EE321 - Signals and Systems
Lab 01 - 02
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Introduction and objective
In this Lab, we were expected to learn about discrete time signals and how to plot them with MATLAB. The requested functions differed slightly from one another, and we were supposed to identify, observe, and describe these discrepancies in order to understand how to compare given functions that used the same architecture

Q1: Matlab supports integers up to 127. It converts infinite values into a finite collection of values (Quantization). The signals are saved as double data type, $x_1[n]$ is calculated by the function, and the variables are stored as " double " data type.

1.1 - Code and results can be seen at Appendice 1.1
1.2 - Graphs and results can be seen at Appendice 1.2
$w = 0.13\pi$ rad $\rightarrow x_1[n] = 3\cos[0.13\pi n + 0.5]$

Q2: $x_2[n] = \cos[2.2\pi n]$
2.1 - Code and results can be seen at Appendice 2.1
2.2 - Graphs and results can be seen at Appendice 2.2
$w = 2.2\pi$ rad

Q3: $x_3[n] = \cos[-1.8\pi n]$
3.1 - Code and results can be seen at Appendice 3.1
3.2 - Graphs and results can be seen at Appendice 3.2

∇ Comparing (2) and (3) above, and commenting on the results ; $\cos[wn] = \cos[(w+2\pi k)n]$ where k is integer

Then $\underbrace{\cos[-1.8\pi n]}_{x_3[n]} = \underbrace{\cos[-1.8\pi n + 2\times 2\pi]}_{x_2[n]}$

Hence, we can observe that $x_3[n]$ and $x_2[n]$ have same values which is also observed in their graphs in Appendice 2.2 and 3.2 in the fact that their w is different.

Q4 : $x_4[n] = \cos[0.26\pi n]$

4.1 - Code can be seen at Appendice 4.1

4.2 - Graph and outcomes can be seen at Appendice 4.2

$w = 0.26 \times \pi$ rad

Q5 : $x_5[n] = \cos[0.26\pi n + 0.7]$

5.1 - Code can be seen at Appendice 5.1

5.2 - Graph and outcomes can be seen at Appendice 5.2

$w = 0.26 \times \pi$ rad

∇ Compare (4) and (5) above, and comment on results

- While the functions are discrete 0.7 shift in the graph of signal 5 in comparison to another cannot be observed

$x_4[n+\alpha] = \cos[0.26\pi(n+\alpha)] = \cos[0.26\pi + 0.26\pi\alpha]$ for integer N

while α is integer, there is no solution that satisfy $x_4[n+\alpha] = x_5[n]$. Therefore, $x_5[n]$ is not a shifted version of $x_4[n]$.

Q6: $x_6[n] = \cos[0.01\pi n]$

6.1 - The code can be seen at Appendice 6.1

6.2 - The graph and outcomes can be seen at Appendice 6.2

$w = 0.01 \times \pi$ rad

Q7: $x_7[n] = \cos[0.39\pi n]$ $w = 0.39 \times \pi$ rad

7.1 - The code can be seen at Appendice 7.1

7.2 - The graph and outcomes can be seen at Appendice 7.2

Q8: $x_8[n] = \cos[\pi n]$

8.1 - The code can be seen at Appendice 8.1

8.2 - The graph and outcomes can be seen at Appendice 8.2

$w = \pi$ rad

Q9: $x_9[n] = \cos[1.08\pi n]$

9.1 - The code can be seen at Appendice 9.1

9.2 - The graph and outcomes can be seen at Appendice 9.2

$w = 1.08\pi$ rad

Q10: $x_{10}[n] = \cos[0.92\pi n]$

10.1 - The code can be seen at Appendice 10.1

10.2 - The graph and outcomes can be seen at Appendice 10.2

! Compare (9) and (10) above, commenting on the results.

While cos is even function, $\cos[0.92\pi n] = \cos -[0.92\pi n]$

And just like comparison between $x_2[n]$ and $x_3[n]$

$$\cos[-0.92\pi n + 2\pi k] = \cos[1.08\pi n]$$
$$\downarrow 1$$

Therefore, it can be seen that they have the same values with different w's.

Q11 - $x_{11}[n] = \cos[n]$

11.1 - The code can be seen at Appendice 11.1

11.2 - The graph and outcomes can be seen at Appendice 11.2

$w = 1$ radian

Q12 - $x_{12}[n] = \cos[0.9n + 0.3]$

12.1 - The code can be seen at Appendice 12.1

12.2 - The graph and outcomes can be seen at Appendice 12.2

$w = 0.9$ radian

Q13 - Finding fundamental periods

1) $x_1[n] = 3\cos[0.13\pi n + 0.5]$

$\cos[0.13\pi n + \underbrace{0.13\pi N}_{\text{fundamental period}}] \Rightarrow = \cos[0.13\pi n]$

$0.13\pi N = 2\pi k$

$0.065N = k$ $\quad \underline{\underline{N = 200}}$

2) $x_2[n] = \cos[2.2\pi n]$

$2.2\pi N = 2\pi k$

$11N = 10k$ $\quad$ k should be 11 $\Rightarrow \underline{\underline{N = 10}}$

3) $x_3[n] = \cos[-1.8\pi n]$

$-1.8\pi N = 2\pi k$ $\quad$ k should be $-9 \Rightarrow \underline{\underline{N = 10}}$

$-9N = 10k$

4) $x_4[n] = \cos[0.26\pi n]$

$0.26\pi N = 2\pi k$

$13N = 100k$ $\quad$ k should be 13 $\quad \underline{\underline{N = 100}}$

5) $x_5[n] = \cos[0.26\pi n + 0.7]$

$0.26\pi N = 2\pi k$

$13N = 100k$ $\quad$ k should be 13 $\quad \underline{\underline{N = 100}}$

Q6 - $x_6[n] = \cos[0.01\pi n]$

$0.01\pi N = 2\pi k$

$N = 200k$ $\qquad$ $\underline{\underline{N = 200}}$

Q7 - $x_7[n] = \cos[0.39\pi n]$

$0.39\pi N = 2\pi k$

$39N = 200k$ $\qquad$ k should be 39 $\quad N = 200$

Q8 - $x_8[n] = \cos[\pi n]$

$\pi N = 2\pi k$, $\underline{\underline{N = 2}}$

Q9 - $x_9[n] = \cos[1.08\pi n]$

$1.08\pi N = 2\pi k$ $\qquad$ $\underline{\underline{N = 50}}$

$108N = 200k$

$27N = 50k$

Q10 - $x_{10}[n] = \cos[0.92\pi n]$

$0.92\pi N = 2\pi k$ $\qquad$ $N = 50$

$23N = 50k$

Q11 - $x_{11}[n] = \cos[n]$

If $\cos[n+N] = \cos[n]$

$N = 2\pi k$ $\quad$ N and k must be integer

While 2π is irrational, there is no integer. N that satisfies this equation with integer k.

