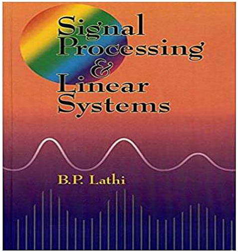
Lecture 1

- Textbooks
- Contents and Grading Scheme
- Examples of Signals
- Classification of Signals

EE322M: Textbooks



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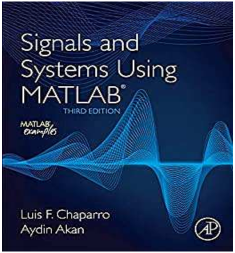

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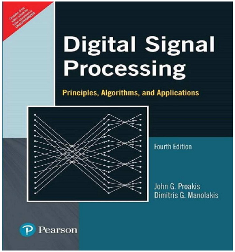

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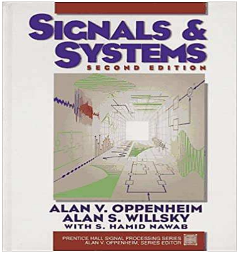

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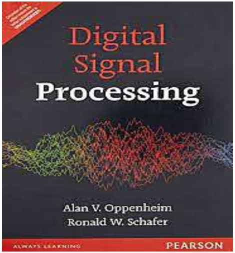

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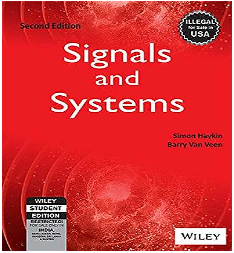

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Contents and Grading Scheme

Contents

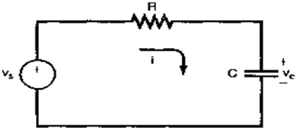
- Signals and systems
- Linear time-invariant systems
- Fourier series representation of periodic signals.
- Continuous-time Fourier transform
- Discrete-time Fourier transform
  - Fast Fourier Transform (FFT)
- Sampling
- Introduction to the design of digital filters
- Application of digital signal processing (DSP).

Grading

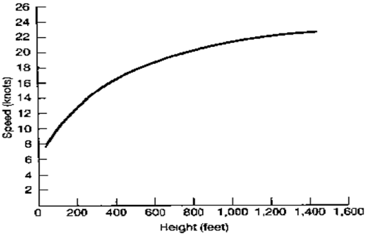
Item	Weight
Quiz (2)	$10 \times 2 = 20$
Mid-sem	40
End-sem	40
Total	100

Laboratory classes/demonstrations based on MATLAB

- A signal is a set of data or information.



Source voltage v_s or capacitor voltage v_c are examples of signals (function of time)



Typical vertical wind profile (function of height)

Classification of Signals

1. Continuous-time and discrete-time signals
2. Analog and digital signals
3. Periodic and aperiodic signals
4. Energy and power signals
5. Deterministic and probabilistic signals

A signal that is specified for a continuum of values of time t is a continuous-time signal .
A signal that is specified only at discrete values of t is a discrete-time signal

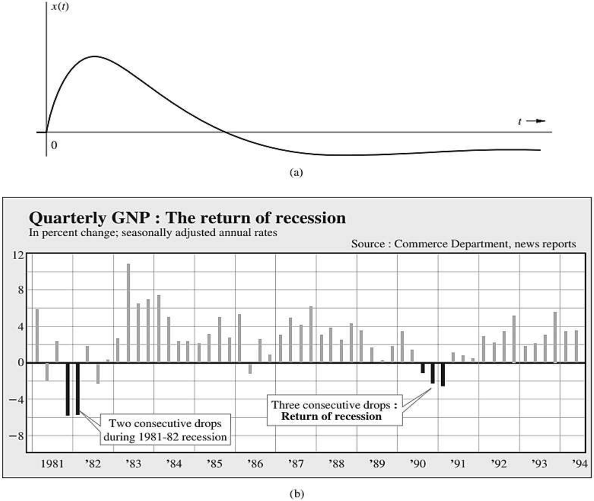


Figure **(a)** Continuous-time and **(b)** discrete-time signals.

A signal whose amplitude can take on any value in a continuous range is an analog signal. A digital signal, on the other hand, is one whose amplitude can take on only a finite number of values.

