MATLAB Assignment 1

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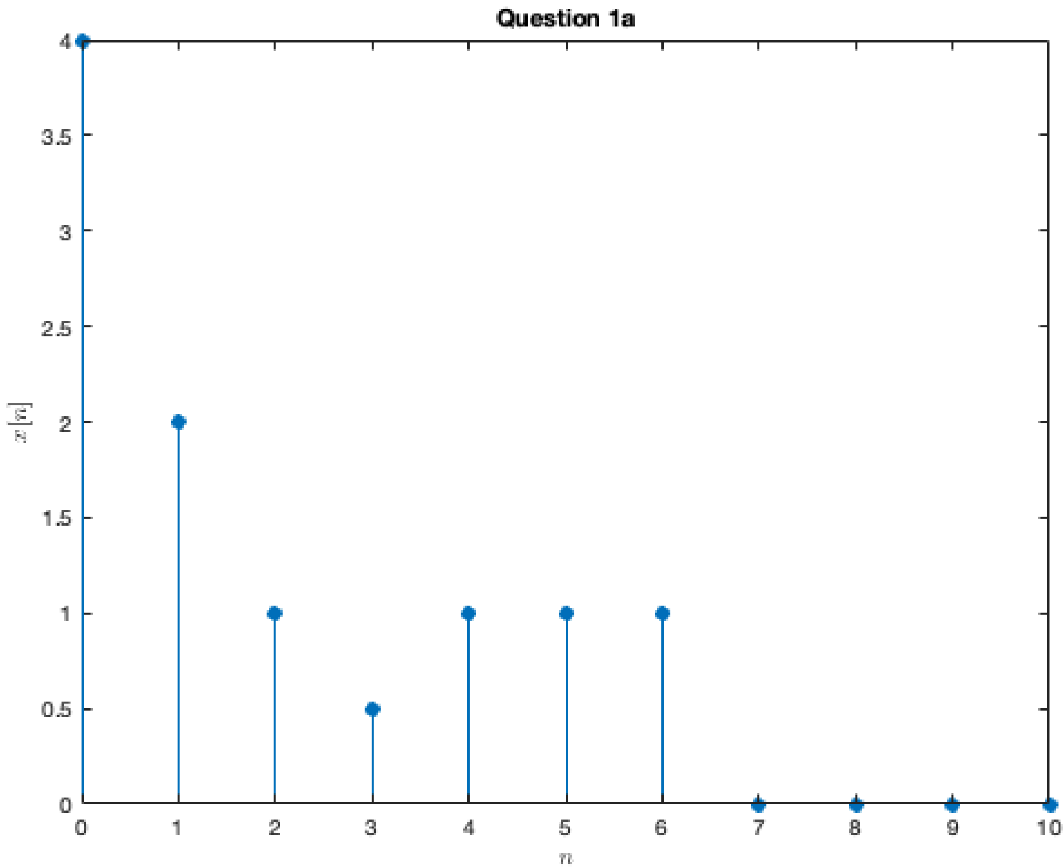
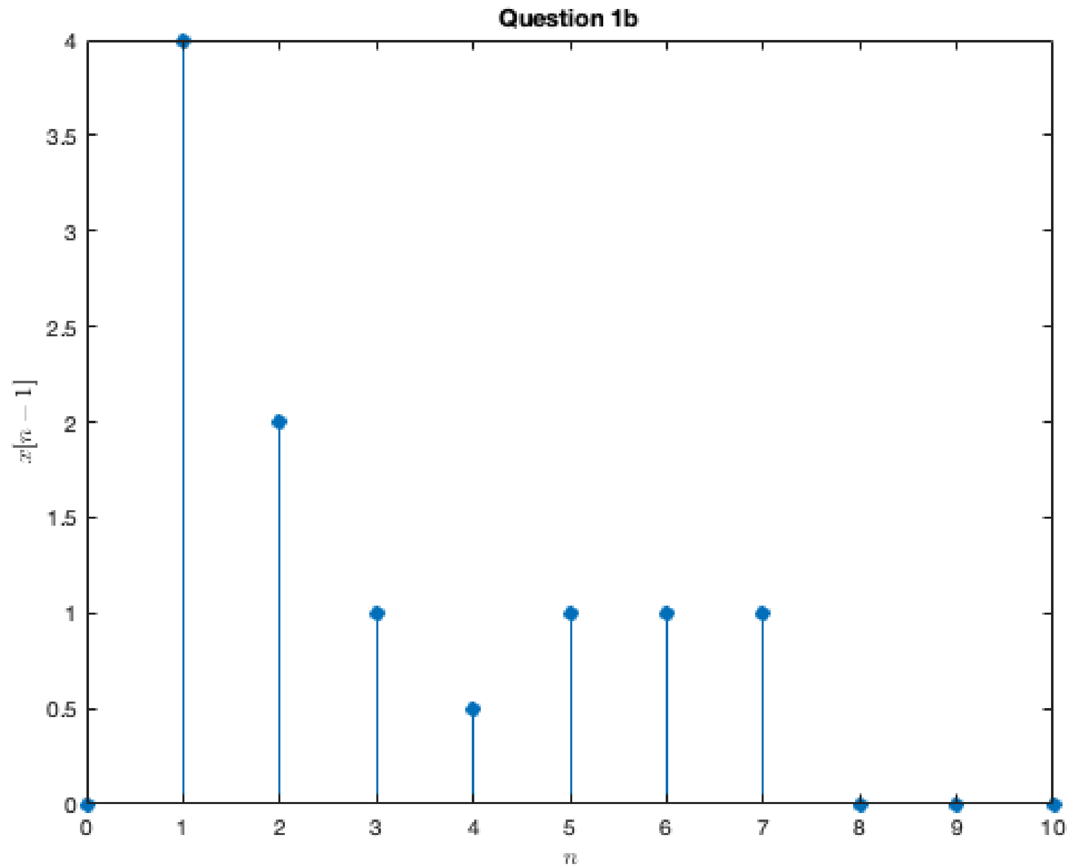
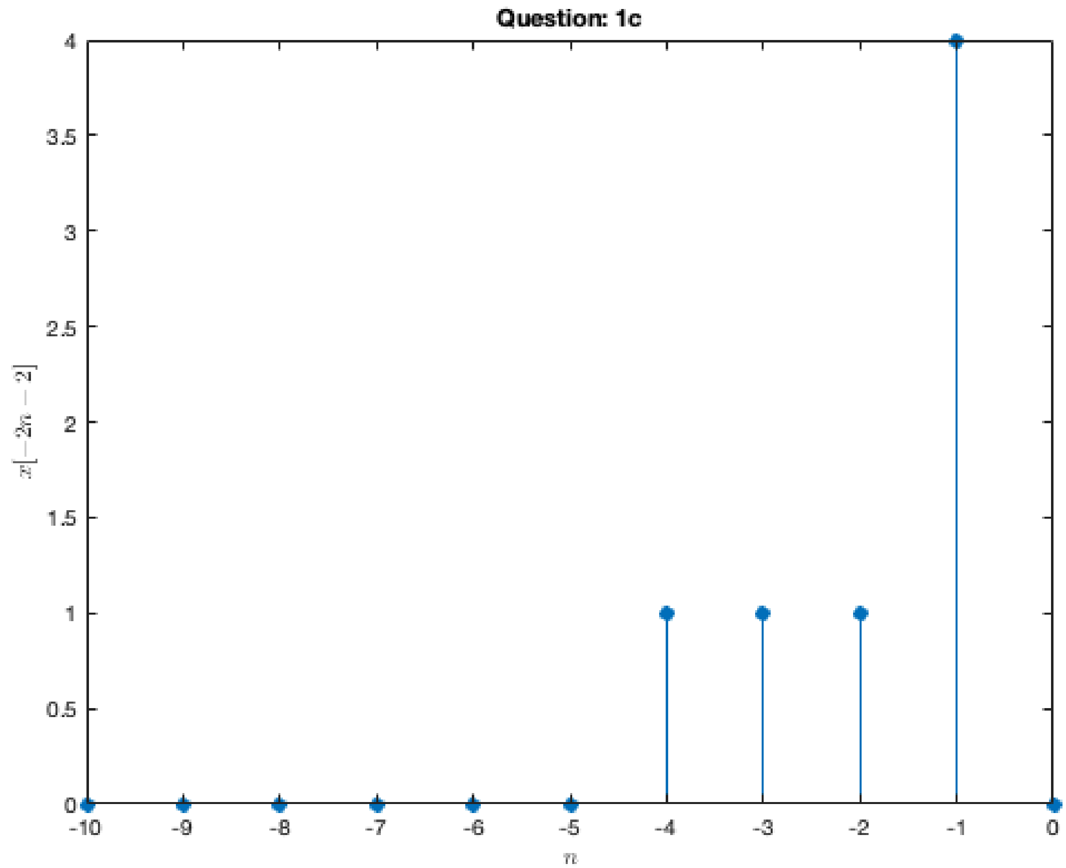
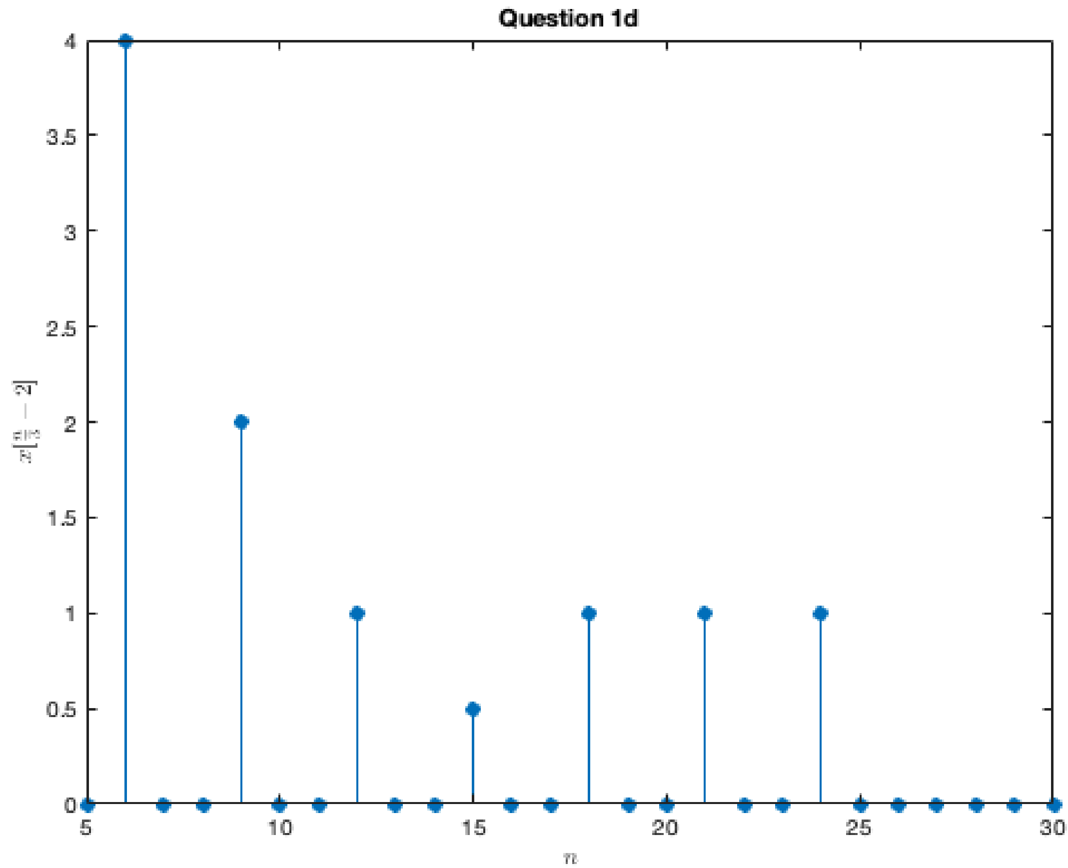
QUESTION 1

```
%question 1a
u1 = @(n) ((n>=0) &(rem(n,1)==0));
n1 = 0:10;  % standard timescale for Question1a and b
xn1 = @(n) (1/2).^(n-2).*(u1(n)-u1(n-4)) + (u1(n-4)-u1(n-7));
figure(1);
stem(n1,xn1(n1),'fill')
title('Question 1a')
xlabel(['','$n$'],'interpreter','latex');
ylabel(['','$x[n]$'],'interpreter','latex')

%question 1b
figure(2);
stem(n1, xn1(n1-1),'fill')
title('Question 1b')
xlabel(['','$n$'],'interpreter','latex');
ylabel(['','$x[n-1]$'],'interpreter','latex')

%question 1c
figure(3);
n2 = -10:0;  %Timescale was adjusted for the compressed signal
stem(n2, xn1(-2*n2 - 2),'fill')
%Labels
title('Question: 1c')
xlabel(['','$n$'],'interpreter','latex');
ylabel(['','$x[-2n-2]$'],'interpreter','latex')

%question 1d
figure(4);
n3 = 5:30;  %Timescale was adjusted for the expanded signal
stem(n3, xn1(n3/3 -2),'fill')
title('Question 1d')
xlabel(['','$n$'],'interpreter','latex');
ylabel(['','$x[\frac{n}{3} - 2]$'],'interpreter','latex')
```