! Not periodic !

Q12 - $x_{12}[n] = \cos[0.9n + 0.3]$

$0.9N = 2\pi k$ $\quad$ N and k must be integers

There is no integer N that satisfies hence not Periodic.

Q14- $x[n] = A\cos[wn+\phi]$

$x[n+N] = A\cos[w(N+n]+\phi] = A\cos[wn+wN+\phi]$

if $wN = 2\pi k \Rightarrow x[n]$ is periodic

$\frac{w}{2\pi} = \frac{k}{N}$, k and N are both integers, $\frac{k}{N}$ is rational

Then $\frac{w}{2\pi}$ must be rational $\Rightarrow w = 2\pi p$ where p is rational

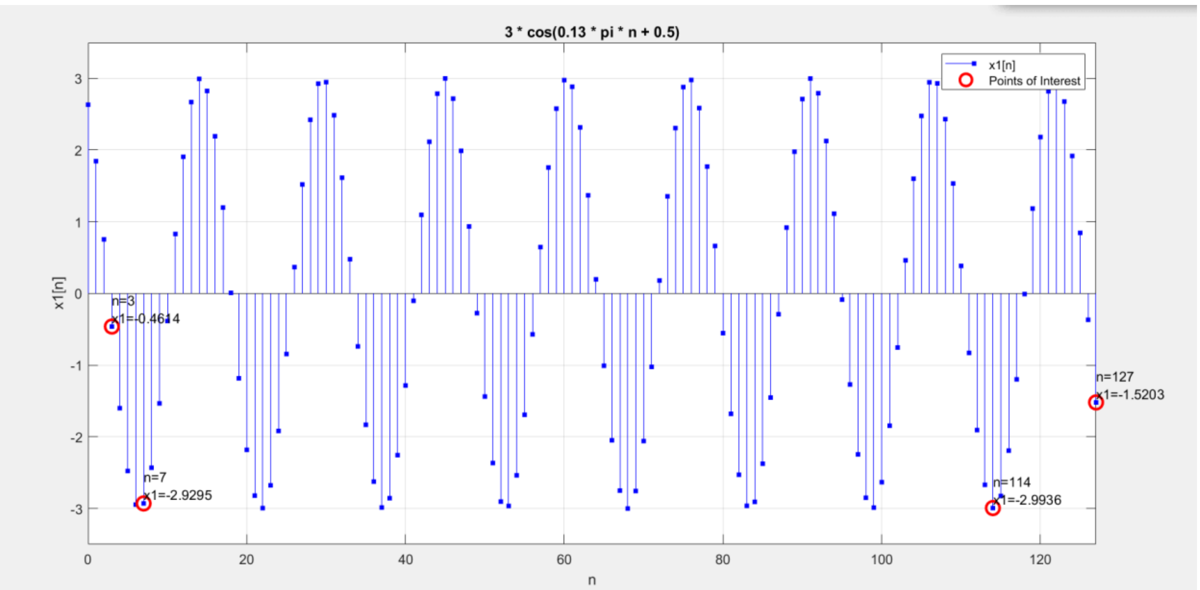
Q15- For $\overbrace{x[n] = \cos[wn+\phi]}^{\text{discrete}}$, $x[n+N] = A\cos[w(N+n] +\phi]$
$= A\cos[wn+wN+\phi]$ then $wN = 2\pi k$ where k and N are integers. $\frac{w}{2\pi} = \frac{k}{n}$ then $\frac{w}{2\pi}$ must be rational for periodic $x[n]$. For, $\underbrace{f(t) = \cos[wt+\phi]}_{\text{continuous}}$, $f(t+T) = A\cos[w(T+t)+\phi]$
$= A\cos(wt+wT+\phi)$, then $wT = 2\pi k$ where k is integer and T is real number. $\frac{w}{2\pi} = \frac{k}{N}$ then $\frac{w}{2\pi}$ must be real for periodic. Therefore, in continuous function signal is unique for $w \in (0,\infty)$; in discrete signals function is unique for $w \in [0, 2\pi)$.

1- x1[n] = 3 cos[0.13πn + 0.5] for ∈ (0,127)

1.1 Code of the question

```

n = 0:127;
x1 = 3 * cos(0.13 * pi * n + 0.5);


save('x1_signal.mat', 'x1');
clear

load('x1_signal.mat');

n = 0:127;
omega = 0.13 * pi;
disp('ω = '); disp(omega);
figure;
stem(n, x1, 'b.', 'MarkerSize', 10);
hold on;

points_of_interest = [3, 7, 114, 127];
plot(points_of_interest, x1(points_of_interest + 1), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

xlabel('n');
ylabel('x1[n]');
title('3 * cos(0.13 * pi * n + 0.5)');
grid on;

legend('x1[n]', 'Points of Interest');
for i = 1:length(points_of_interest)
    n_val = points_of_interest(i);
    x_val = x1(n_val + 1);
    text(n_val, x_val, sprintf('n=%d\nx1=%.4f', n_val, x_val), ...
         'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left');
end
axis([0 127 min(x1)-0.5 max(x1)+0.5]);
fprintf('x1[3] = %.10f\n', x1(4));
fprintf('x1[7] = %.10f\n', x1(8));
fprintf('x1[114] = %.10f\n', x1(115));
fprintf('x1[127] = %.10f\n', x1(128));
```

1.2 Graph and output of the code



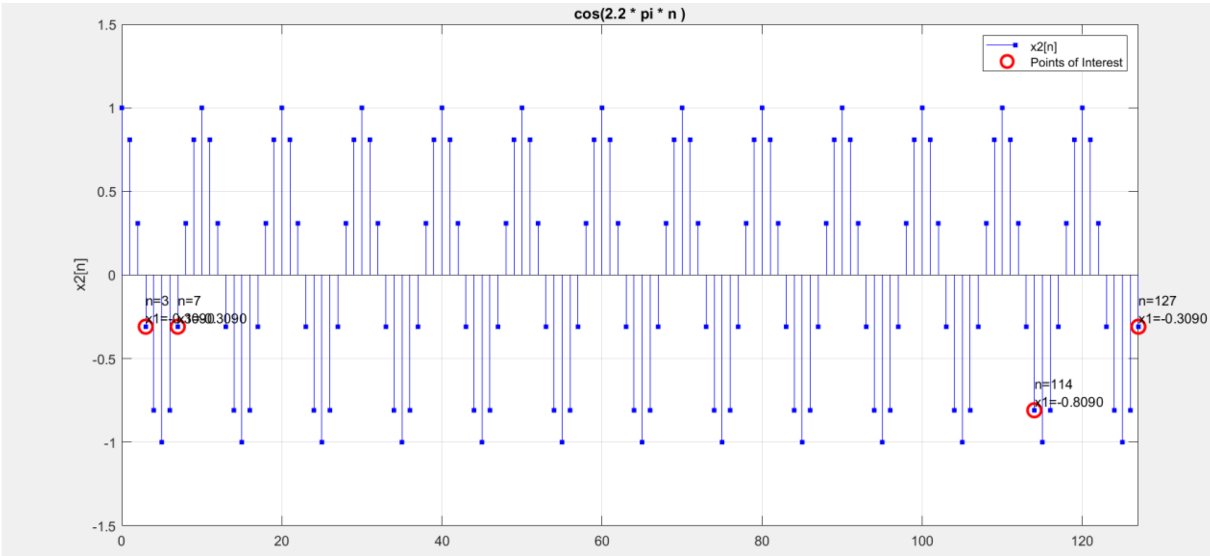
```
>> sorubir
ω =
    0.4084

x1[3] = -0.4614353327
x1[7] = -2.9294773624
x1[114] = -2.9935695412
x1[127] = -1.5202635164
```

