EE110B Lab 1

Name: Buddy Ugwumba

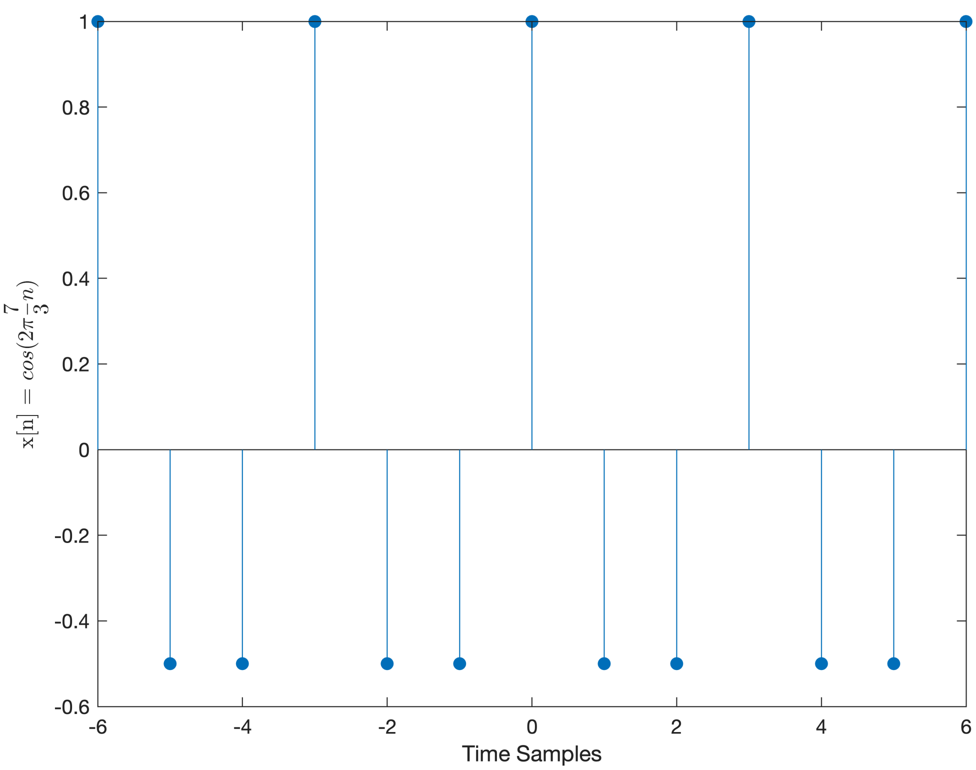
SID: 862063029

1) Use MATLAB to plot the following sequences and discus their periodicity. Choose a proper range of n and a proper pattern for the plots.

a) $x[n] = \cos\left(2\pi \frac{7}{3} n\right)$

T = 3s

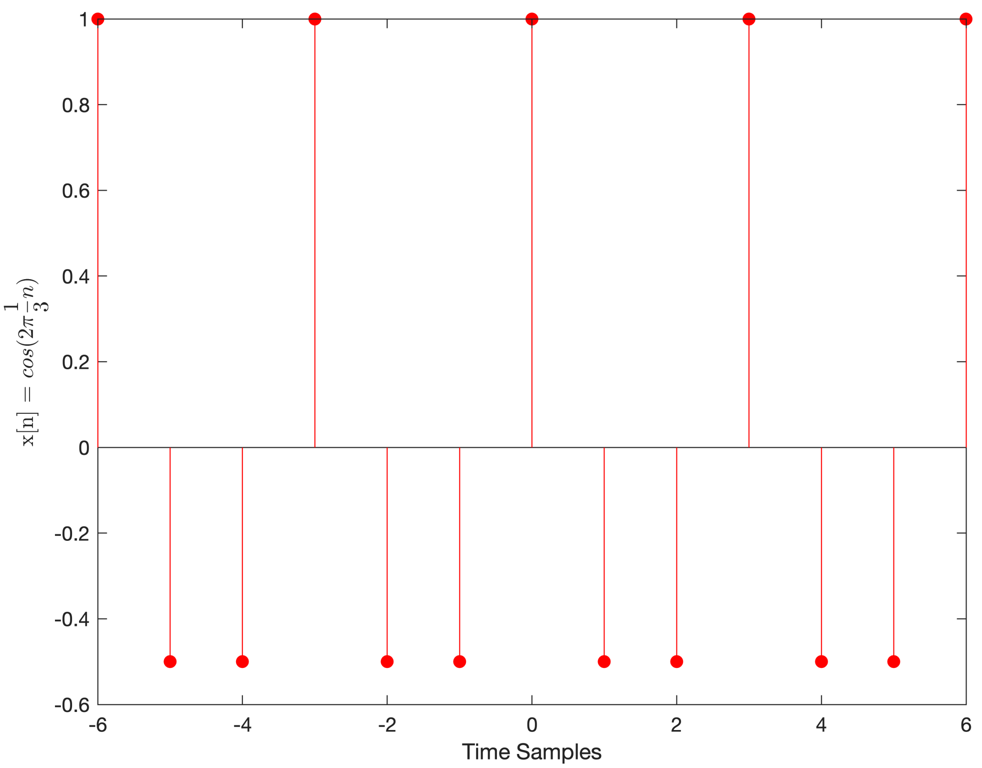
```
n = -6:1:6;
figure
stem(n, One_a_function_i(n), 'filled');
xlabel('Time Samples');
ylabel('x[n] = $$cos(2\pi\frac{7}{3}n)$$', 'Interpreter', 'latex')
```



$$x[n] = \cos\left(2\pi\frac{1}{3}n\right)$$

T = 3s

```
n = -6:1:6;
figure
stem(n, One_a_function_ii(n),'filled','red');
xlabel('Time Samples');
ylabel('x[n] = $$cos(2\pi\frac{1}{3}n)$$', 'Interpreter', 'latex')
```



