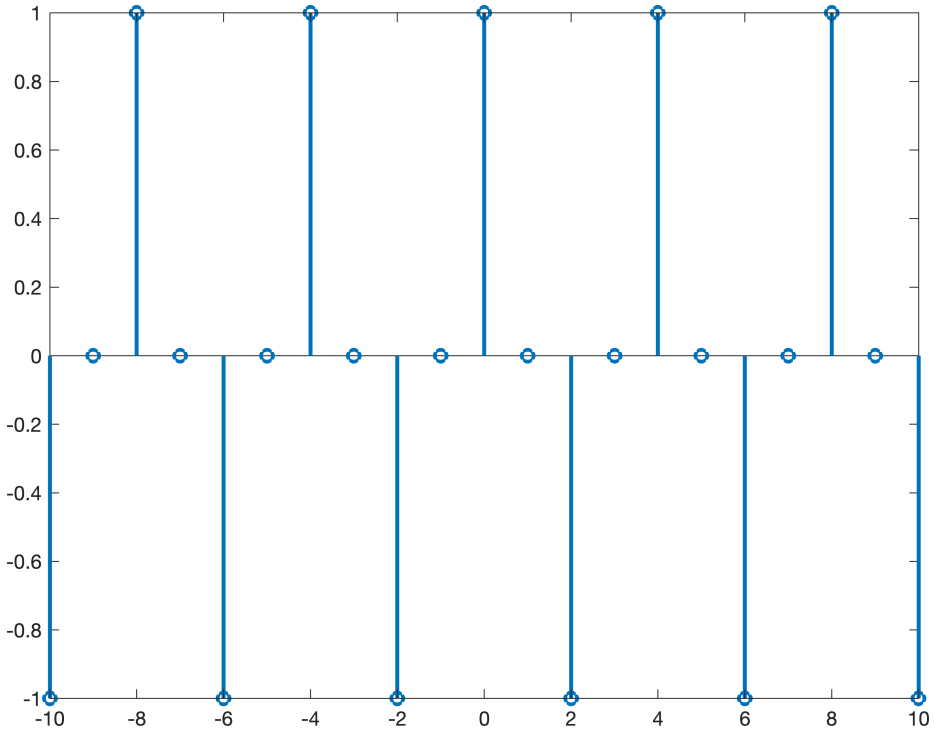
```
clear n;

n = -10:1:10;
t = -10:1:10;
xt = cos(2000*pi.*t/6000);
plot(t, xt, "LineWidth", 2);
```




```
x1 = cos((2000*pi.*n)./6000);
stem(n, x1, 'LineWidth',2);
```

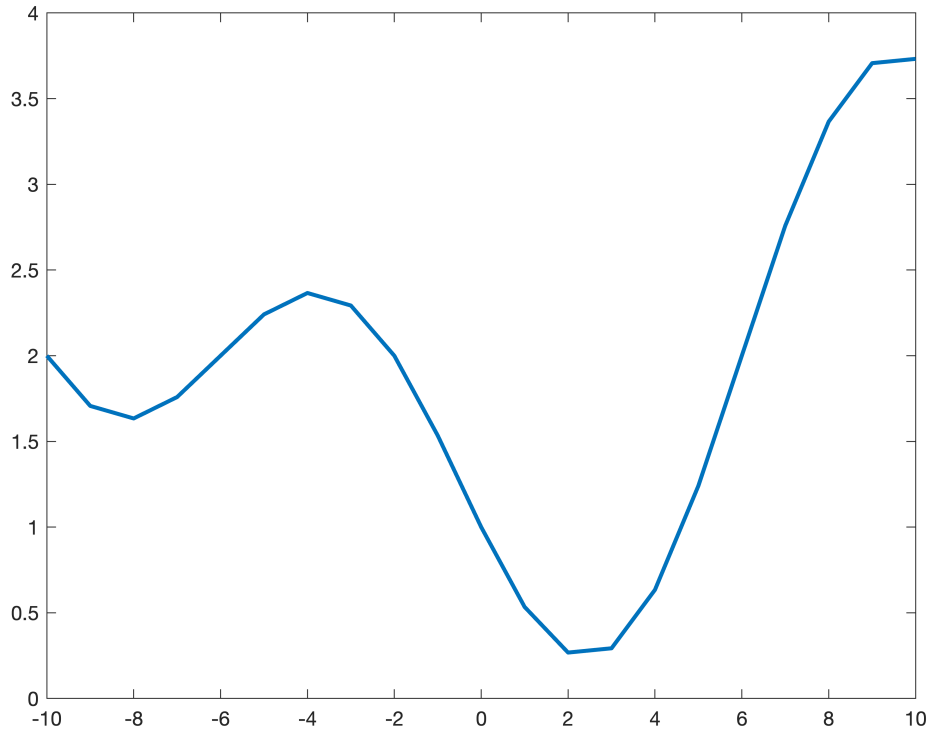


```
x2 = cos((2000*pi.*n)./800);
stem(n, x2, 'LineWidth', 2);
```

