Signals and Noise

- Quarter-wave symmetry
  - ✓ In this case, there is a full set of even harmonics
  - ✓ Odd harmonics that are present are in phase with the fundamental sine wave

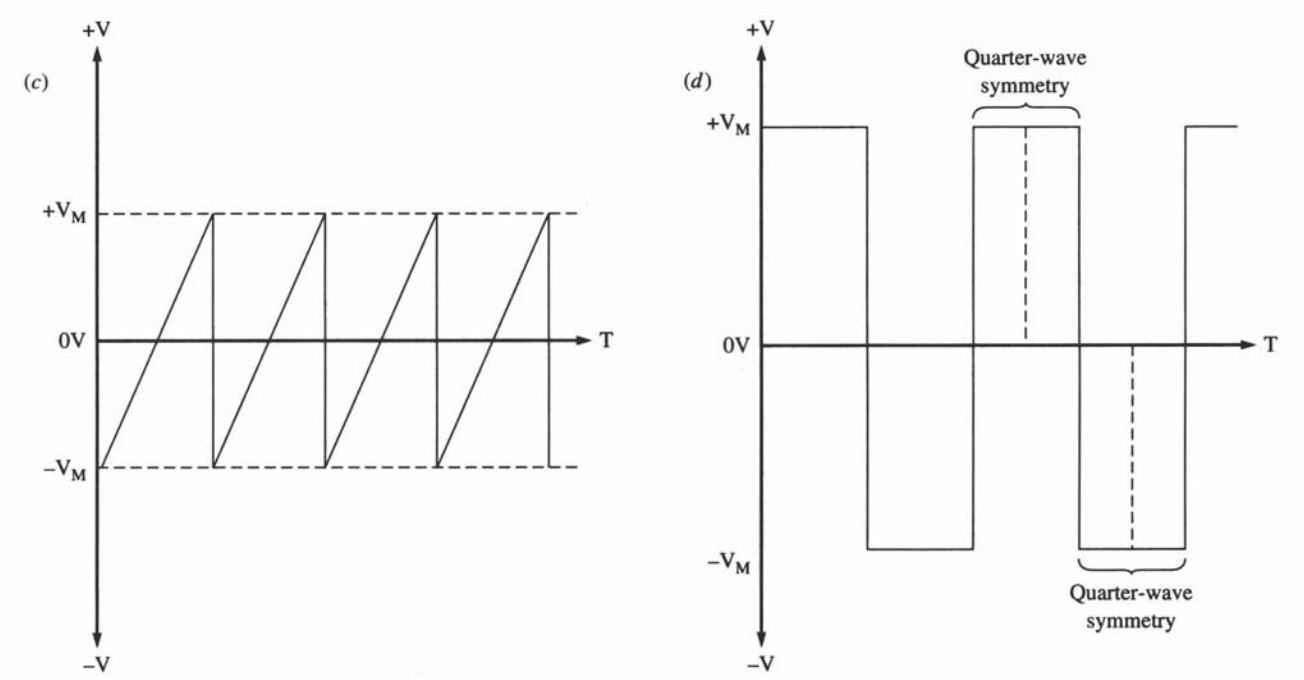
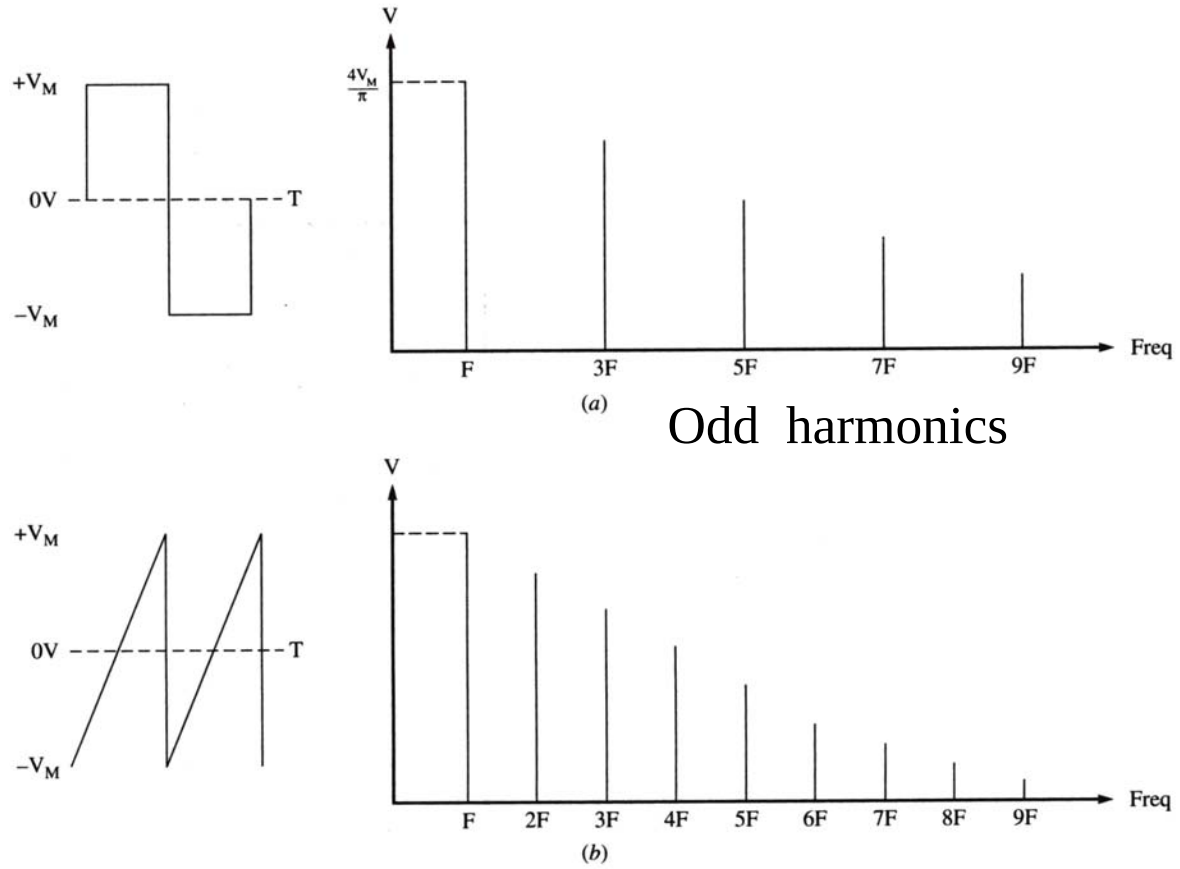


