Teacher's Introduction

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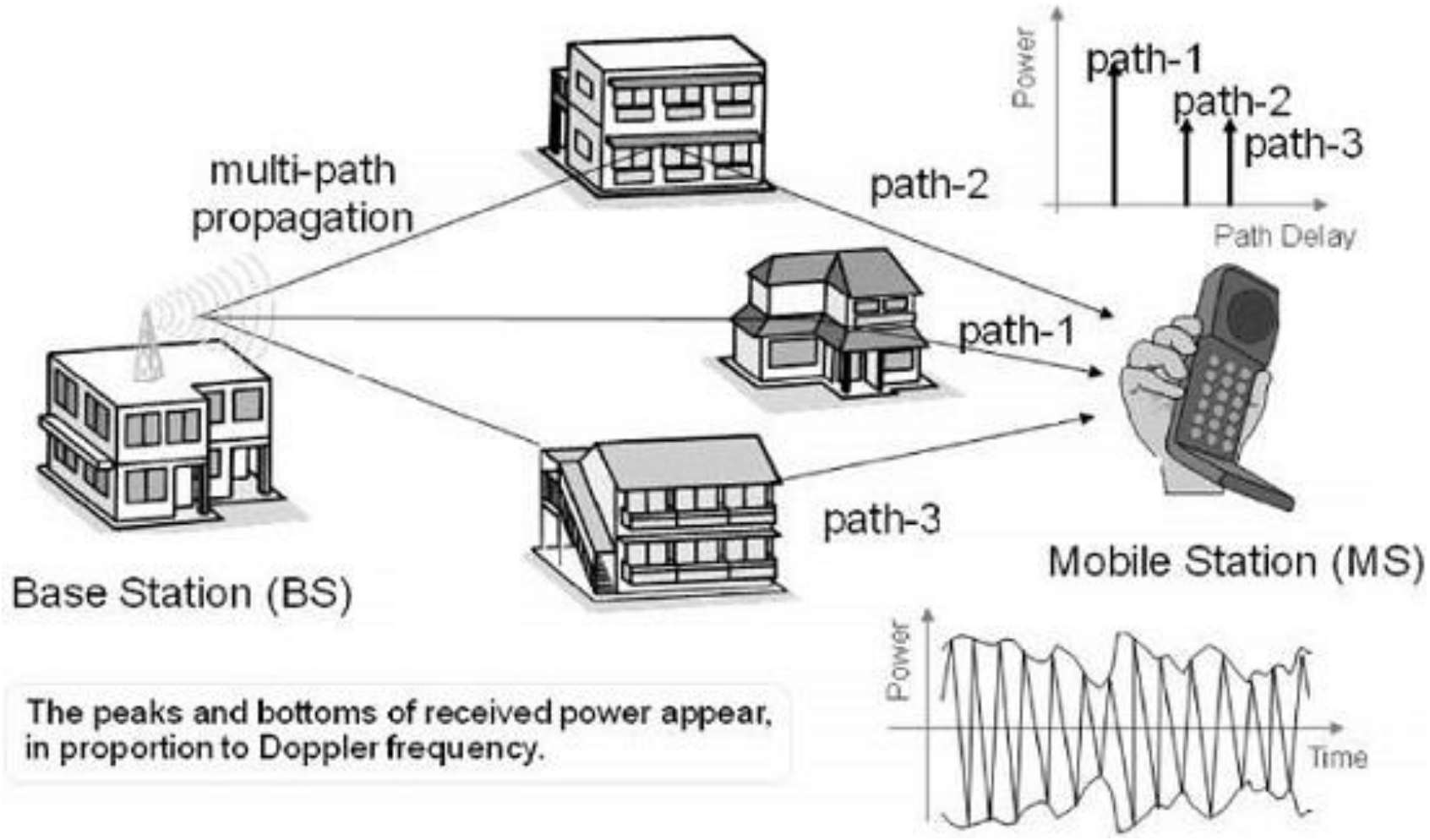
INTRODUCTION TO SIGNALS AND SYSTEMS

Motivation

- A common application is the restoration of signals that have been degraded in some way
- For example, when a pilot is communicating with an air-traffic control tower, the communication can be degraded by the high level of background noise in the cockpit
- In this case, it is possible to design systems that will retain the desired signal (pilot's voice), and reject (at least approximately) the unwanted signal (noise)
- Restoration and enhancement of images that are a degraded version of the scene being photographed (e.g. space images)

Motivation



https://www.tutorialspoint.com/cdma/cdma_fading.htm

What is a Signal?