2- x2[n] = cos[2.2πn] for ∈ (0,127)

2.1 Code of the question

```

n = 0:127;
x2 = cos(2.2 * pi * n );


save('x2_signal.mat', 'x2');
clear

load('x2_signal.mat');

n = 0:127;
omega = 2.2* pi;
disp('ω = '); disp(omega);
figure;
stem(n, x2, 'b.', 'MarkerSize', 10);
hold on;

points_of_interest = [3, 7, 114, 127];
plot(points_of_interest, x2(points_of_interest + 1), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

xlabel('n');
ylabel('x2[n]');
title('cos(2.2 * pi * n )');
grid on;

legend('x2[n]', 'Points of Interest');
for i = 1:length(points_of_interest)
    n_val = points_of_interest(i);
    x_val = x2(n_val + 1);
    text(n_val, x_val, sprintf('n=%d\nx1=%.4f', n_val, x_val), ...
         'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left');
end
axis([0 127 min(x2)-0.5 max(x2)+0.5]);
fprintf('x2[3] = %.10f\n', x2(4));
fprintf('x2[7] = %.10f\n', x2(8));
fprintf('x2[114] = %.10f\n', x2(115));
fprintf('x2[127] = %.10f\n', x2(128));
```

2.2 Graph and output of the code



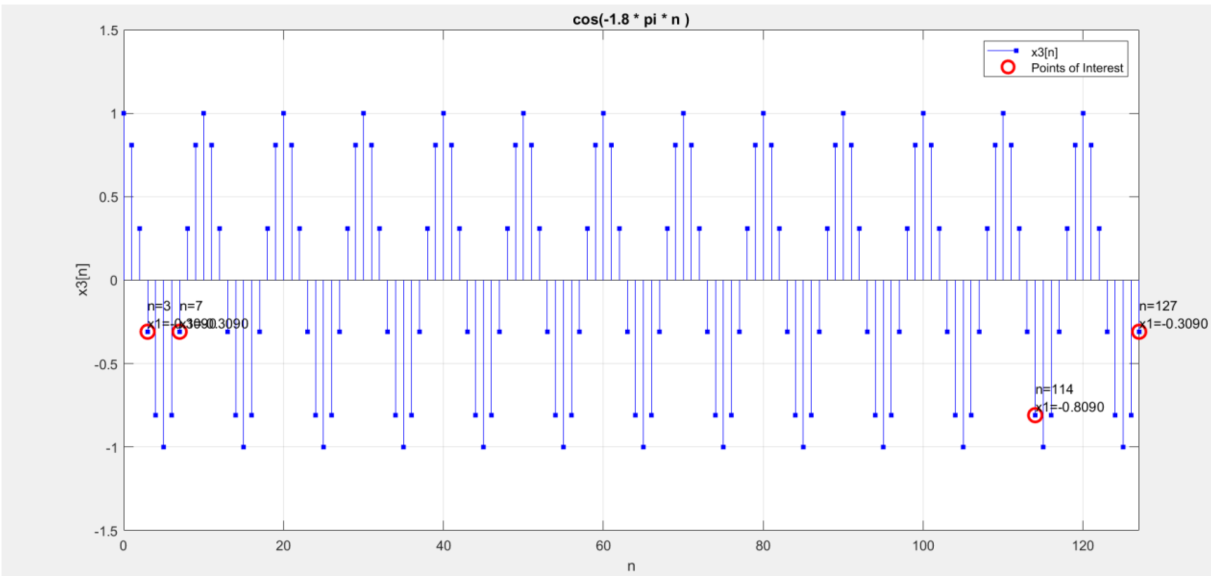

```
>> soruiki
ω =
    6.9115

x2[3] = -0.3090169944
x2[7] = -0.3090169944
x2[114] = -0.8090169944
x2[127] = -0.3090169944
fx >>
```

3- **x3[n] = cos[-1.8πn] for ∈ (0,127)**

3.1 Code of the question

```
n = 0:127;
x3 = cos(-1.8 * pi * n );


save('x3_signal.mat', 'x3');
clear

load('x3_signal.mat');

n = 0:127;
omega = -1.8* pi;
disp('ω = '); disp(omega);
figure;
stem(n, x3, 'b.', 'MarkerSize', 10);
hold on;

points_of_interest = [3, 7, 114, 127];
plot(points_of_interest, x3(points_of_interest + 1), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

xlabel('n');
ylabel('x3[n]');
title('cos(-1.8 * pi * n )');
grid on;

legend('x3[n]', 'Points of Interest');
for i = 1:length(points_of_interest)
    n_val = points_of_interest(i);
    x_val = x3(n_val + 1);
    text(n_val, x_val, sprintf('n=%d\nx1=%.4f', n_val, x_val), ...
        'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left');
end
axis([0 127 min(x3)-0.5 max(x3)+0.5]);
fprintf('x3[3] = %.10f\n', x3(4));
fprintf('x3[7] = %.10f\n', x3(8));
fprintf('x3[114] = %.10f\n', x3(115));
fprintf('x3[127] = %.10f\n', x3(128));
```

