DSP HW #1

1a) $\cos[.01\pi n]$ Periodic if $f_0 = \frac{k}{N}$ is rational

$\omega = .01\pi = 2\pi f$

$f = \frac{.01}{2}$

Periodic with $f_0 = \frac{k}{N} = 200$, $N_0 = \frac{1}{200}$ samples

b) $\cos\left[\pi \frac{30n}{105}\right]$

$\omega = \frac{30}{105}\pi = 2\pi f$

$f = \frac{30}{210}$

Periodic w/ $f_0 = \frac{k}{N} = \frac{30}{210}$, $N_0 = \frac{210}{30}$ samples

c) $\cos[3\pi n]$

$\omega = 3\pi = 2\pi f$

$f = \frac{3}{2}$

Periodic w/ $f_0 = \frac{3}{2} = \frac{k}{N}$, $N_0 = \frac{2}{3}$ samp

d) $\sin[3n]$

$\omega = 3 = 2\pi f$

$f = \frac{3}{2\pi}$

Non-periodic

e) $\sin\left[\pi \frac{62}{10} n\right]$

$\omega = \frac{62}{10}\pi = 2\pi f$

$f = \frac{62}{20}$

Periodic with $f_0 = \frac{62}{20} = \frac{k}{N}$, $N_0 = \frac{20}{62}$ samples

2a) $x_a(t) = 3\cos(5t + \pi/6)$ - Since in time domain
$\quad\quad = 3\cos(5(t+\tau) + \pi/6)$ f_0 doesn't have to be rational

$\quad 5T = 2\pi$

$\quad T_0 = \frac{2\pi}{5}$

> Periode with $T_0 = \frac{2\pi}{5}$

b) $x[n] = 3\cos[5n + \pi/6]$

$\quad \omega = 5 = 2\pi f$

$\quad f = \frac{5}{2\pi}$

> Non Periode since $f_0 = \frac{5}{2\pi}$ isn't rational

c) $x[n] = 2e^{j(\frac{n}{6} - \pi)} = 2(\cos(\frac{n}{6} - \pi) + j\sin(\frac{n}{6} - \pi))$

$\quad \omega = \frac{1}{6} = 2\pi f$

$\quad f = \frac{1}{12\pi}$

> Non Periode since $f_0 = \frac{1}{12\pi}$ isn't rational

d) $x[n] = \cos[\frac{n}{8}]\cos[\frac{\pi n}{8}] = \frac{1}{2}(\cos(\frac{n}{8} - \frac{\pi n}{8}) + \cos(\frac{n}{8} + \frac{\pi n}{8}))$

$\quad = \frac{1}{2}(\cos[\frac{n(1-\pi)}{8}] + \cos[\frac{n(1+\pi)}{8}]$

$\quad \omega = \frac{1-\pi}{8} = 2\pi f$

$\quad f = \frac{1-\pi}{16\pi}$

> Non periode since the fundamental frequency aren't rational

e) $x[n] = \cos\{\frac{\pi n}{2}\} - \sin\{\frac{\pi n}{8}\} + 3\cos[\frac{\pi n}{4} + \pi/3]$

$\quad \omega_0 = \frac{\pi}{2} = 2\pi f$ $\omega_1 = \frac{\pi}{8} = 2\pi f$ $\omega_2 = \frac{\pi}{4} = 2\pi f$

$\quad f_0 = \frac{1}{4}$ $f_1 = \frac{1}{16}$ $f_2 = \frac{1}{8}$

> Periode w/ $f_0 = \frac{1}{16}$, $N_0 = 16$
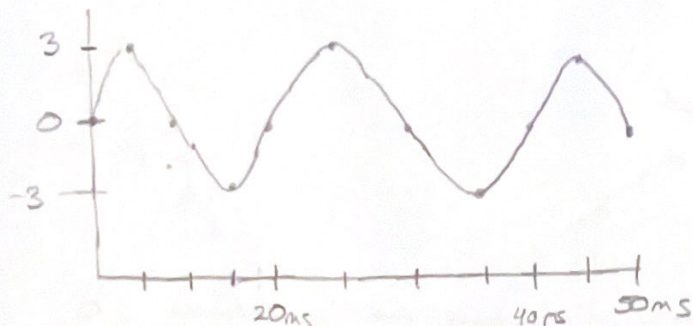
3) $x_a(t) = 3 \sin(100\pi t)$