b) $\cos\left(2\pi\frac{1}{3}n\right)\cos\left(2\pi\frac{4}{5}n\right)$

The trigonometric product identity can be used here

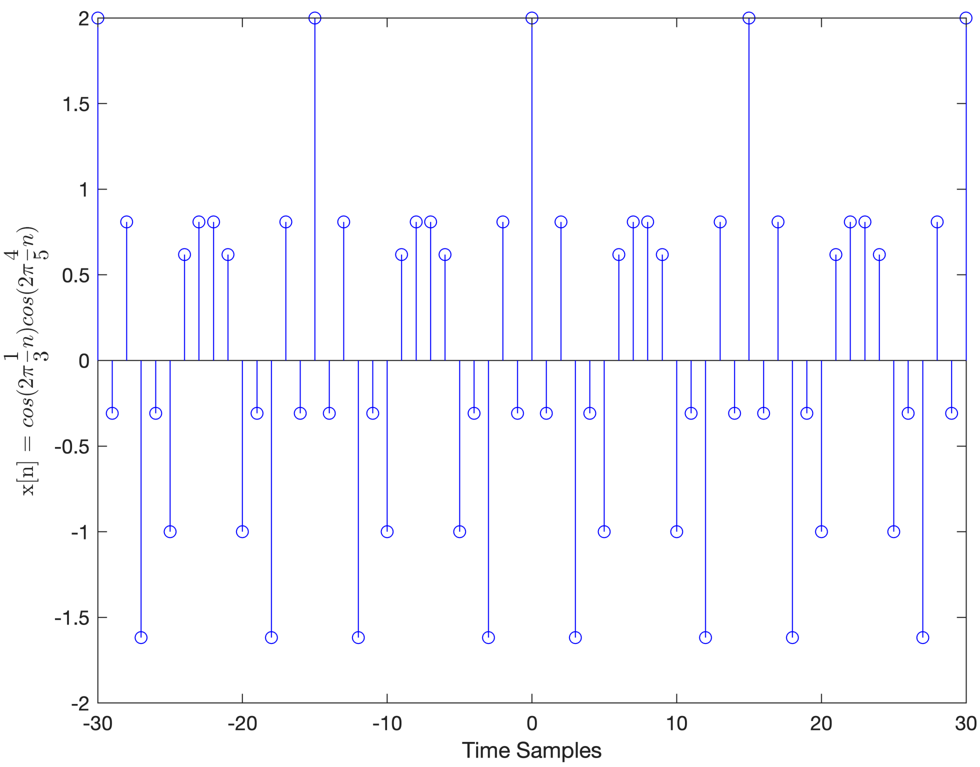
$\cos\alpha * \cos\beta = \dfrac{\cos(\alpha+\beta)+\cos(\alpha-\beta)}{2}$ there fore the system now becomes:

$$x[n] = \frac{\cos\left(2\pi n\left(\frac{1}{3}+\frac{4}{5}\right)\right) + \cos\left(2\pi n\left(\frac{1}{3}-\frac{4}{5}\right)\right)}{2}$$

$$= \frac{\cos\left(2\pi\frac{17}{15}n\right) + \cos\left(2\pi\left(-\frac{7}{15}\right)\right)}{2}$$

T = 15s

```
n = -30:1:30;
figure
stem(n, two_function(n), 'blue');
xlabel('Time Samples');
ylabel('x[n] = $$cos(2\pi\frac{1}{3}n)cos(2\pi\frac{4}{5}n)$$', 'Interpreter', 'latex'
```



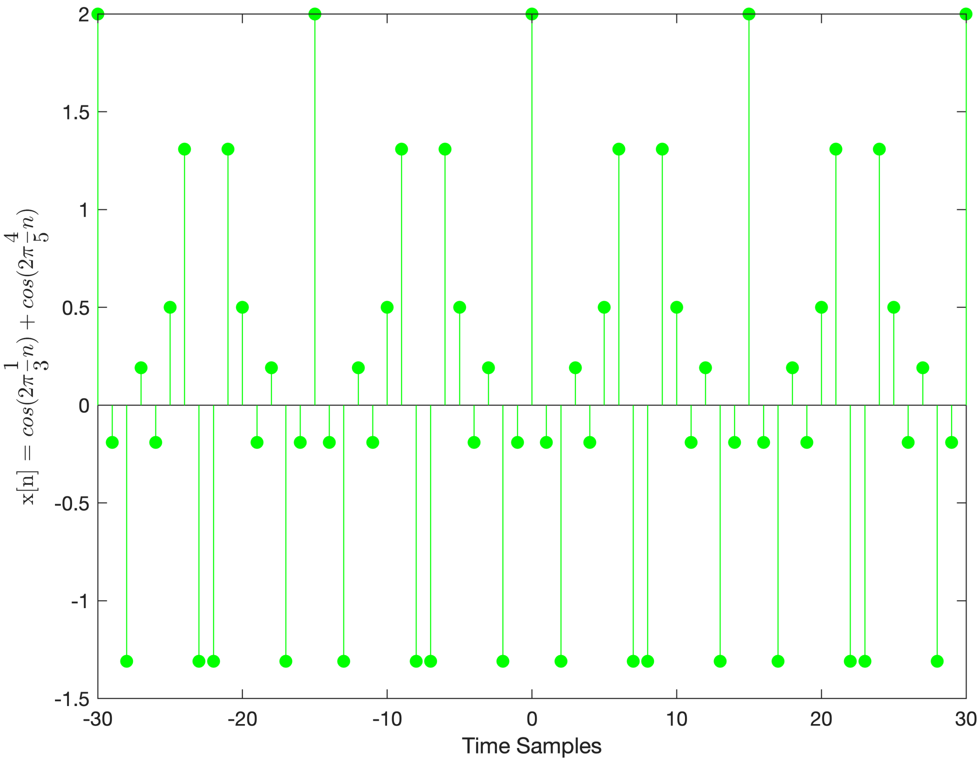
I was suprised to find that the period is equal to 3 * 5

c) $\cos\left(2\pi\frac{1}{3}n\right) + \cos\left(2\pi\frac{4}{5}n\right)$

Yes, the period is equal to $q_1 * q_2$. T is found using this equation: $N = m_1q_1 = m_2q_2 \rightarrow N = \frac{m_1}{m_2} = \frac{q_2}{q_1} \rightarrow N = \frac{m_1}{m_2} = \frac{5}{3} = \frac{5}{3}$. Thus $m_1 = 5$ and $q_1 = 3$. This makes the period equal to 3*5

