UTM UNIVERSITI TEKNOLOGI MALAYSIA

SEEE 1223
DIGITAL ELECTRONICS

CHAPTER 1: DIGITAL LOGIC OVERVIEW

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P19a-04-03-30

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TIMETABLE (SECTION 13):

Sunday: 8 am -10 am (P07-411.2)

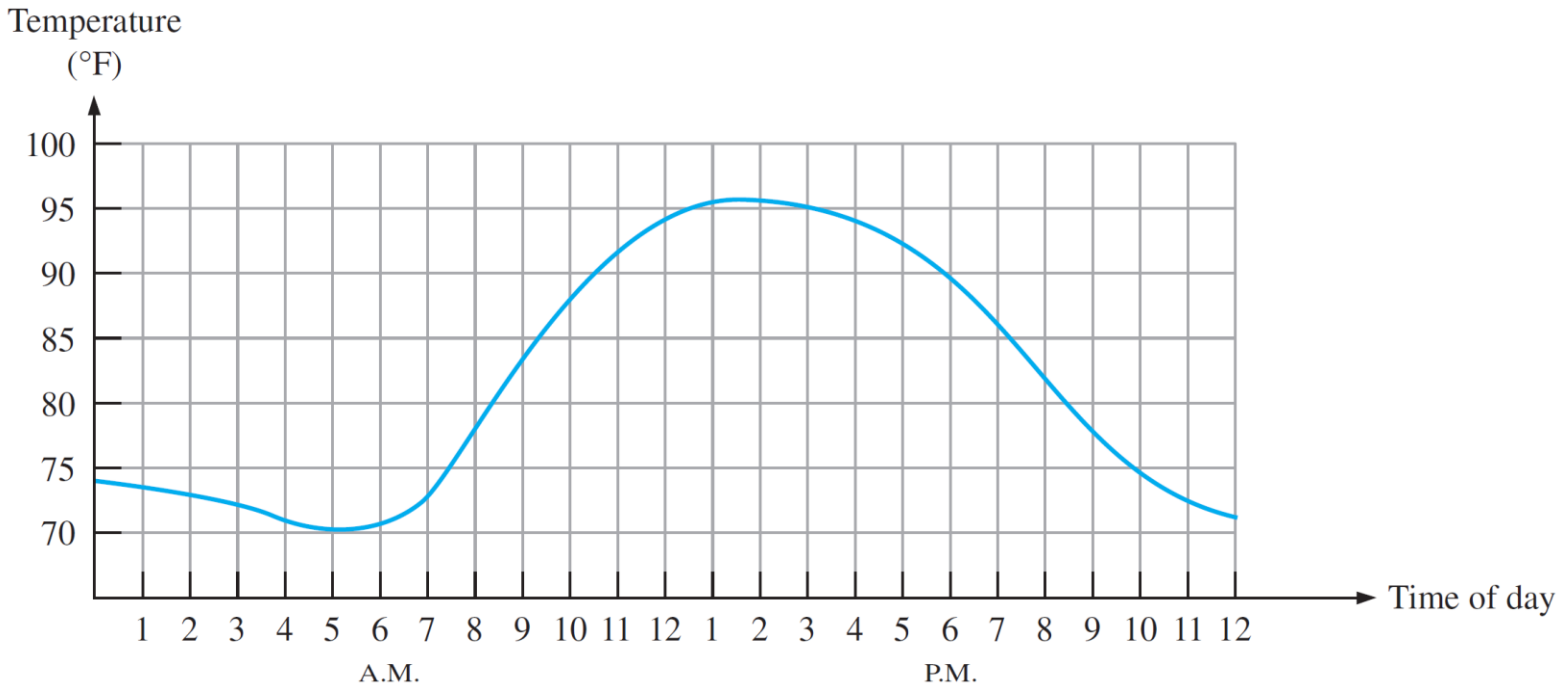
Tuesday: 8 am -10 am (P07-411.1)

ANALOG & DIGITAL

ANALOG & DIGITAL

ANALOG

- A quantity that has a **continuous** set of values.