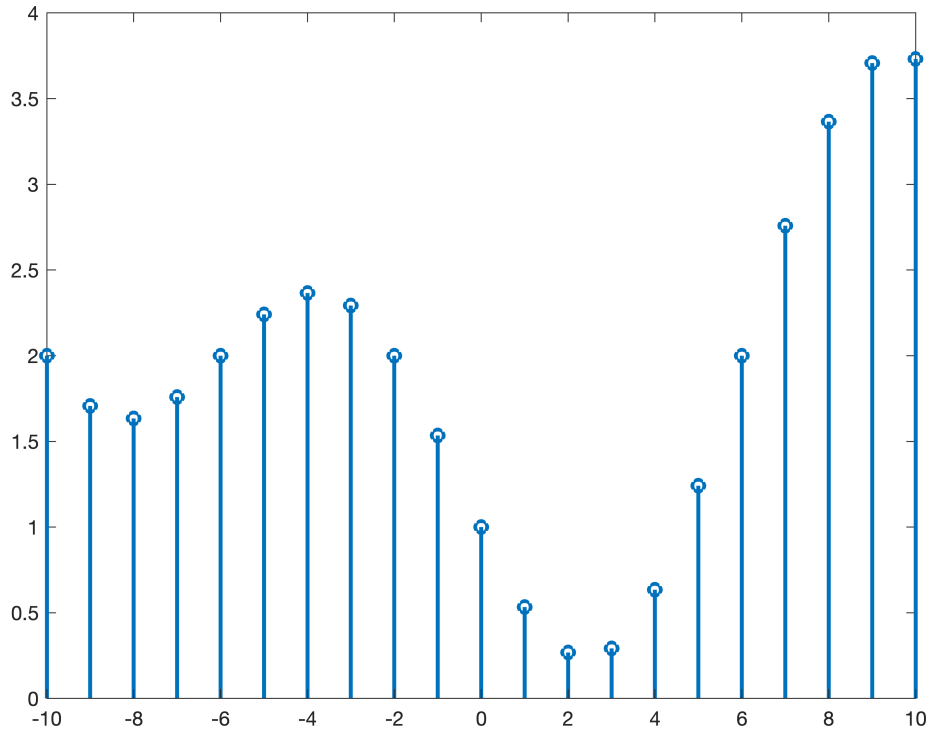


Q3

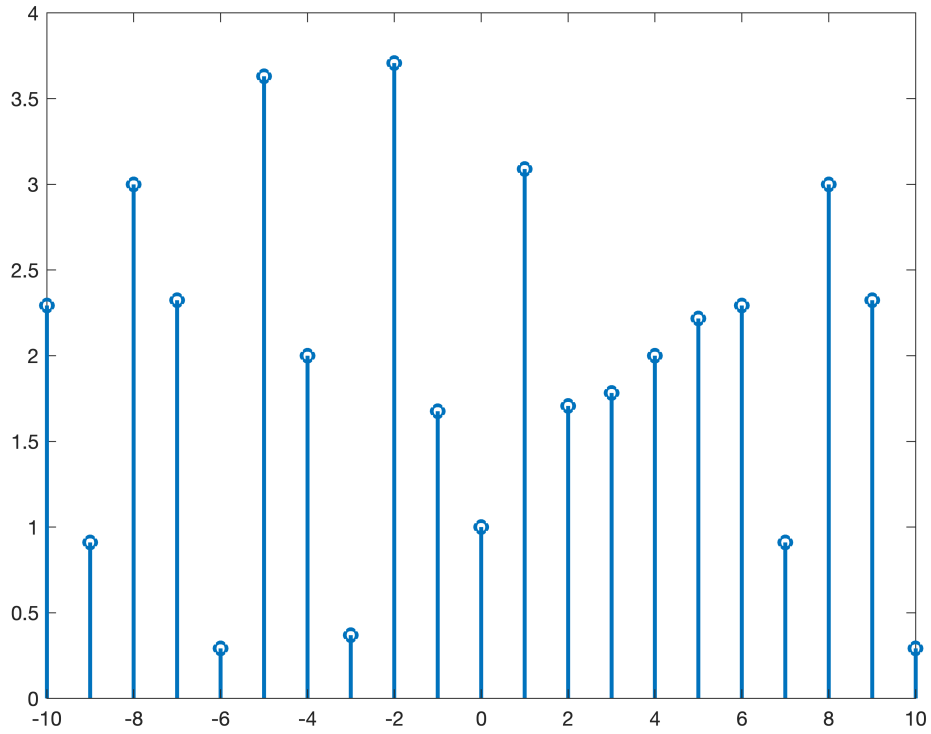
```
clear n;
clear t;

t = -10:1:10;
y = 2 - cos(500.*pi.*t/6000) - sin(2.*pi.*500.*t/6000);
plot(t, y, 'LineWidth', 2);
```



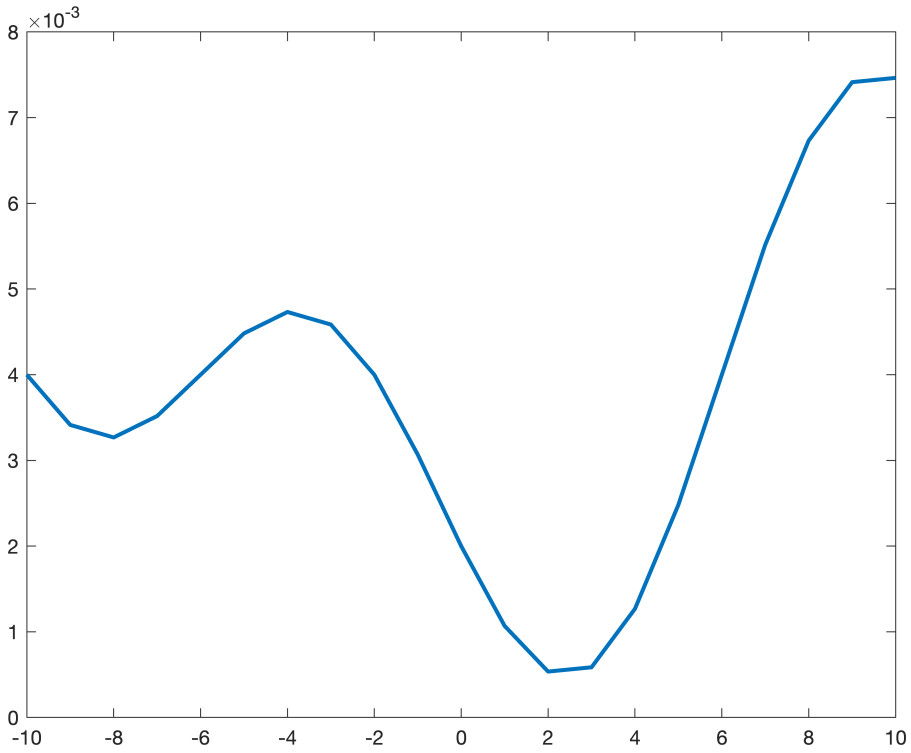

```
n = -10:1:10;
x1 = 2 - cos((500.*pi.*n)./6000) - sin((2*500*pi.*n)./6000);
stem(n, x1, 'LineWidth', 2);
```




```
x3 = fft(x1);
x2 = 2 - cos((500.*pi.*n)./800) - sin((2*500*pi.*t)./800);
stem(n, x2, 'LineWidth', 2);
```




```
wc = pi*1000;
T = 0.002;
h = (T*sin(wc*t))./(pi*t);
h(11) = T;
xr1 = conv(x1, h, "same");
b = -10:1:10;
plot(b, xr1, 'LineWidth', 2);
```




```
xr2=conv(x2, h, "same");
plot(b, xr2, 'LineWidth', 2);
```