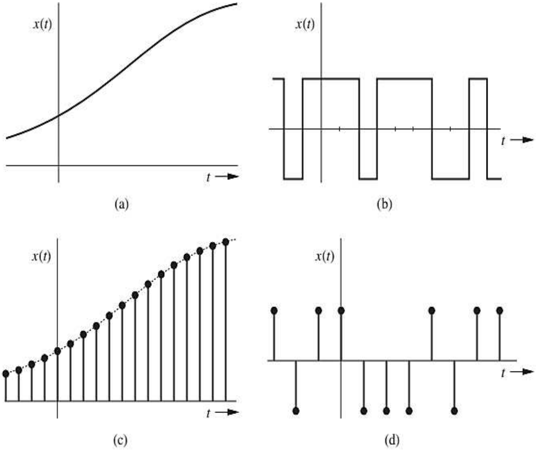
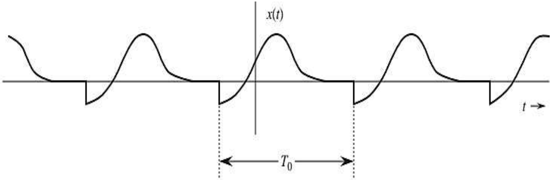


Figure Examples of signals: **(a)** analog, continuous time; **(b)** digital, continuous time; **(c)** analog, discrete time; and **(d)** digital, discrete time.

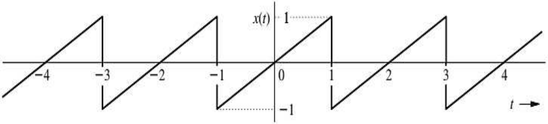
A signal $x(t)$ is said to be periodic if for some positive constant T_0

$$x(t) = x(t + T_0) \text{ for all } t$$

The smallest value of T_0 that satisfies the above periodicity condition is the fundamental period of $x(t)$.



A periodic signal of period T_0.



A periodic signal with period 2

An additional useful property of a periodic signal $x(t)$ of period T_0 is that the area under $x(t)$ over any interval of duration T_0 is the same; that is, for any real numbers a and b,

$$\int_a^{a+T_0} x(t)dt = \int_b^{b+T_0} x(t)dt.$$

For convenience, the area under $x(t)$ over any interval of duration T_0 will be denoted by

$$\int_{T_0} x(t)dt$$

The signal energy E_x is defined as

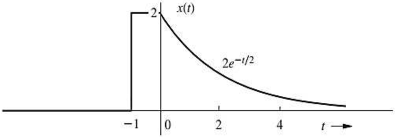
$$E_x = \int_{-\infty}^{\infty} |x(t)|^2 dt.$$

For a signal $x(t)$, we define its power P_x as

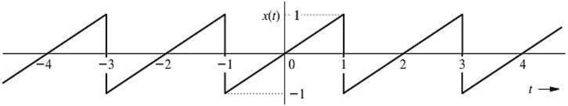
$$P_x = \lim_{T \to \infty} \frac{1}{T} \int_{-T/2}^{T/2} |x(t)|^2 dt$$

When $x(t)$ is periodic, $|x(t)|^2$ is also periodic. Hence, the power of $x(t)$ can be computed by averaging $|x(t)|^2$ over one period.

A signal with finite energy is an energy signal, and a signal with finite and nonzero power is a power signal.



(a)



(b)

$$E_x = \int_{-\infty}^{\infty} |x(t)|^2 \, dt = \int_{-1}^{0} (2)^2 \, dt + \int_{0}^{\infty} 4e^{-t} \, dt = 4 + 4 = 8$$

$$P_x = \frac{1}{2} \int_{-1}^{1} |x(t)|^2 \, dt = \frac{1}{2} \int_{-1}^{1} t^2 \, dt = \frac{1}{3}$$

The signal in (a) is an energy signal and the one in (b) is a power signal.

Determinsitic and random signals

A signal whose physical description is known completely, in either a mathematical form or a graphical form, is a deterministic signal.
A signal whose values cannot be predicted precisely but are known only in terms of probabilistic description, such as mean value or mean-squared value, is a random signal.