COE 202: Digital Logic Design Introduction

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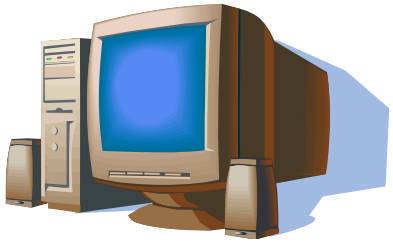
Objectives

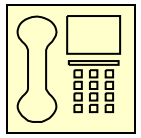
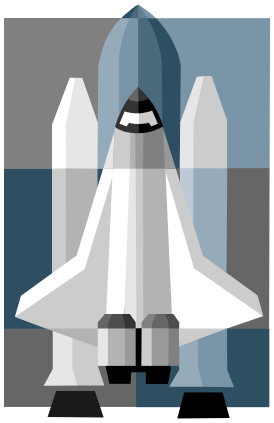
1. Digital Systems
2. "*Analog*" versus "*Digital*" parameters and systems.
3. Digitization of "*Analog*" signals.
4. Digital representation of information.
5. Effect of noise on the reliability and choice of digital system representation.

Digital Systems

- Digital Systems exist everywhere
  - Communication, banks, hospitals, Internet etc.
- Computers are digital systems
  - Programmable, flexible

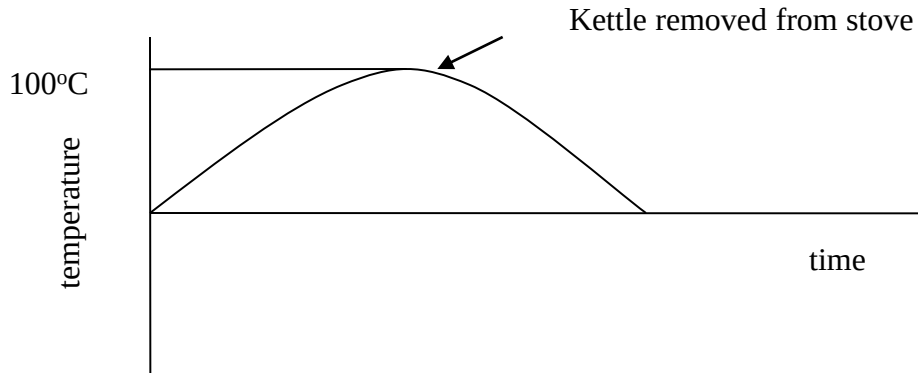




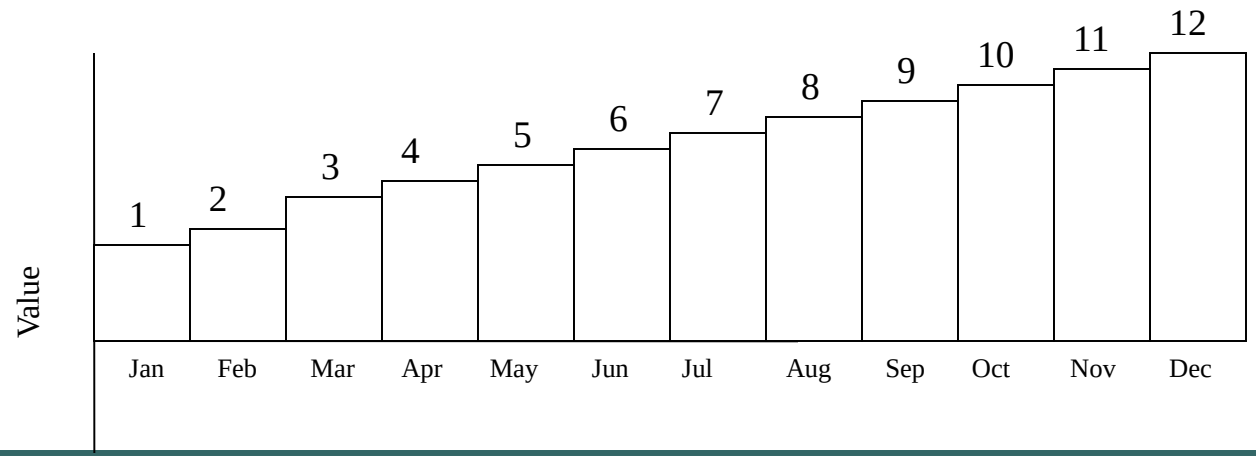
Digital vs. Analog Systems

- We live in an analog world (continuous)
- Analog signals are continuous in nature
  - Smooth transition over a period of time
  - Represent a physical quantity or phenomenon
  - E.g. temperature of a cup of tea being boiled



