

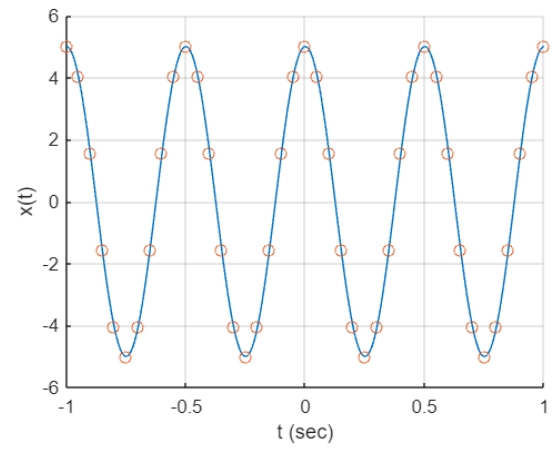
Problem 1

part a

```
start = -1
final = -1 * start
tt = start:1/1000:final
x = 5 * cos(4 * pi * tt)
hold on;
grid on;
plot(tt,x)
xlim([-1 1]); ylim([-6 6]);
xlabel('t (sec)'); ylabel('x(t)');
```

part b

```
f_s = 20
tta = start:1/f_s:final
xa = 5 * cos(4 * pi * tta)
scatter(tta, xa)
hold off;
```



P.S 5-Problem 1-Part a-e

Given: $x(t) = 5\cos(4\pi t)$ and its plot from $t = [-1, 1]$

$f_s = 20$ sample/sec

Find:

c) $x[n]$ for $x(t)$

d) if $x[n]$ is under, over or nyquist sampled

Solution:

$$\hat{\omega}_k = \frac{2\pi f_k}{f_s} \quad \omega_0 = 4\pi = 2\pi(2) \quad \hat{\omega} = \frac{2\pi(2)}{20} = \frac{1\pi}{5}$$

$$c) x[n] = 5\cos\left(\frac{\pi}{5}n\right)$$

d) nyquist rate = $2f_{\max}$

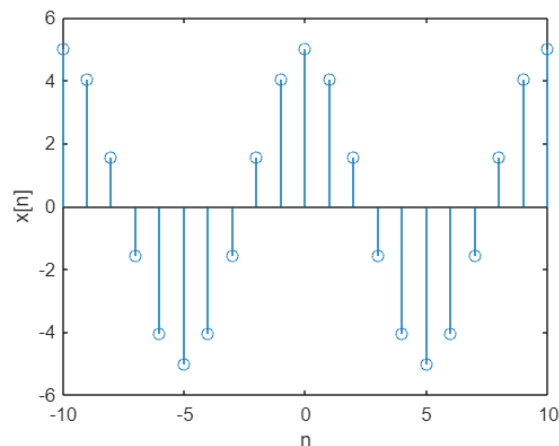
$f_{\max} = 2$ Hz $\rightarrow 4$ samples/sec

$f_s = 20$ $f_s > 2f_{\max}$

Over sampled

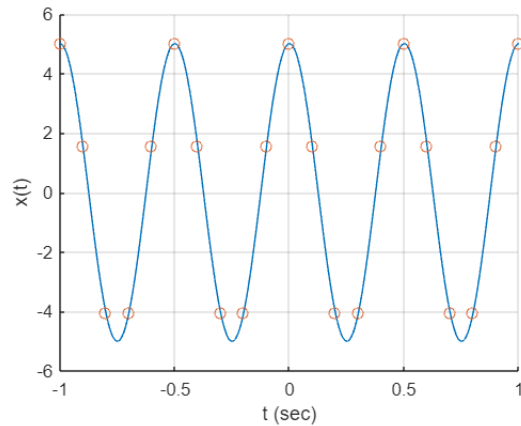
part e

```
tt_s = -10:1:10
omega_hat = 2 * pi * 2 / f_s
x_s = 5 * cos(omega_hat * tt_s)
stem(tt_s, x_s);
xlim([-10 10]); ylim([-6 6]);
xlabel('n'); ylabel('x[n]);
```



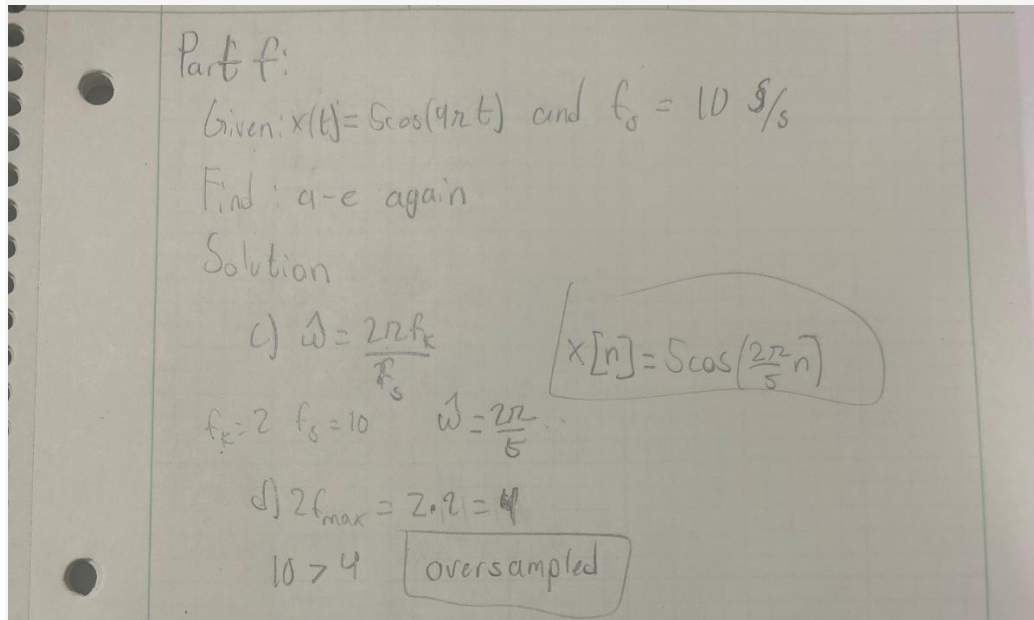
part a

```
start = -1
final = -1 * start
tt = start:1/1000:final
x = 5 * cos(4 * pi * tt)
hold on; grid on;
plot(tt,x)
xlim([-1 1]); ylim([-6 6]);
xlabel('t (sec)'); ylabel('x(t)');
```