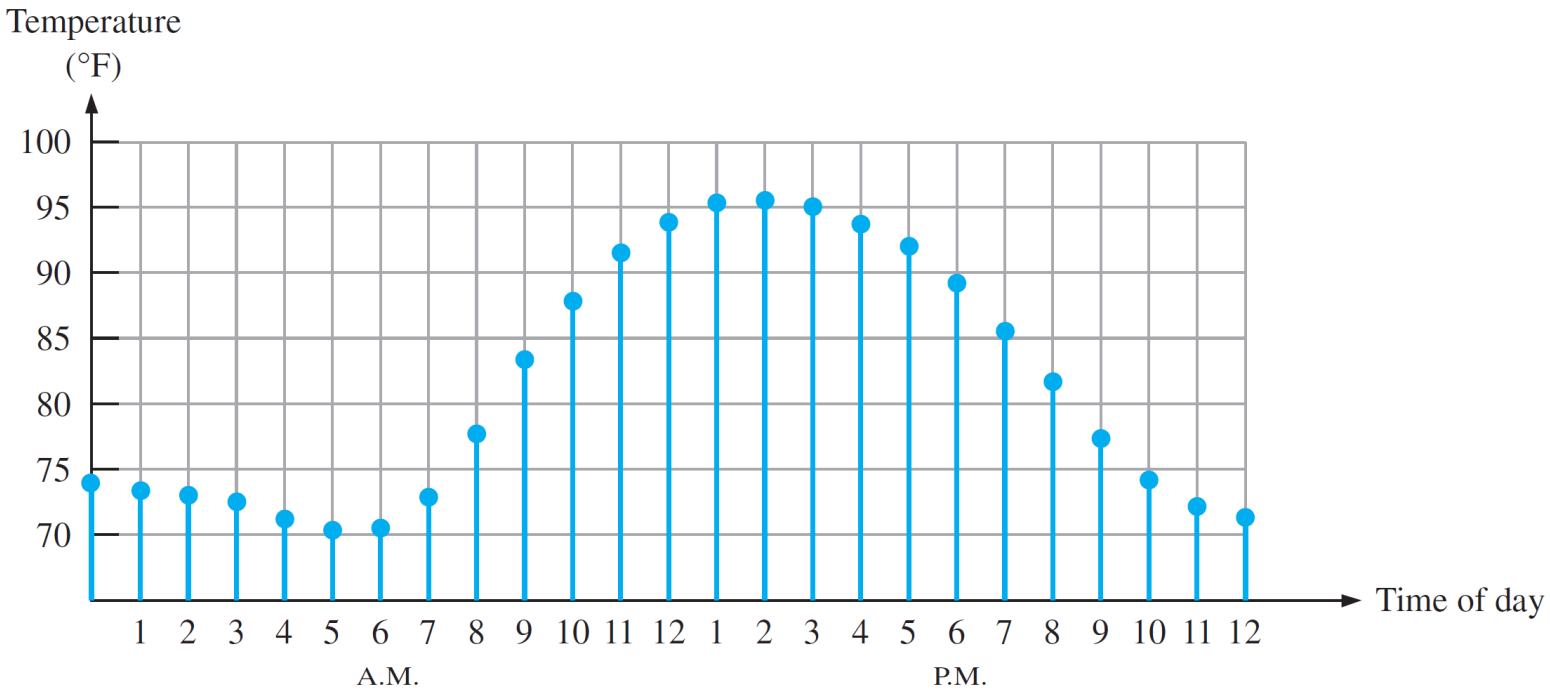


- A variable signal **continuous** in both **time** and **amplitude**.

ANALOG & DIGITAL

DIGITAL

- A quantity that has a **discrete** set of values.



- A variable signal discrete in **both time** and **amplitude**.