T 15s

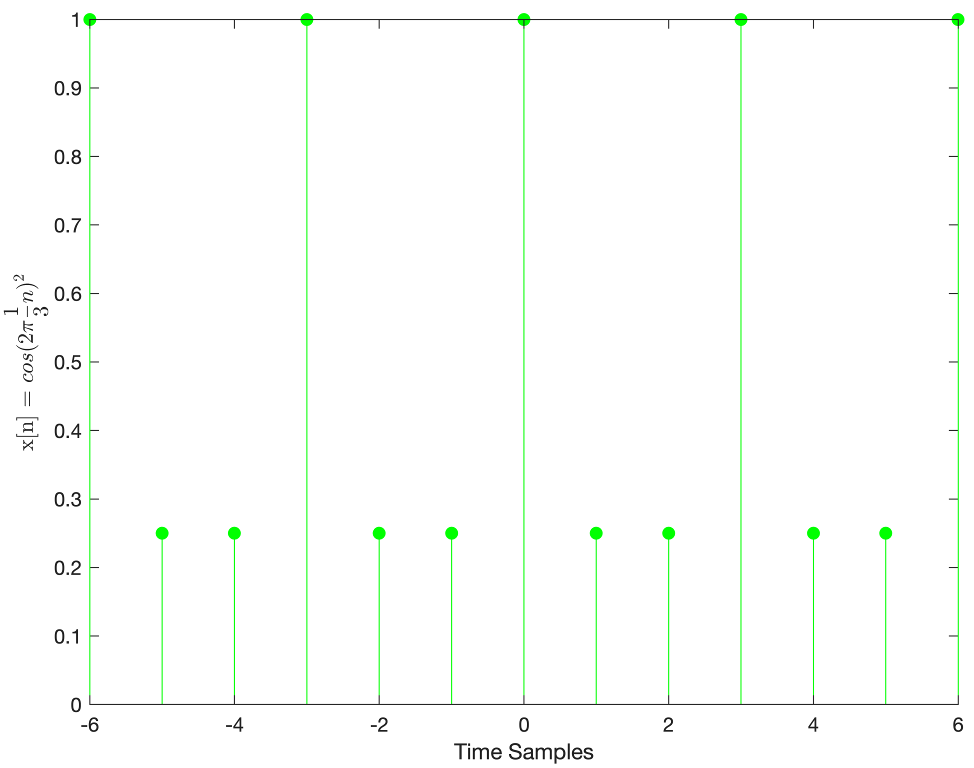
```
n = -30:1:30;
figure
stem(n, three_function(n), 'filled', 'green');
xlabel('Time Samples');
ylabel('x[n] = $$cos(2\pi\frac{1}{3}n) + cos(2\pi\frac{4}{5}n)$$', 'Interpreter', 'late
```



d) $x[n] = \cos\left(2\pi\frac{1}{3}n\right)^2$

T = 3s

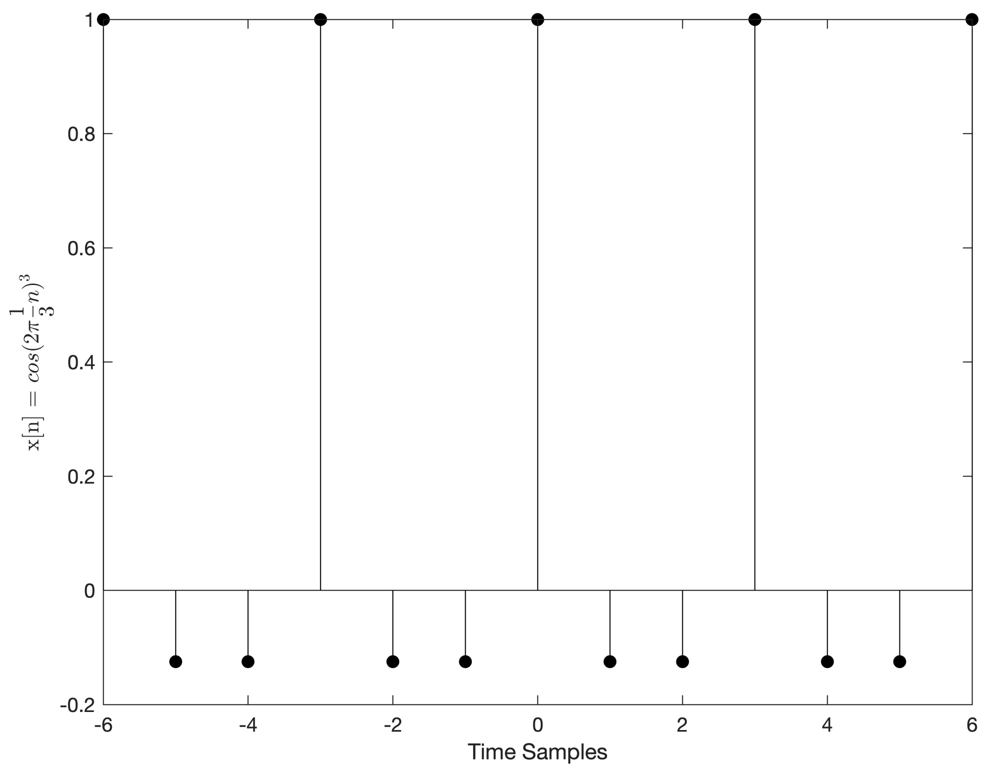
```
n = -6:1:6;
figure
stem(n, four_function(n), 'filled', 'green');
xlabel('Time Samples');
ylabel('x[n] = $$cos(2\pi\frac{1}{3}n)^{2}$$', 'Interpreter', 'latex');
```



e) $x[n] = \cos\left(2\pi\frac{1}{3}n\right)^3$

T = 3s

```
n = -6:1:6;
figure
stem(n, five_function(n), 'filled', 'black');
xlabel('Time Samples');
ylabel('x[n] = $$cos(2\pi\frac{1}{3}n)^{3}$$', 'Interpreter', 'latex');
```

