

## Data and Signal

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# Data and Signal

The Topics will be cover in this chapter

- **What is data?**
- **Distinguish between data and signal.**
- **Distinguish between Analog and digital signal.**
- **Explanation the difference between time and Frequency domain representation of signal.**
- **Specify the bandwidth of the signal.**
- **Explain the bit interval and bit rate of the Digital signal.**

# Outline of The Lecture

- Data and Data Types.
- Analog and Digital Data.
- Signal and Signal Type.
- Example of Analog and Digital signal.
- Periodic Signal Characteristics.
- Time and Frequency domain representation.
- Spectrum and bandwidth of signal.
- Propagation time and bandwidth.

# Data and Data Type

## ➤ ***What is Data?***

Data is an entity that conveys some meaning based on some mutually agreed up rule/convention between a sender and a receiver.

## **Data Type**

Data can be analog and digital

# Analog Data

- Analog data have continuous values over time.
- **Example of analog data:-** Voice and video.  
Audio or acoustic data:  
Video:  
Physical Parameters: Data collected from all the real world with the help of transducer are continuous in nature.

# Digital Data



- Digital data can take on discrete values.
- **Example of Digital Data:-**
  - Text or character string.
  - Data stored in memory, say CD, have two discrete values, which can be represented by 0 and 1.

# Signal and Signal Type



## ➤ What is signal?

It is electric, electronic or optical representation of data, which can be sent over communication media.

## ➤ **Signal Type:** Analog and Digital

➤ Analog signal has continuous(infinite no of) values over a period of time.

# Example of Analog Signal

- A microphone converts voice data into voice signal, which can be sent over a pair of wire.



# Example of Digital Signal

- Digital signal can have only a limited no of defined values, usually two values 0 and 1.

# Analog Signal

- Analog signal can be classified as simple and composite.
- Example of simple analog signal is sine wave.
- A composite analog signal consists of a combination of multiple simple signals.

# Periodic Signal

- A signal is periodic if  $s(t+T)=s(t)$ , for  $-\infty < t < \infty$ , where  $T$  is time period of time.
- A periodic signal can be characterized by the following three parameters- **Amplitude, Frequency and phase**

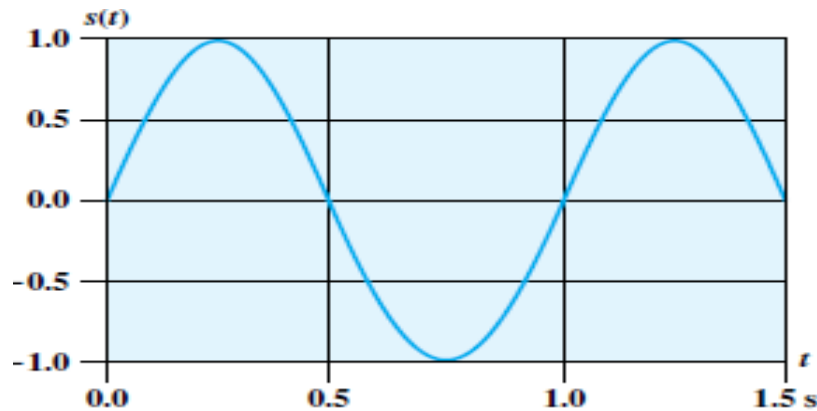
# Periodic Signal

- **Amplitude:** Value of signal at different instant of time, measured in volts.
- **Frequency:** It is inverse of time period. It is measured in Hertz.
- **Phase:** It gives a measure of relative position of two signals in time, expressed in degree or radian.

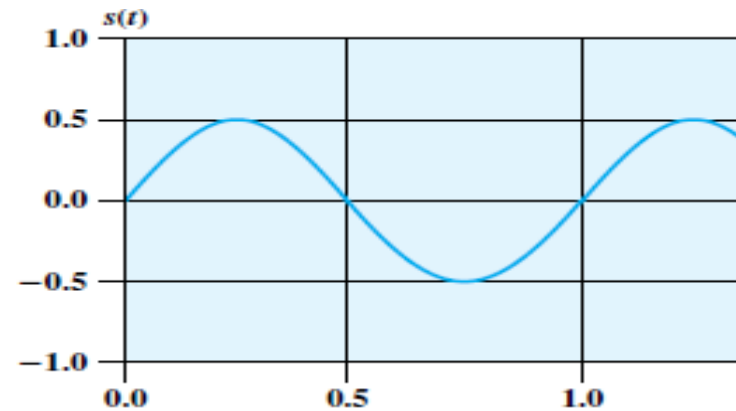
# Time and Frequency Domain

- An electromagnetic signal is commonly a composite signal made up of many frequencies.
- According to Fourier analysis, any composite signal can be expressed as a combination of simple sine wave with different amplitudes, frequencies and phase.
- $s(t) = A_1 \sin(2\pi f_1 t + \phi_1) + A_2 \sin(2\pi f_2 t + \phi_2) + \dots$