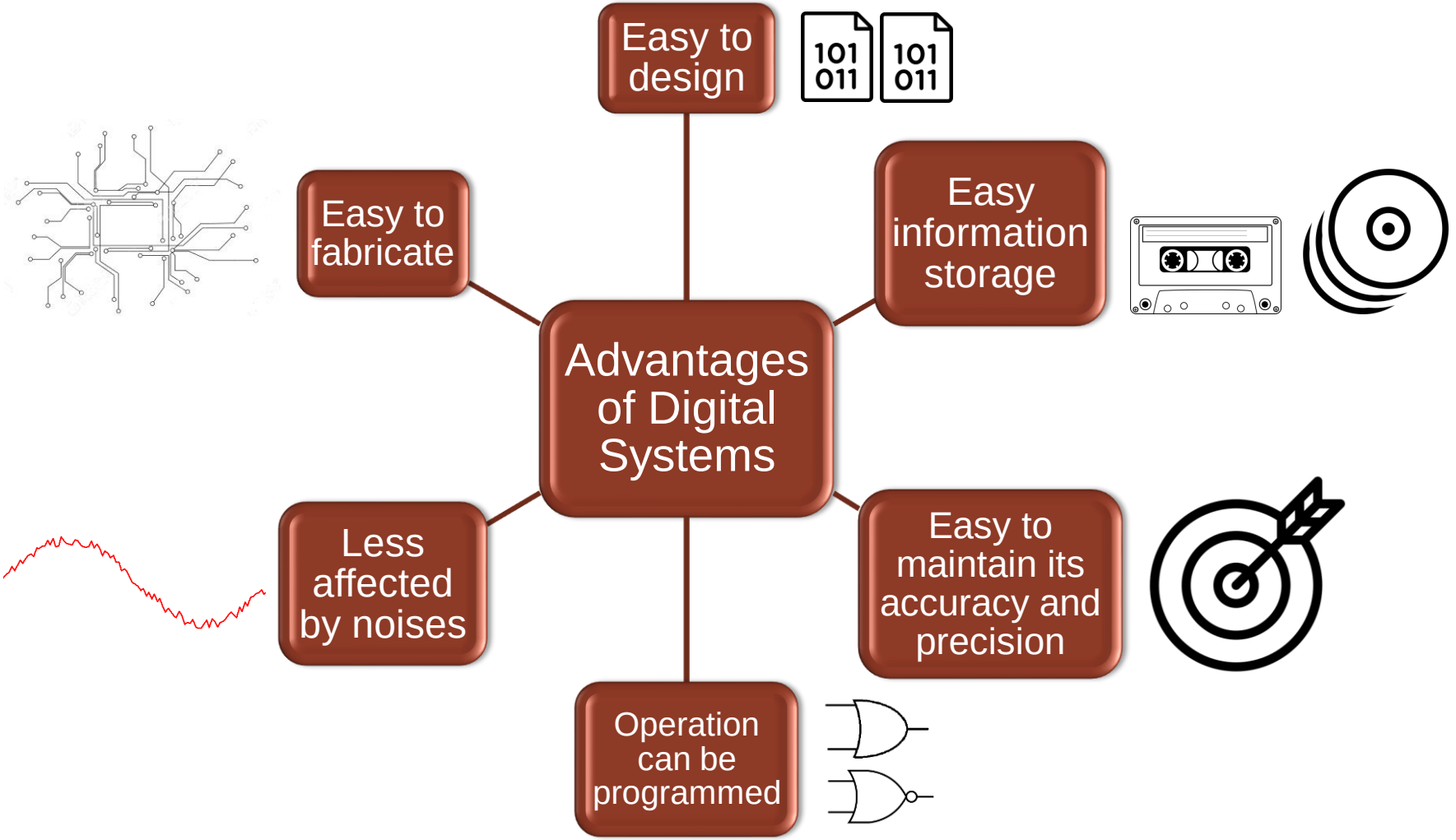
ANALOG & DIGITAL

ANALOG VS DIGITAL SIGNALS

Analog	Digital
Use base 10 (decimal)	Use base 2 (binary)
Represented by 10 different level: 0,1,2,3,4,5,6,7,8 and 9	Represented by 2 different level: 0 and 1
Analog system: A combination of devices that manipulate values represented in analog form.	Digital System: a combination of devices that manipulate values represented in digital form
Examples:  Analog phone  Analog clock	Examples:  Mobile phone  Digital clock

