Signals

Sinusoidal waveform

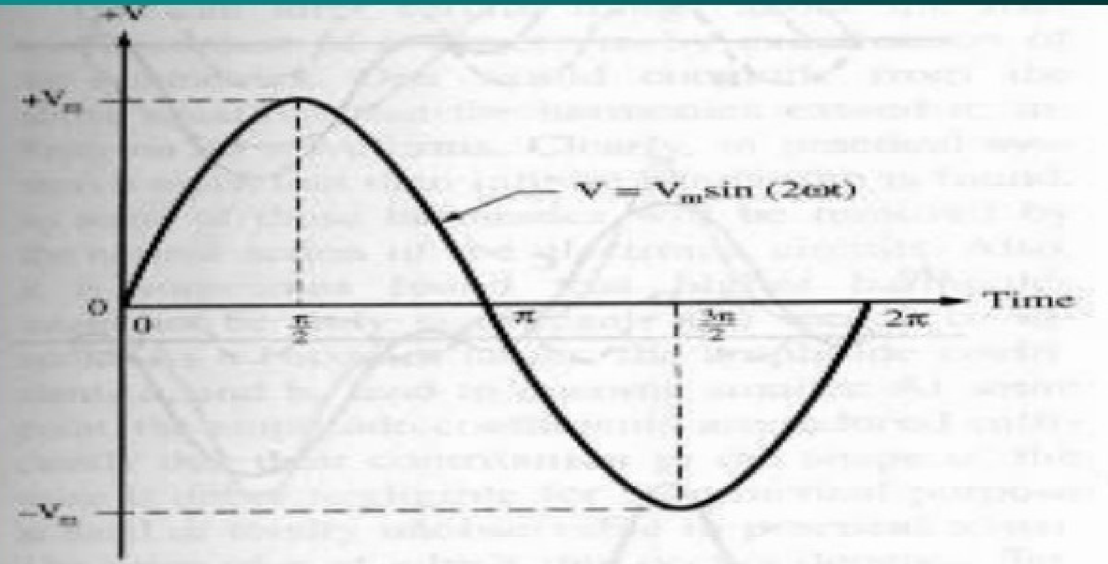


Figure 5-2
Sinusoidal waveform.

where

- v is the instantaneous amplitude of the sine wave
- V_M is the peak amplitude of the sine wave
- ω is the angular frequency (2πF) of the sine wave
- t is the time in seconds

