1.1 (a) One dimensional, multichannel, discrete time and digital.
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.

1.7

(a) $F_{max} = 10\,kHz \Rightarrow F_s \geq 2F_{max} = 20\,kHz$ This is based on Sampling Theorem.

(b) Since $F_s = 8\,kHz < 20\,kHz$, there is aliasing.
Therefore, the frequency content above the sampling rate F_s gets folded about $F_{fold} = \frac{1}{2}F_s = 4\,kHz$. So the frequency $F_1 = 5\,kHz$ gets folded to $F_a = 3\,kHz$

Note: We can also calculate the aliasing frequency F_a by using the following equation: $F_a = |k \cdot F_s - F_1|$, where k is the integer to get minimum F_a.
e.g. in this question, $F_a = |8 \cdot k - 5|$, by choosing $k=1$, we can get $F_a = 3\,kHz$.

(c) Following the same method illustrated in (b), we can get the frequency $F_2 = 9\,kHz$ get folded to $F_a = 1\,kHz$.

1.8) $F = 100$ Hz

a) Nyquist frequency $= 2F_{max}$

$\Rightarrow$ Nyquist frequency $= 200$ Hz

b) $F_s = 250$ samples/s

The maximum frequency that can be recovered is $\frac{250}{2} = 125$ Hz

1.9) $x_a(t) = \sin(480\pi t) + 3\sin(720\pi t)$, $F_s = 600$ Hz

a) The maximum frequency in this signal is radians is

$\Omega_{max} = 720\pi$ radian/sec

since $\Omega_{max} = 2\pi F_{max} \Rightarrow F_{max} = 360$ Hz

$\therefore$ The Nyquist rate $= 2F_{max} = 720$ Hz

b) The folding frequency $F_{fold} = F_s/2 \Rightarrow F_{fold} = 600/2 = 300$ Hz

c) The sampling of a continuous signal to a discrete signal is described by:

$x(n) = x_a(nT)$, we know $T = \frac{1}{F_s}$ — 600 Hz

$$\Rightarrow \quad x(n) = \sin\left(\frac{480}{600}\pi n\right) + 3\sin\left(\frac{720\pi n}{600}\right)$$

$$= \sin\left(\frac{4\pi n}{5}\right) - 3\sin\left(\frac{4}{5}\pi n\right)$$

$$\Rightarrow \quad x(n) = -2\sin\left(\frac{4}{5}\pi n\right)$$

$$\therefore \quad \omega = 2\pi f n \Rightarrow \omega = \frac{4\pi}{5} \text{ radians/sample}$$

d) We know the sampling frequency is 600 times/second

since $f = \frac{F}{F_s}$

$$\Rightarrow \quad y_a(t) = -2\sin\left(\frac{4\pi}{5} \times 600t\right) = -2\sin(480\pi t)$$

1.15 P_2

(a) The plot in Fig. 1 is the mirror-image of the plot in Fig. 4.
The plot in Fig. 2 is the mirror-image of the plot in Fig. 3.
When $F_0 = 3$ kHz and 4.5 kHZ, $F_s < 2F_0$, therefore this is aliasing.
$F_{fold} = \frac{F_s}{2} = 2.5$ kHz, thus $F_0 = 3$ kHz is aliased to 0.5 kHz and $F_0 = 4.5$ kHz is aliased to 2 kHz.