ANALOG & DIGITAL

ADVANTAGES OF DIGITAL SYSTEMS

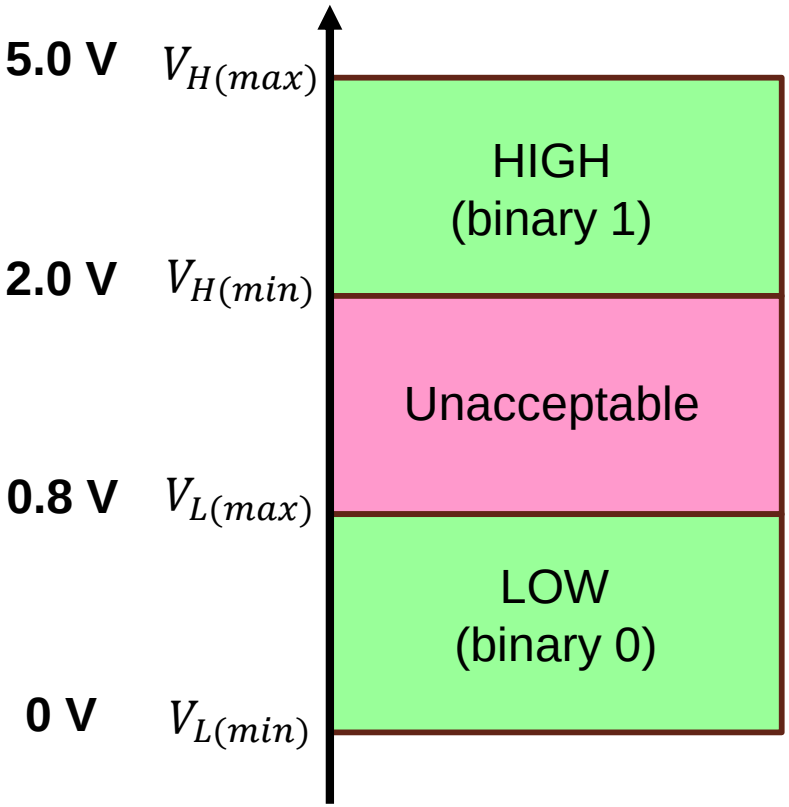


ANALOG & DIGITAL

ADVANTAGES OF DIGITAL SYSTEMS

1. Easy to design:

- There are only **two different voltages** to be considered in the digital signal.
- Either **HIGH** or **LOW**.

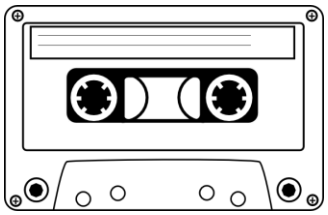


ANALOG & DIGITAL

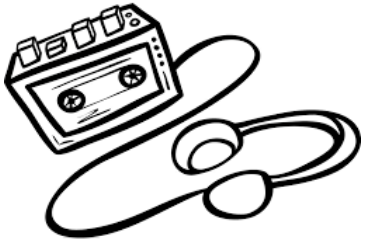
ADVANTAGES OF DIGITAL SYSTEMS

2. Easy information storage:

- Can be kept as long as necessary in digital memory.
- Can be stored more compactly.



Cassette



Cassette Player

CD

CD Player

3. Easy to maintain accuracy and precision:

- The digital signal does not deteriorate once it is stored.
- The analog information maybe distorted by the effects of temperature, humidity and etc.

ANALOG & DIGITAL

ADVANTAGES OF DIGITAL SYSTEMS

4. Operation can be programmed:

- It is easy to program and reprogram the operation of digital system.
- The operations in the analog system are complex, difficult to program.