Types of signal

a. Static: dc

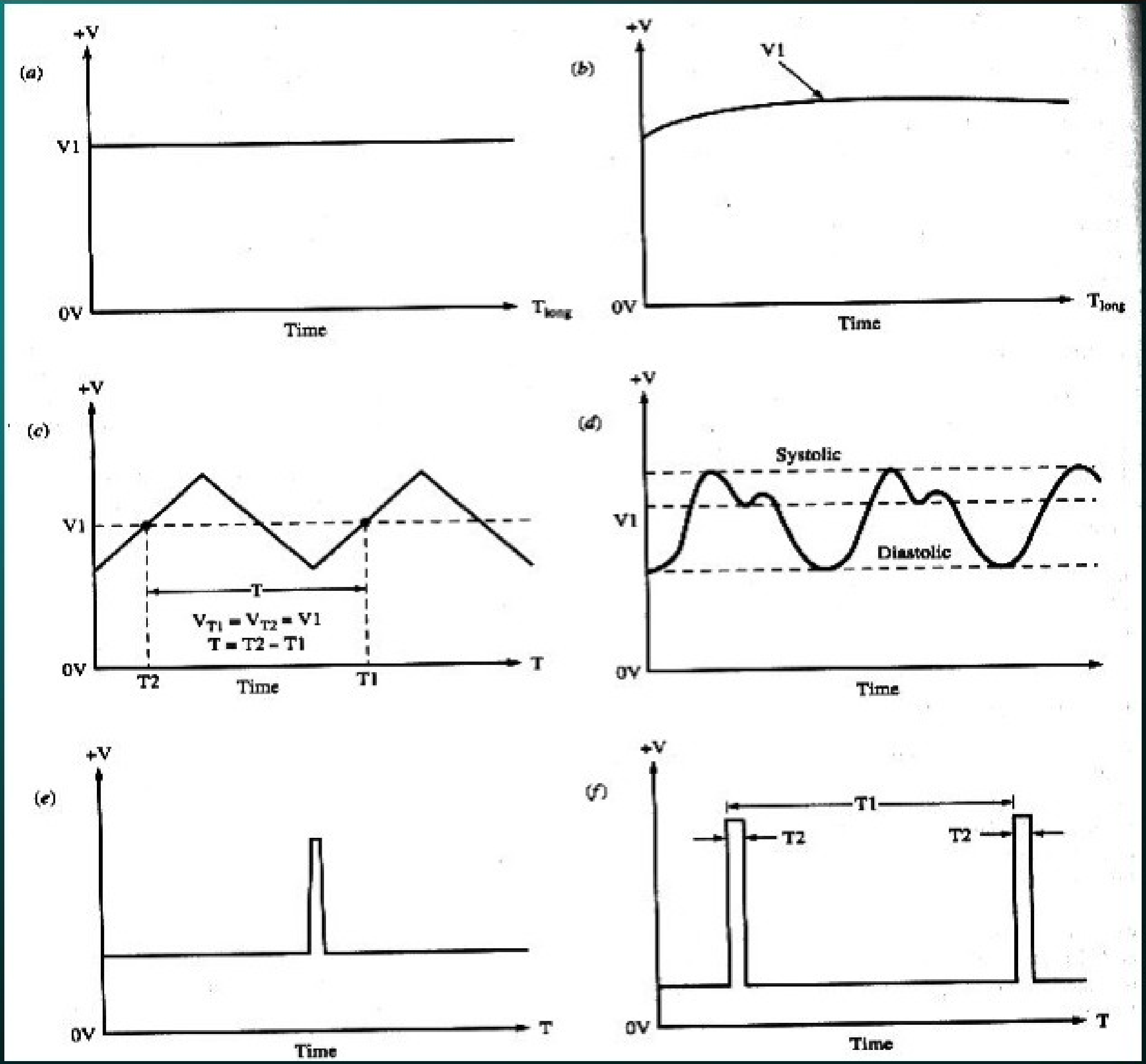
b. Quasistatic

c. Periodic: sine, square,…
   v(t)=v(t+T)