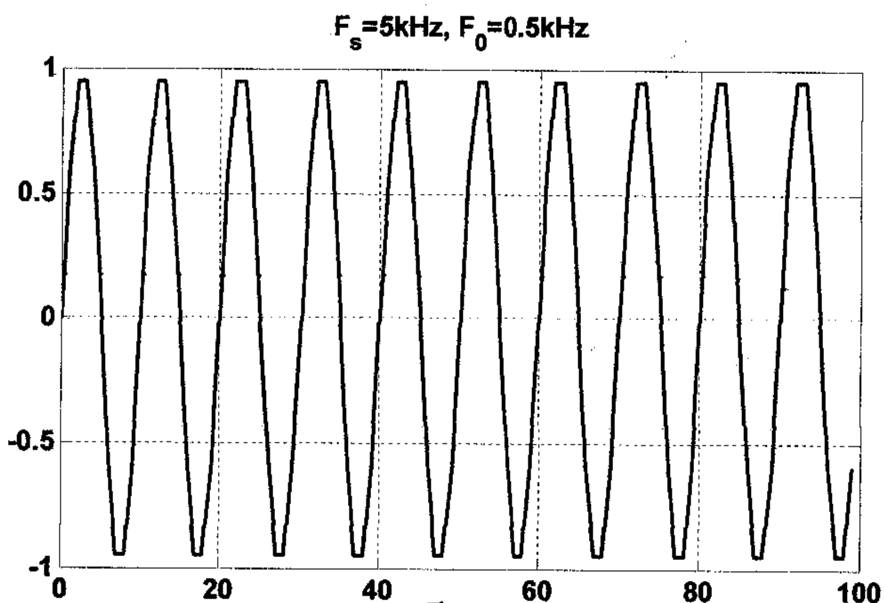

Fig. 1

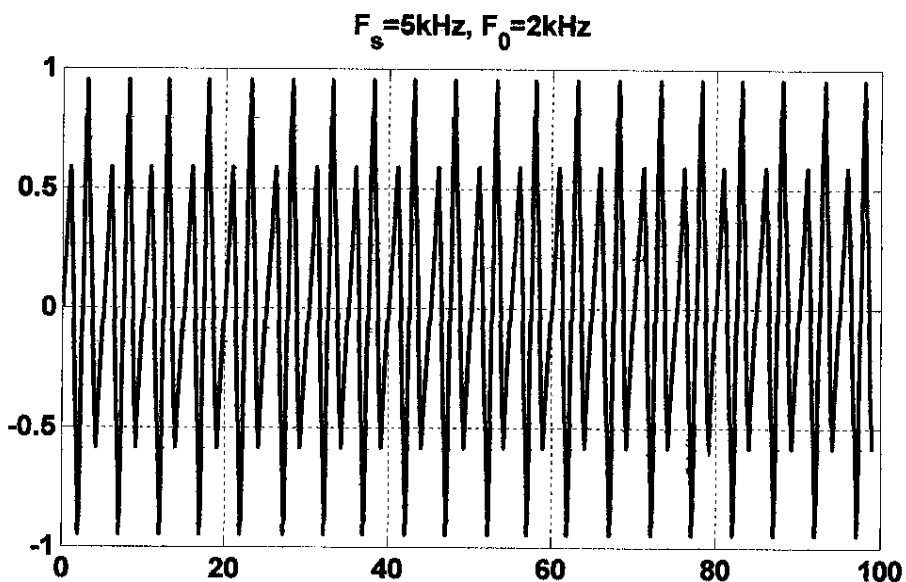

Fig. 2.

P3

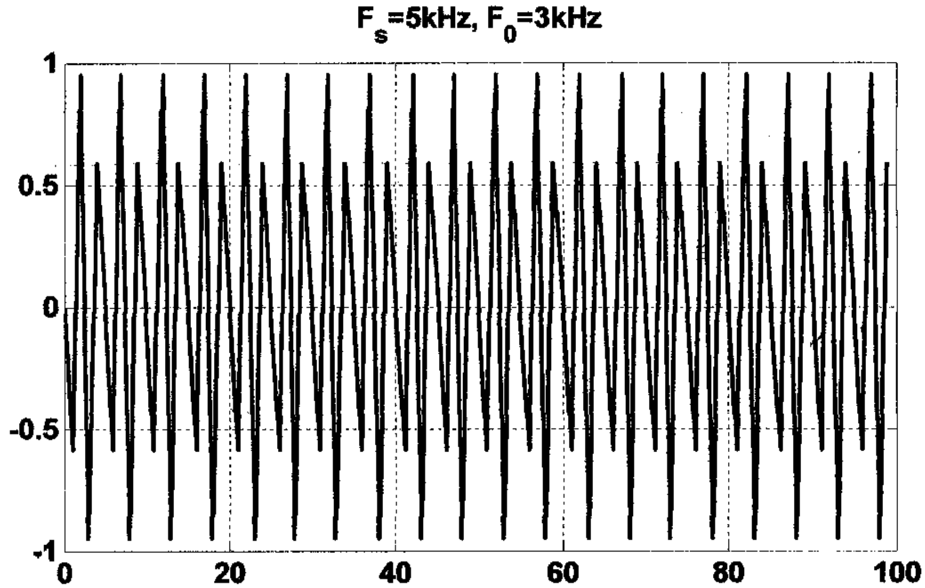
F_s=5kHz, F_0=3kHz
1
0.5
0
-0.5
-1
0
20
40
60
80
100

Fig. 3

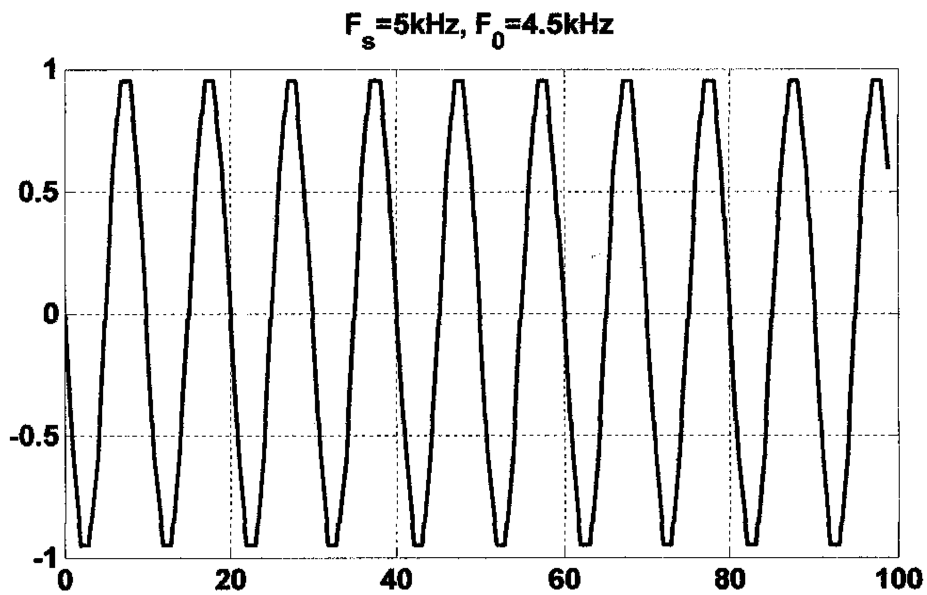
F_s=5kHz, F_0=4.5kHz
1
0.5
0
-0.5
-1
0
20
40
60
80
100