5. More digital circuits can be fabricated on chips:

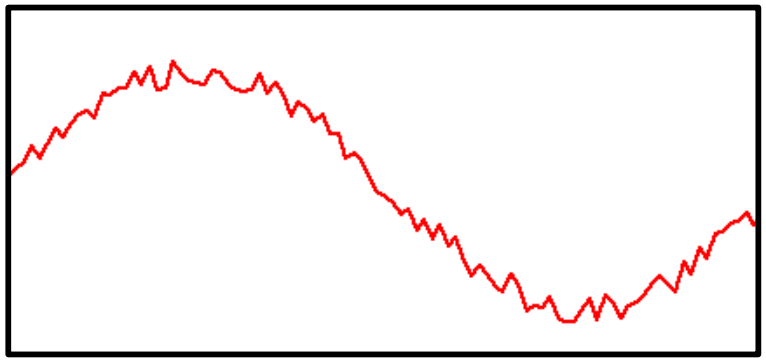
- Analog components such as high-value capacitors, precision resistors, inductors and transformers cannot be ergonomically integrated.
- Digital circuit is easy to fabricate using silicon technology which is cheaper and easy to produce.

ANALOG & DIGITAL

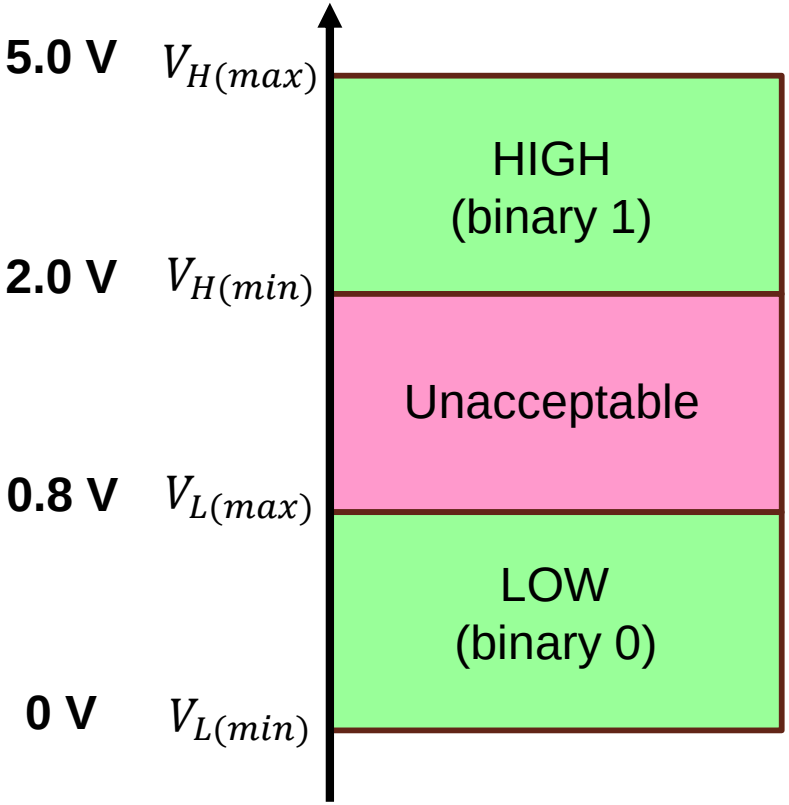
ADVANTAGES OF DIGITAL SYSTEMS

6. Less affected by noises:

- The exact voltage is not important in the digital system.
- Using High/Low comparisons and 0/1 bits.