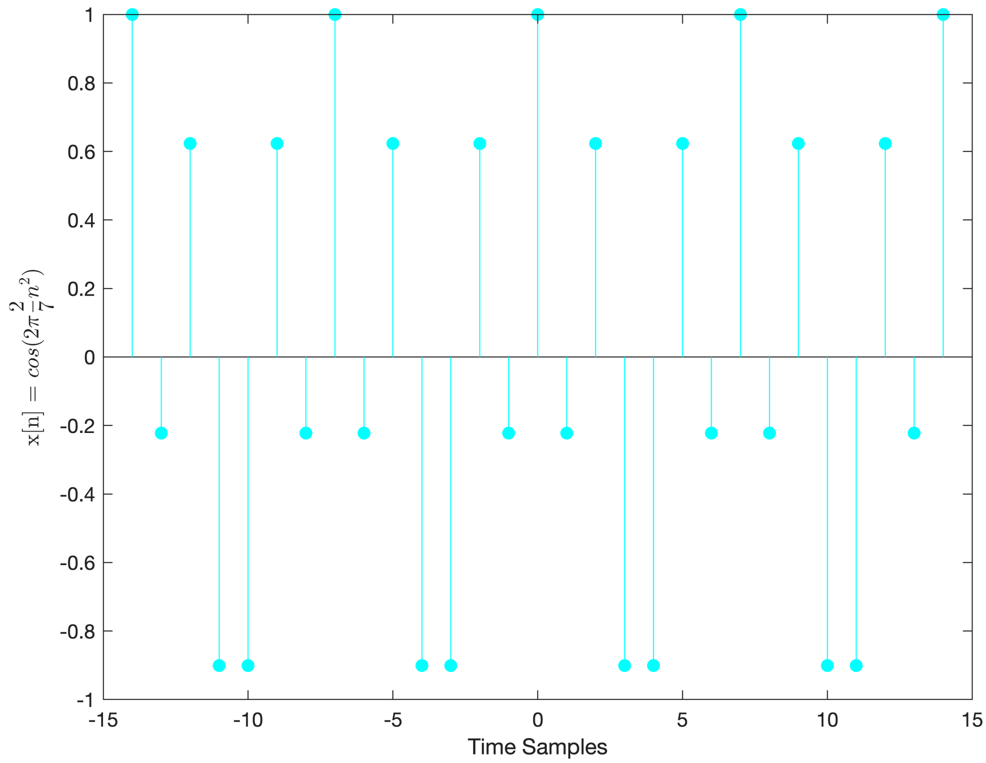


f) $x[n] = \cos\left(2\pi\frac{2}{7}n^2\right)$

It's frequency is not changing with time

T = 7s

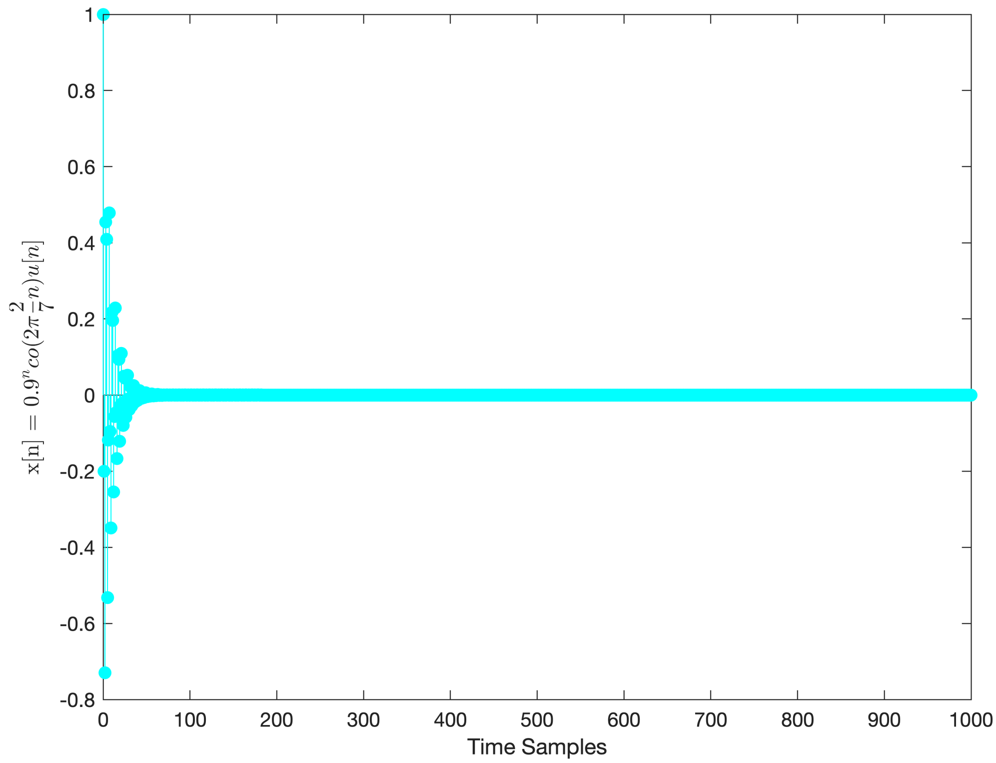
```
n = -14:1:14;
figure
stem(n, six_function(n), 'filled', 'cyan');
xlabel('Time Samples');
ylabel('x[n] = $$cos(2\pi\frac{2}{7}n^{2})$$', 'Interpreter', 'latex');
```



g) $0.9^n\cos\left(2\pi\frac{2}{7}n\right)u[n]$

if $n = \infty$ the value of the sequence is approaching zero because as N grows the denominator grows larger than the numberator

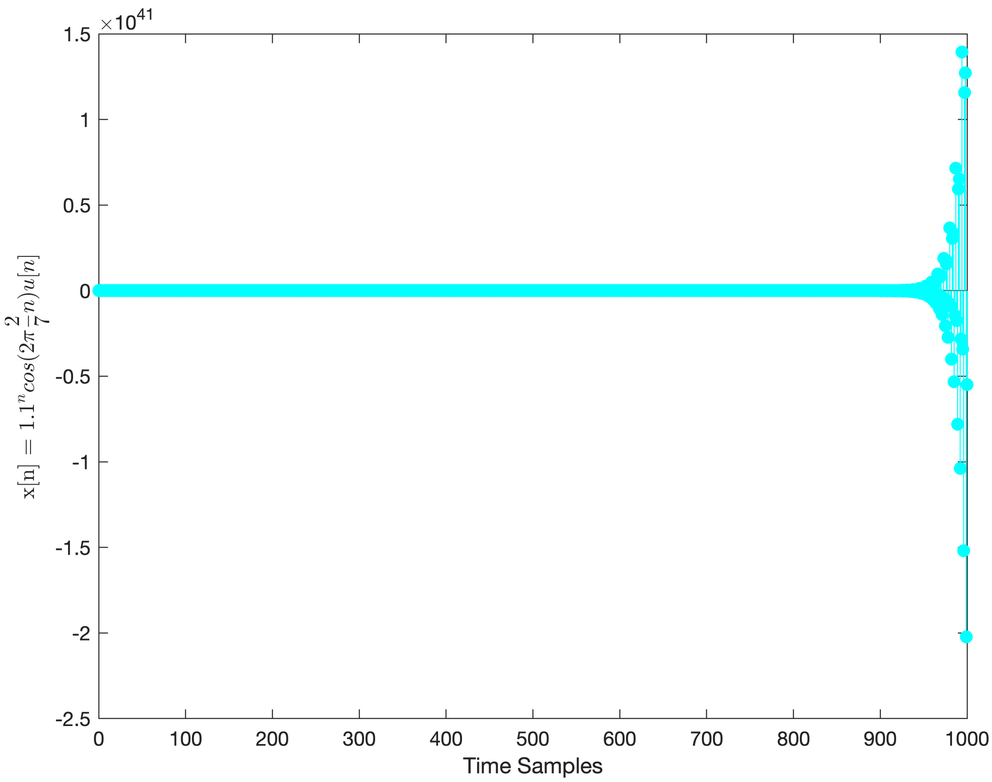
```
n = 0:1:1000;
figure
stem(n, eleventh_function(n), 'filled', 'cyan');
xlabel('Time Samples');
ylabel('x[n] = $$0.9^{n}co(2\pi\frac{2}{7}n)u[n]$$', 'Interpreter', 'latex');
```



h) $1.1^n \cos\left(2\pi \frac{2}{7} n\right) u[n]$

if $n = \infty$ the value of the sequencce approaches infinity.

```
n = 0:1:1000;
figure
stem(n, tweleth_function(n), 'filled', 'cyan');
xlabel('Time Samples');
ylabel('x[n] = $$1.1^{n}cos(2\pi\frac{2}{7}n)u[n]$$', 'Interpreter', 'latex');
```