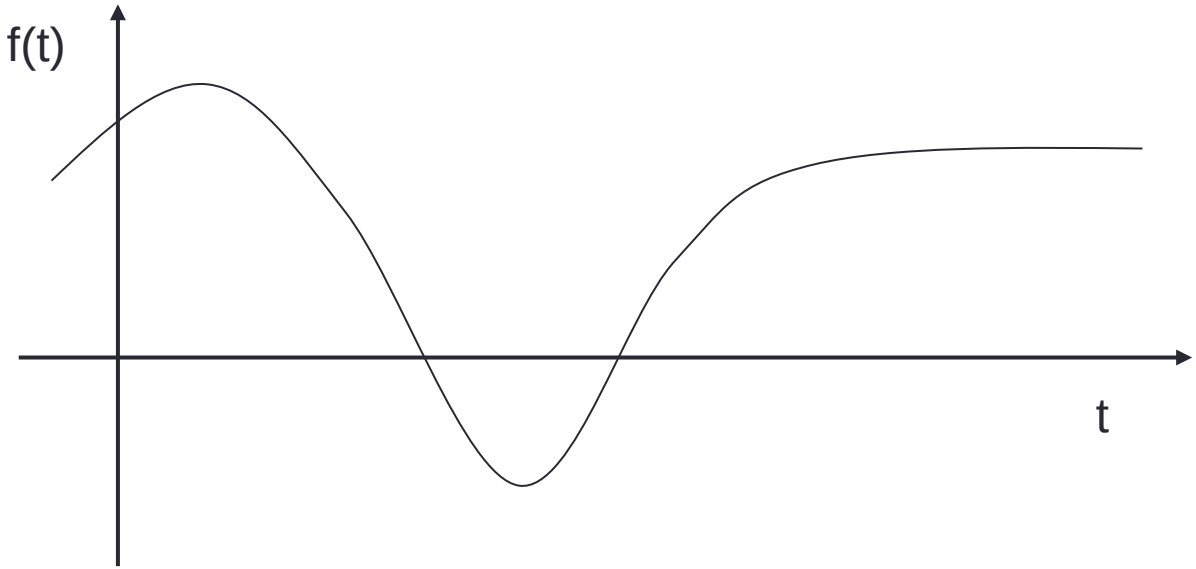
- A signal is a pattern of variation of some form
- Signals are variables that carry information
- Examples of signal include:
- Electrical signals - Voltages and currents in a circuit
- Acoustic signals - Acoustic pressure (sound) over time
- Mechanical signals - Velocity of a car over time
- Video signals - Intensity level of a pixel (camera, video) over time

Signal Representation

- Mathematically, signals are represented as a function of one or more independent variables

- For instance, the magnitude of a Radio Frequency signal is dependent on *x*, *y*, *z* coordinates as well as time *t*, $f(x,y,z,t)$

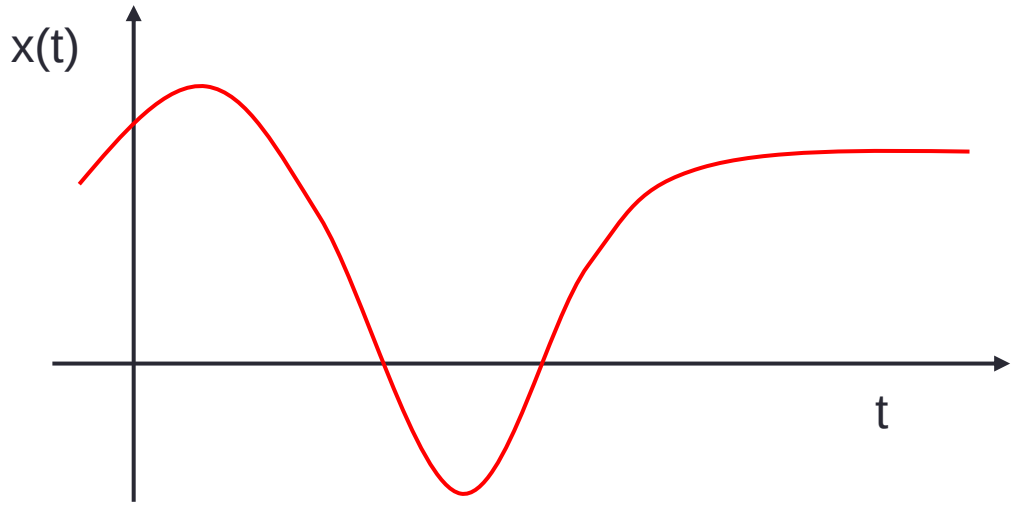
- In this course, we shall be exclusively concerned with signals that are a function of a single variable: time