$\omega = 2\pi f = 100\pi$
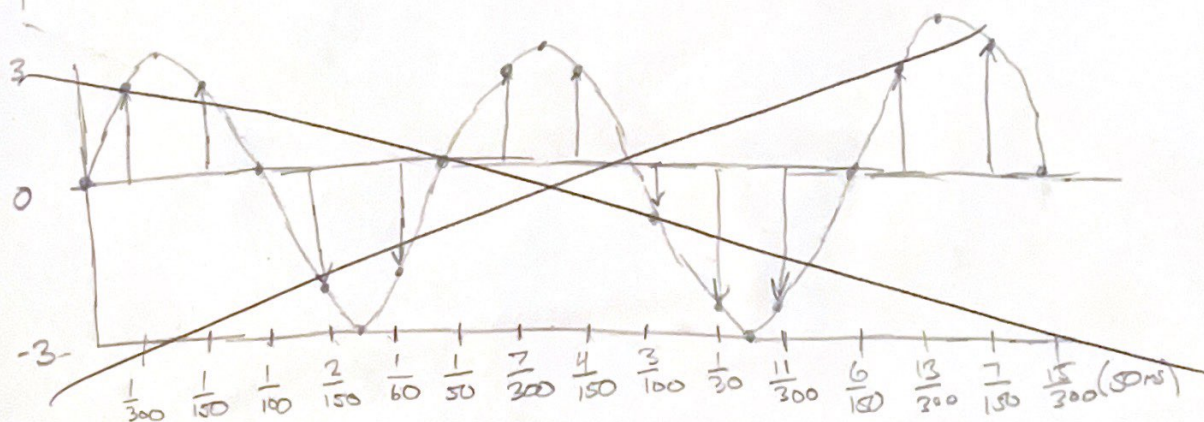$f = 50\ Hz$

a)

b) $x[n] = x_a(nT_s)$ $T_s = 1/300$

$x[n] = 3 \sin\left(\frac{100\pi n}{300}\right) = 3 \sin\left(\frac{\pi n}{3}\right)$

$\omega = \frac{\pi}{3} = 2\pi f$

$f_0 = \frac{1}{6}$

Periodic sine $f_0 = \frac{1}{6}$ is rational

c)

D) Period is 20 ms

e) Sample rate must be $F_s = 600\ Hz$

4) "Pay the price"
   Put in time + make sacrafices

5) No use the school version

6) No use a newer version

7) All needed work + answers marked
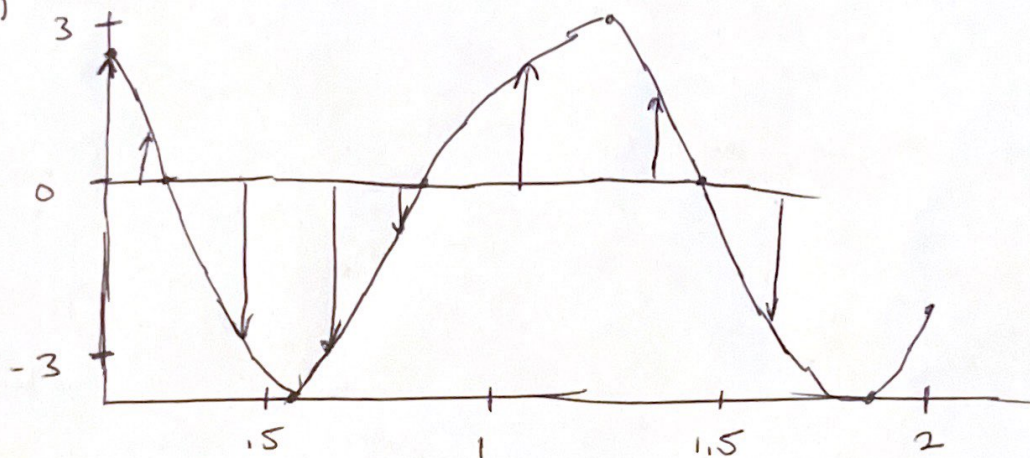
4) W: Radial freq, rad/sample
   Ω: Physical Radial Freq, rad/sec
   F: Physical Freq, Hz
   f: Freq, cycles/sample

3c)

```matlab
% DSP HW1 #3d
clear; close all;

% Variables
n = linspace(0, 5, 6);
t_n = n ./ 300;
t_a = linspace(0, 6, 100) ./ 300;

% Functions
x_n = 3 * sin(pi * n / 3);
x_a = 3 * sin(100 * pi * t_a);

% Plot
hold on
stem(t_n, x_n)
plot(t_a, x_a)
ylabel('Amplitude')
xlabel('Time')
legend('Samples', 'Analog')
hold off
```