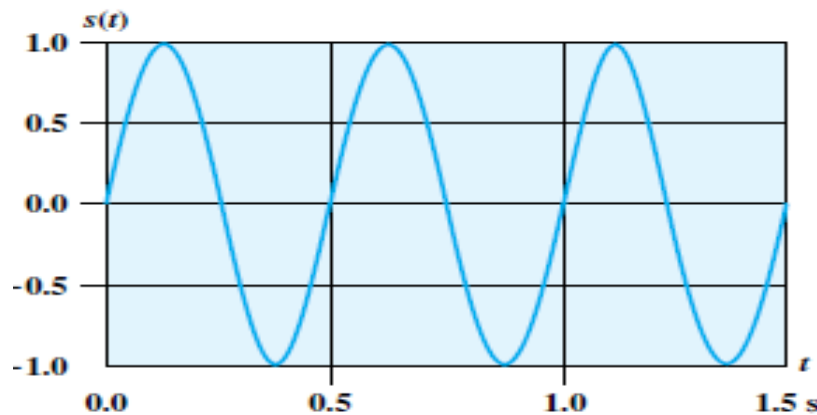
# Example of Signal With Different Amplitude, Frequency and Phase



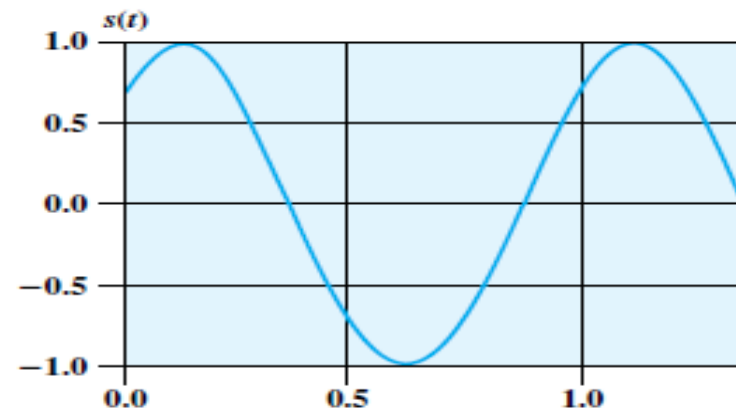
(a)  $A = 1, f = 1, \phi = 0$



(b)  $A = 0.5, f = 1, \phi = 0$



(c)  $A = 1, f = 2, \phi = 0$



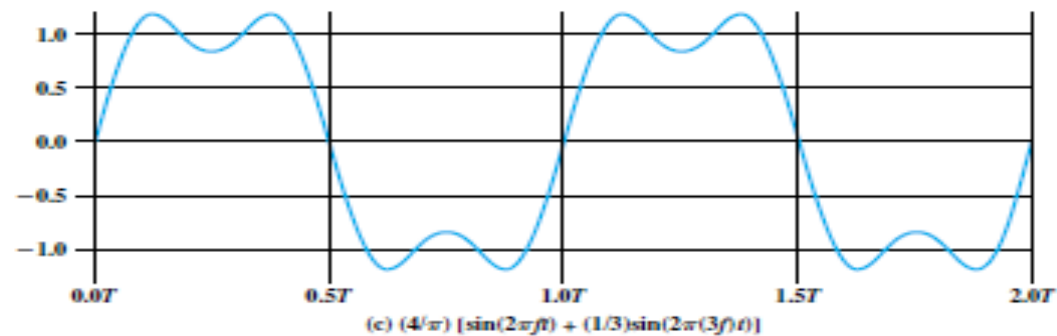
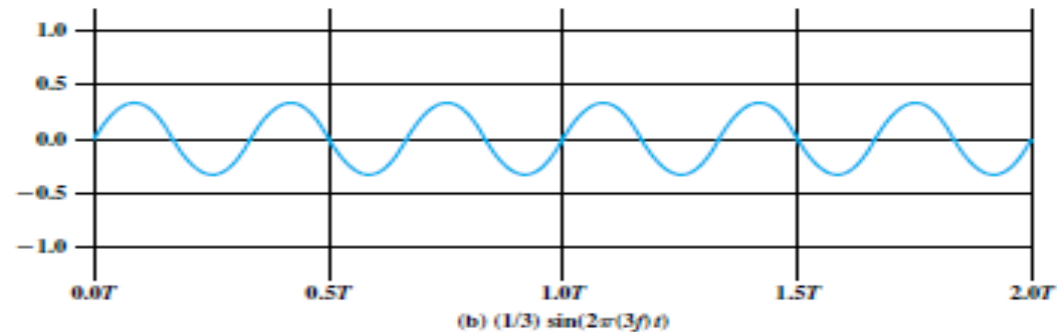