Continuous Time Signals

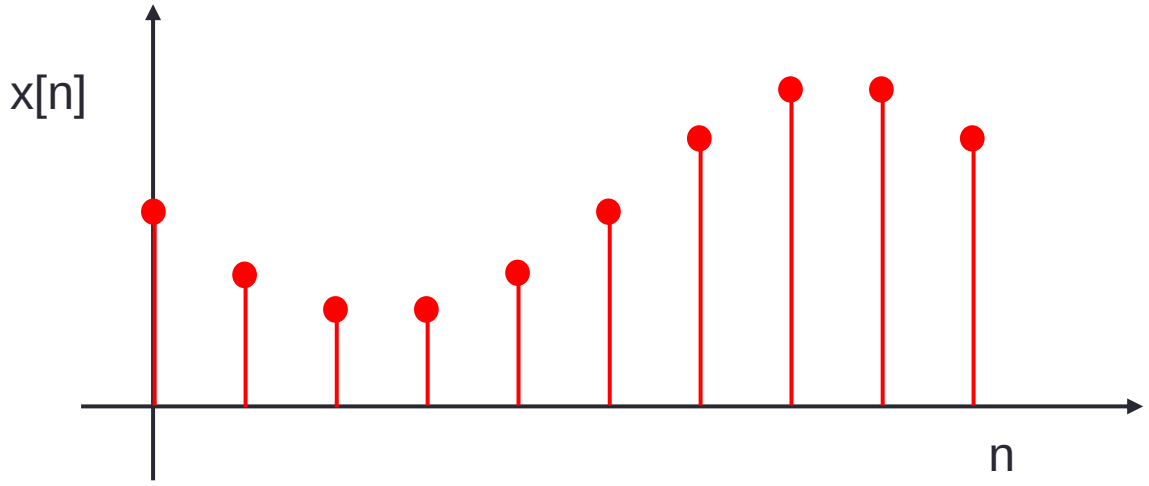
- Most signals in the real world are continuous time as the scale is infinitesimally fine, for example voltage, velocity…

- Denoted by $x(t)$, where the time interval may be bounded (finite) or infinite



Discrete-Time Signals

- A signal that is specified only at discrete values of time
- Some real world and many digital signals are discrete time as they are sampled, for example pixels, daily stock averages
- Denoted by $x[n]$, where n is an integer value that varies discretely