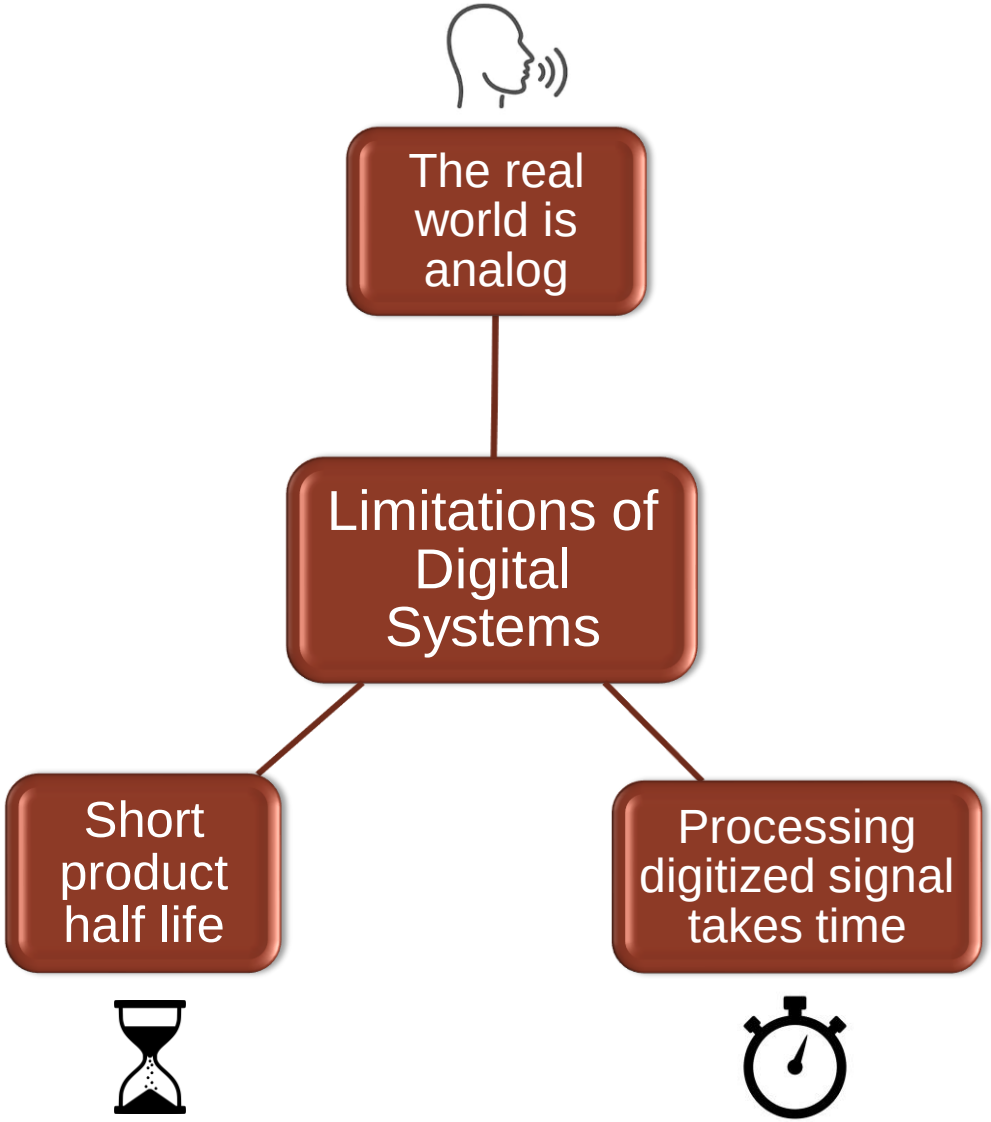


Noises in analog signal



ANALOG & DIGITAL

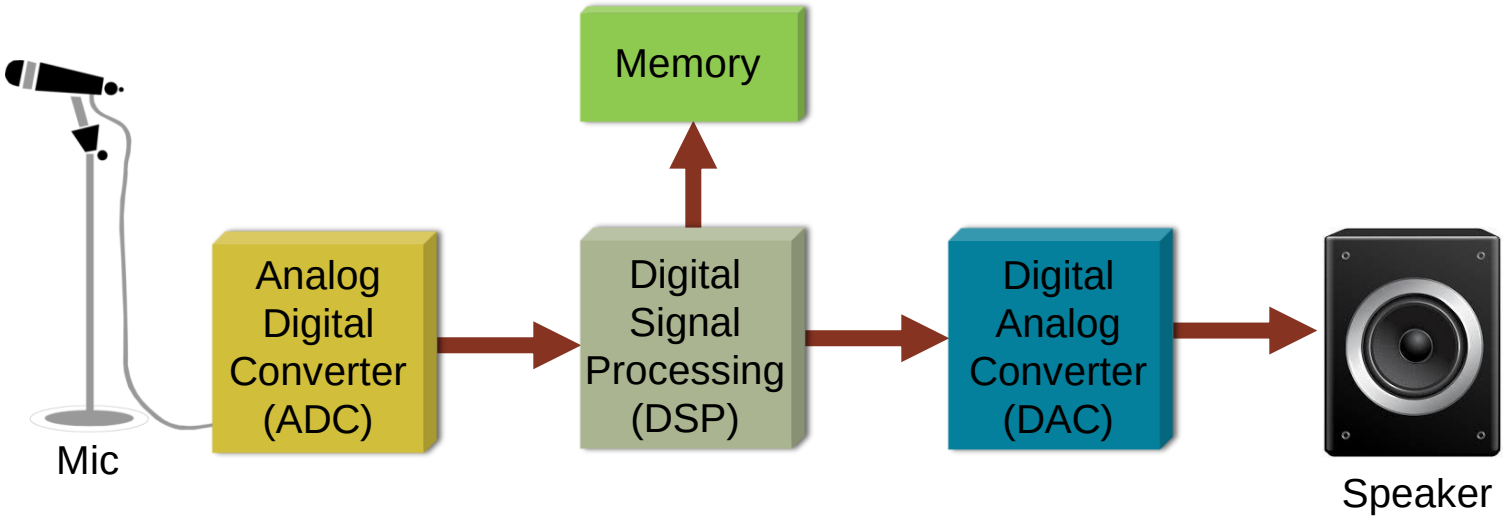
LIMITATIONS OF DIGITAL SYSTEMS



ANALOG & DIGITAL

SYSTEM USING DIGITAL AND ANALOG METHODS