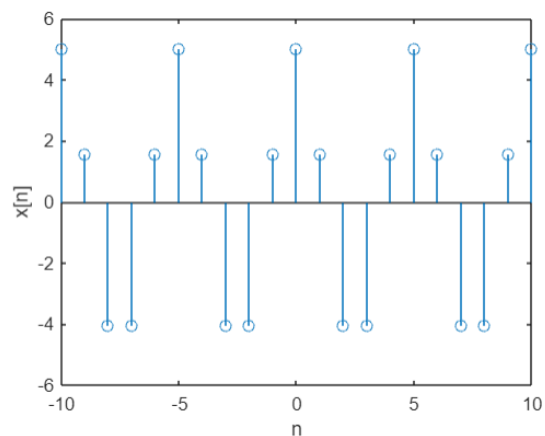
part b

```
f_s = 10
tta = start:1/f_s:final
xa = 5 * cos(4 * pi * tta)
scatter(tta, xa)
hold off;
```



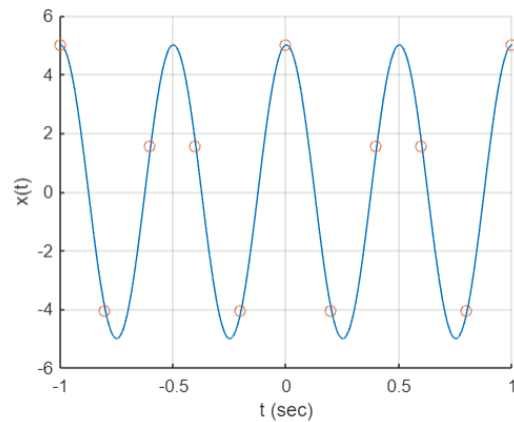
part e

```
tt_s = -10:1:10
omega_hat = 4 * pi / f_s
x_s = 5 * cos(omega_hat * tt_s)
stem(tt_s, x_s);
xlim([-10 10]); ylim([-6 6]);
xlabel('n'); ylabel('x[n]');
```



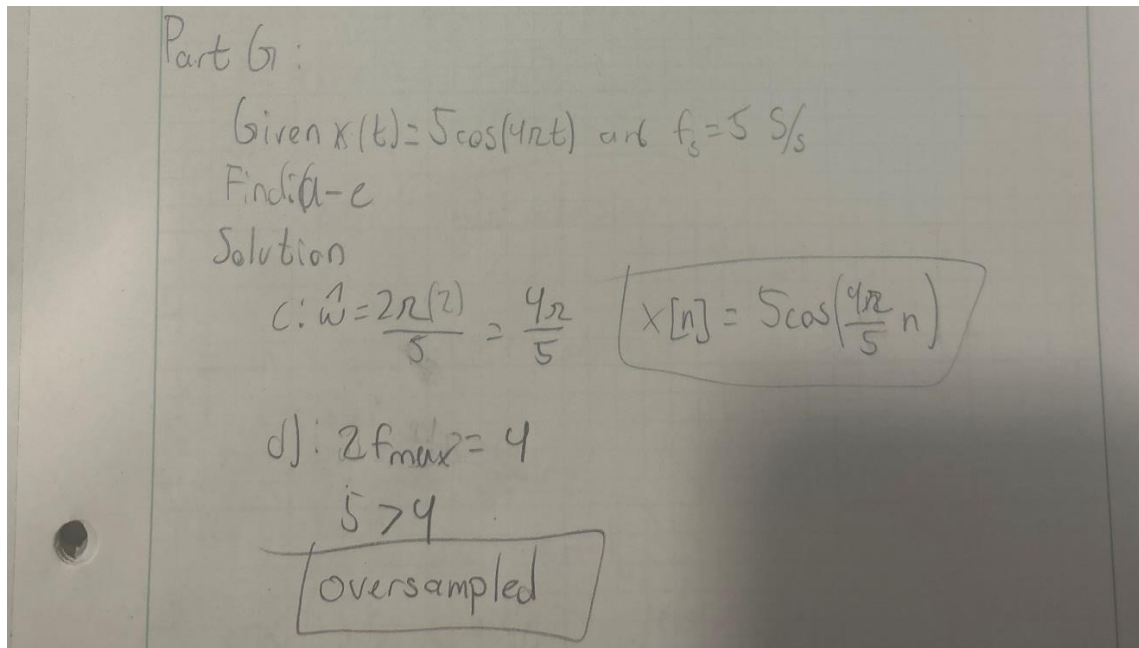
part a

```
start = -1
final = -1 * start
tt = start:1/1000:final
x = 5 * cos(4 * pi * tt)
hold on; grid on;
plot(tt,x)
xlim([-1 1]); ylim([-6 6]);
xlabel('t (sec)'); ylabel('x(t)');
```



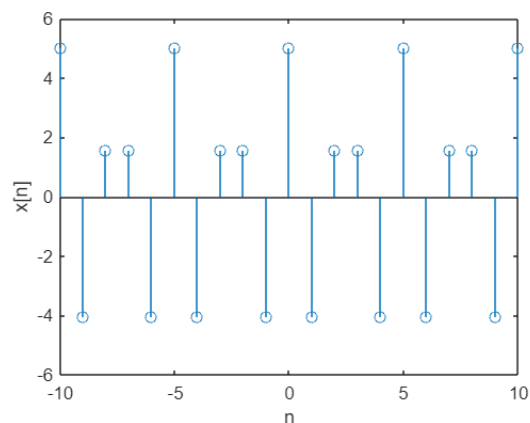
part b

```
f_s = 5
tta = start:1/f_s:final
xa = 5 * cos(4 * pi * tta)
scatter(tta, xa)
hold off;
```



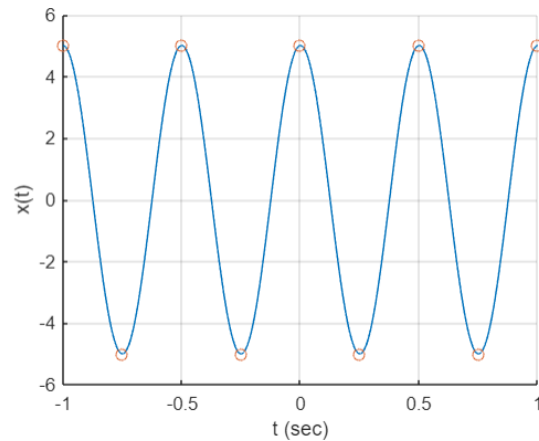
part e

```
tt_s = -10:1:10
omega_hat = 4 * pi / f_s
x_s = 5 * cos(omega_hat * tt_s)
stem(tt_s, x_s);
xlim([-10 10]); ylim([-6 6]);
xlabel('n'); ylabel('x[n]');
```