Question 1a
$x[n]$
n
0
0.5
1
1.5
2
2.5
3
3.5
4
0
1
2
3
4
5
6
7
8
9
10


Question 1b
x[n − 1]
n
0
0.5
1
1.5
2
2.5
3
3.5
4
0
1
2
3
4
5
6
7
8
9
10


Question: 1c
$x[-2n-2]$
n
4
3.5
3
2.5
2
1.5
1
0.5
0
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
0



QUESTION 2

$Period : x_1[n]$

$x_1[n] = 2sin(\frac{\pi}{N}n) + cos(\frac{3\pi}{N}n); N = 4$

$\Omega_{o1} = \frac{\pi}{4}$

$\frac{\Omega_{o1}}{2\pi} = \frac{m}{N_{o1}} = \frac{1}{8} : Rational- > periodic$

$N_{o1} = 8$

$\Omega_{o2} = \frac{3\pi}{4}$

$\frac{\Omega_{o2}}{2\pi} = \frac{m}{N_{o2}} = \frac{3}{8} : Rational- > periodic$

$N_{o2} = 8$

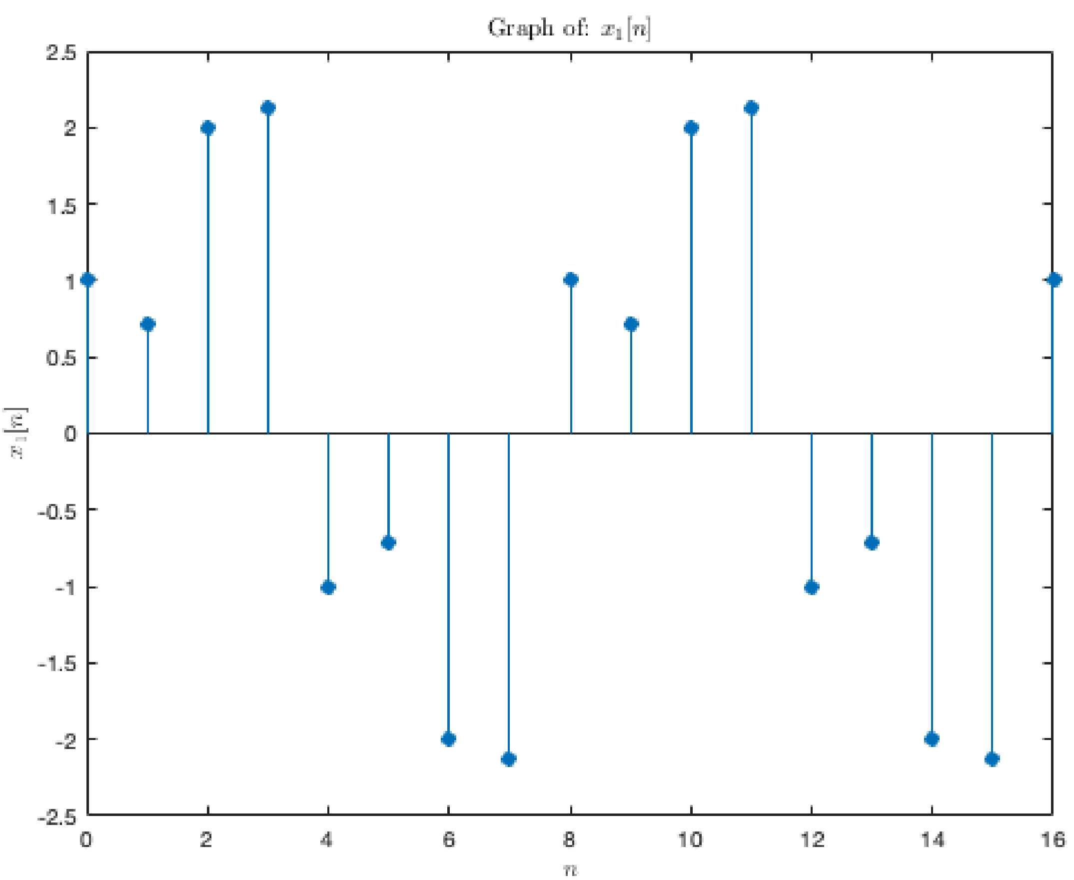
$N_{o1} = N_{o2} = N_o = 8$

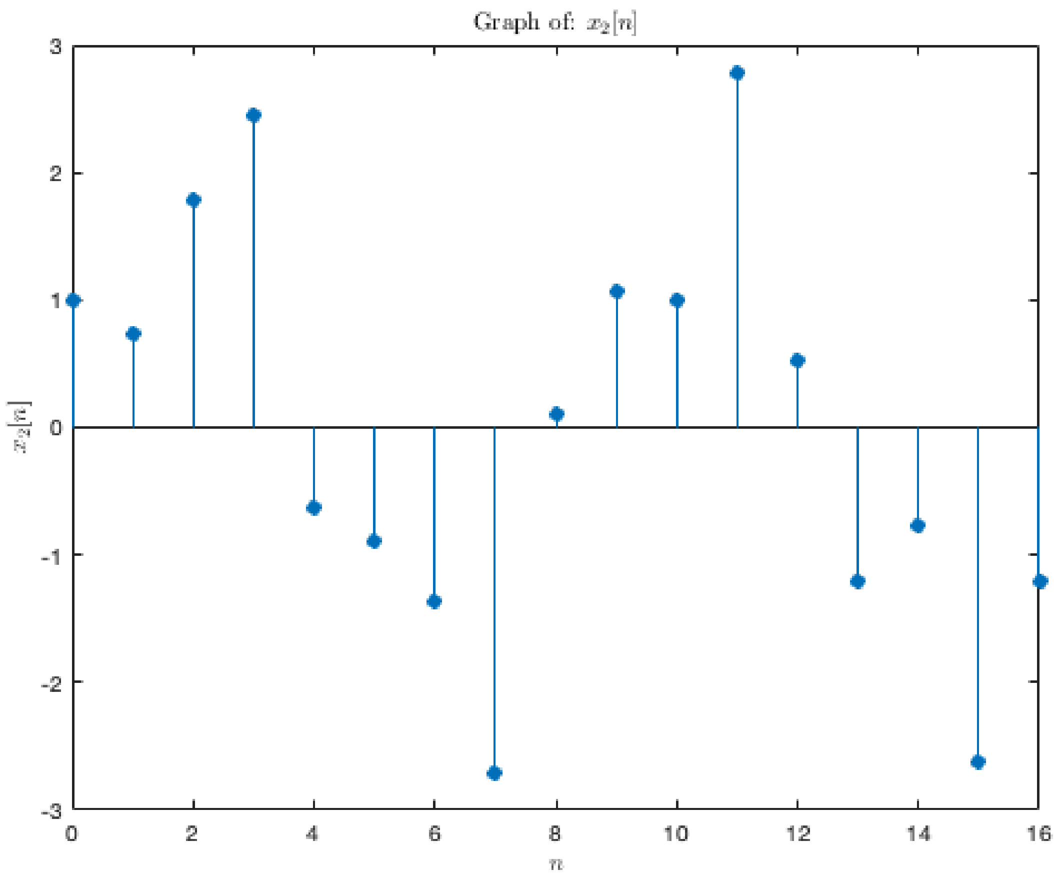
$Period : x_2[n]$

$x_2[n] = 2sin(\frac{3}{N}n) + cos(\frac{9}{N}n); N = 4$

