Signals and classification of signals

A signal is a function representing physical quantity or variable and typically it contain information about the behavior or nature of the phenomenon. For instance, in a *RC* circuit the signal may represent the voltage across the capacitor or the current flowing in the resistor. Mathematically, a signal is represented as a function of an independent variable *t.* Usually *t* represents time. Thus, a signal is denoted by x(t).

A. Continuous-Time and Discrete-Time Signals: A signal *x(t)* is a *continuous-time* signal if *t* is a continuous variable. If *t* is a discrete variable, that is, *x(t)* is defined at discrete times, then *x(t)* is a *discrete-time* signal. Since a discrete-time signal is defined at discrete times, a discrete-time signal is often identified as a *sequence* of numbers, denoted by *{x n}* or x[n], where ***n*** = integer. Illustrations of a continuous-time signal *x(t)* and of a discrete-time signal ***x[n]*** are shown in Fig.

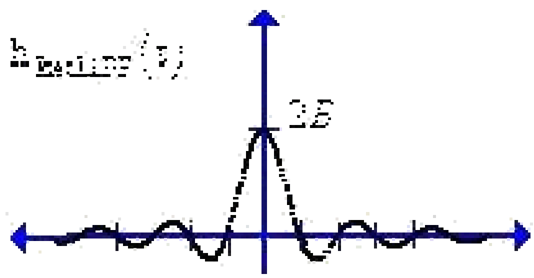

Figure 1.4

A discrete-time signal *x[n] may* represent a phenomenon for which the independent variable is inherently discrete. For instance, the daily closing stock market average is by its nature a signal that evolves at discrete points in time (that is, at the close of each day). On the other hand a discrete-time signal *x[n]* may be obtained by *sampling* a continuous-time

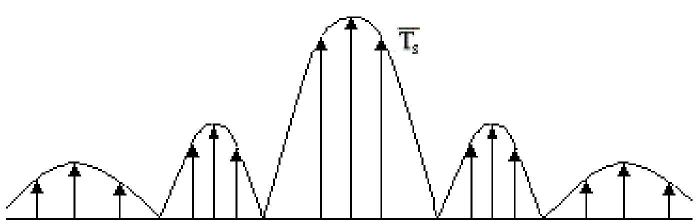

Figure 1.5

signal *x (t)* such as *x (to), x (ti), ...,x (tn), ...*

B. Analog and Digital Signals: If a continuous-time signal *x(t)* can take on any value in the continuous interval *(a, b),*

where *a* may be – ∞ and *b* may be ∞ then the continuous-time signal *x(t)* is called an *analog* signal. If a discrete-time signal *x[n] can* take on only a finite number of distinct values, then we call this signal a *digital* signal.

C. Real and Complex Signals: A signal *x(t)* is a *real* signal if its value is a real number, and a signal *x(t)* is a *complex* signal if its value is a complex number. A general complex signal *x(t)* is a function of the form

$$x(t) = x\, l\, (t) + jx$$

D. **Deterministic and Random Signals:**

Deterministic signals are those signals whose values are completely specified for any given time. Thus, a deterministic signal can be modeled by a known function of time *1.* *Random* signals are those signals that take random values at any given time and must becharacterized statistically. Random signals will not be discussed in this text.

E. **Even and Odd Signals:**

A signal *x(t)* or is referred to as an *even* signal if

$$x\,(-t) = x(t)$$

A signal *x(t)* or is referred to as an *odd* signal if

$$x\,(-t) = -\,x(t)$$

Examples of even and odd signals:

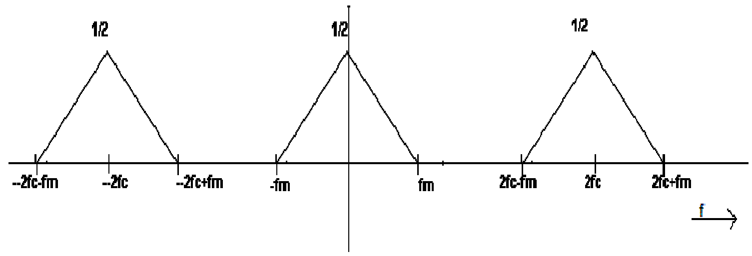

Figure 1.6 Even signal

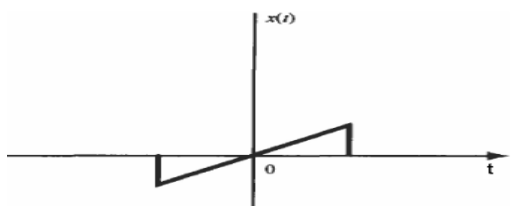

Figure 1.7 Odd signal

F. Periodic and Nonperiodic Signals:

A continuous-time signal *x(t)* is said to be *periodic with period T* if there is a positive nonzero value of *T* for which

$$x(t) = x(t+T)$$

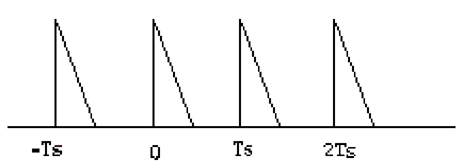

Figure 1.8

Othewise it is called aperiodic signal.