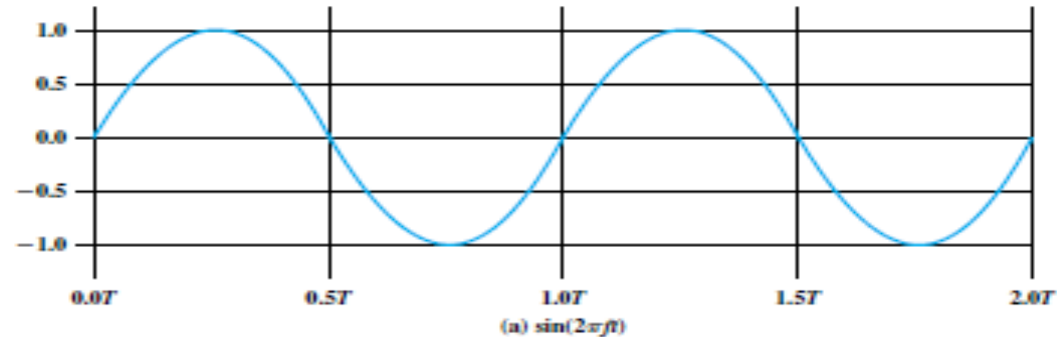
(d)  $A = 1, f = 1, \phi = \pi/4$

Figure 3.3  $s(t) = A \sin(2\pi ft + \phi)$

Example:

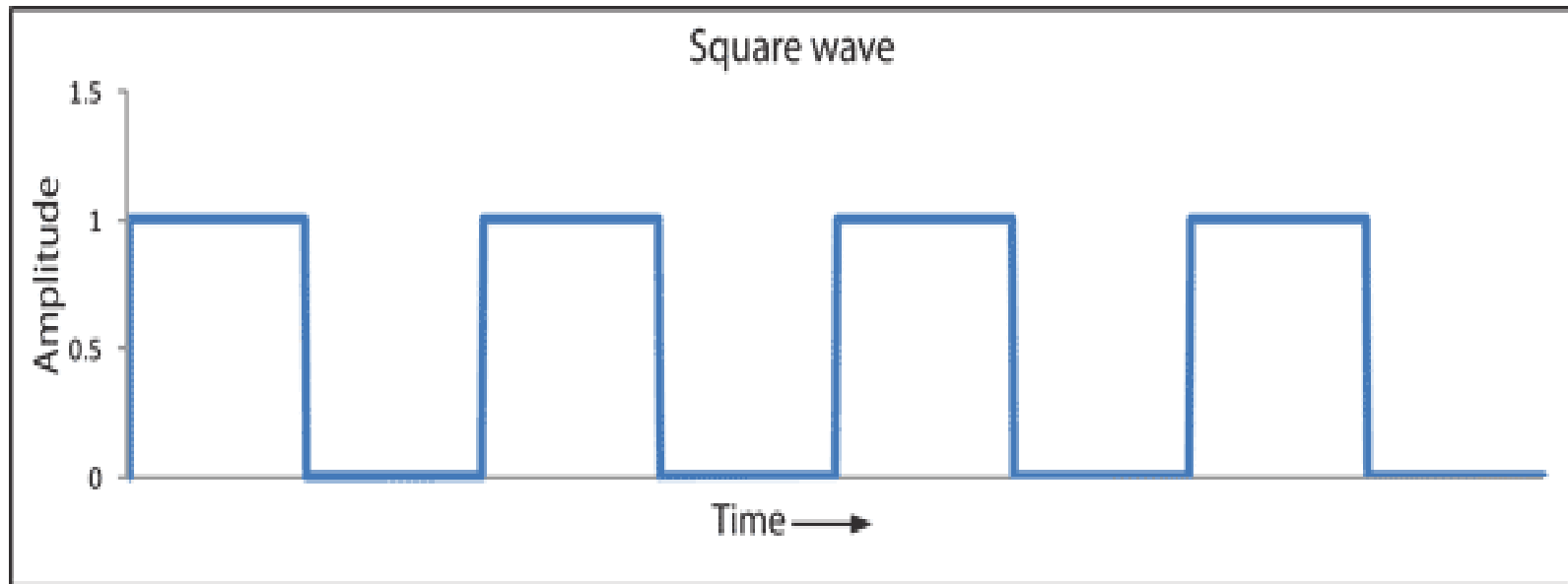
$$s(t) = \sin(2\pi f_1 t) + \frac{1}{3}\sin(2\pi f_1 t)$$

This has led to frequency  
-Domain representation  
of signals.