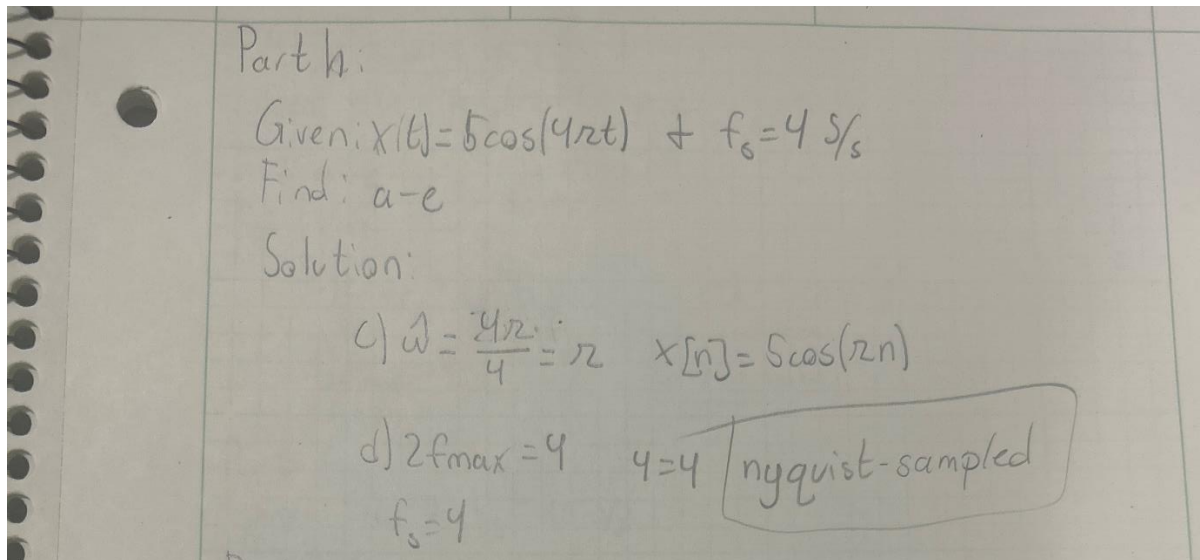
part a

```
start = -1
final = -1 * start
tt = start:1/1000:final
x = 5 * cos(4 * pi * tt)
hold on; grid on;
plot(tt,x)
xlim([-1 1]); ylim([-6 6]);
xlabel('t (sec)'); ylabel('x(t)');
```



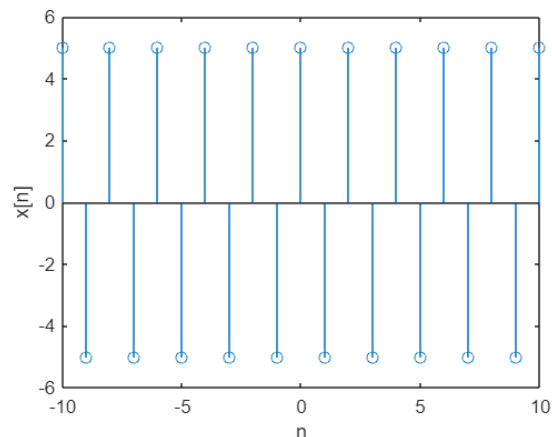
part b

```
f_s = 4
tta = start:1/f_s:final
xa = 5 * cos(4 * pi * tta)
scatter(tta, xa)
hold off;
```



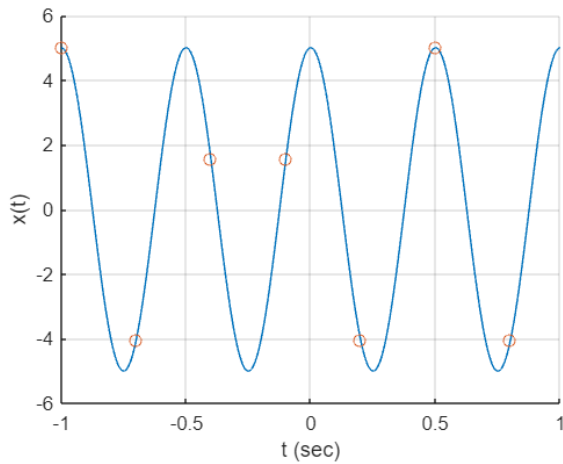
part e

```
tt_s = -10:1:10
omega_hat = 4 * pi / f_s
x_s = 5 * cos(omega_hat * tt_s)
stem(tt_s, x_s);
xlim([-10 10]); ylim([-6 6]);
xlabel('n'); ylabel('x[n]');
```



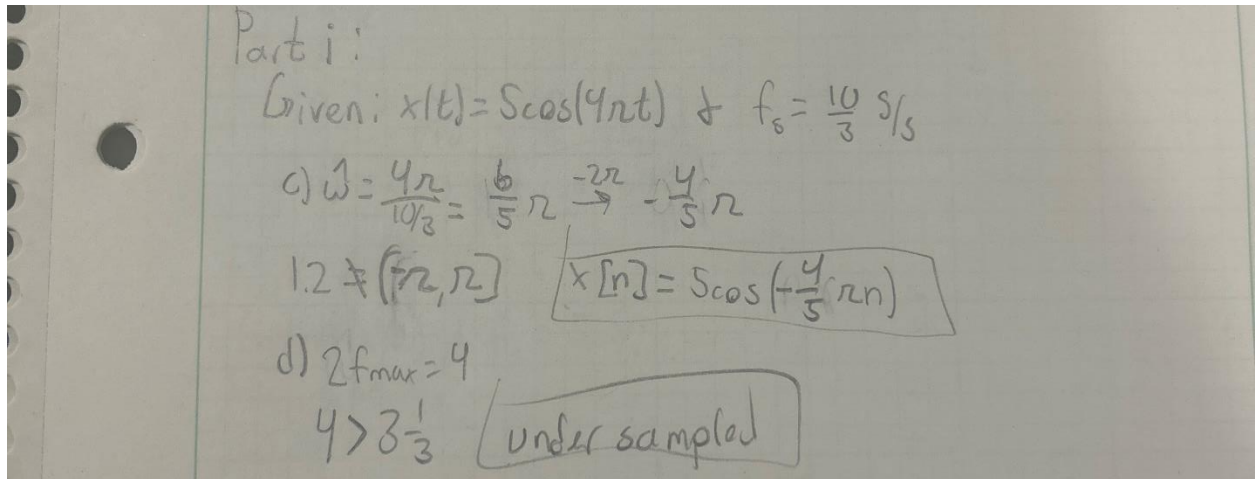
part a

```
start = -1
final = -1 * start
tt = start:1/1000:final
x = 5 * cos(4 * pi * tt)
hold on; grid on;
plot(tt,x)
xlim([-1 1]); ylim([-6 6]);
xlabel('t (sec)'); ylabel('x(t)');
```