3.2 Graph and output of the question



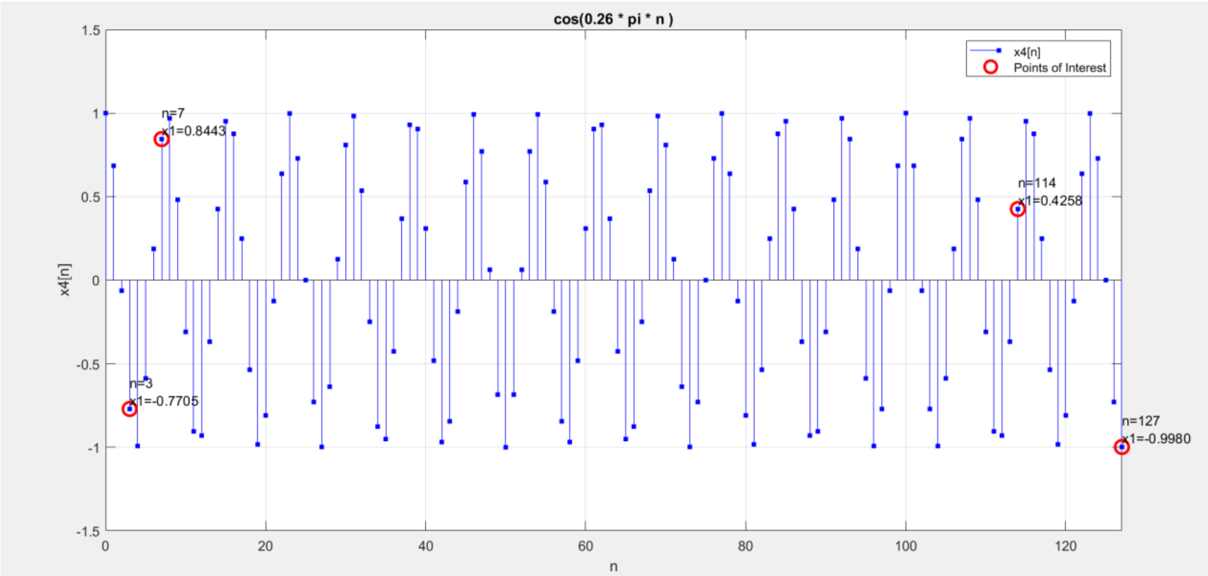
```
>> soruuc
ω =
   -5.6549

x3[3] = -0.3090169944
x3[7] = -0.3090169944
x3[114] = -0.8090169944
x3[127] = -0.3090169944
fx >>
```

4- x4[n] = cos[0.26πn] for ∈ (0,127)

4.1- Code of the question

```
n = 0:127;
x4 = cos(0.26 * pi * n );


save('x4_signal.mat', 'x4');
clear

load('x4_signal.mat');

n = 0:127;
omega = 0.26* pi;
disp('ω = '); disp(omega);
figure;
stem(n, x4, 'b.', 'MarkerSize', 10);
hold on;

points_of_interest = [3, 7, 114, 127];
plot(points_of_interest, x4(points_of_interest + 1), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

xlabel('n');
ylabel('x4[n]');
title('cos(0.26 * pi * n )');
grid on;

legend('x4[n]', 'Points of Interest');
for i = 1:length(points_of_interest)
    n_val = points_of_interest(i);
    x_val = x4(n_val + 1);
    text(n_val, x_val, sprintf('n=%d\nx1=%.4f', n_val, x_val), ...
         'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left');
end
axis([0 127 min(x4)-0.5 max(x4)+0.5]);
fprintf('x4[3] = %.10f\n', x4(4));
fprintf('x4[7] = %.10f\n', x4(8));
fprintf('x4[114] = %.10f\n', x4(115));
fprintf('x4[127] = %.10f\n', x4(128));
```

4.2- Graph and outcome of the question



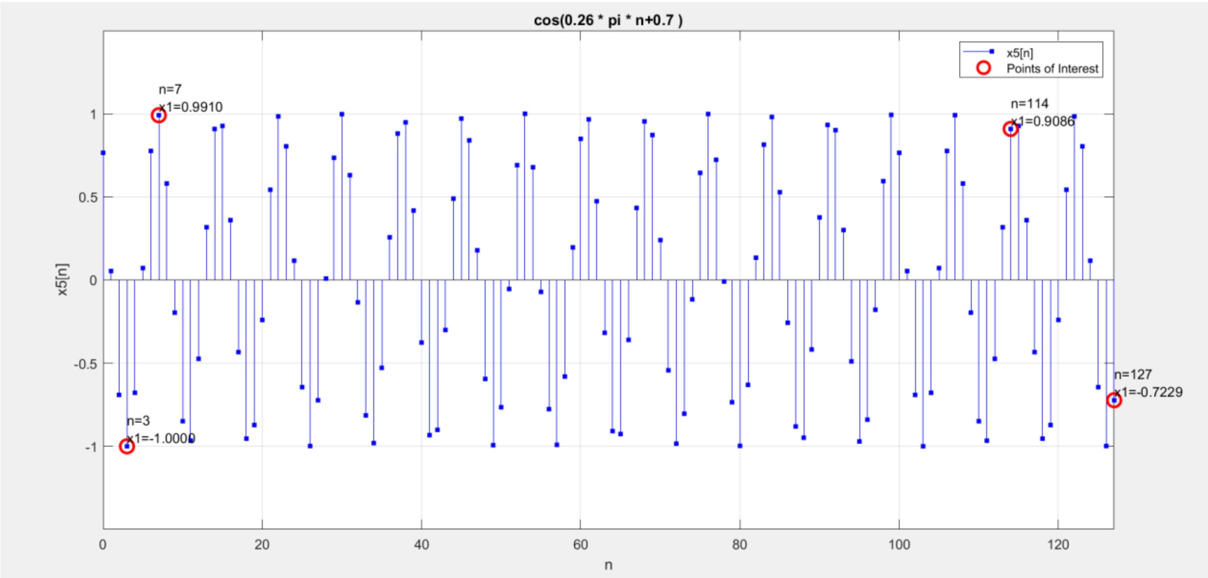

```
>> sorudort
ω =
     0.8168

x4[3] = -0.7705132428
x4[7] = 0.8443279255
x4[114] = 0.4257792916
x4[127] = -0.9980267284
>>
```

5- **x5[n] = cos[0.26πn +0.7] for ∈ (0,127)**

5.1- Code of the question

```
n = 0:127;
x5 = cos(0.26 * pi * n + 0.7);


save('x5_signal.mat', 'x5');
clear

load('x5_signal.mat');

n = 0:127;
omega = 0.26* pi;
disp('ω = '); disp(omega);
figure;
stem(n, x5, 'b.', 'MarkerSize', 10);
hold on;

points_of_interest = [3, 7, 114, 127];
plot(points_of_interest, x5(points_of_interest + 1), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

xlabel('n');
ylabel('x5[n]');
title('cos(0.26 * pi * n+0.7 )');
grid on;

legend('x5[n]', 'Points of Interest');
for i = 1:length(points_of_interest)
    n_val = points_of_interest(i);
    x_val = x5(n_val + 1);
    text(n_val, x_val, sprintf('n=%d\nx1=%.4f', n_val, x_val), ...
        'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left');
end
axis([0 127 min(x5)-0.5 max(x5)+0.5]);
fprintf('x5[3] = %.10f\n', x5(4));
fprintf('x5[7] = %.10f\n', x5(8));
fprintf('x5[114] = %.10f\n', x5(115));
fprintf('x5[127] = %.10f\n', x5(128));
```