Digital vs. Analog Systems

- Digital signals are non-continuous i.e. discrete
  - Consist of fixed set of digits. E.g. number of months in a year = 12; digits = {1,2,3,….,10,11,12} note that 11.3 or 4.9 are invalid here.
  - Abrupt transition (jumping) from one digit to another



Digital vs. Analog Systems

Q: Digital or Analog?

- Earth movement
- English letters
- Internet IP addresses
- Human voice
- Week days

Digitization

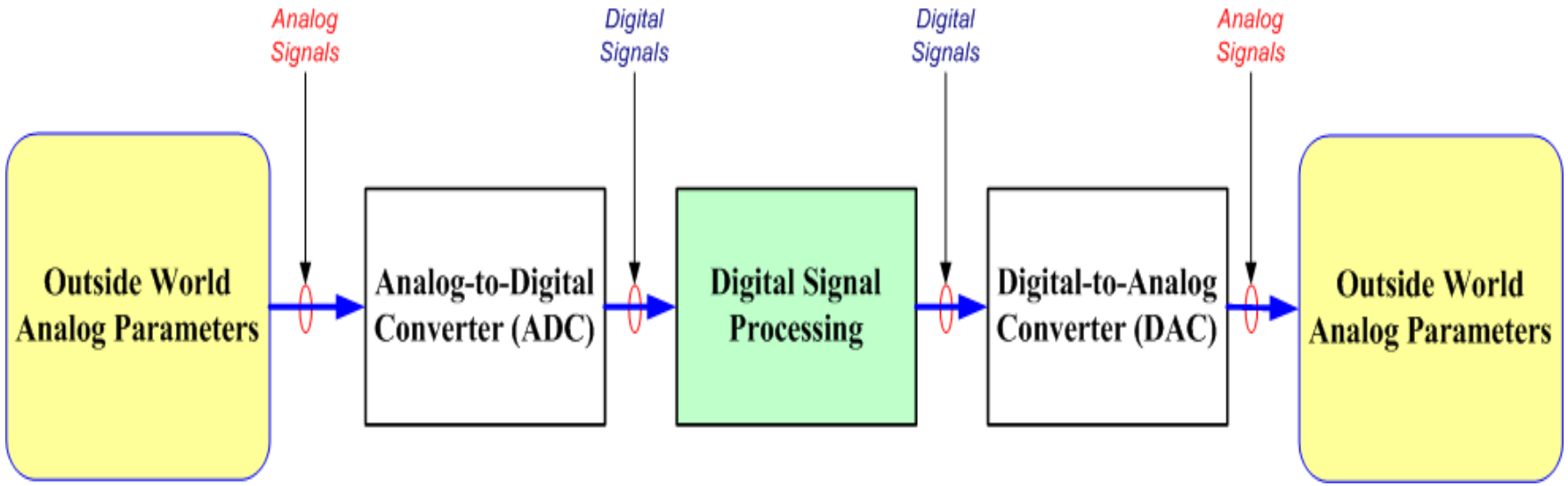
- Process of conversion from analog to digital is called digitization
- Analog to digital (ADC) converters perform digitization
- Digital to analog (DAC) converters regenerate the analog signals from their digitized form

Digitization (Why?)