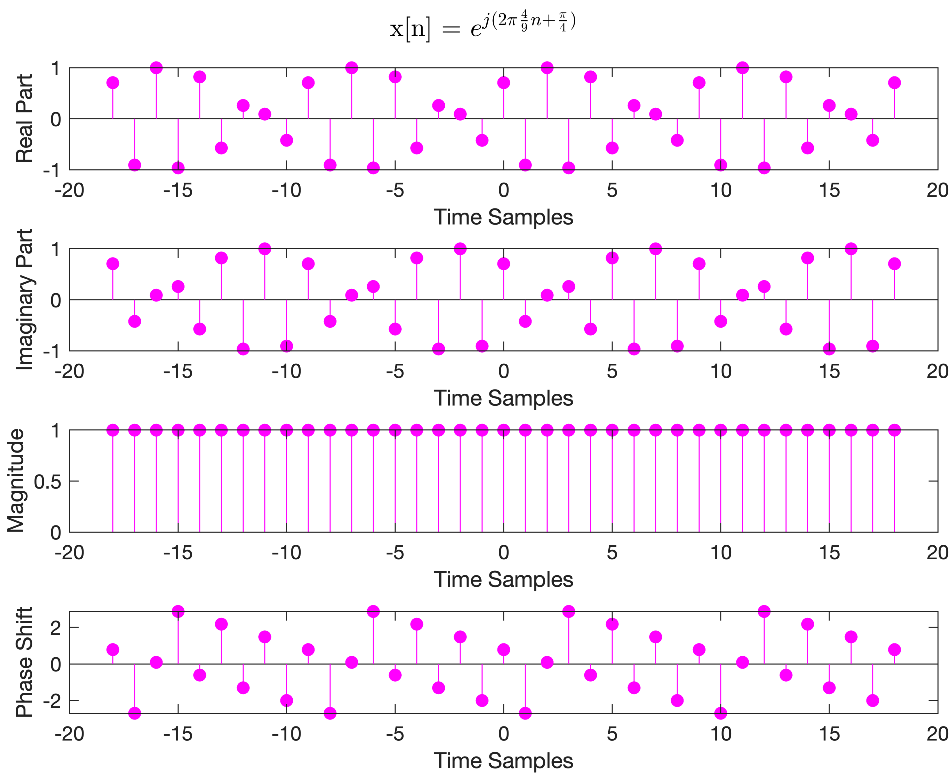
2) Plot the values of the following complex discrete-time signals on 2-D complex plots

a) $x[n] = e^{j\left(2\pi\frac{4}{9}n + \frac{\pi}{4}\right)}$

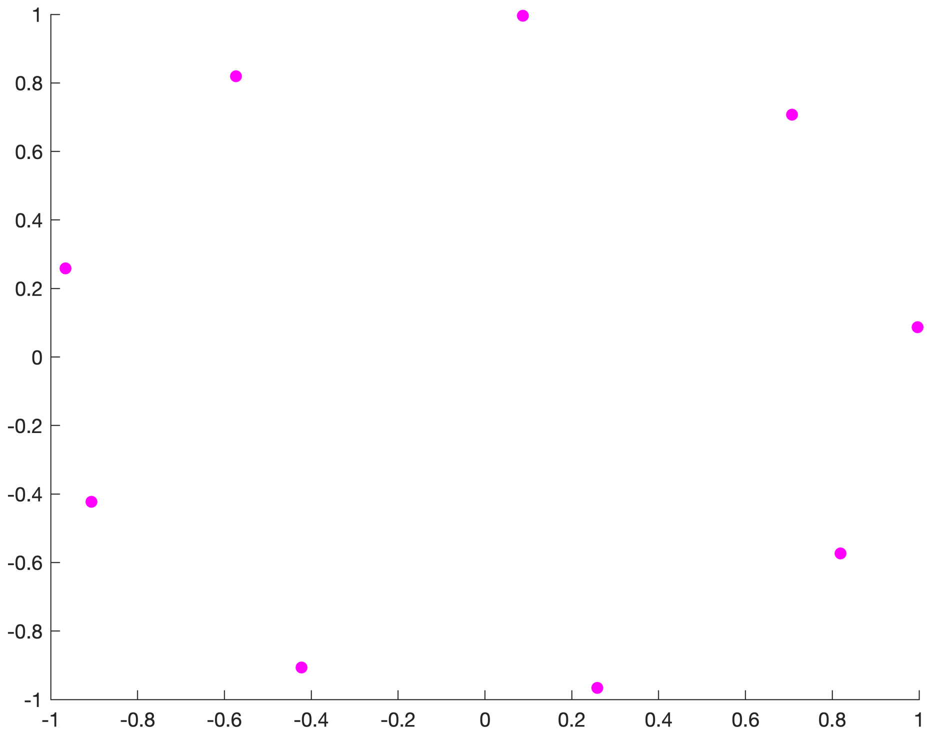
There are nine distinct points on the unit circle becasue nine is the period of the complex function. Moreover, the phase shift is constant

```
n = -18:1:18;
% For a complex signal, the command 'real' must be used to map the real
% part and the command 'imag' must be used for the imaginary part
subplot(4,1,1);
sgtitle('x[n] = $$e^{j(2\pi\frac{4}{9}n + \frac{\pi}{4})}$$','Interpreter', 'latex');
stem(n, real(seventh_function(n)), 'filled', 'Magenta');
xlabel('Time Samples');
ylabel('Real Part');
subplot(4,1,2);
stem(n, imag(seventh_function(n)), 'filled', 'Magenta');
xlabel('Time Samples');
ylabel('Imaginary Part')
% Now we meed to compute and plot the magnitude
subplot(4,1,3);
```

```
stem(n, abs(seventh_function(n)), 'filled', 'Magenta');
xlabel('Time Samples');
ylabel('Magnitude');
% Next we need to plot the phase
subplot(4,1,4);
stem(n, angle(seventh_function(n)), 'filled', 'Magenta');
xlabel('Time Samples');
ylabel('Phase Shift');
```




```
x = -1000:1:1000;
y = seventh_function(x);
figure
scatter(real(y),imag(y), 'filled', 'Magenta');
```