Figure 5-6
Waveform symmetry. (*a*) Square wave with DC component that causes asymmetry. (*b*) Symmetrical square wave. (*c*) Sawtooth waveform forms mirror image across zero baseline. (*d*) Quarter-wave symmetry.

Signals and Noise

- Fourier series for Square wave and Saw tooth wave



Odd harmonics

Figure 5-7
Fourier series for two waveforms: (*a*) Square wave. (*b*) Sawtooth wave.

Signals and Noise

- Transient signals
  - The signal is an event that occurs once only, occurs randomly over long period of time.
  - The spectrum of the transient signal is continuous rather than discrete
- The spectral density:

$$g(\omega) = \int_{-\infty}^{+\infty} f(t) e^{-j\omega t} dt$$

- Reconstructed:

$$f(t) = \frac{1}{2\pi} \int_{-\infty}^{+\infty} g(\omega) e^{j\omega t} d\omega$$

- The shape of the spectral density:

$$g(\omega) = \frac{\sin \omega t}{\omega t}$$

Signals and Noise

- Negative frequencies do not have physical reality

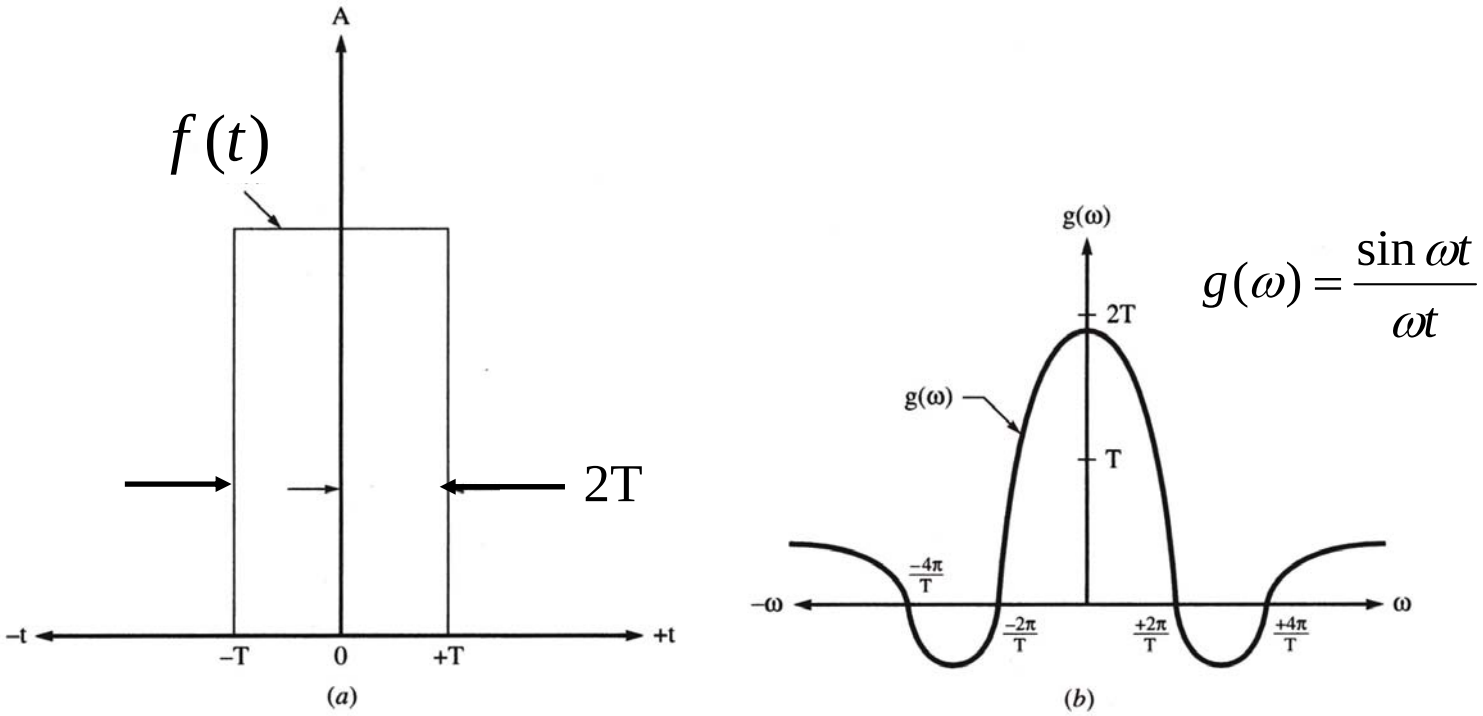


Figure 5-8
Transient signal has continuous spectrum. (*a*) Transient signal of duration 2T. (*b*) Spectral density region.

Signals and Noise

Sampled signals

- The digital computer is incapable of accepting(不能接受) analog input signal
- The computer requires a digitized representation(數位表示)of that signal
- The analog-to-digital (A/D) converter will convert the input voltage to representative binary word.

Continuous voltage function of time: $V(t)$
Sampling signal : $P(t)$
Frequency of sampling signal : F_s
Period of samping signal : $T = \frac{1}{F_s}$

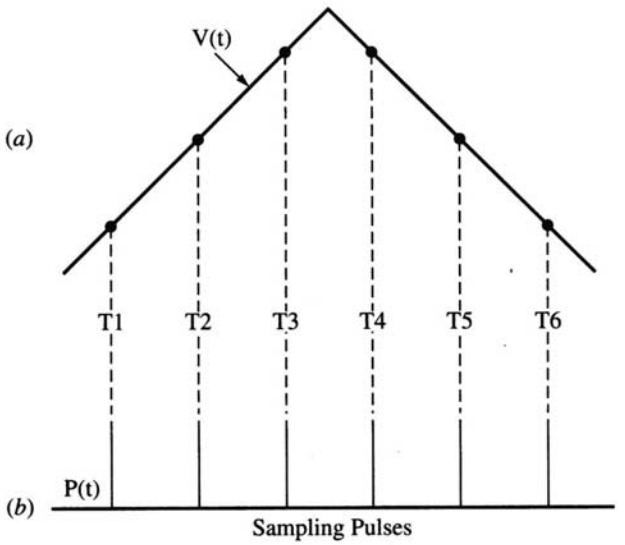


Figure 5-9
Sampled signal. (*a*) Continuous waveform.
(*b*) Sampled version of continuous waveform.
(*c*) Reconstructed waveform.