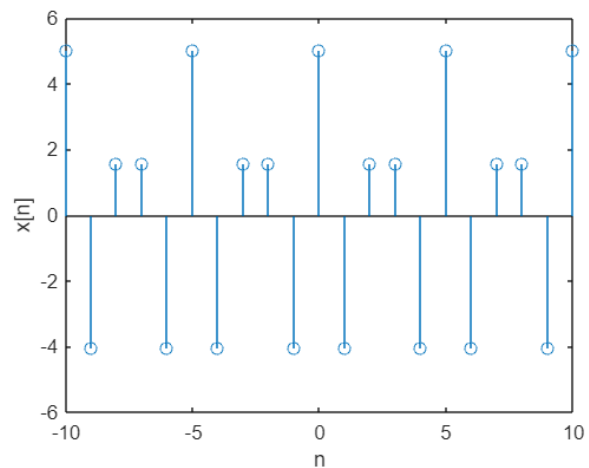
part b

```
f_s = 10/3
tta = start:1/f_s:final
xa = 5 * cos(4 * pi * tta)
scatter(tta, xa)
hold off;
```



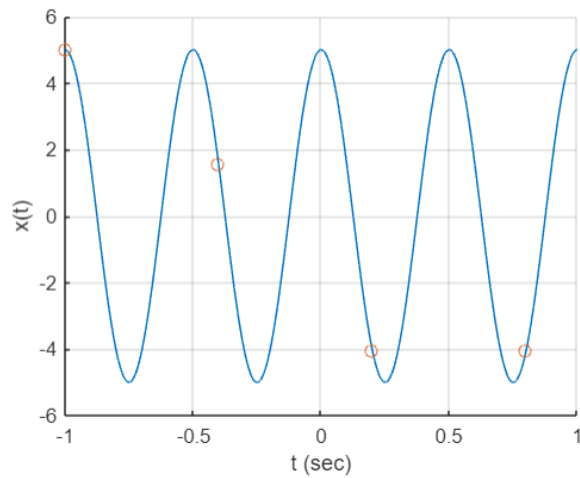
part e

```
tt_s = -10:1:10
omega_hat = 4 * pi / f_s
while omega_hat > pi
    omega_hat = omega_hat - (2 * pi)
end
while omega_hat <= -1 * pi
    omega_hat = omega_hat + (2 * pi)
end
x_s = 5 * cos(omega_hat * tt_s)
stem(tt_s, x_s);
xlim([-10 10]); ylim([-6 6]);
xlabel('n'); ylabel('x[n]');
```



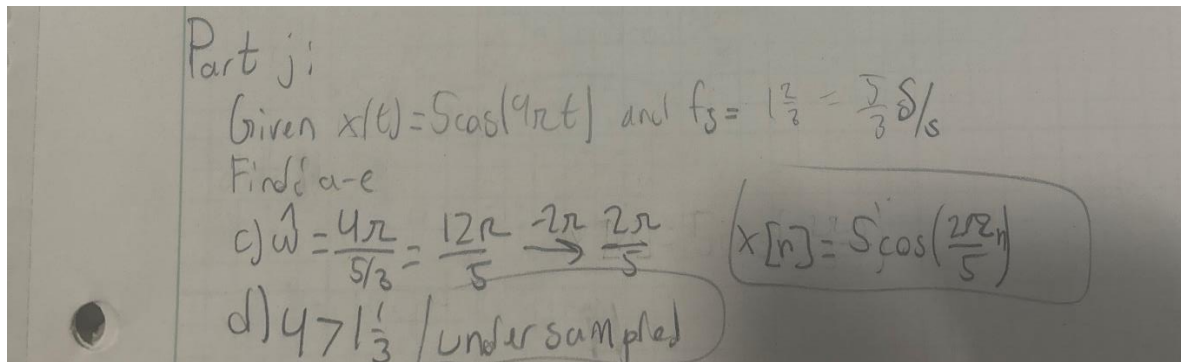
part a

```
start = -1
final = -1 * start
tt = start:1/1000:final
x = 5 * cos(4 * pi * tt)
hold on; grid on;
plot(tt,x)
xlim([-1 1]); ylim([-6 6]);
xlabel('t (sec)'); ylabel('x(t)');
```



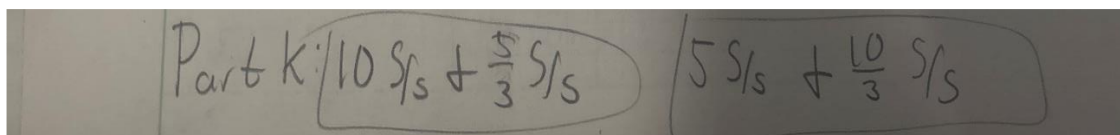
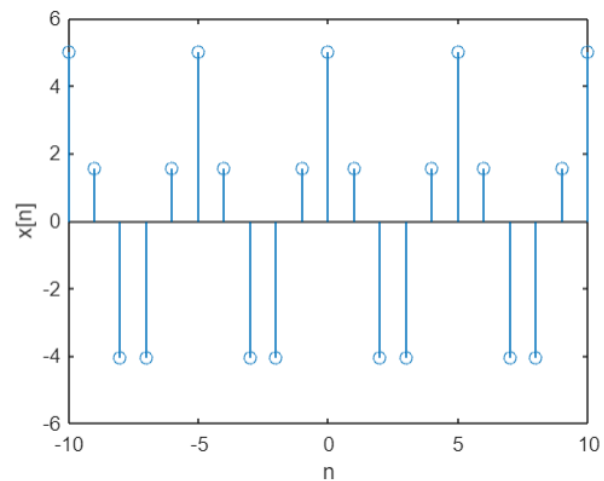
part b

```
f_s = 5/3
tta = start:1/f_s:final
xa = 5 * cos(4 * pi * tta)
scatter(tta, xa)
hold off;
```



part e

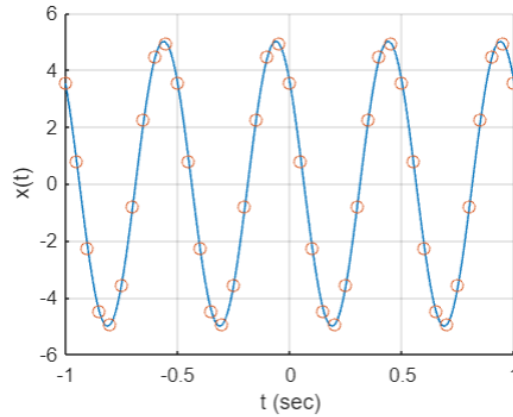
```
tt_s = -10:1:10
omega_hat = 4 * pi / f_s
while omega_hat > pi
    omega_hat = omega_hat - (2 * pi)
end
while omega_hat <= -1 * pi
    omega_hat = omega_hat + (2 * pi)
end
x_s = 5 * cos(omega_hat * tt_s)
stem(tt_s, x_s);
xlim([-10 10]); ylim([-6 6]);
xlabel('n'); ylabel('x[n]');
```