$\Omega_{o1} = \frac{3}{4}; \frac{\Omega_{o2}}{2\pi} = \frac{m}{N_{o2}} = \frac{3}{8\pi} : Irrational -> aperiodic$

```
N = 4;
nq2 = 0:4*N;  % time index
xq2_1 = 2 * sin( (pi/N) * nq2 ) + cos( ((3*pi)/N) * nq2 );
xq2_2 = 2 * sin( (3/N) * nq2 ) + cos( (9/N) * nq2 ); % plotting the original
 function

figure(5);
stem(nq2,xq2_1,'fill')
title(['Graph of: ','$x_{1}[n]$'],'interpreter','latex')
xlabel(['','$n$'],'interpreter','latex');
ylabel(['','$x_{1}[n]$'],'interpreter','latex')

figure(6);
stem(nq2,xq2_2,'fill')
title(['Graph of: ','$x_{2}[n]$'],'interpreter','latex')
xlabel(['','$n$'],'interpreter','latex');
ylabel(['','$x_{2}[n]$'],'interpreter','latex')
```





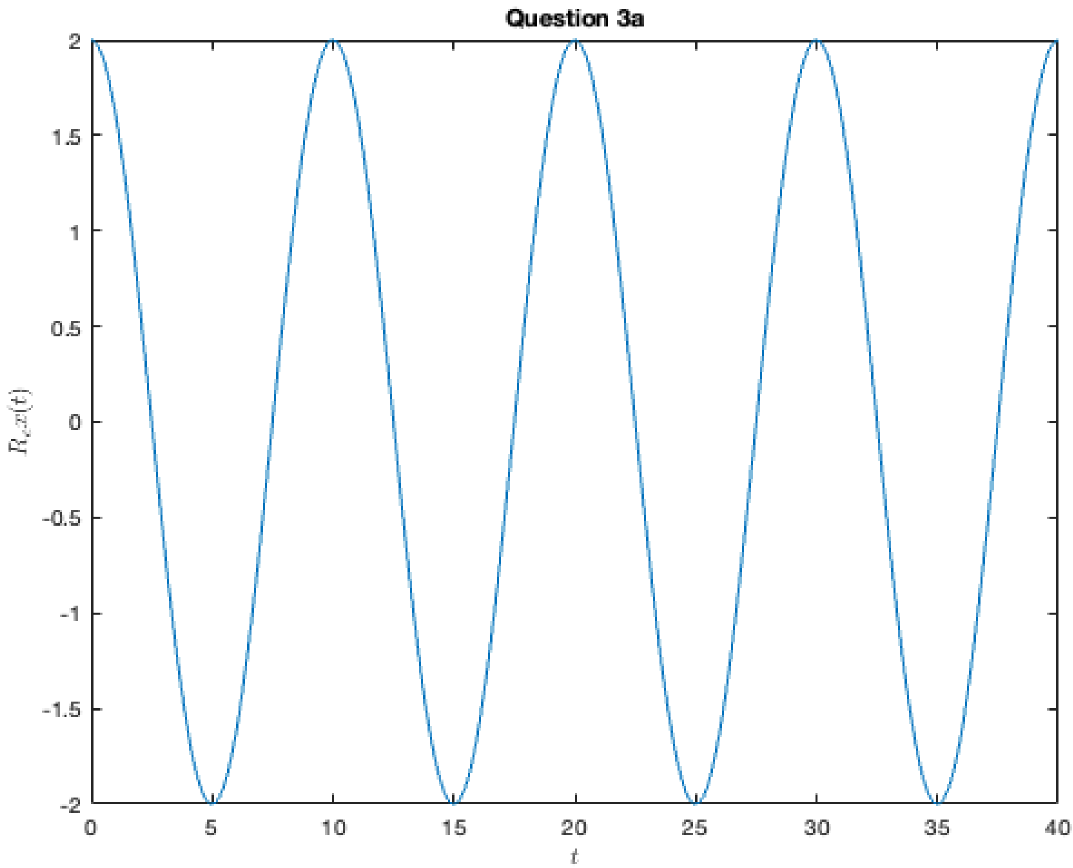
For plot 1, the graph displays a periodic function. It is confirmed to be periodic as the plot repeats itself every 8 steps. So: x[0]=x[8] and x[1]=x[9] and x[n]=x[n+8]=x[n+16] etc.

