6.1-3 The pulse train is a periodic signal with fundamental frequency $2B$ Hz. Hence, $\omega_s = 2\pi(2B) = 4\pi B$. The period is $T_0 = 1/2B$. It is an even function of t. Hence, the Fourier series for the pulse train can be expressed as

$$p_{T_s}(t) = C_0 + \sum_{n=1}^{\infty} C_n \cos n\omega_s t$$

Using Eqs. (2.72), we obtain

$$a_0 = C_0 = \frac{1}{T_0}\int_{-1/16B}^{1/16B} dt = \frac{1}{4}, \qquad a_n = C_n = \frac{2}{T_0}\int_{-1/16B}^{1/16B} \cos n\omega_s t \, dt = \frac{2}{n\pi}\sin\left(\frac{n\pi}{4}\right), \qquad b_n = 0$$

Hence,

$$\begin{aligned}\overline{g}(t) &= g(t)p_{T_s}(t)\\ &= \frac{1}{4}g(t) + \sum_{n=1}^{\infty}\frac{2}{n\pi}\sin\left(\frac{n\pi}{4}\right) g(t)\cos n\omega_s t\end{aligned}$$

6.1-6 **(a)** When the input to this filter is $\delta(t)$, the output of the summer is $\delta(t) - \delta(t-T)$. This acts as the input to the integrator. And, $h(t)$, the output of the integrator is:

$$h(t) = \int_0^t [\delta(\tau) - \delta(\tau - T)]\, d\tau = u(t) - u(t-T) = \text{rect}\left(\frac{t - \frac{T}{2}}{T}\right)$$

The impulse response $h(t)$ is shown in Fig. S6.1-6a.
(b) The transfer function of this circuit is:

$$H(\omega) = T\,\text{sinc}\left(\frac{\omega T}{2}\right)e^{-j\omega T/2}$$

and

$$|H(\omega)| = T\left|\text{sinc}\left(\frac{\omega T}{2}\right)\right|$$

The amplitude response of the filter is shown in Fig. S6.1-6b. Observe that the filter is a lowpass filter of bandwidth $2\pi/T$ rad/s or $1/T$ Hz.
The impulse response of the circuit is a rectangular pulse. When a sampled signal is applied at the input, each sample generates a rectangular pulse at the output, proportional to the corresponding sample value. Hence the output is a staircase approximation of the input as shown in Fig. S6.1-6c.

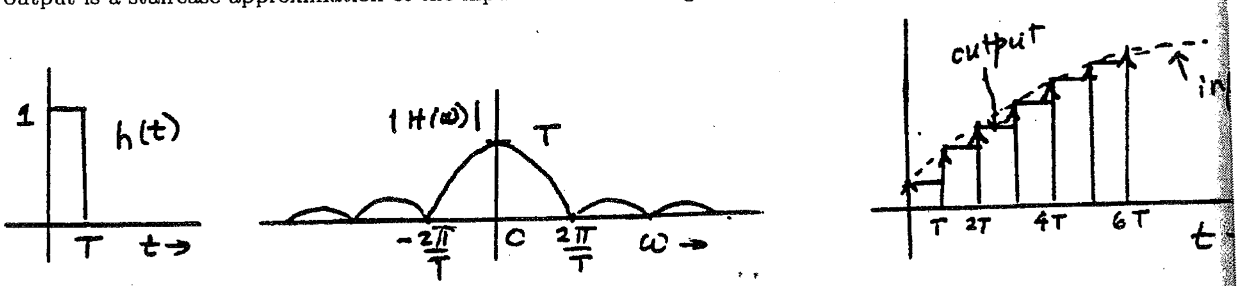

Figure S6.1-6

6.2-3

(a) The Nyquist rate is $2 \times 4.5 \times 10^6 = 9$ MHz. The actual sampling rate $= 1.2 \times 9 = 10.8$ MHz.
(b) $1024 = 2^{10}$, so that 10 bits or binary pulses are needed to encode each sample.
(c) $10.8 \times 10^6 \times 10 = 108 \times 10^6$ or 108 Mbits/s.

6.2-5 Nyquist rate for each signal is 200 Hz.
The sampling rate $f_s = 2 \times$ Nyquist rate $= 400$ Hz
Total number of samples for 10 signals $= 400 \times 10 = 4000$ samples/second.
Quantization error $\leq \frac{0.25 m_p}{100} = \frac{m_p}{400}$
Moreover, quantization error $= \frac{\Delta v}{2} = \frac{2m_p}{2L} = \frac{m_p}{L} = \frac{m_p}{400} \implies L = 400$
Because L is a power of 2, we select $L = 512 = 2^9$, that is, 9 bits/sample.
Therefore, the minimum bit rate $= 9 \times 4000 = 36$ kbits/second.
The minimum cable bandwidth is 36/2=18 kHz.

6.2-8 Here $\mu = 100$ and the SNR = 45 dB= 31,622.77. From Eq. (6.18)

$$\frac{S_0}{N_0} = \frac{3L^2}{(\ln 101)^2} = 31,622.77 \implies L = 473.83$$

Because L is a power of 2, we select $L = 512 = 2^9$. The SNR for this value of L is

$$\frac{S_0}{N_0} = \frac{3(512)^2}{(\ln 101)^2} = 36922.84 = 45.67 \text{ dB}$$