- Although a digital system has many advantages, **real world** quantities are **analog**.
- Therefore, there is need to **convert** between **analog and digital** signals.



ANALOG & DIGITAL

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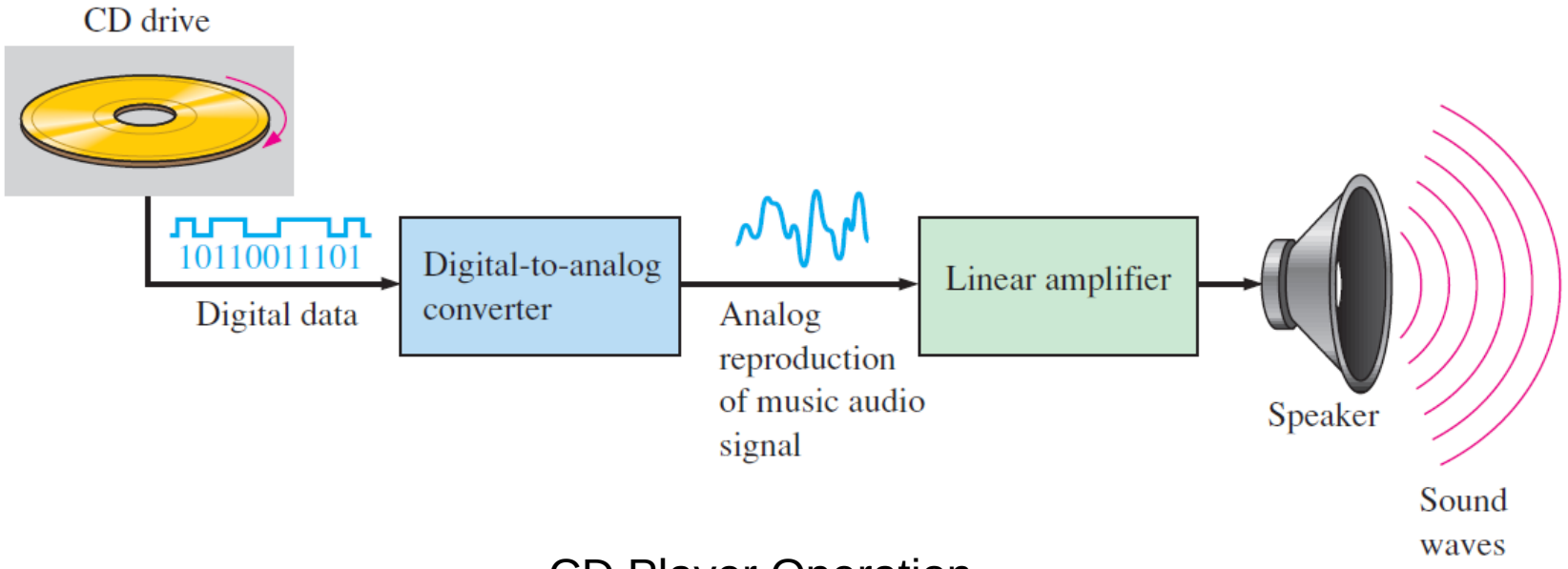


