

ECE 485 - Digital Audio Processing

Introduction

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Digital Audio Processing

- **Digital Signal Processing (DSP)**

- ▶ “is the automatic manipulation of a quantized discrete-time information signal to modify or improve it in some way.”

- **Audio Processing**

- ▶ “is the intentional alteration of audio signals through an audio effects unit.”

- DSP theory was introduced in the 1950s with the advent of sampling. The first DSP chip was proposed in 1976 for the “Speak & Spell” children’s toy.
- Audio processing began with radio transmission and was used to mitigate overmodulation and non-linearities in the system. Now, it is used in the production of high-quality sound and music for stage, radio, television, and movies.

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**What is the difference between
these two audio clips?**

Why should I take this class?

Philosophy of Learning for Engineering

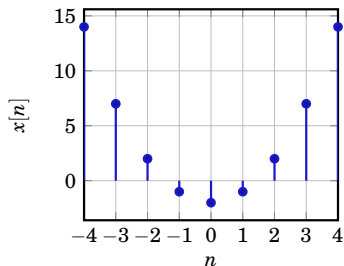
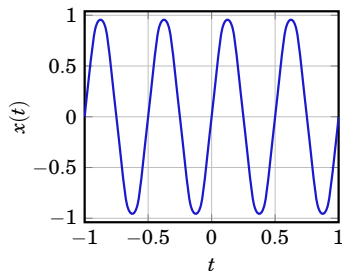
- “Engineering Maturity” is not a simple thing to define or achieve
 - ▶ One develops the basic concepts (e.g., mathematics, physics, linear systems) in introductory classes
 - ▶ And a few more advanced topics in senior level classes
 - ▶ Maturity occurs when one can follow new topics in engineering on their own by filling in the gaps
- For some of you
 - ▶ This class could be central to your future work as engineers
- For others
 - ▶ It will add only to the breadth of your engineering knowledge

**Learning DSP with practical
audio examples is more fun!**

Questions?

- 1 What are you hoping to get out of this class?
- 2 Do you like to listen to or play music?
- 3 What is your major?
- 4 Have you taken ECE 280? ECE 381?
- 5 How familiar are you with MATLAB? Do you have it installed?
- 6 Do you prefer slide-based lectures or board-based lectures?
- 7 What are good days and times for make-up classes?

Signals



A *signal* is a function of an independent variable (e.g., time) that carries some information or describes some physical phenomenon.

- Continuous-time (CT) $x(t)$ where t takes continuous values
- Discrete-time (DT) $x[n]$ where n takes integer values
- Note: $x(t)$ is used to denote both the “signal” and “the signal value at time t ”

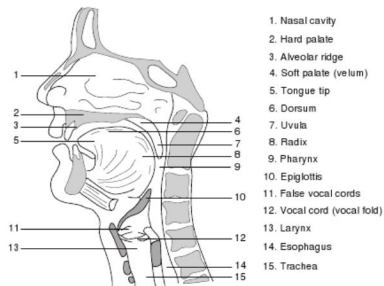
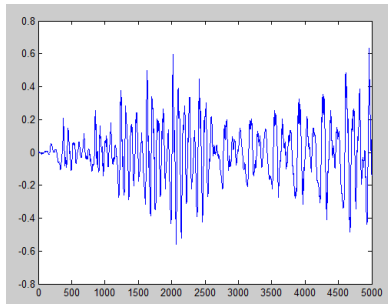
Signals

- Types of Signals

- ▶ Electrical signals: Voltages and currents in a circuit
- ▶ Acoustic signals: Audio and speech signals
- ▶ Biological signals: ECG, EEG, medical images
- ▶ Financial signals: Dow Jones indices
- ▶ Can be continuous: Time and location
- ▶ Can be discrete: Digital image pixels, DNA sequence
- ▶ Can be 1-D, 2-D, ..., N -D

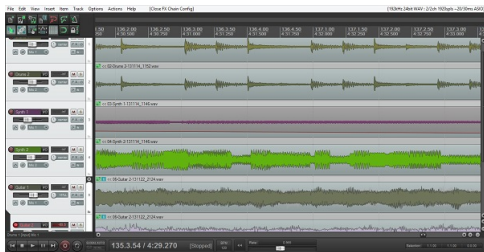
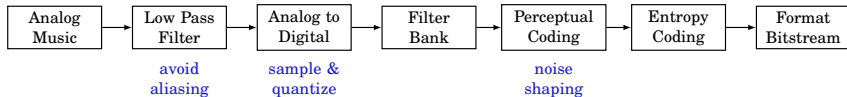
- Most signals are CT signals and DT signals are often formed by sampling a CT signal
- DT signals can be directly processed by the powerful digital computers and digital signal processors (DSPs)

Applications



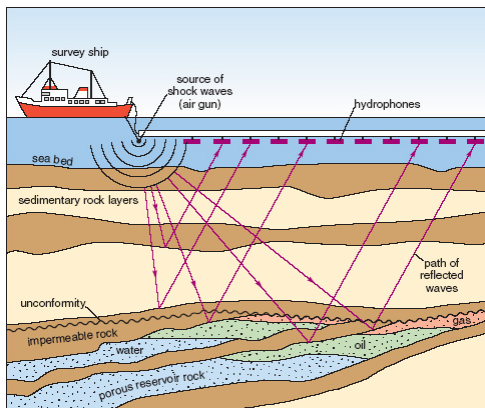
Speech waveform and production

MP3 Source Encoder Block Diagram



Digital Audio Workstation

Applications



Marine Reflection Seismology for Oil Exploration

Learning to Play

- Everyone knows learning to play a sport requires the practice of basic skills
 - ▶ For example, consider the catching and throwing a ball
 - ▶ It would be crazy for me to expect my daughter to master this skill without hours of repetitive practice

- Yet, many intelligent students try to:
 - ▶ Learn new skills (e.g., DSP) without doing the necessary repetitive practice of basic skills (i.e., homework)
 - ▶ Like learning your multiplication tables, repetitive practice of basic skills allows your brain to perform automatically
 - ▶ This allows your conscious thought process to focus on more abstract details