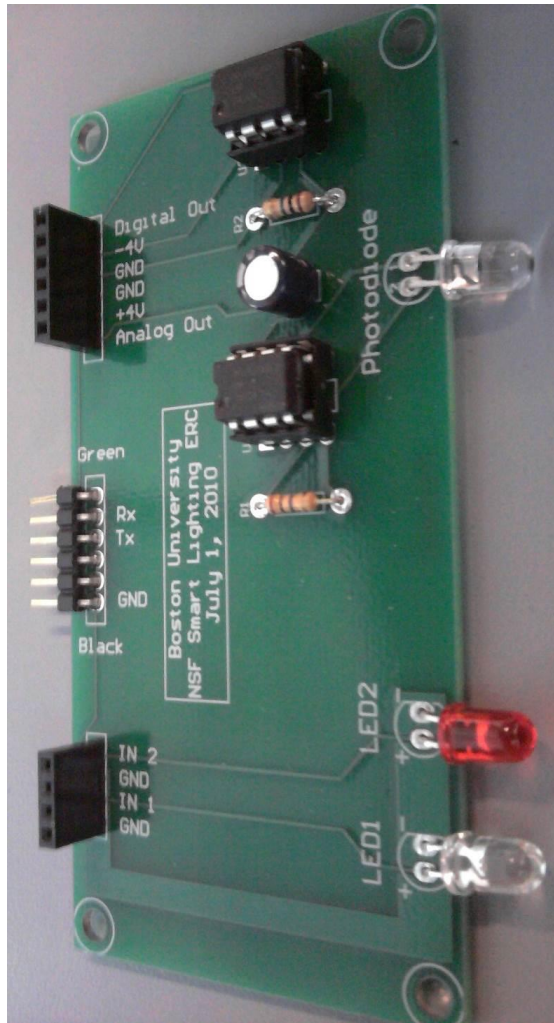


Lab 7: Analog Modulation

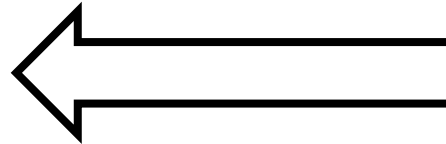
SUMMER CHALLENGE COURSE SMART LIGHTING

Ayse Coskun
acoskun@bu.edu

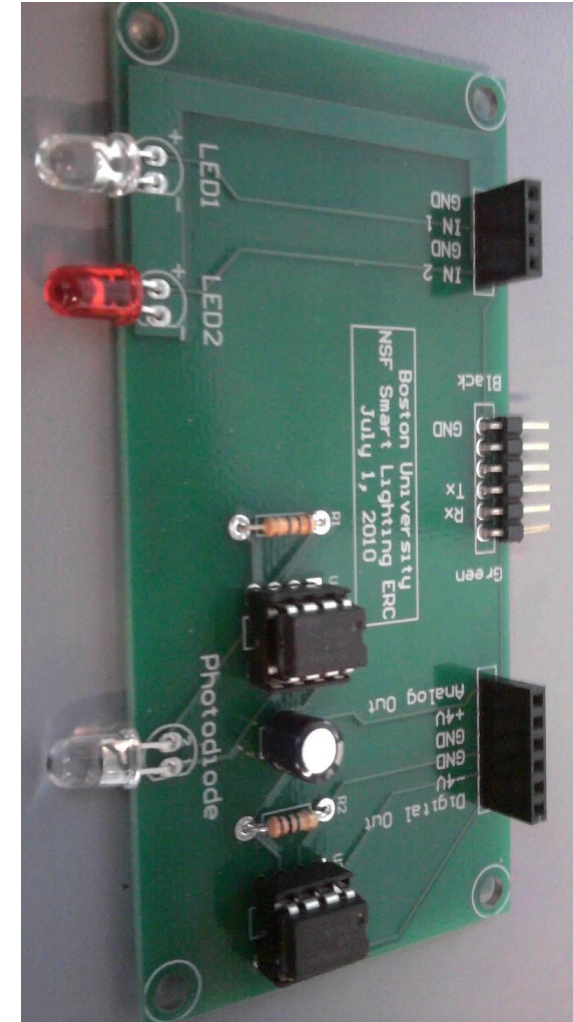
Slides: Hany Elgala



White-LED link

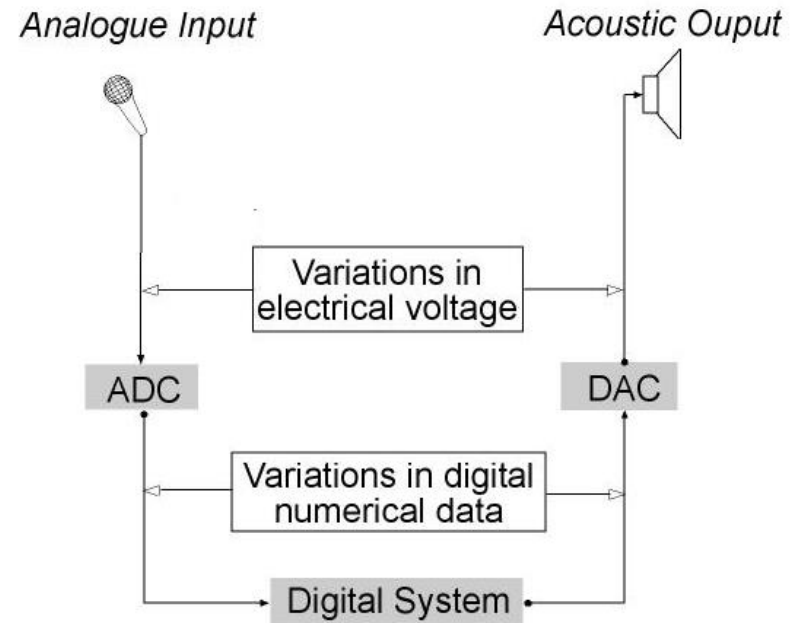


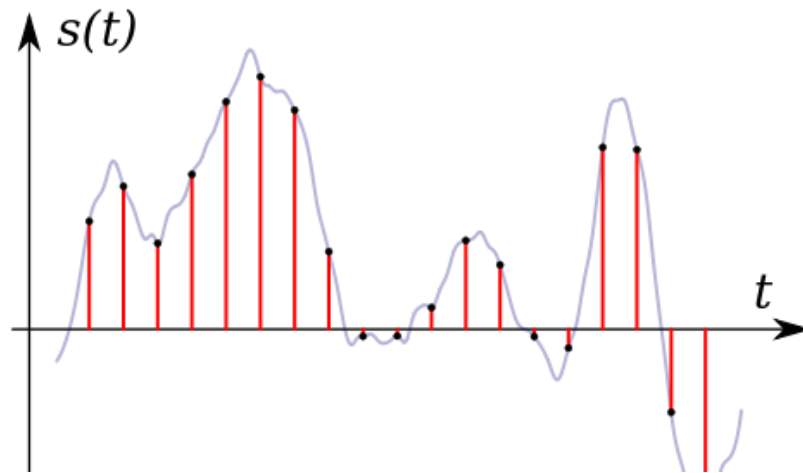
Red-LED link



The Audio Signal Path

1. An acoustical input source such as a microphone converts air pressure variations into an electrical signal (voltage).
2. An analogue-to-digital converter (ADC) converts the signal into digital data by repeatedly measuring the signal of the changes in voltage.
3. The numerical data is passed to a digital system to be stored or manipulated/processed.
4. The digital system creates a stream of output values, either from the stored values or manipulated values of the input.
5. A digital-to-analogue converter (DAC) converts the output of the digital system to variations in electrical voltage.
6. An acoustic output, such as a loudspeaker device, converts voltage changes to air pressure variations (audible sound).