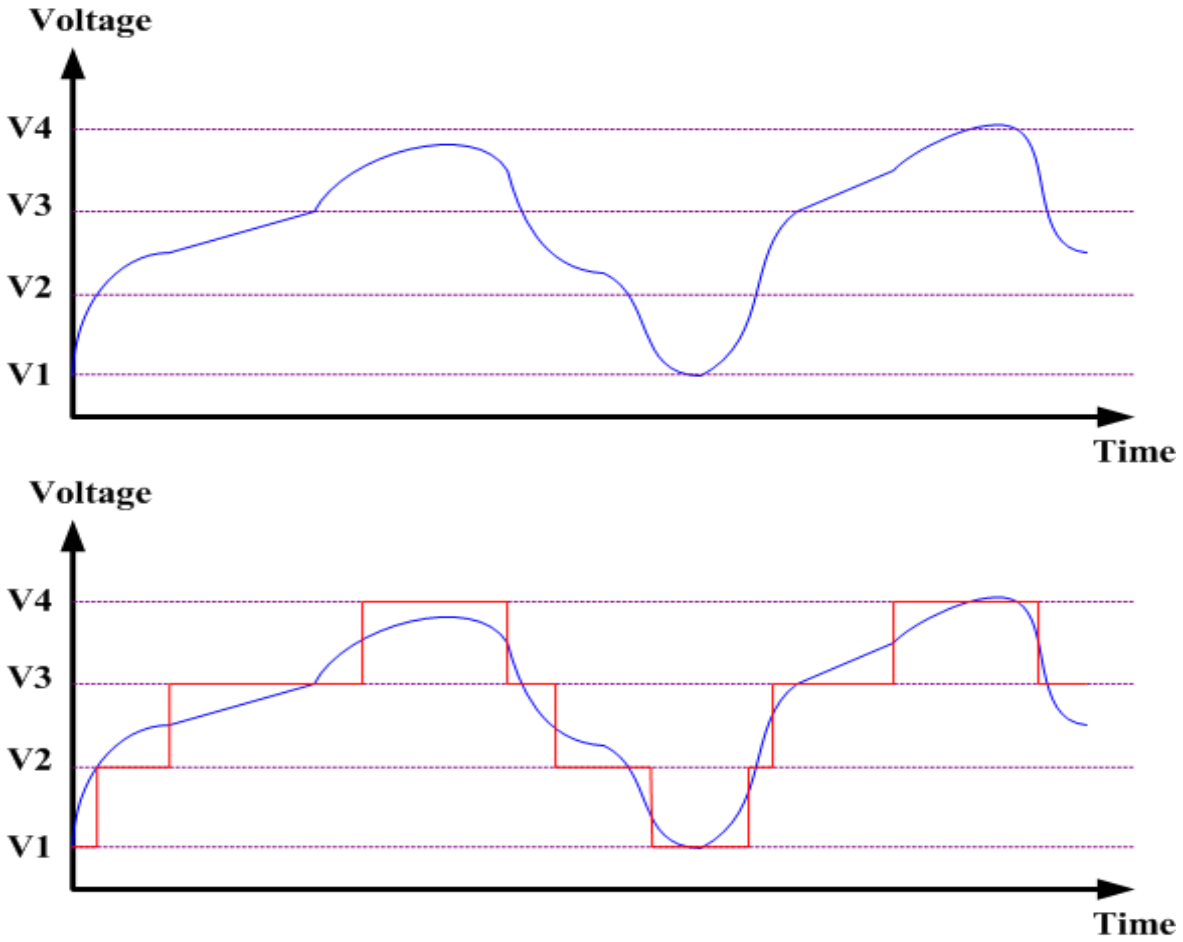
- The world around us is analog
- Digital systems are simple to understand & comprehend
- Thus …. Common practice is to convert analog signals into digital form for efficient processing of signals
- Inevitable to avoid loss of some accuracy (information) due to this conversion

  Reason: digital systems can only represent fixed (finite or discrete) set of values