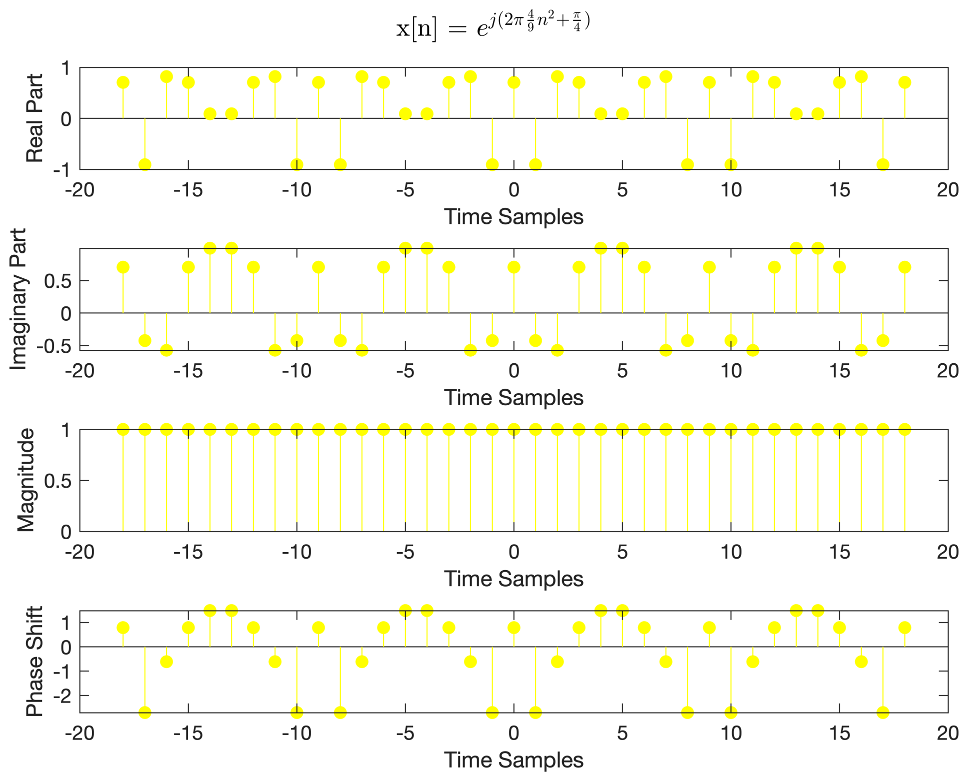


b) $x[n] = e^{j\left(2\pi\frac{4}{9}n^2 + \frac{\pi}{4}\right)}$

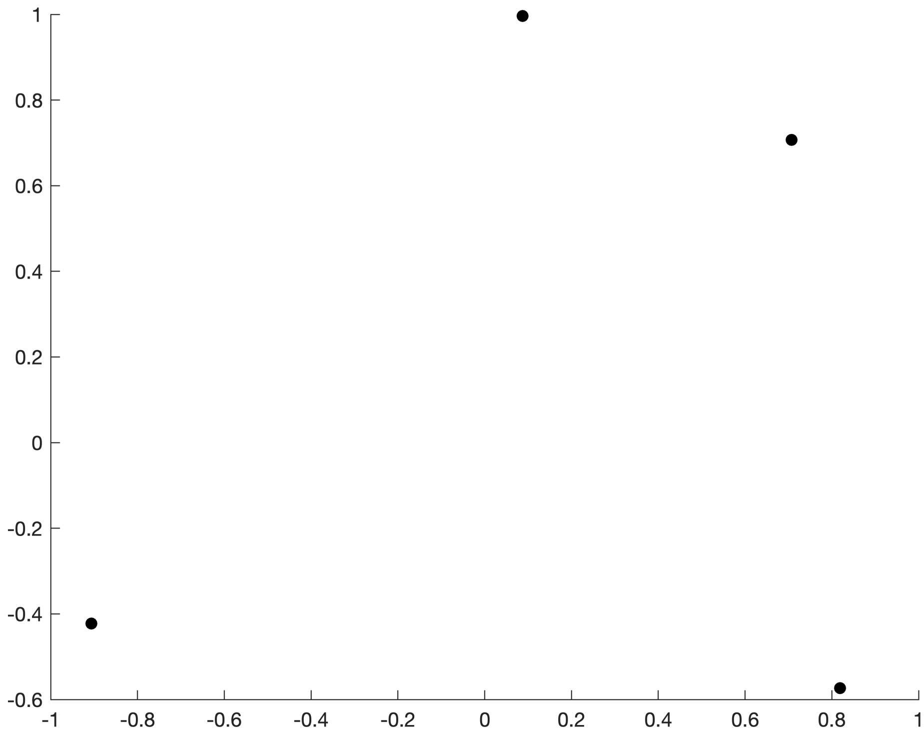
Ther are four distinct points on the unit circle because n is squared in the complex function. Moreover, the phase shift is constant

```
n = -18:1:18;
% For a complex signal, the command 'real' must be used to map the real
% part and the command 'imag' must be used for the imaginary part
subplot(4,1,1);
sgtitle('x[n] = $$e^{j(2\pi\frac{4}{9}n^{2} + \frac{\pi}{4})}$$','Interpreter', 'latex
stem(n, real(eigth_function(n)), 'filled', 'Yellow');
xlabel('Time Samples');
ylabel('Real Part');
subplot(4,1,2);
stem(n, imag(eigth_function(n)), 'filled', 'Yellow');
xlabel('Time Samples');
ylabel('Imaginary Part')
% Now we meed to compute and plot the magnitude
subplot(4,1,3);
stem(n, abs(eigth_function(n)), 'filled', 'Yellow');
xlabel('Time Samples');
ylabel('Magnitude');
% Next we need to plot the phase
subplot(4,1,4);
stem(n, angle(eigth_function(n)), 'filled', "Yellow");
```

```
xlabel('Time Samples');
ylabel('Phase Shift');
```




```
x = -1000:1:1000;
y = eigth_function(x);
figure
scatter(real(y),imag(y),'filled','black');
```