# Frequency Spectrum

- Frequency spectrum of a signal is the range of frequencies a signal contains.
- Example: A square wave

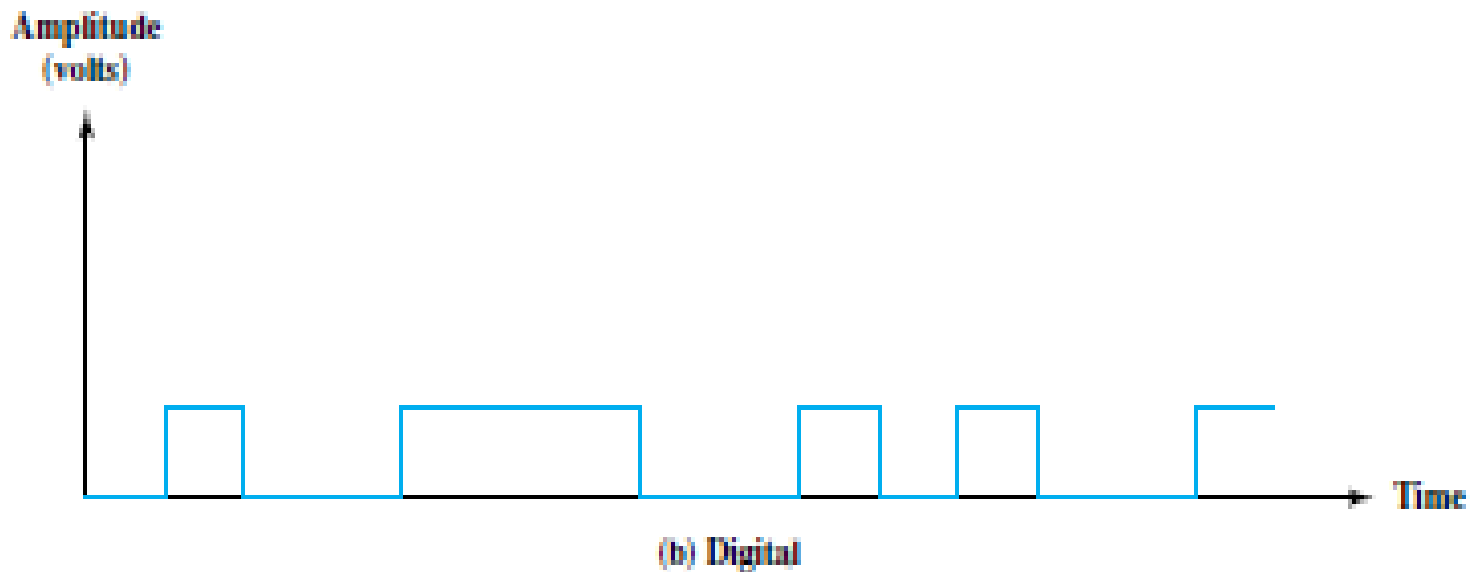




# Bandwidth

- Range of frequencies over which most of the signal energy of signal is contained is known as bandwidth or effective bandwidth of the signal. The term 'most' is somewhat arbitrary.

- Digital signal: data can be represented by a digital signal.



Most digital signal aperiodic in nature

# Bit Interval and Bit Rate

- **Bit Interval:** It is time required to send a single bit.
- **Bit Rate:** It is the no of bit intervals per second(bps).

# Analog Vs Digital

- A digital signal can be considered as a signal with infinite no frequencies.
- Digital transmission requires a low-pass channel.
- Analog transmission requires a band-pass channel.

# Propagation Time and Wavelength

- **Propagation Time:** Time require for signal to travel from one point of transmission medium to the other.
- **Propagation Time:-Distance/Propagation speed**
- **Wavelength:** Distance occupied in space by a single period.
- **Wavelength=Propagation speed × Period**  
**=Propagation speed /Frequency**

# Example

- Speed of electromagnetic signal in free space

# Thanks!