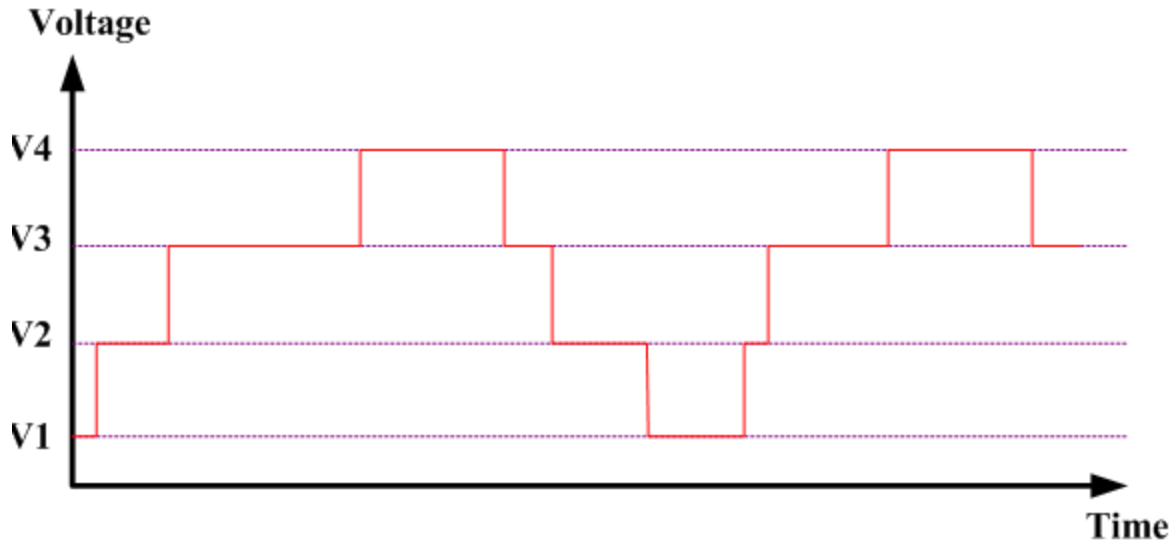
Analog to Digital to Analog



Digitization Example



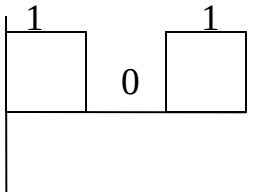
Digitization Example



- The digital signal can contain a combination of only one of four voltage values – V1, V2, V3, V4
- Analog values are mapped to the closest discrete voltage value

Computers

- Computers are digital systems
- Deal with a vocabulary of two elements namely 0 and 1 – also known as the binary system of numbers
- Binary digits i.e. 0 and 1 are called **bits**
- Decimal digits 0,1,2,3,….,9 are simply called ‘digits’ – these digits constitute the decimal number system



Data representation

Computers represent data (V1, V2, V3, V4) in binary system using:

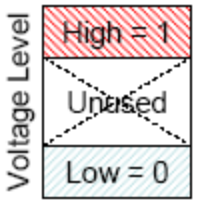
- Electrical voltages (processors, memory)
- Magnetism (hard disks, floppy)
- Light (CD, DVD)

Signal representation (Voltage)

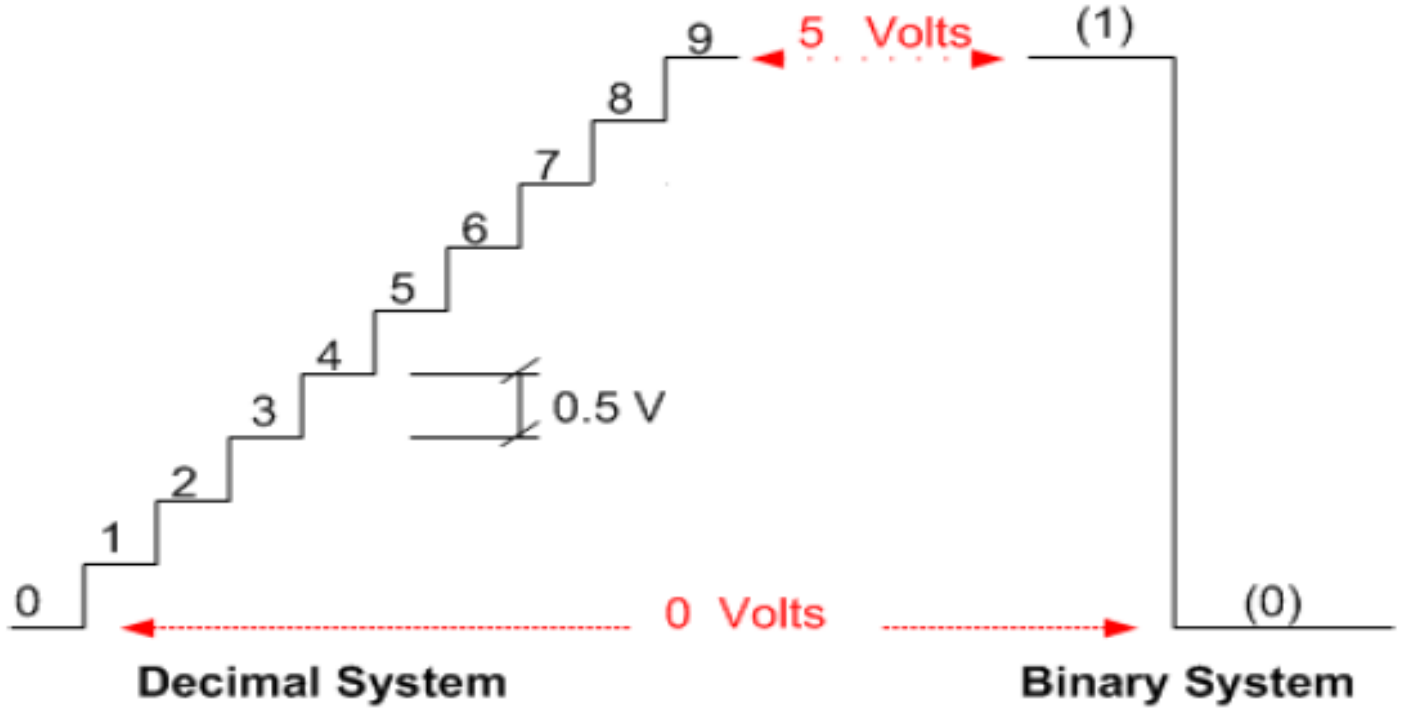
- Computers use low power supply voltage, typically from 0V to 5V
- In decimal numbering system, the voltage levels are divided into 10 equal parts. Therefore:
  - 0 represents 0 – 0.5V
  - 1 represents 0.5 – 1.0V
  - 2 represents 1.0-1.5V and so forth.
- Only 0.5V separate two consecutive voltage ranges if decimal digits are used.