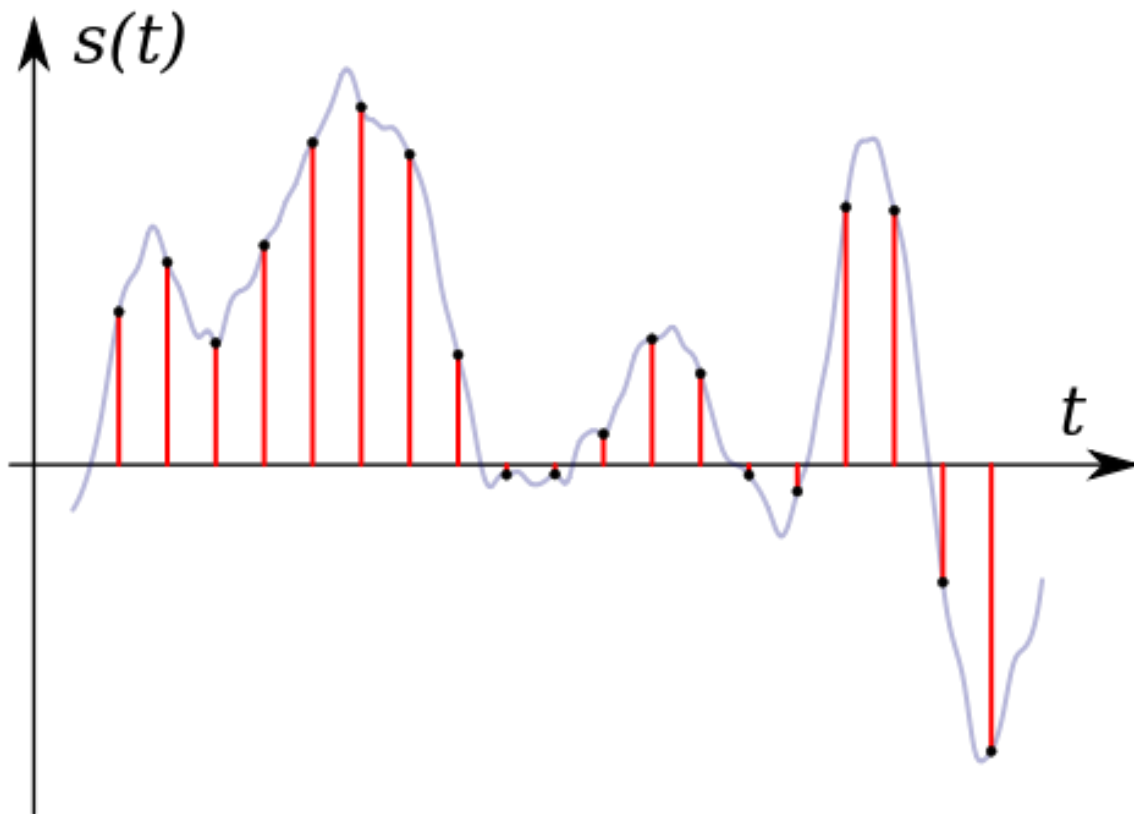


- The sampling frequency/rate: the number of samples per seconds taken from a continuous signal to make a discrete signal.
- The unit for sampling frequency is hertz; sometimes Sa/s or S/s (samples per second).
- The reciprocal of the sampling frequency is the sampling period or sampling interval, which is the time between samples.
- Bit depth: the number of bits of information recorded for each sample.

Examples:

1. CD quality audio, 16-bits
2. DVD and Blu-ray audio, up to 24-bits

Binary Form					Decimal Form
16	8	4	2	1	
0	0	0	0	0	0
0	0	0	0	1	1
0	0	0	1	0	2
0	0	0	1	1	3
0	0	1	0	0	4
0	0	1	0	1	5
0	0	1	1	0	6
0	0	1	1	1	7
0	1	0	0	0	8
1	0	0	0	0	16
1	1	1	1	1	31



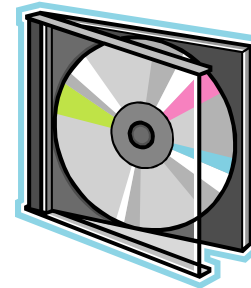
Analog vs. Discrete vs. Digital

- The Nyquist sampling theorem: reconstruction of a signal is possible when the sampling frequency is greater than twice the maximum frequency of the signal being sampled.
- If lower sampling rates are used, the original signal's information may not be completely recoverable from the sampled signal.
- The full range of human hearing is between 20 Hz and 20 kHz.
- The minimum sampling rate that satisfies the sampling theorem for this full bandwidth is 40 kHz.
- The 44.1 kHz sampling rate used for Compact Disc was chosen for this reason.

- Example:

74 minutes CD music:

- 44.1KHz sampling frequency
- 16-bits bit-depth or sample-width
- 2-channels
- Bit rate = $44.1\text{KHz} * 16\text{-bits} * 2\text{-channels} = 1,411,220 \text{ bits/Sec}$
- Require storage = $44.1\text{KHz} * 16\text{-bits} * 2\text{-channels} * 60 \text{ seconds} * 70 \text{ mins} = 5,927,040,000 \text{ bits}$



Amplitude Modulation

- “Modulation” is the process of putting information onto a high frequency carrier for transmission (frequency translation)
- Once this information is received, the low frequency information must be removed from the high frequency carrier. This process is known as “Demodulation”.