5.2- Graph and outcomes of the question



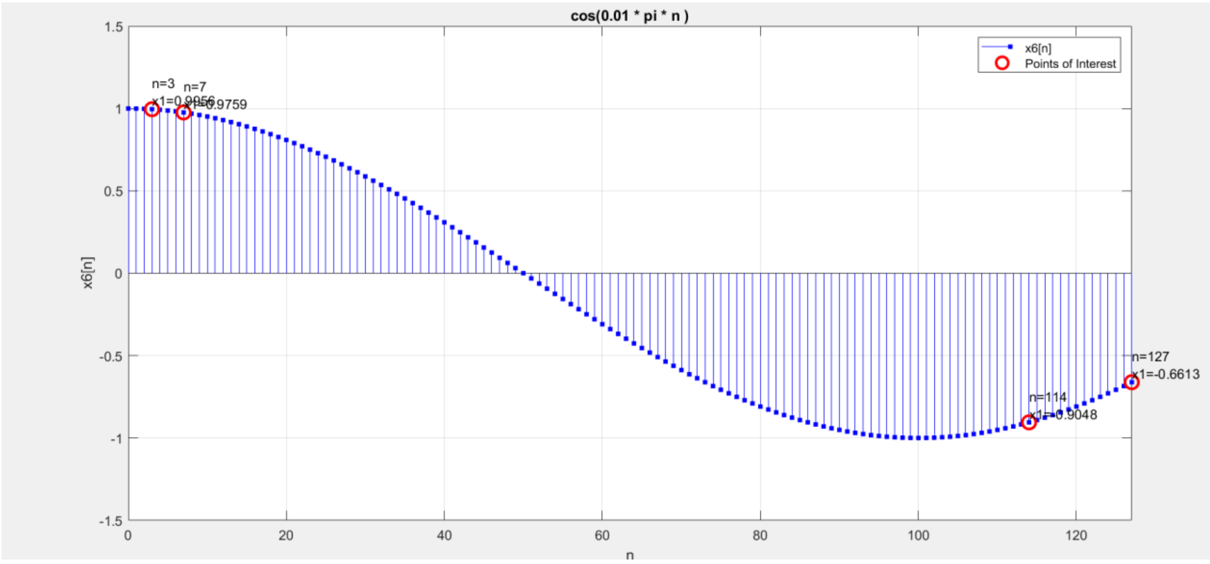
```
>> sorubes
ω =
    0.8168

x5[3] = -0.9999608424
x5[7] = 0.9909667159
x5[114] = 0.9085595558
x5[127] = -0.7228821827
```

6- x6[n] = cos[0.01πn] for ∈ (0,127)

6.1- Code of the question

```
n = 0:127;
x6 = cos(0.01* pi * n );


save('x6_signal.mat', 'x6');
clear

load('x6_signal.mat');

n = 0:127;
omega = 0.01* pi;
disp('ω = '); disp(omega);
figure;
stem(n, x6, 'b.', 'MarkerSize', 10);
hold on;

points_of_interest = [3, 7, 114, 127];
plot(points_of_interest, x6(points_of_interest + 1), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

xlabel('n');
ylabel('x6[n]');
title('cos(0.01 * pi * n )');
grid on;

legend('x6[n]', 'Points of Interest');
for i = 1:length(points_of_interest)
    n_val = points_of_interest(i);
    x_val = x6(n_val + 1);
    text(n_val, x_val, sprintf('n=%d\nx1=%.4f', n_val, x_val), ...
        'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left');
end
axis([0 127 min(x6)-0.5 max(x6)+0.5]);
fprintf('x6[3] = %.10f\n', x6(4));
fprintf('x6[7] = %.10f\n', x6(8));
fprintf('x6[114] = %.10f\n', x6(115));
fprintf('x6[127] = %.10f\n', x6(128));
```

6.2- Graph and outcome of the question



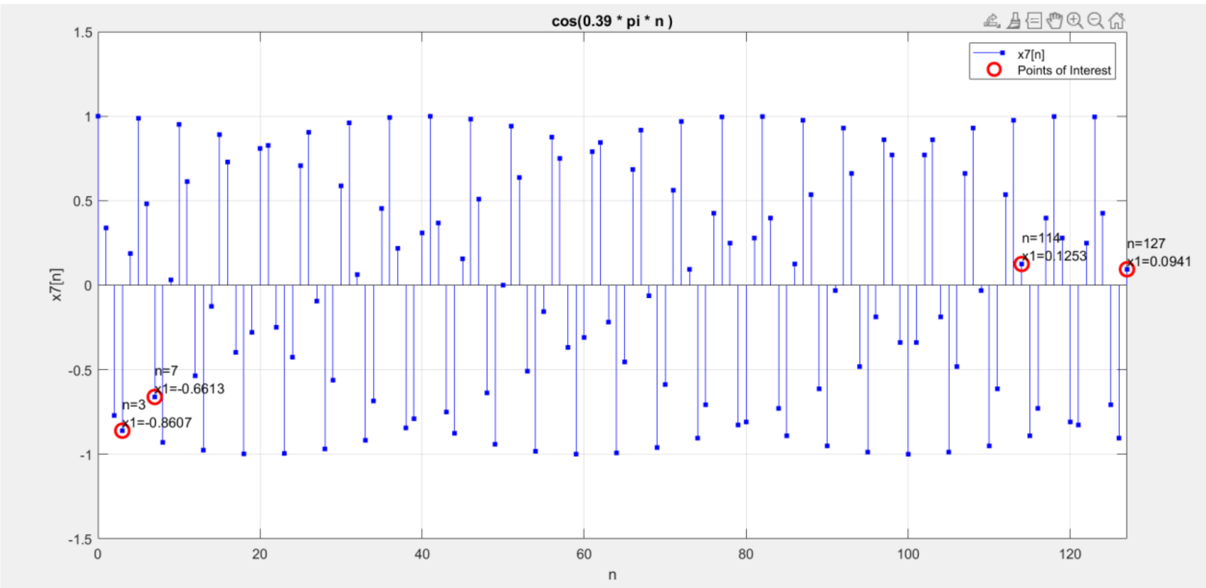

```
ω =
     0.0314

x6[3] = 0.9955619646
x6[7] = 0.9759167619
x6[114] = -0.9048270525
x6[127] = -0.6613118653
fx >>
```