Problem 2

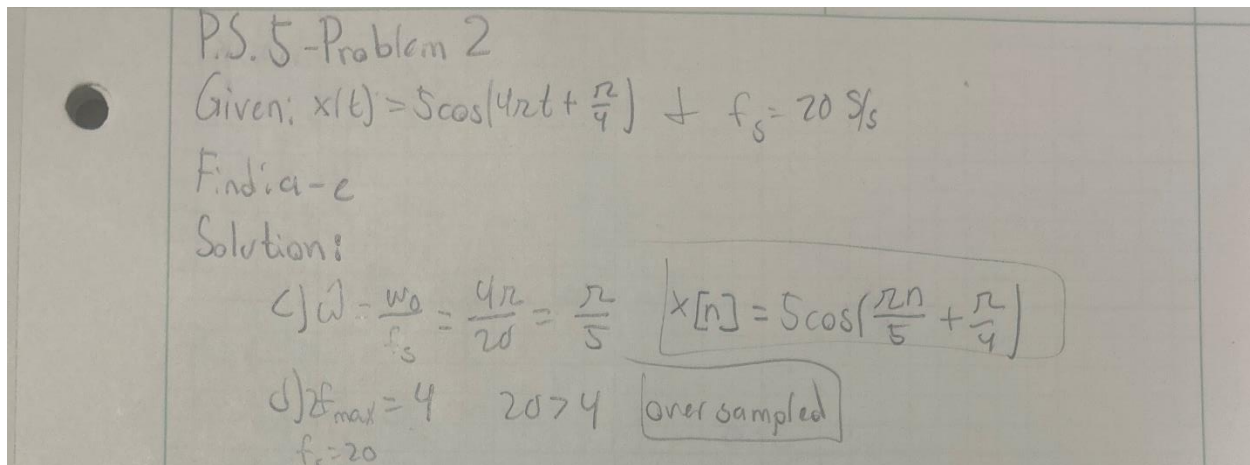
part a

```
start = -1
final = -1 * start
tt = start:1/1000:final
p = pi / 4
x = 5 * cos((4 * pi * tt) + p)
hold on; grid on;
plot(tt,x)
xlim([-1 1]); ylim([-6 6]);
xlabel('t (sec)'); ylabel('x(t)');
```



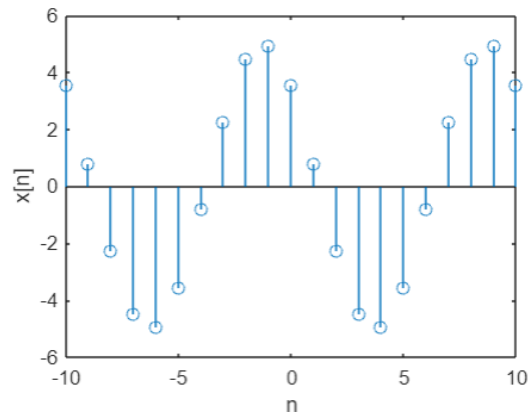
part b

```
f_s = 20
tta = start:1/f_s:final
xa = 5 * cos((4 * pi * tta) + p)
scatter(tta, xa)
hold off;
```



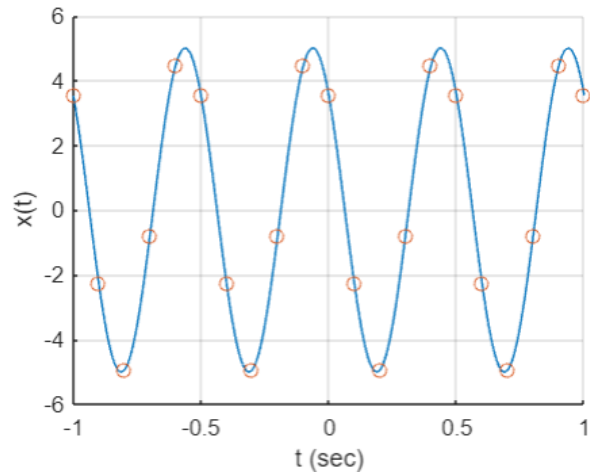
part e

```
n = -10:1:10
omega_hat = 4 * pi / f_s
while omega_hat > pi
    omega_hat = omega_hat - (2 * pi)
end
while omega_hat <= -1 * pi
    omega_hat = omega_hat + (2 * pi)
end
x_s = 5 * cos((omega_hat * n) + p)
stem(n, x_s);
xlim([-10 10]); ylim([-6 6]);
xlabel('n'); ylabel('x[n]');
```



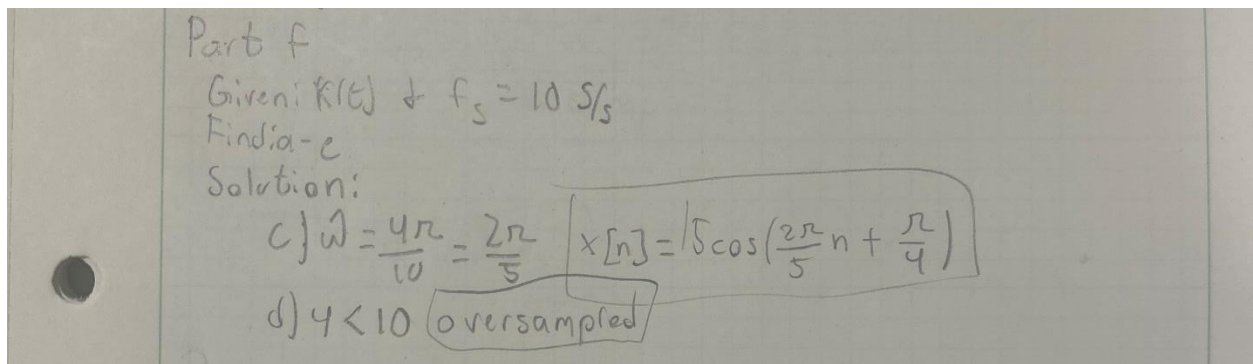
part a

```
start = -1
final = -1 * start
tt = start:1/1000:final
p = pi / 4
x = 5 * cos((4 * pi * tt) + p)
hold on; grid on;
plot(tt,x)
xlim([-1 1]); ylim([-6 6]);
xlabel('t (sec)'); ylabel('x(t)');
```



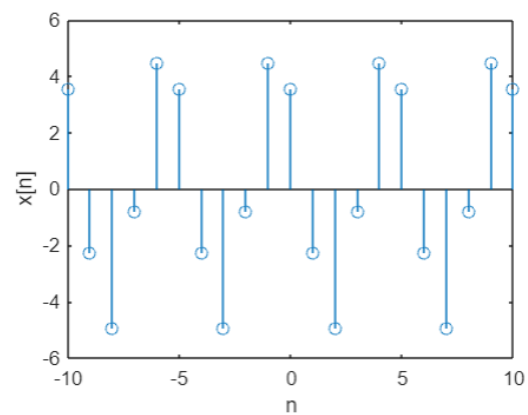
part b

```
f_s = 10
tta = start:1/f_s:final
xa = 5 * cos((4 * pi * tta) + p)
scatter(tta, xa)
hold off;
```



