EECS 206 - SIGNALS AND SYSTEMS I: INTRODUCTION

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INTRODUCTION TO EECS 206

About this Course: Who / Why / What / How

Why this course?

- Engineering systems are complex and perform sophisticated tasks.
- For example, consider a CD player:
  - digital data (i.e., bits) engraved on a compact disk has to be read by a laser (servo-mechanisms for controlling focus of laser beam, position of beam, and rotational speed of disk)
  - the data has to be processed for error correction in reading (error-correcting codes)
  - the corrected data has to be converted into an analog signal (D/A converter)
  - the analog signal has to be *filtered* (i.e., its frequency content altered) and amplified (filters and amplifiers)
  - the resulting signal is then transformed by the speaker into an acoustical wave that exerts pressure on your ear drum
  - your nervous system and brain do the rest
- Electrical and Computer Engineers need *techniques* to analyze and design the various components of such "systems".
- These components take *signals* as inputs and produce modified signals as outputs.

What do we mean by Signals and Systems?

About Signals:

- A signal is a function of an independent variable, usually *time.* We often plot functions.
- In the CD example, we have the following signals:
  - Bio-electrical signals in your brain
  - Acoustical wave output by the speaker
  - Currents and voltages in the electronic circuitry of the amplifier (electrical signals)
  - Stream of bits read by the laser (digital signal)
- The software package MATLAB allows us to build, manipulate, and plot signals.
- Classification of Signals:
  - In terms of *Signal Values:*
    - *continuum*: continuous-amplitude signal; e.g., voltage, pressure
    - *discrete set*: discrete-amplitude signal; e.g., binary signal (0 or 1)
  - In terms of the *Values of the Independent Variable – Time:*
    - *continuum*: continuous-time signal; e.g., voltage
    - *discrete set*: discrete-time signal; e.g., stream of bits

Remarks:

1. All four combinations of the above are possible.
2. Discrete-time signals arise in two ways:
   – inherently discrete-time signals; e.g., stream of bits
   – *sampled* continuous-time signals; e.g., music recorded/engraved on your CD.

   [Sampling]

   Question: What is the sampling frequency used for CDs?
3. Discrete-amplitude signals also arise in two ways:
   – signal can only take values in a discrete set; e.g., binary signals
   – *quantized* continuous-amplitude signals; again, consider the signal engraved on your CD.

   [Quantization]

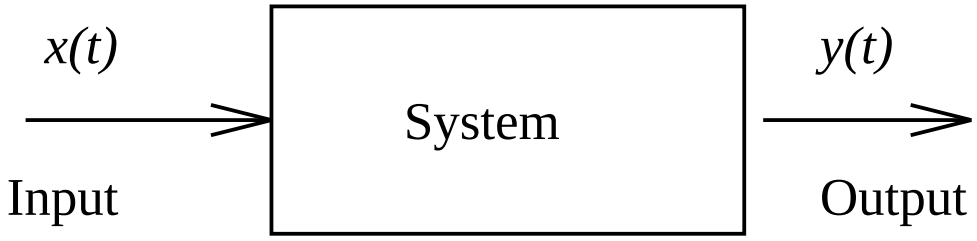
   Question: How many quantization bits are used in CDs?
4. An **Analog Signal** is continuous-amplitude and continuous-time.

   A **Digital Signal** is discrete-amplitude and discrete-time.

   A/D and D/A converters transform signals from Analog to Digital and from Digital to Analog, respectively.

About Systems:

- A system is an abstraction, or *model*, of anything that operates on a signal (or signals) and produces another signal(s).
- The original signal is called the **Input**; the input is ofttten denoted by the function $x(t)$.
- The resulting signal is called the **Output**; the output is often denoted by the function $y(t)$.
- The familiar "black-box" picture of a system:



- What "systems" did I use today?

  radio (one-way music and voice transmission)
  toaster / coffee-maker (simple control system)
  cellular phone (two-way mobile voice communication)
  car / bus (complex control systems: fuel injection, ABS, ...)
  computer (OS, hard-drive, networking, ...)
  Web browsing: data compression (MP3, JPEG)
  vending machine (pattern recognition)
  fax
  Northwest Airlines (voice recognition)
  etc!

<u>How</u> do we go about understanding (and improving!) all this technology?

- 206 in the EE/CE curricula: the "big picture"
- "Signals and Systems Engineering" as a discipline that EEs and CEs need to know.
  - It encompasses communications, control, and signal processing
  - Compare with: circuits and electronics, hardware, software
  - "... and the computer does ..."
  - Algorithms (!), based on fundamental principles
  - Mathematics is the "language" and the "tool"
- Objectives of 206
  $\rightarrow$ it is the starting point, with focus on discrete-time signals, their analysis, and their manipulation
- Details about how we will do it:
  $\rightarrow$ course information handout
  $\rightarrow$ syllabus handout