7- **x7[n] = cos[0.39πn] for ∈ (0,127)**

7.1- Code of the question

```
n = 0:127;
x7 = cos(0.39* pi * n );


save('x7_signal.mat', 'x7');
clear

load('x7_signal.mat');

n = 0:127;
omega = 0.01* pi;
disp('ω = '); disp(omega);
figure;
stem(n, x7, 'b.', 'MarkerSize', 10);
hold on;

points_of_interest = [3, 7, 114, 127];
plot(points_of_interest, x7(points_of_interest + 1), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

xlabel('n');
ylabel('x7[n]');
title('cos(0.39 * pi * n )');
grid on;

legend('x7[n]', 'Points of Interest');
for i = 1:length(points_of_interest)
    n_val = points_of_interest(i);
    x_val = x7(n_val + 1);
    text(n_val, x_val, sprintf('n=%d\nx1=%.4f', n_val, x_val), ...
        'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left');
end
axis([0 127 min(x7)-0.5 max(x7)+0.5]);
fprintf('x7[3] = %.10f\n', x7(4));
fprintf('x7[7] = %.10f\n', x7(8));
fprintf('x7[114] = %.10f\n', x7(115));
fprintf('x7[127] = %.10f\n', x7(128));
```

7.2- Graph and outcome of the question



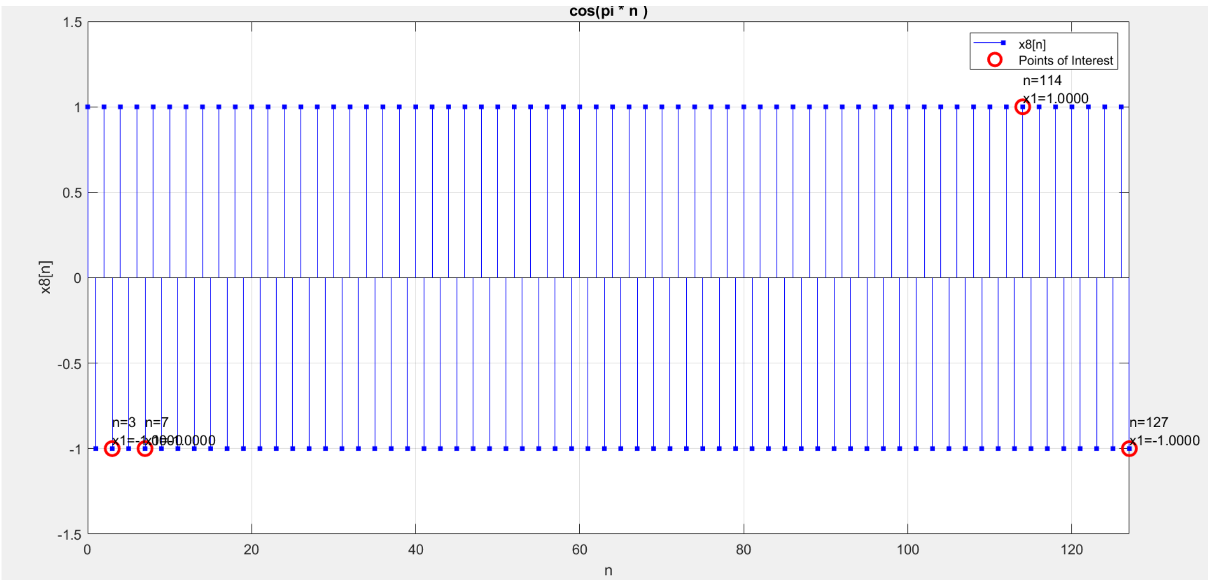
```
>> soruyedi
ω =
     0.0314

x7[3] = -0.8607420270
x7[7] = -0.6613118653
x7[114] = 0.1253332336
x7[127] = 0.0941083133
fx >> 
```

8- **x8[n] = cos[πn] for ∈ (0,127)**

8.1- Code of the question

```
n = 0:127;
x8 = cos( pi * n );


save('x8_signal.mat', 'x8');
clear

load('x8_signal.mat');

n = 0:127;
omega =  pi;
disp('ω = '); disp(omega);
figure;
stem(n, x8, 'b.', 'MarkerSize', 10);
hold on;

points_of_interest = [3, 7, 114, 127];
plot(points_of_interest, x8(points_of_interest + 1), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

xlabel('n');
ylabel('x8[n]');
title('cos(pi * n )');
grid on;

legend('x8[n]', 'Points of Interest');
for i = 1:length(points_of_interest)
    n_val = points_of_interest(i);
    x_val = x8(n_val + 1);
    text(n_val, x_val, sprintf('n=%d\nx1=%.4f', n_val, x_val), ...
         'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left');
end
axis([0 127 min(x8)-0.5 max(x8)+0.5]);
fprintf('x8[3] = %.10f\n', x8(4));
fprintf('x8[7] = %.10f\n', x8(8));
fprintf('x8[114] = %.10f\n', x8(115));
fprintf('x8[127] = %.10f\n', x8(128));
```

8.2- Graph and outcome of the question



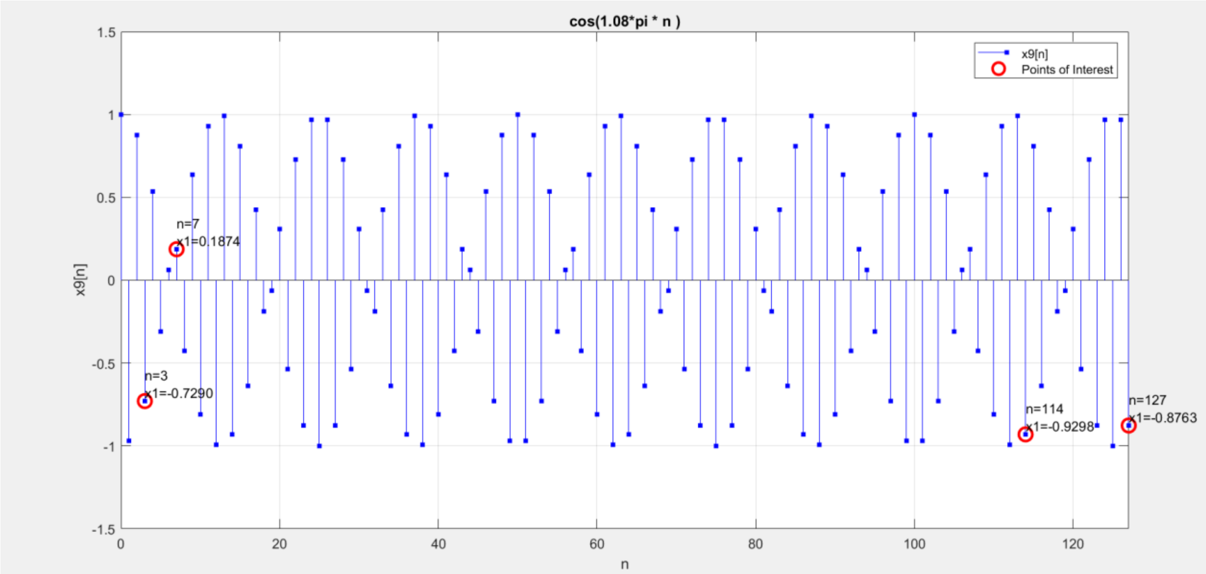
```
>> sorusekiz
ω =
    3.1416

x8[3]  = -1.0000000000
x8[7]  = -1.0000000000
x8[114]  = 1.0000000000
x8[127]  = -1.0000000000
fx >>
```