d. Repetitive: quasiperiodic

e. Single event transient signal

f. Repetitive single event



Waveform symmetry

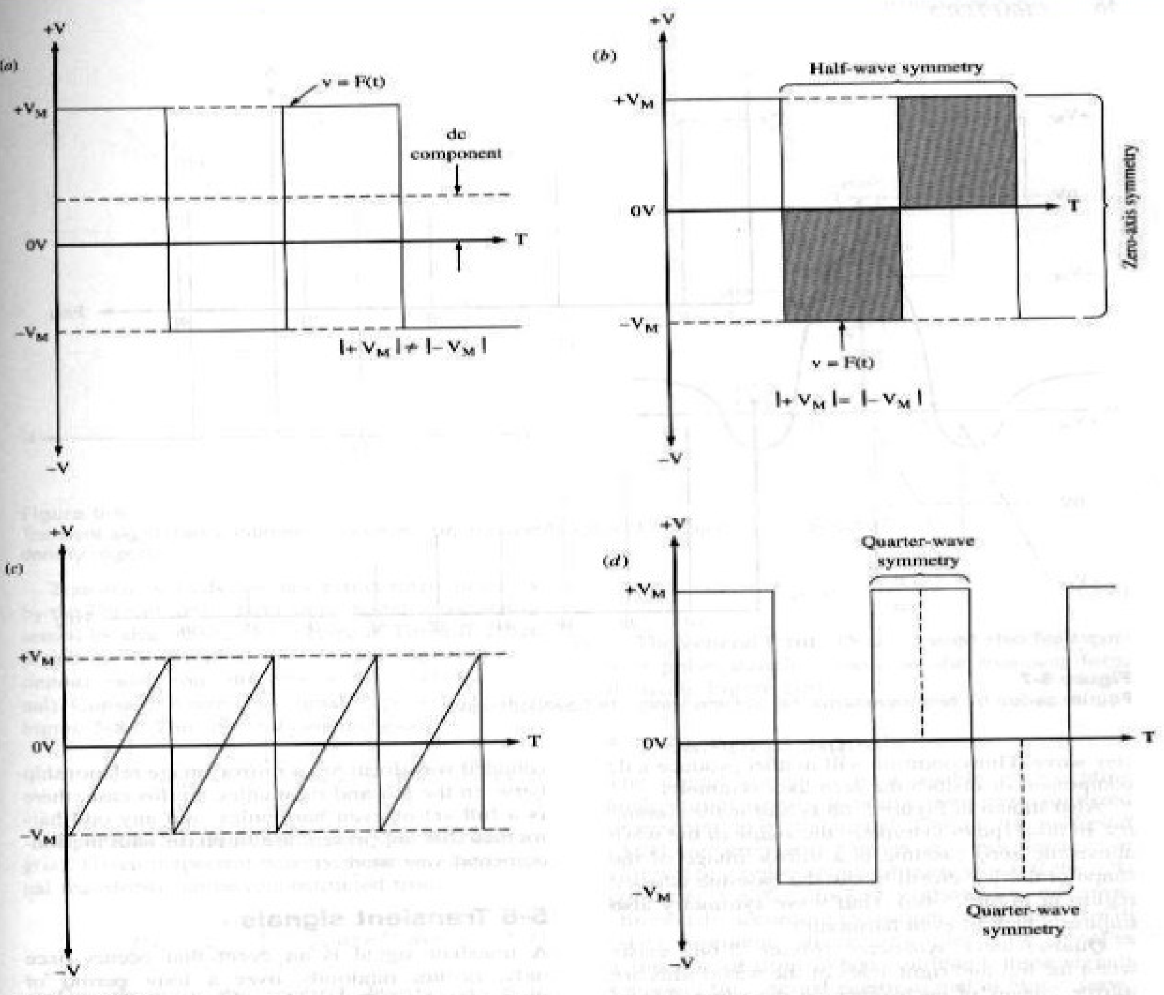
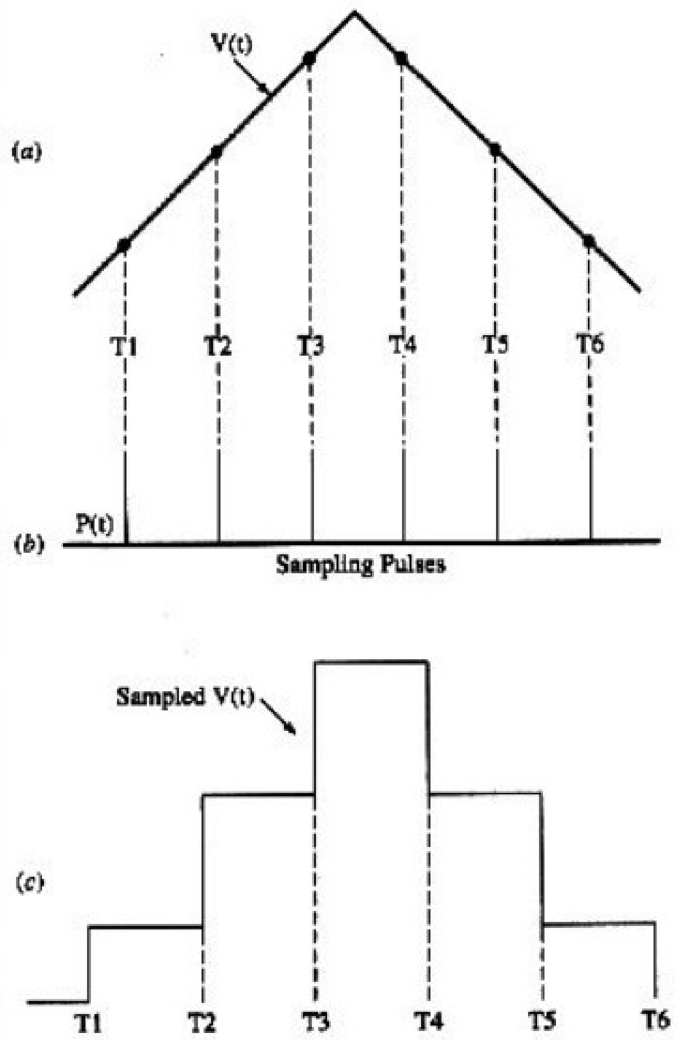