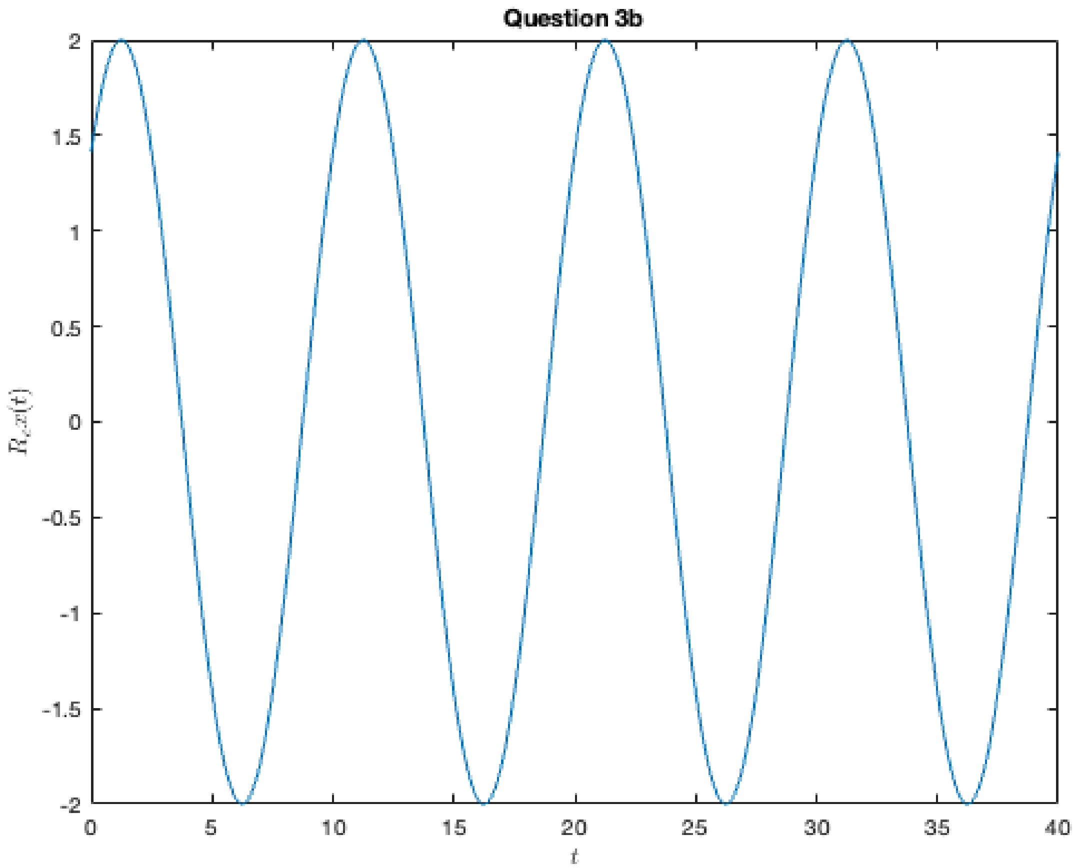
For plot 2, the graph displays a periodic function. It is confirmed to be periodic as the plot never repeats itself as the period is irrational and the graph displays no repeating periodic patterns.

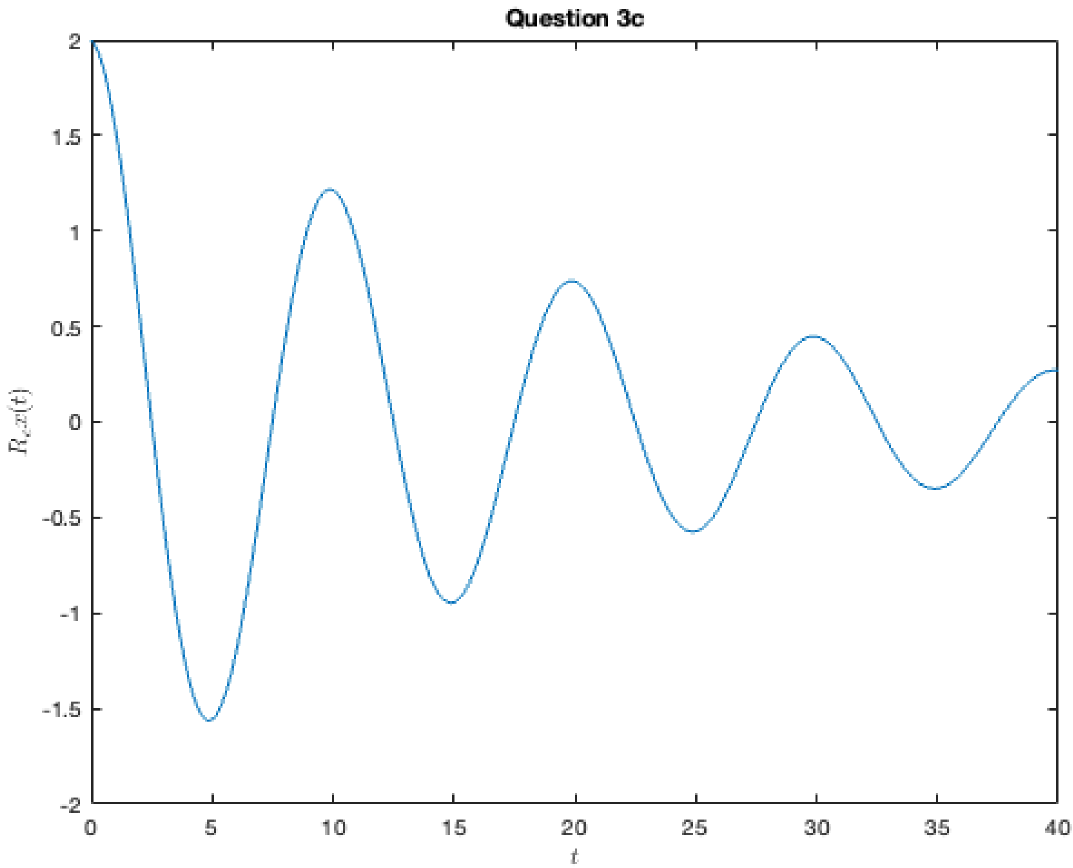
QUESTION 3

```
%Question 3a
phi_a = 0;
a_a = 0;
To_a = 10;% Fundamental period

t_step_a = To_a/100;   % time step
t_a = 0:t_step_a:4*To_a; % time array
x_r1 = 2 * exp(a_a*t_a).*cos(((2*pi)/To_a)*t_a + phi_a);% signal expression
 Re{x(t)}


figure(7);
plot(t_a,x_r1);
```

```
title('Question 3a')
xlabel(['','$t$'],'interpreter','latex');
ylabel(['','$R_e{x(t)}$'],'interpreter','latex')

%Question 3b
phi_b = -pi/4; % shifts the signal to the right by pi/4
a_b = 0;
To_b = 10;% Fundamental period

t_step_b = To_b/100;   % time step
t_b = 0:t_step_b:4*To_b; % time array
x_r2 = 2 * exp(a_b*t_b).*cos(((2*pi)/To_b)*t_b + phi_b);% signal expression
 Re{x(t)}


figure(8);
plot(t_b,x_r2);
title('Question 3b')
xlabel(['','$t$'],'interpreter','latex');
ylabel(['','$R_e{x(t)}$'],'interpreter','latex')


%Question 3c
phi_c = 0;
a_c = -0.05;
To_c = 10;% Fundamental period

t_step_c = To_c/100;   % time step
t_c = 0:t_step_c:4*To_c; % time array
x_r3 = 2 * exp(a_c*t_c).*cos(((2*pi)/To_c)*t_c + phi_c);% signal expression
 Re{x(t)}


figure(9);
plot(t_c,x_r3);
title('Question 3c')
xlabel(['','$t$'],'interpreter','latex');
ylabel(['','$R_e{x(t)}$'],'interpreter','latex')
```