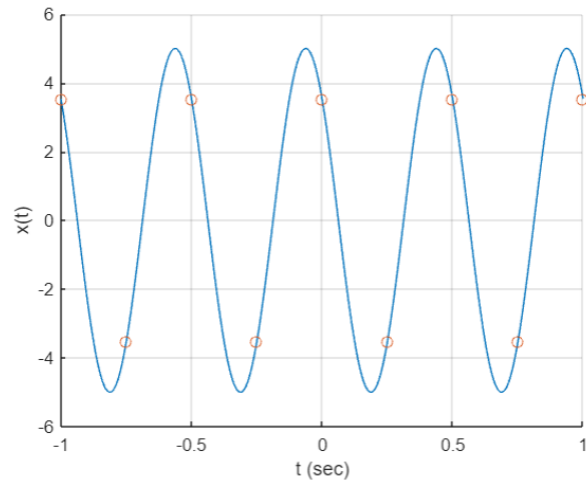
part e

```
n = -10:1:10
omega_hat = 4 * pi / f_s
while omega_hat > pi
    omega_hat = omega_hat - (2 * pi)
end
while omega_hat <= -1 * pi
    omega_hat = omega_hat + (2 * pi)
end
x_s = 5 * cos((omega_hat * n) + p)
stem(n, x_s);
xlim([-10 10]); ylim([-6 6]);
xlabel('n'); ylabel('x[n]');
```



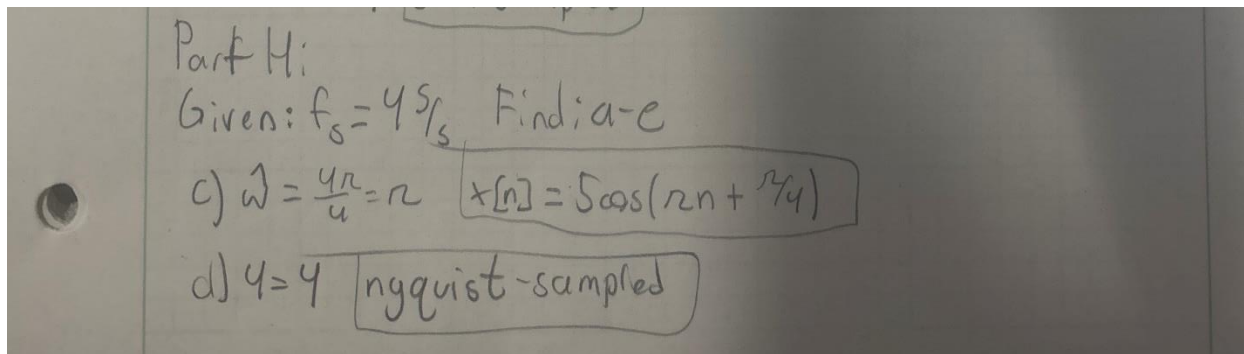
part a

```
start = -1
final = -1 * start
tt = start:1/1000:final
p = pi / 4
x = 5 * cos((4 * pi * tt) + p)
hold on; grid on;
plot(tt,x)
xlim([-1 1]); ylim([-6 6]);
xlabel('t (sec)'); ylabel('x(t)');
```



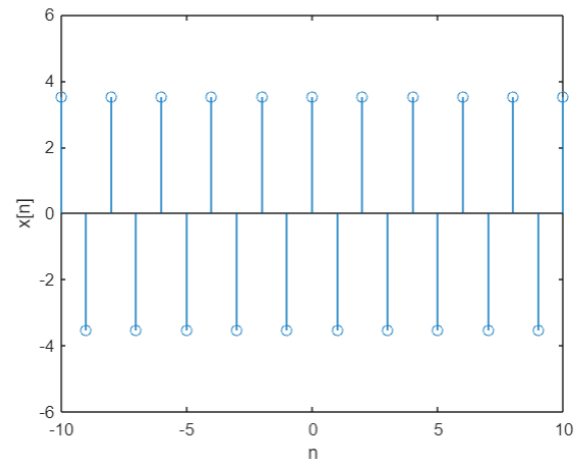
part b

```
f_s = 4
tta = start:1/f_s:final
xa = 5 * cos((4 * pi * tta) + p)
scatter(tta, xa)
hold off;
```



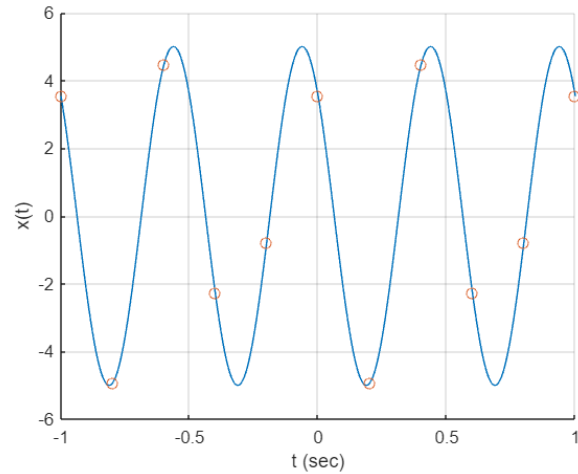
part e

```
n = -10:1:10
omega_hat = 4 * pi / f_s
while omega_hat > pi
    omega_hat = omega_hat - (2 * pi)
end
while omega_hat <= -1 * pi
    omega_hat = omega_hat + (2 * pi)
end
x_s = 5 * cos((omega_hat * n) + p)
stem(n, x_s);
xlim([-10 10]); ylim([-6 6]);
xlabel('n'); ylabel('x[n]');
```



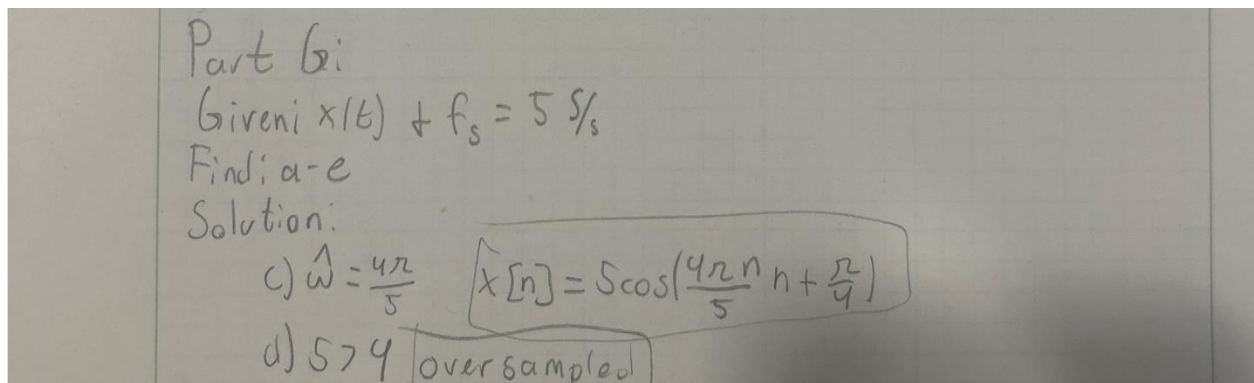
part a

```
start = -1
final = -1 * start
tt = start:1/1000:final
p = pi / 4
x = 5 * cos((4 * pi * tt) + p)
hold on; grid on;
plot(tt,x)
xlim([-1 1]); ylim([-6 6]);
xlabel('t (sec)'); ylabel('x(t)');
```