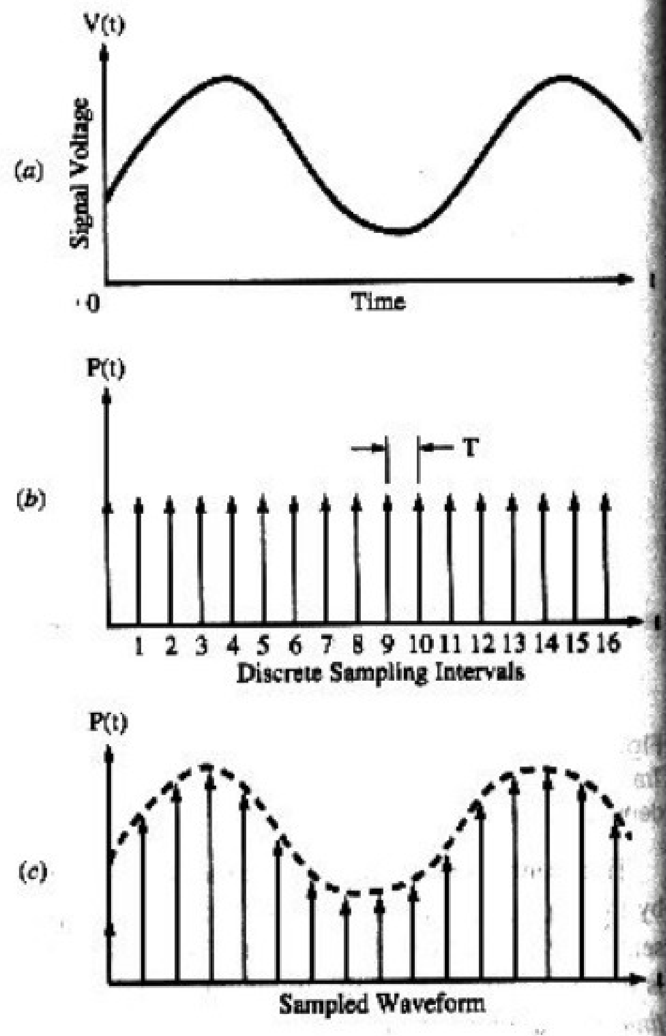
Figure 5-6
Waveform symmetry. (*a*) Square wave with DC component that causes asymmetry. (*b*) Symmetrical square wave. (*c*) Sawtooth waveform forms mirror image across zero baseline. (*d*) Quarter-wave symmetry.