Question 3a
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
$R_e x(t)$
0
5
10
15
20
25
30
35
40
t


Question 3b
$R_e x(t)$
t
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
5
10
15
20
25
30
35
40



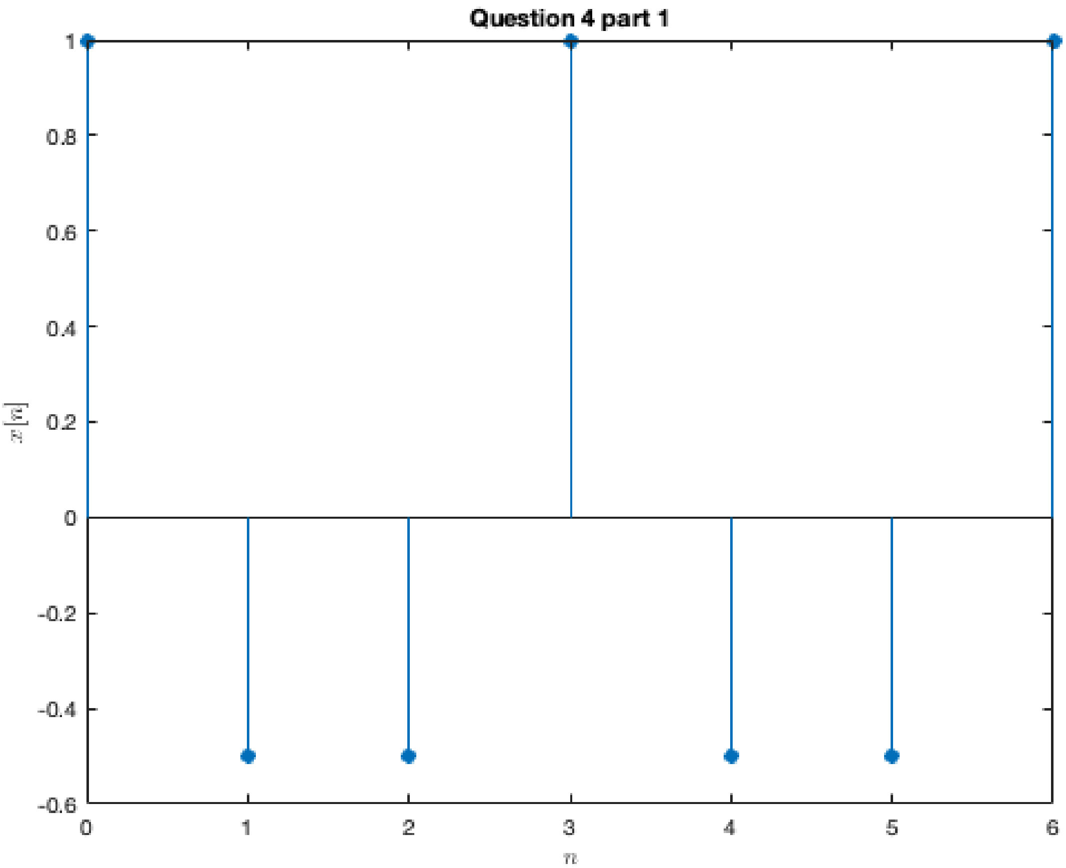

```
Answer to question 3b: -pi/4 shifts the signal to the right.
```