Fig. 4

1.15

(b) 1. $x(n) = \sin(2\pi \frac{F_0}{F_s} n) = \sin(2\pi \frac{2}{50} n) = \sin(\frac{2\pi}{25} n)$

Thus $f_0 = \frac{1}{25}$ and the plot is shown in Fig. 5.

2. By taking the even numbered samples, the sampling frequency is reduced to half of F_s, i.e. 25 Hz, which is still larger than the Nyquist rate $2F_0$. Thus, there is no aliasing, and $y(n)$ is still a sinusoidal signal. $y(n) = \sin(2\pi \frac{F_0}{F_s'} n) = \sin(2\pi \frac{2}{25} n) = \sin(\frac{4\pi}{25} n)$ is plotted in Fig. 6, and its frequency is $f_0 = \frac{2}{25}$.

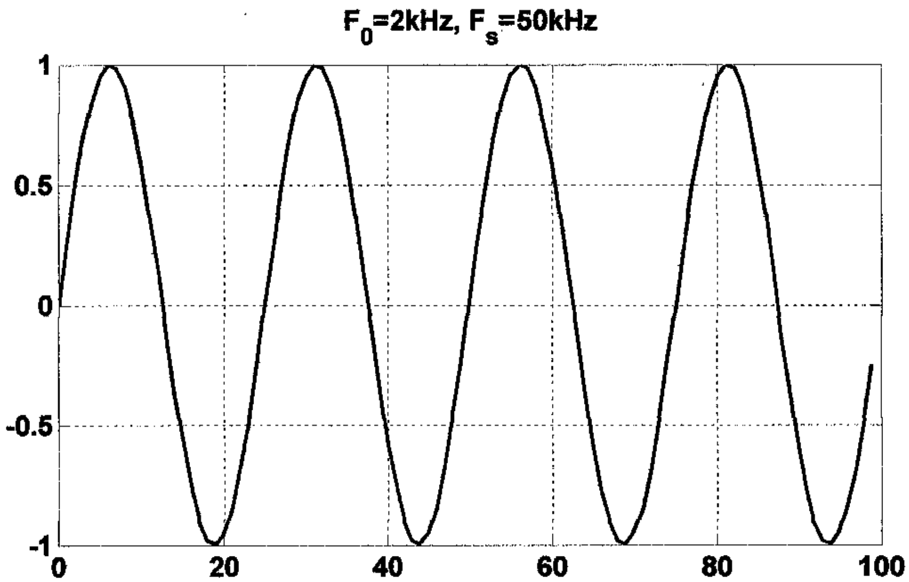

Fig. 5

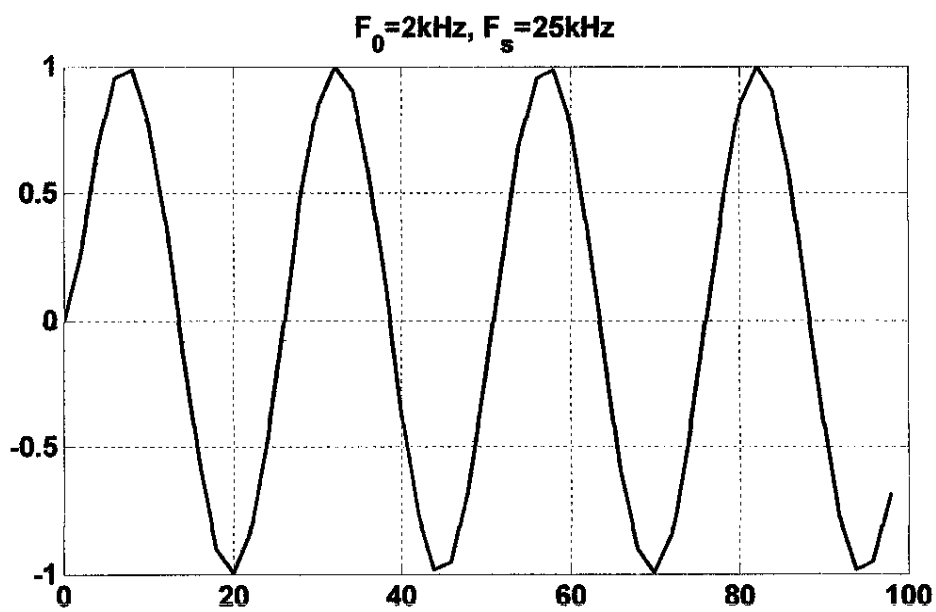

Fig. 6