Signal sampling

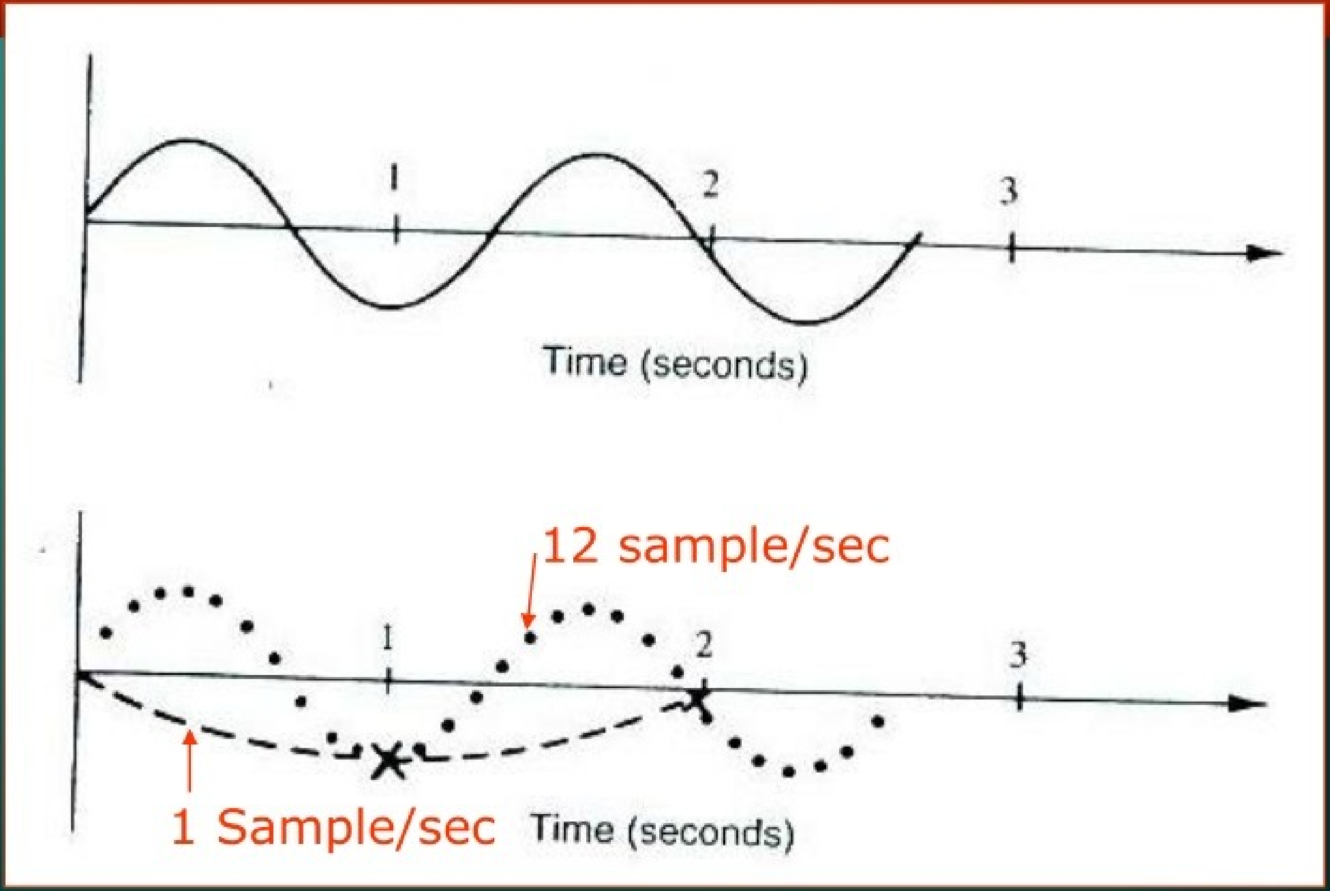
- Most instrumentation transducers have analog output
- At the interface between analog transducers and digital computers the signal must be digitized
- So the signal is sampled at regular intervals
- Each sample voltage is then converted into an equivalent digital value
- The next sample cannot be taken until the conversion of the last sample is to digital form is completed

Sampled signals





Effect of the sampling rate



If $f_{sampling} > f_{signal}$ → o.k. **Ideally $f_{sampling} = 2 f_{signal}$**

If $f_{sampling} < f_{signal}$ → aliasing

- To reconstruct the original signal after sampling pass the sampled waveform through a low-pass filter that blocks f_s
- Sampling is used to form
  - AM, PM,
- Some applications don't accept $f_{sampling}=2f_{signal}$ as in ECG $=5f_{signal}$

Essential Electronics Formula

- **Ohm's Law**

  The first of these is Ohm's Law, which states that a voltage of 1V across a resistance of 1 Ohm will cause a current of 1 Amp to flow. The formula is

  - R = V / I

    (where R = resistance in Ohms, V = Voltage in Volts, and I = current in Amps)
  - V = R * I
  - I = V / R

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Reactance

- **The impedance (reactance) of a capacitor**, which varies inversely with frequency (as frequency is increased, the reactance falls and vice versa).
  - $X_C = 1 / (2 \Pi f C)$
    - where X_c is capacitive reactance in Ohms, (Π pi) is 3.14159, f is frequency in Hz, and C is capacitance in Farads.
- **Inductive reactance**, being the reactance of an inductor. This is proportional to frequency.
  - $X_L = 2 \Pi f L$
    - where X_L is inductive reactance in Ohms, and L is inductance in Henrys

- **Decibels (dB)**

  $$dB = 20 \log (V1 / V2)$$
  $$dB = 20 \log (I1 / I2)$$
  $$dB = 10 \log (P1 / P2)$$

  Either way, a drop of **3dB** represents half the power and vice versa.

- **Frequency**
  There are many different calculations for this, depending on the combination of components.
  - The -3dB frequency for resistance and capacitance (the most common in amplifier design) is determined by

$$f_o = 1 / (2 \Pi R \mathbf{C})$$

- where f_o is the -3dB frequency

When resistance and inductance are combined, the formula is

$$f_o = R / (2 \Pi \mathbf{L})$$

- **Power**

  Power in any form can be calculated by a number of means:

$$P = V\ I$$
$$P = V^2 / R$$
$$P = I^2\ R$$

where P is power in watts, V is voltage in Volts, and I is current in Amps.