1.1 (a) One dimensional, multichannel, discrete time and digital. Y_1
This signal is generated by multiple sources at certain specific time. Thus it is discrete-time and multichannel signal. Since this discrete-time signal has a set of discrete values, it is digital. Because it is also a function of a single independent variable, it is one-dimensional signal.

(b) Multi-dimensional, single channel, continuous time and analog

(c) One-dimensional, single channel, continuous-time and analog.

(d) One-dimensional, single channel, continuous time and analog.

(e) One-dimensional, ~~sing~~ multichannel, discrete time and digital.

1.3 (a) $x_a(t) = 3\cos(5t + \frac{\pi}{6})$

It is periodic, and the period $T = \frac{1}{F} = \frac{1}{\frac{5}{2\pi}} = \frac{2\pi}{5}$

(b) $x(n) = 3\cos(5n + \frac{\pi}{6})$

Since $f = \frac{5}{2\pi}$ is irrational, it is non-periodic.

(c) $x(n) = 2\exp[j(\frac{n}{6} - \pi)]$

Since $f = \frac{\frac{1}{6}}{2\pi} = \frac{1}{12\pi}$ is irrational, it is non-periodic.

(d) $x(n) = \cos(\frac{n}{8})\cos(\frac{\pi n}{8})$

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

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

$= x_1(n) + x_2(n)$, where $x_1(n) = \frac{1}{2}\cos(\frac{(\pi+1)n}{8})$ and $x_2(n) = \frac{1}{2}\cos(\frac{(\pi-1)n}{8})$.

Since the frequency for $x_1(n)$ is $f_1 = \frac{\frac{(\pi+1)}{8}}{2\pi} = \frac{(\pi+1)}{16\pi}$ is irrational, $x_1(n)$ is non-periodic. Therefore $x(n)$ is non-periodic.

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

Since $\cos(\frac{\pi n}{2})$ is periodic with the period $N_{p_1} = \frac{1}{f_1} = \frac{1}{\frac{\pi/2}{2\pi}} = 4$, $\sin(\frac{\pi n}{8})$ is periodi with period $N_{p_2} = \frac{1}{f_2} = \frac{1}{\frac{\pi/8}{2\pi}} = 16$, and $3\cos(\frac{\pi n}{4} + \frac{\pi}{3})$ is periodic with period $N_{p_3} = \frac{1}{f_3} = \frac{1}{\frac{\pi/4}{2\pi}} = 8$, $x(n)$ is periodic with the period $N_p = 16$, which is the least common multiple of N_{p_1}, N_{p_2} and N_{p_3}.

1.4 (a) $S_k(n) = e^{j2\pi kn/N} = e^{j2\pi k_1 n/N_1}$, where $k_1 = \frac{k}{GCD(k,N)}$ and $N_1 = \frac{N}{GCD(k,N)}$.

$S_k(n+N_p) = e^{j2\pi n(k_1+N_p)/N_1} = e^{j2\pi n N_p/N_1} S_k(n)$

In order to ensure $S_k(n+N_p) = S_k(n)$, $e^{j2\pi n N_p/N_1} = 1$.

Therefore the fundamental period $N_p = N_1 = \frac{N}{GCD(k,N)}$.

(b) For $N=7$, $k = 0, 1, 2, 3, 4, 5, 6, 7$.

Thus $GCD(k,N) = 7, 1, 1, 1, 1, 1, 1, 7$.

Thus $N_p = \frac{N}{GCD(k,N)} = 1, 7, 7, 7, 7, 7, 7, 1$.

(c) For $N=16$, $k = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16$.

Thus $GCD(k,N) = 16, 1, 2, 1, 4, 1, 2, 1, 8, 1, 2, 1, 4, 1, 2, 1, 16$.

Thus $N_p = \frac{N}{GCD(k,N)} = 1, 16, 8, 16, 4, 16, 8, 16, 2, 16, 8, 16, 4, 16, 8, 16, 1$.

1.5

(a) $T = \frac{1}{F} = \frac{1}{\frac{100\pi}{2\pi}} = \frac{1}{50}s = 20ms$.

We can sketch the signal $x_a(t)$ for $0 \le t \le 30ms$ as follows:

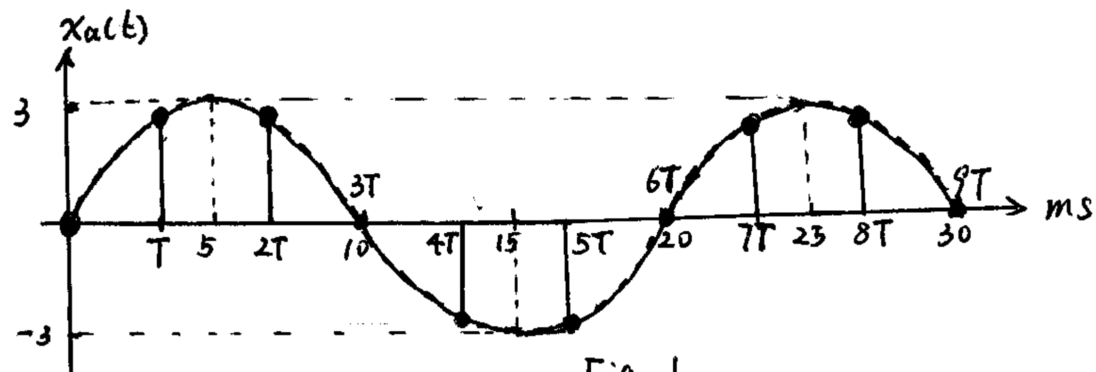

Fig. 1.

(b) $f = \frac{F}{F_s} = \frac{50}{300} = \frac{1}{6}$

$T = \frac{1}{F_s} = \frac{1}{300}s$

Since the frequency $f = \frac{1}{6}$ is rational, $x(n)$ is periodic.

(c) $x(n) = x_a(nT) = 3\sin(100\pi nT) = 3\sin(\frac{\pi n}{3})$

$T_a = \frac{1}{f_a} = \frac{1}{\frac{\pi/3}{2\pi}} = 6$

$x(0) = 0$, $x(1) = \frac{3\sqrt{3}}{2}$, $x(2) = \frac{3\sqrt{3}}{2}$, $x(3) = 0$, $x(4) = -\frac{3\sqrt{3}}{2}$, $x(5) = -\frac{3\sqrt{3}}{2}$,

$x(n)$ is sketched on Fig. 1 with black color. The period of $x(n)$ is 20 ms.

(d) $x(n) = x_a(nT) = x_a(\frac{n}{F_s}) = 3\sin(\frac{100\pi n}{F_s})$. P3

$3\sin(\frac{100\pi n}{F_s}) = 3 \Rightarrow \frac{100 n}{F_s} = \frac{1}{2} \Rightarrow F_s = 200 n$.

Therefore the minimum value for F_s is 200 samples/sec.