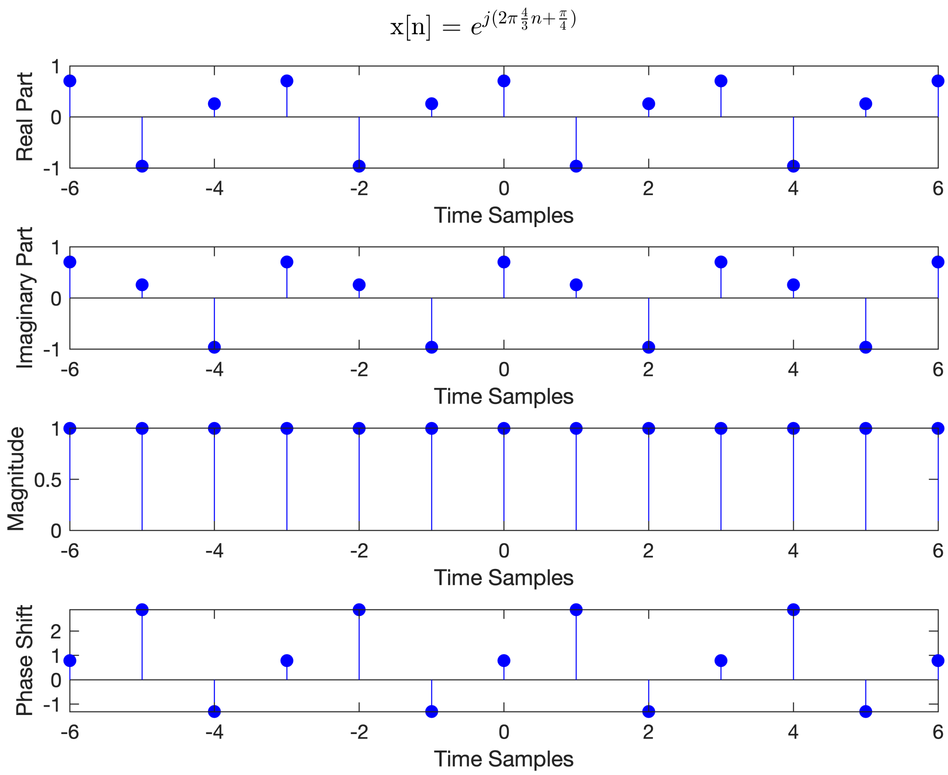


c) $x[n] = e^{j\left(2\pi\frac{4}{3}n + \frac{\pi}{4}\right)}$

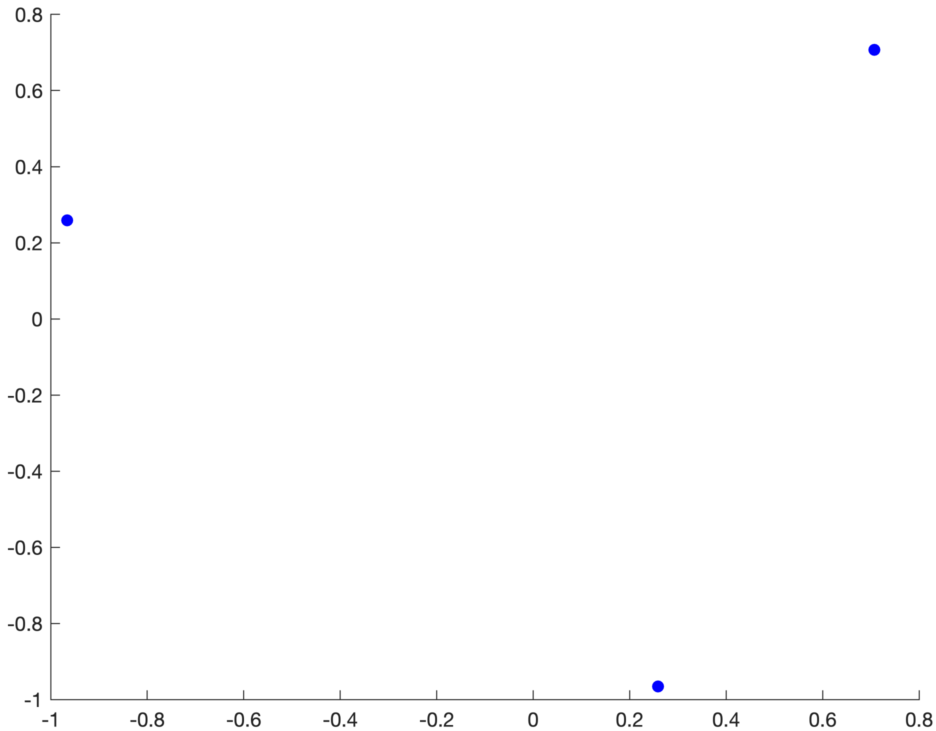
Ther are three distinct points on the unit circle because three is the period of the complex function. Moreover, the phase shift is constant

```
n = -6:1:6;
% For a complex signal, the command 'real' must be used to map the real
% part and the command 'imag' must be used for the imaginary part
subplot(4,1,1);
sgtitle('x[n] = $$e^{j(2\pi\frac{4}{3}n + \frac{\pi}{4})}$$','Interpreter', 'latex');
stem(n, real(ninth_function(n)), 'filled', 'blue');
xlabel('Time Samples');
ylabel('Real Part');
subplot(4,1,2);
stem(n, imag(ninth_function(n)), 'filled', 'blue');
xlabel('Time Samples');
ylabel('Imaginary Part')
% Now we meed to compute and plot the magnitude
subplot(4,1,3);
stem(n, abs(ninth_function(n)), 'filled', 'blue');
xlabel('Time Samples');
ylabel('Magnitude');
% Next we need to plot the phase
```

```
subplot(4,1,4);
stem(n, angle(ninth_function(n)), 'filled', 'blue');
xlabel('Time Samples');
ylabel('Phase Shift');
```




```
x = -1000:1:1000;
y = ninth_function(x);
figure
scatter(real(y),imag(y),'filled','Blue');
```