Signal representation (Voltage)

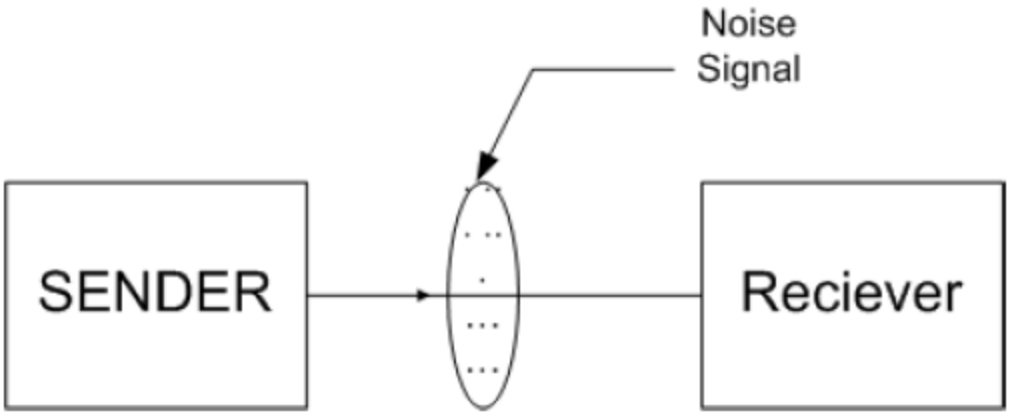
- Using the binary system, as is the case with all computers, and a low power voltage range from 0-5V
  - A binary ‘0’ is represented with 0 Volts
  - A binary ‘1’ is represented with 5 Volts
- A larger range of Volts differentiate between the two values (0 and 1) in the binary system



Signal representation (Voltage)



Noise



- Noise exists in environments (mobile & TV)
- Noise can change voltage level (higher or lower)

Noise

- Noise exists in the environment
- Causes disruption in the voltage levels.
- If the range of differentiation between consecutive values is low, the data can be disrupted

Example: 1.6V (represented using decimal digit 3) when transmitted in a noisy environment becomes 1.5V (i.e. decimal digit 2), thus corrupting the data

Conclusion: Digital systems (using binary digits) are more reliable than the decimal system

Conclusions

- Information can be represented using analog and digital form
- Processing of digital data is flexible, reliable, simple and powerful
- Computers represent data using the binary system
- Digitization of data (converting from analog to digital)

Next Lecture: Numbering systems (representation and manipulation)