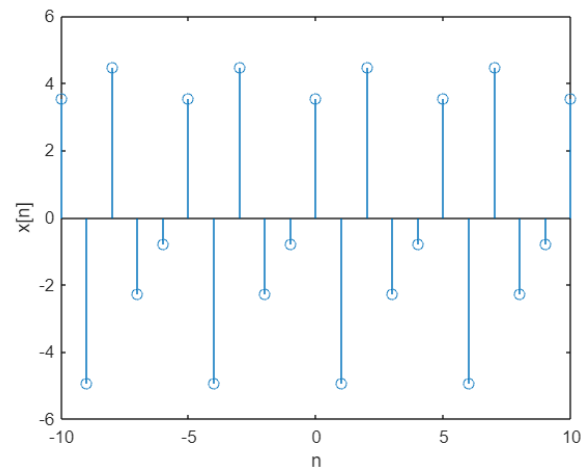
part b

```
f_s = 5
tta = start:1/f_s:final
xa = 5 * cos((4 * pi * tta) + p)
scatter(tta, xa)
hold off;
```



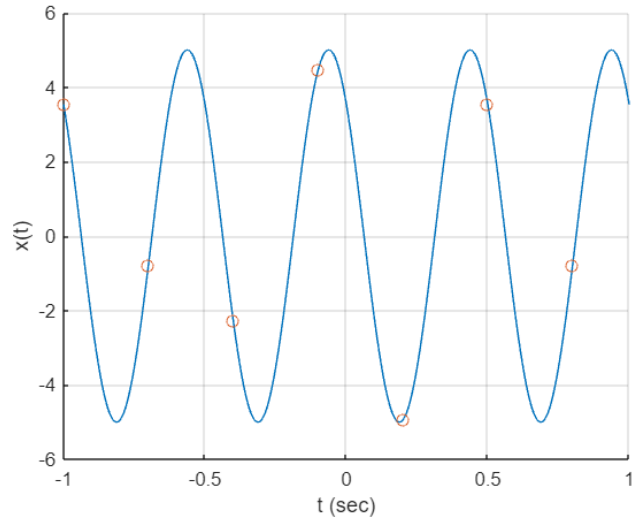
part e

```
n = -10:1:10
omega_hat = 4 * pi / f_s
while omega_hat > pi
    omega_hat = omega_hat - (2 * pi)
end
while omega_hat <= -1 * pi
    omega_hat = omega_hat + (2 * pi)
end
x_s = 5 * cos((omega_hat * n) + p)
stem(n, x_s);
xlim([-10 10]); ylim([-6 6]);
xlabel('n'); ylabel('x[n]');
```



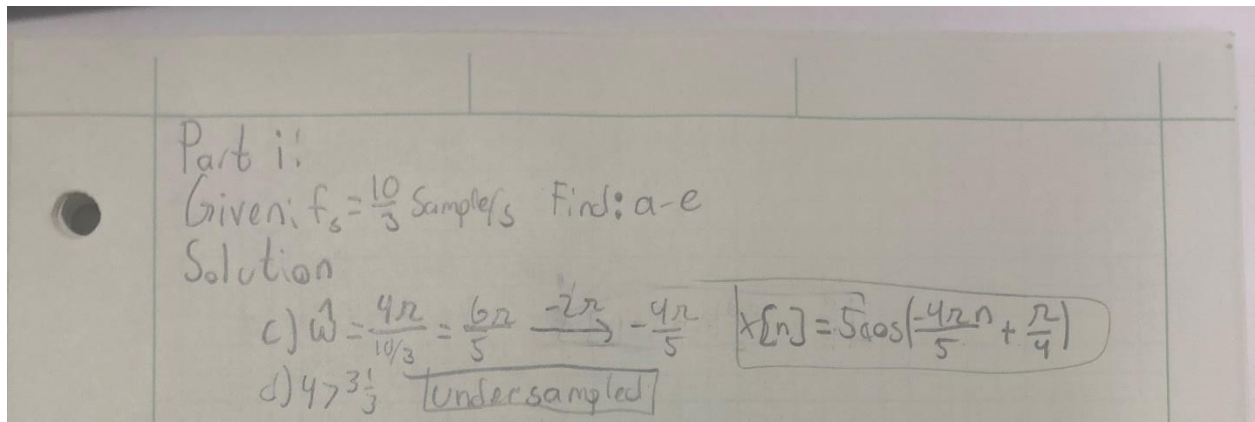
part a

```
start = -1
final = -1 * start
tt = start:1/1000:final
p = pi / 4
x = 5 * cos((4 * pi * tt) + p)
hold on; grid on;
plot(tt,x)
xlim([-1 1]); ylim([-6 6]);
xlabel('t (sec)'); ylabel('x(t)');
```



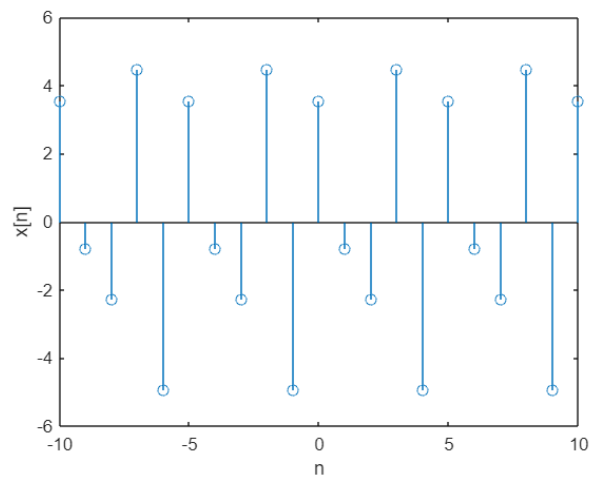
part b

```
f_s = 10/3
tta = start:1/f_s:final
xa = 5 * cos((4 * pi * tta) + p)
scatter(tta, xa)
hold off;
```