9- x9[n] = cos[1.08πn] for ∈ (0,127)

9.1- Code of the question

```
n = 0:127;
x9 = cos( 1.08 *pi * n );


save('x9_signal.mat', 'x9');
clear

load('x9_signal.mat');

n = 0:127;
omega = 1.08* pi;
disp('ω = '); disp(omega);
figure;
stem(n, x9, 'b.', 'MarkerSize', 10);
hold on;

points_of_interest = [3, 7, 114, 127];
plot(points_of_interest, x9(points_of_interest + 1), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

xlabel('n');
ylabel('x9[n]');
title('cos(1.08*pi * n )');
grid on;

legend('x9[n]', 'Points of Interest');
for i = 1:length(points_of_interest)
    n_val = points_of_interest(i);
    x_val = x9(n_val + 1);
    text(n_val, x_val, sprintf('n=%d\nx1=%.4f', n_val, x_val), ...
        'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left');
end
axis([0 127 min(x9)-0.5 max(x9)+0.5]);
fprintf('x9[3] = %.10f\n', x9(4));
fprintf('x9[7] = %.10f\n', x9(8));
fprintf('x9[114] = %.10f\n', x9(115));
fprintf('x9[127] = %.10f\n', x9(128));
```

9.2- Graph and outcome of the question



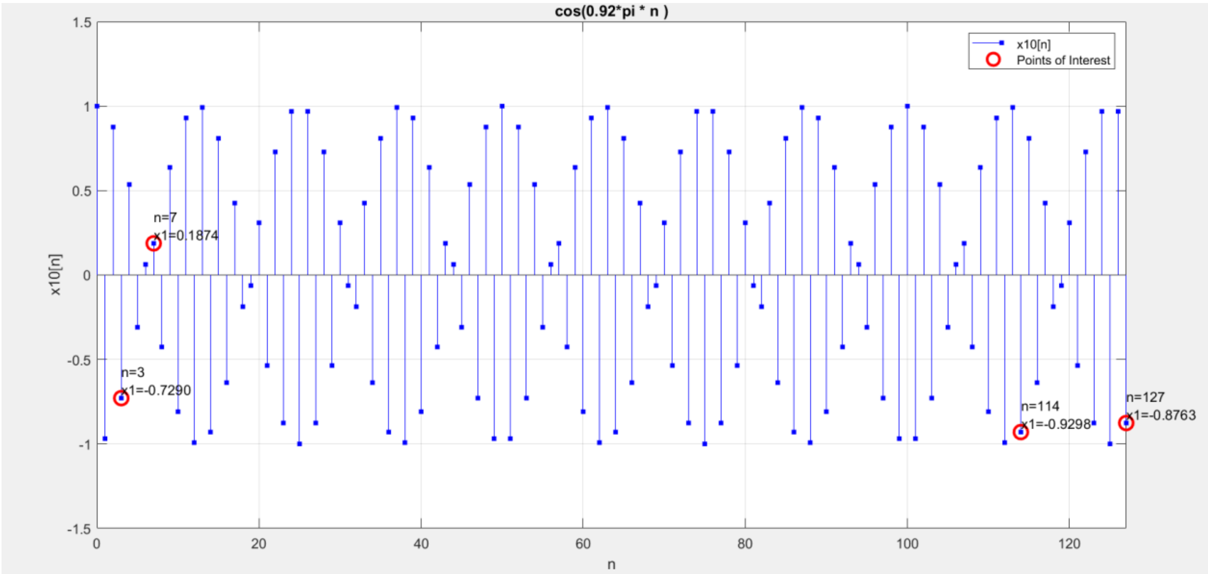

```
>> sorudokuz
ω =
     3.3929

x9[3] = -0.7289686274
x9[7] = 0.1873813146
x9[114] = -0.9297764859
x9[127] = -0.8763066800
fx >>
```

10- x10[n] = $\cos[0.92\pi n]$ for ∈ (0,127)

10.1- Code of the question

```
n = 0:127;
x10 = cos( 1.08 *pi * n );


save('x10_signal.mat', 'x10');
clear

load('x10_signal.mat');

n = 0:127;
omega = 0.92* pi;
disp('ω = '); disp(omega);
figure;
stem(n, x10, 'b.', 'MarkerSize', 10);
hold on;

points_of_interest = [3, 7, 114, 127];
plot(points_of_interest, x10(points_of_interest + 1), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

xlabel('n');
ylabel('x10[n]');
title('cos(0.92*pi * n )');
grid on;

legend('x10[n]', 'Points of Interest');
for i = 1:length(points_of_interest)
    n_val = points_of_interest(i);
    x_val = x10(n_val + 1);
    text(n_val, x_val, sprintf('n=%d\nx1=%.4f', n_val, x_val), ...
         'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left');
end
axis([0 127 min(x10)-0.5 max(x10)+0.5]);
fprintf('x10[3] = %.10f\n', x10(4));
fprintf('x10[7] = %.10f\n', x10(8));
fprintf('x10[114] = %.10f\n', x10(115));
fprintf('x10[127] = %.10f\n', x10(128));
```