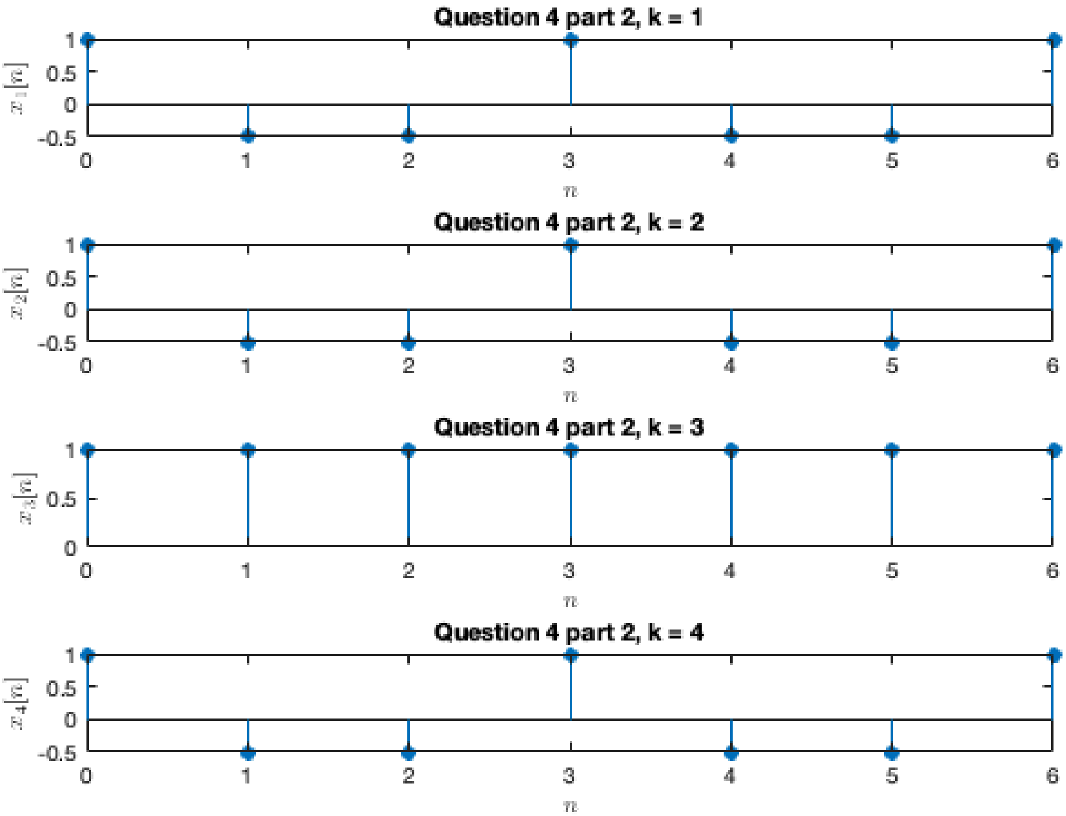
Answer to question 3c: a value of -0.05 for the 'a' variable makes the wave exponentially decay.

QUESTION 4

```
% Question 4 part 1
figure(10)
No_1 = 3;
nq4_1 = 0:2*No_1;
xq4_1 = cos( (2*pi/No_1) * nq4_1 );
stem(nq4_1,xq4_1,'fill')
title('Question 4 part 1')
xlabel(['','$n$'],'interpreter','latex');
ylabel(['','$x[n]$'],'interpreter','latex')


% Question 4 part 2
figure(11)
k_1 = 1;
k_2 = 2;
k_3 = 3;
k_4 = 4;
```

```
%k=1
subplot(4,1,1)
xq4_2 = cos( (2*pi*k_1/No_1) * nq4_1 );
stem(nq4_1,xq4_2,'fill')
title('Question 4 part 2, k = 1')
xlabel(['','$n$'],'interpreter','latex');
ylabel(['','$x_1[n]$'],'interpreter','latex')

%k=2
subplot(4,1,2)
xq4_3 = cos( (2*pi*k_2/No_1) * nq4_1 );
stem(nq4_1,xq4_3,'fill')
title('Question 4 part 2, k = 2')
xlabel(['','$n$'],'interpreter','latex');
ylabel(['','$x_2[n]$'],'interpreter','latex')

%k=3
subplot(4,1,3)
xq4_4 = cos( (2*pi*k_3/No_1) * nq4_1 );
stem(nq4_1,xq4_4,'fill')
title('Question 4 part 2, k = 3')
xlabel(['','$n$'],'interpreter','latex');
ylabel(['','$x_3[n]$'],'interpreter','latex')

%k=4
subplot(4,1,4)
xq4_5 = cos( (2*pi*k_4/No_1) * nq4_1 );
stem(nq4_1,xq4_5,'fill')
title('Question 4 part 2, k = 4')
xlabel(['','$n$'],'interpreter','latex');
ylabel(['','$x_4[n]$'],'interpreter','latex')
```


Question 4 part 1
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
$x[n]$
0
1
2
3
4
5
6
n




```
Although four distinct signals have been plotted, there are two unique
signals that are outputted. The first signal has peaks of magnitude 1 at
every third interval. Every other interval has reaches a point of
magnitude -0.5.

This is contrasted with the signal when k=3. All the intervals display
a peak of magnitude 1.

These results agree with the expected outputs. This output is expected
to occur when $k = 3^{z}$ inputs. Where $z > 0$ .
So k values of 9, 27, 81, etc will display the same output albeit with
a higher frequency.
```

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