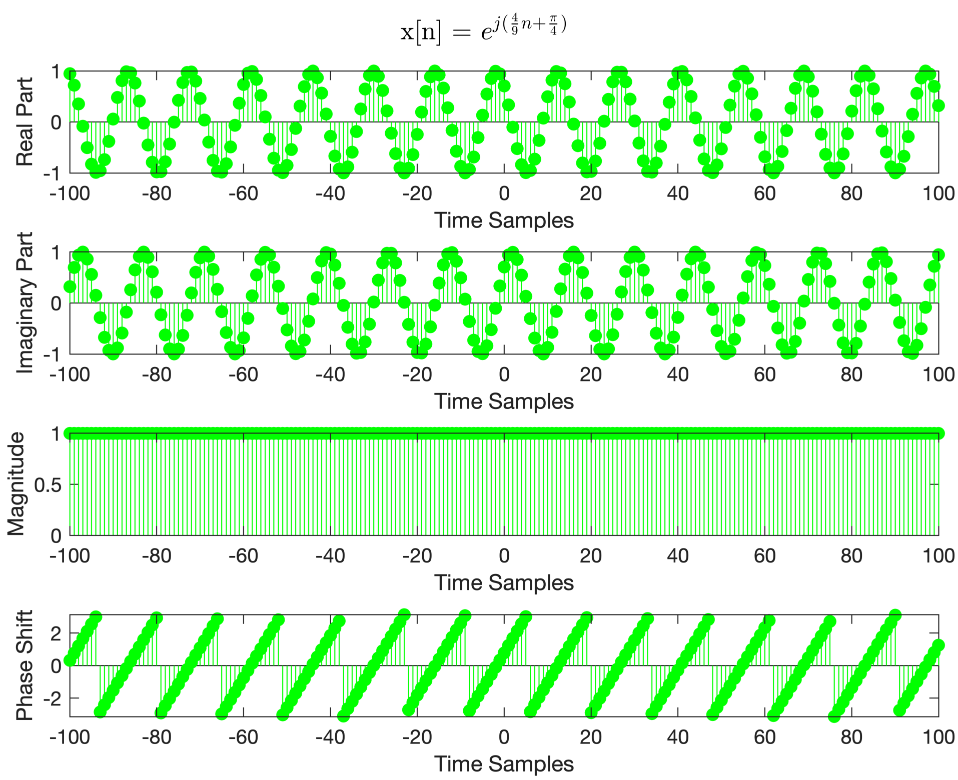


d) $x[n] = e^{j\left(\frac{4}{9}n + \frac{\pi}{4}\right)} = e^{j\left(2\pi\frac{4}{18\pi}n + \frac{\pi}{4}\right)}$

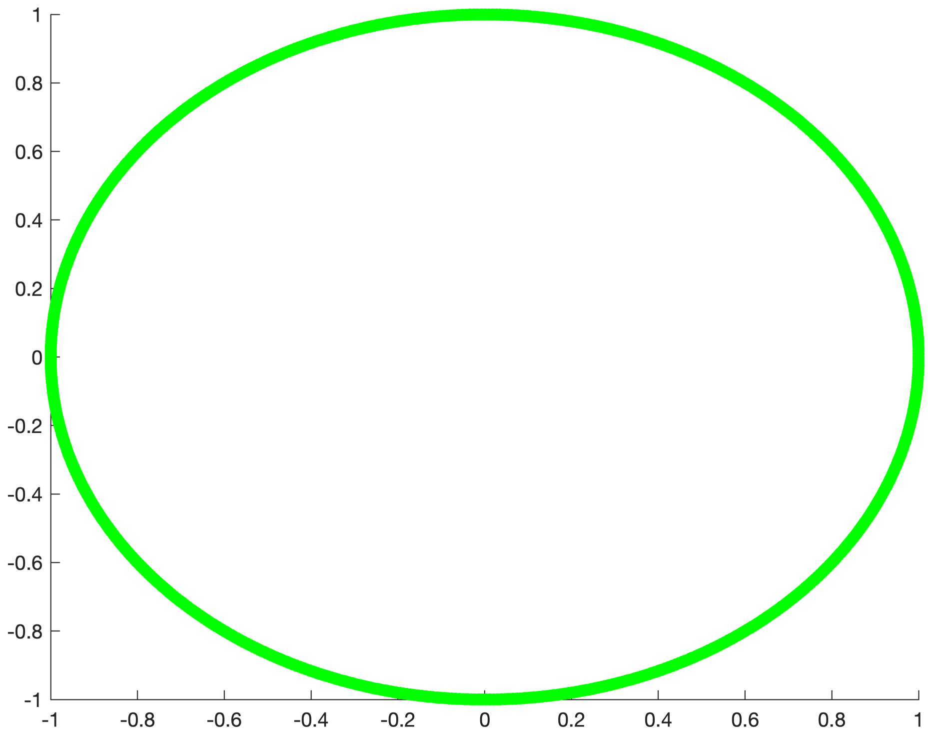
There are infinitely many distinct points on the unit circle because the signal is not periodic.

```
n = -100:1:100;
% For a complex signal, the command 'real' must be used to map the real
% part and the command 'imag' must be used for the imaginary part
subplot(4,1,1);
sgtitle('x[n] = $$e^{j(\frac{4}{9}n + \frac{\pi}{4})}$$','Interpreter', 'latex');
stem(n,real(tenth_function(n)),'filled', 'green');
xlabel('Time Samples');
ylabel('Real Part');
subplot(4,1,2);
stem(n, imag(tenth_function(n)),'filled','green');
xlabel('Time Samples');
ylabel('Imaginary Part')
% Now we meed to compute and plot the magnitude
subplot(4,1,3);
stem(n, abs(tenth_function(n)), 'filled','green');
xlabel('Time Samples');
ylabel('Magnitude');
% Next we need to plot the phase
subplot(4,1,4);
stem(n, angle(tenth_function(n)), 'filled','green');
xlabel('Time Samples');
```

```
ylabel('Phase Shift');
```




```
x = -1000:1:1000;
y = tenth_function(x);
figure
scatter(real(y),imag(y), 'filled', 'green');
```




```
function c = three_function(n)
c = cos(2*pi*(1/3)*n) + cos(2*pi*(4/5)*n);
end

function d = two_function(n)
d = cos(2*pi*(17/15)*n) + cos(2*pi*(-7/15)*n);
end

function e = four_function(n)
e = cos(2*pi*(1/3)*n).^(2);
end

function f = five_function(n)
f = cos(2*pi*(1/3)*n).^(3);
end

function f = six_function(n)
f = cos(2*pi*(2/7)*n.^(2));
end

function f = seventh_function(n)
f = exp(1i*(2*pi*(4/9)*n + (pi/4)));
end

function g = eigth_function(n)
g = exp(1i*((2*pi*(4/9)*n.^(2)) + (pi/4)));
```

```
end

function h = ninth_function(n)
h = exp(1i*((2*pi*(4/3)*n + (pi/4))));
end

function i = tenth_function(n)
i = exp(1i*((4/9)*n + (pi/4)));
end

function j = eleventh_function(n)
j = 0.9.^(n).*cos(2*pi*(2/7)*n);
end

function k = tweleth_function(n)
k = 1.1.^(n).*cos(2*pi*(2/7)*n);
end
```