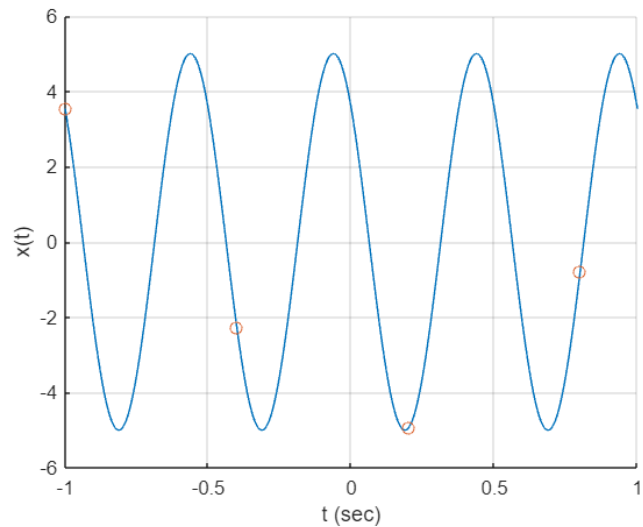
part e

```
n = -10:1:10
omega_hat = 4 * pi / f_s
while omega_hat > pi
    omega_hat = omega_hat - (2 * pi)
end
while omega_hat <= -1 * pi
    omega_hat = omega_hat + (2 * pi)
end
x_s = 5 * cos((omega_hat * n) + p)
stem(n, x_s);
xlim([-10 10]); ylim([-6 6]);
xlabel('n'); ylabel('x[n]');
```



part a

```
start = -1
final = -1 * start
tt = start:1/1000:final
p = pi / 4
x = 5 * cos((4 * pi * tt) + p)
hold on; grid on;
plot(tt,x)
xlim([-1 1]); ylim([-6 6]);
xlabel('t (sec)'); ylabel('x(t)');
```



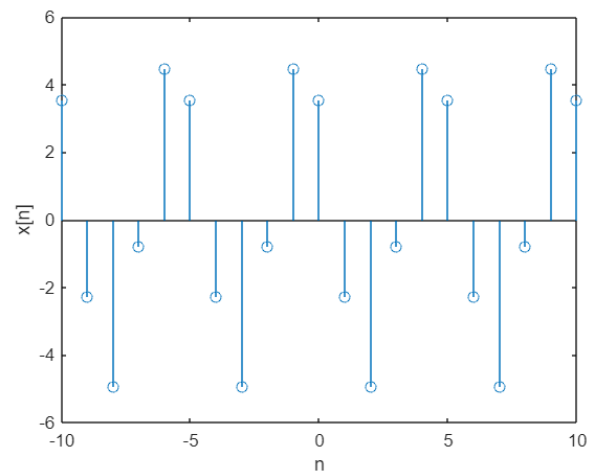
part b

```
f_s = 5/3
tta = start:1/f_s:final
xa = 5 * cos((4 * pi * tta) + p)
scatter(tta, xa)
hold off;
```

Part j:
 Given: $f_s = 5/3$ samples/s Find: a-e
 c) $\omega = \frac{4\pi}{5/3} = \frac{12\pi}{5} \rightarrow \frac{2\pi}{5}$ $x[n] = 5\cos(\frac{2n}{5} + \frac{\pi}{4})$
 d) $4 > 1\frac{2}{3}$ under sampled

part e

```
n = -10:1:10
omega_hat = 4 * pi / f_s
while omega_hat > pi
    omega_hat = omega_hat - (2 * pi)
end
while omega_hat <= -1 * pi
    omega_hat = omega_hat + (2 * pi)
end
x_s = 5 * cos((omega_hat * n) + p)
stem(n, x_s);
xlim([-10 10]); ylim([-6 6]);
xlabel('n'); ylabel('x[n]');
```



Part k:
 $\frac{5}{3} \text{ s/s} \div 10 \text{ s/s}$

PS 5-Problem 3 - P-4.3

Given:

$$a) y[n] = 8 \cos(0.6\pi n - \pi/3)$$

$$b) y[n] = 4 \cos(1.2\pi n - \pi/4)$$

$$c) y[n] = 2 \cos(2.4\pi n - \pi/5)$$

$$f_s = 3600$$

Find: $y(t)$ for a-c given f_s

Solution:

$$a) \omega = \frac{2\pi f_s}{f_s} \quad 0.6\pi = \frac{\omega_0}{3600} \quad \omega_0 =$$

$$y(t) = 8 \cos(2160\pi t - \pi/3)$$

$$b) 1.2\pi > \pi \quad \begin{matrix} (-2\pi) \\ \rightarrow \end{matrix} -\frac{4\pi}{5} \quad -\frac{4\pi}{5} = \frac{\omega_0}{3600} \quad -2880\pi = \omega_0 = 2880\pi$$

$$y(t) = 4 \cos(2880\pi t + \pi/4)$$

$$\cos(-x) = \cos(x)$$

$$c) 2.4\pi > \pi \quad \begin{matrix} (-2\pi) \\ \rightarrow \end{matrix} 0.4\pi \quad 0.4\pi = \frac{\omega_0}{3600} \quad \omega_0 = 1440\pi$$

$$y(t) = 2 \cos(1440\pi t - \pi/5)$$

P.S. 5 - Problem 4 - 4.13

a)

Given:

$$nn = 0:2190099;$$

$$xx = (77\pi) \cos(1.8\pi(nn + 203))$$

$$\text{soundsc}(xx, 16000)$$

Find: the freq. that will be heard

Solution:

$$f_s = 16000 \quad \omega = \frac{2\pi f_k}{f_s} \quad 0.2\pi = \frac{2\pi f_k}{16000} \quad \boxed{f_k = 1600 \text{ Hz}}$$

$$\omega = 1.8\pi \Rightarrow -0.2\pi$$

b) Given:

$$tt = 0:1/2400:10000$$

$$xx = \cos(2\pi \times 1600 \times tt + \pi/3)$$

$$\text{soundsc}(xx, f_{\text{samp}})$$

Find: f_{samp} so the output is in 2400 Hz

Solution:

$$\omega = \frac{2\pi f_k}{f_s} \quad \omega = \frac{2\pi(1600)}{2400} = 1.5\pi \Rightarrow -0.5\pi \Rightarrow 0.5\pi$$

$$f_s = 2400 \text{ Hz}$$

$$f_k = 1600$$

$$0.5\pi = \frac{2\pi(1600)}{f_s} \quad \boxed{f_s = 9600 \text{ Hz}}$$

c) Given:

$$tt = 0:1/8000:64$$

$$xx = 1.23 + \cos(2\pi \times 440 \times tt)$$

$$\text{soundsc}(xx, 40000)$$

Find: the frequency and duration

$$f_k = 440$$

$$f_s = 8000$$

$$\omega = \frac{2\pi f_k}{f_s} = 0.011\pi = \frac{2\pi f_k}{40000}$$

$$\boxed{f_k = 2200 \text{ Hz}}$$

$$\frac{\text{total samples}}{\text{samples/sec}} = \text{sec}$$

$$\frac{8000 \cdot 64}{40000}$$

$$\boxed{= 12.8 \text{ sec}}$$