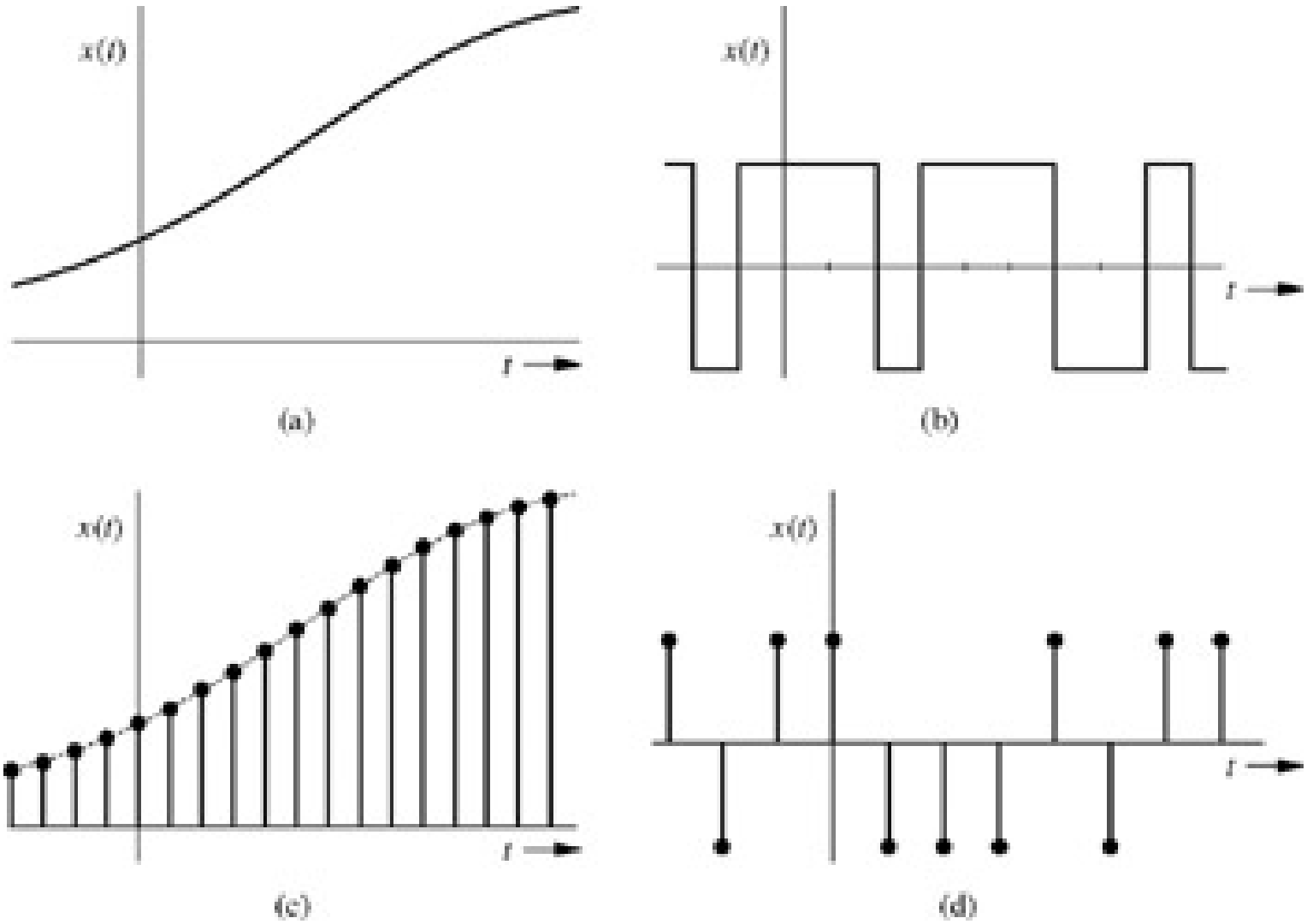


Analog and Digital Signals

- A signal whose amplitude can take on any value in a continuous range is an analog signal
- This means that an analog signal amplitude can take on an infinite number of values
- A digital signal, on the other hand, is one whose amplitude can take on only a finite number of values
- Signals associated with a digital computer are digital because they take on only two values (binary signals)

- **Sampled continuous signal**
- $x[n] = x(nk)$, where k is sample time

Analog and Digital Signals



- (a)-Analog CT, (b)-Digital CT, (c)-Analog DT, (d)-Digital DT

What is a System?

- A System processes input signals to produce output signals

- Examples:

  - A circuit involving a capacitor can be viewed as a system that transforms the source voltage (signal) to the voltage (signal) across the capacitor

  - A microphone system converts the sound input to an electrical output signal

  - A communication system is generally composed of three sub-systems, the transmitter, the channel and the receiver

How is a System Represented?

- A system takes a signal as an input and transforms it into another signal

- In a very broad sense, a system can be represented as the ratio of the output signal over the input signal
  - That way, when we "multiply" the system by the input signal, we get the output signal
  - This concept will be discussed in further detail in the coming weeks

END