10.2- Graph and outcome of the question



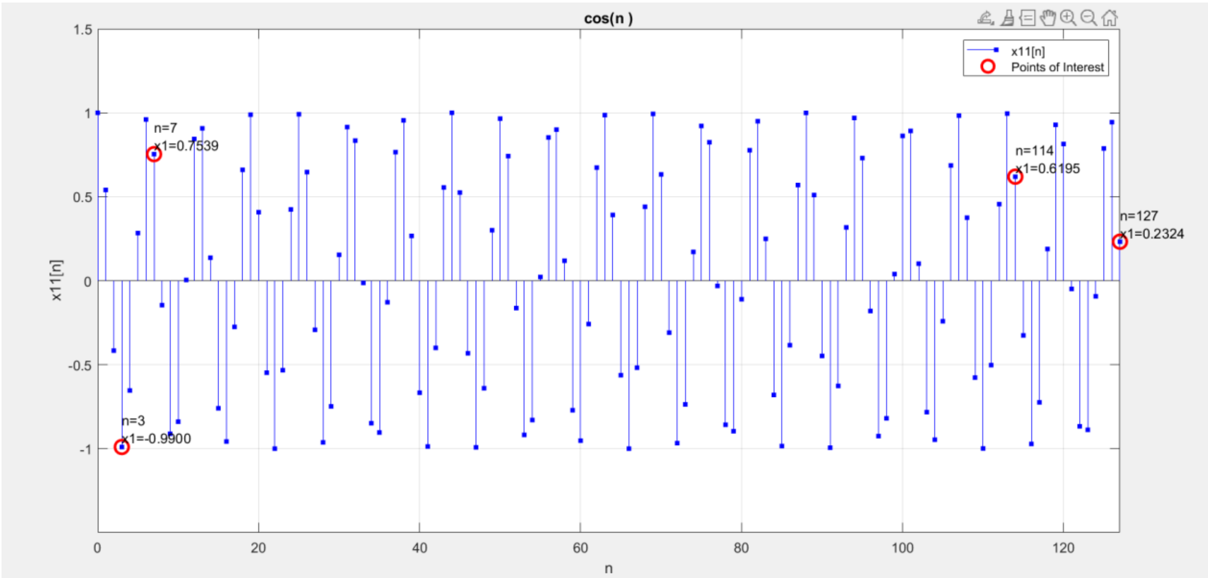

```
>> soruon
ω =
     2.8903

x10[3] = -0.7289686274
x10[7] = 0.1873813146
x10[114] = -0.9297764859
x10[127] = -0.8763066800
fx >>
```

11- **x11[n] = cos[n] for ∈ (0,127)**

11.1- Code of the question

```
n = 0:127;
x11 = cos(  n );


save('x11_signal.mat', 'x11');
clear

load('x11_signal.mat');

n = 0:127;
omega = 1;
disp('ω = '); disp(omega);
figure;
stem(n, x11, 'b.', 'MarkerSize', 10);
hold on;

points_of_interest = [3, 7, 114, 127];
plot(points_of_interest, x11(points_of_interest + 1), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

xlabel('n');
ylabel('x11[n]');
title('cos(n )');
grid on;

legend('x11[n]', 'Points of Interest');
for i = 1:length(points_of_interest)
    n_val = points_of_interest(i);
    x_val = x11(n_val + 1);
    text(n_val, x_val, sprintf('n=%d\nx1=%.4f', n_val, x_val), ...
        'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left');
end
axis([0 127 min(x11)-0.5 max(x11)+0.5]);
fprintf('x11[3] = %.10f\n', x11(4));
fprintf('x11[7] = %.10f\n', x11(8));
fprintf('x11[114] = %.10f\n', x11(115));
fprintf('x11[127] = %.10f\n', x11(128));
```

11.2- Graph and outcome of the question



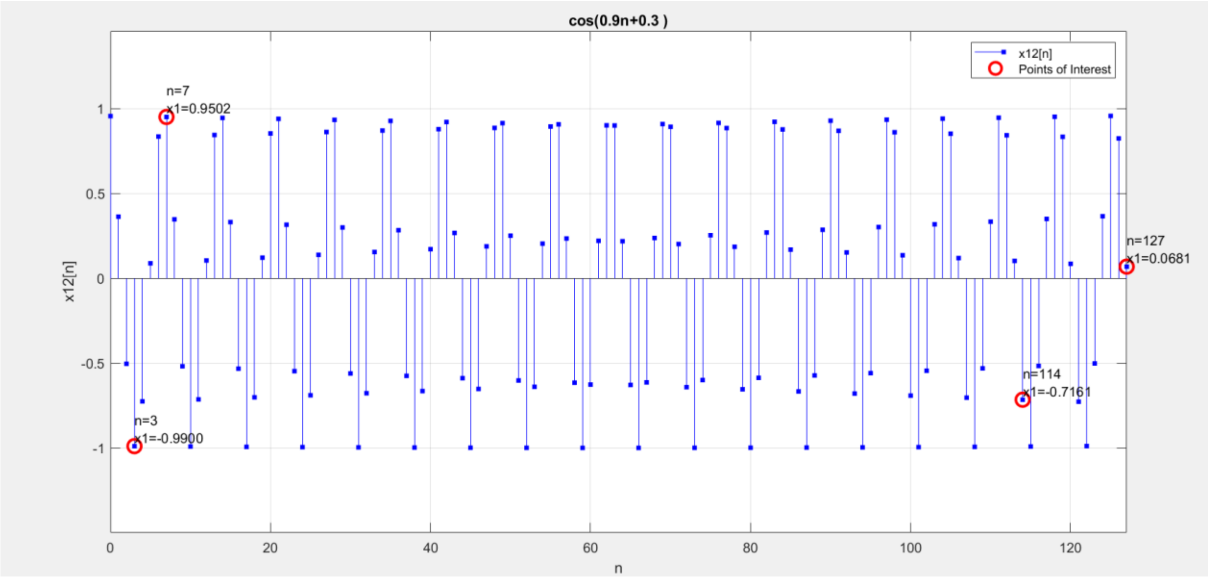

```
ω =
     1

x11[3] = -0.9899924966
x11[7] = 0.7539022543
x11[114] = 0.6195206126
x11[127] = 0.2323591020
fx >>
```

12- **x12[n] = cos[0.9n+0.3] for ∈ (0,127)**

12.1- Code of the question

```
n = 0:127;
x12 = cos(0.9*n +0.3);


save('x12_signal.mat', 'x12');
clear

load('x12_signal.mat');

n = 0:127;
omega = 0.9;
disp('ω = '); disp(omega);
figure;
stem(n, x12, 'b.', 'MarkerSize', 10);
hold on;

points_of_interest = [3, 7, 114, 127];
plot(points_of_interest, x12(points_of_interest + 1), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

xlabel('n');
ylabel('x12[n]');
title('cos(0.9n+0.3 )');
grid on;

legend('x12[n]', 'Points of Interest');
for i = 1:length(points_of_interest)
    n_val = points_of_interest(i);
    x_val = x12(n_val + 1);
    text(n_val, x_val, sprintf('n=%d\nx1=%.4f', n_val, x_val), ...
         'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'left');
end
axis([0 127 min(x12)-0.5 max(x12)+0.5]);
fprintf('x12[3] = %.10f\n', x12(4));
fprintf('x12[7] = %.10f\n', x12(8));
fprintf('x12[114] = %.10f\n', x12(115));
fprintf('x12[127] = %.10f\n', x12(128));
```

12.2- Graph and outcome of the question




```
>> soruoniki
ω =
    0.9000

x12[3] = -0.9899924966
x12[7] = 0.9502325920
x12[114] = -0.7161279100
x12[127] = 0.0680791575
fx >>
```