CD Player Operation

BINARY DIGITS, LOGIC LEVELS & DIGITAL WAVEFORMS

BINARY DIGITS

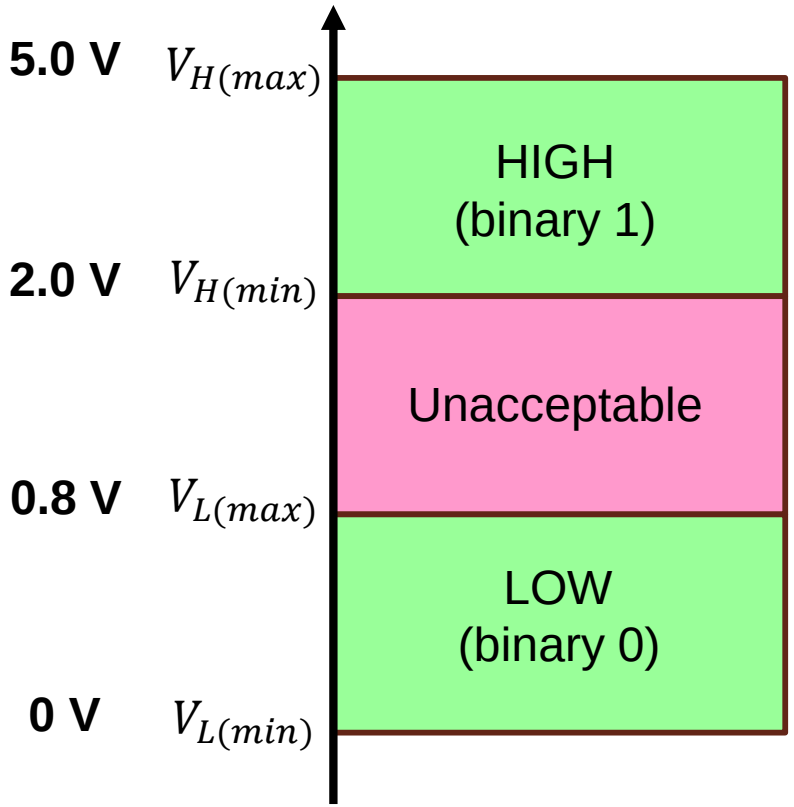
DEFINITION

- Digital electronics involves circuits and system that are only two possible states:
  - **HIGH (Bit 1)**
  - **LOW (Bit 0)**
- Each of the **1** and **0**, is called a **bit** in *binary digit system.*

LOGIC LEVELS

DEFINITION

- The voltages used to represent a **1 (HIGH)** and **0 (LOW)** are called **logic levels**.



Bit 1: 2 – 5 V (HIGH)

Undefined: 0.8 – 2 V

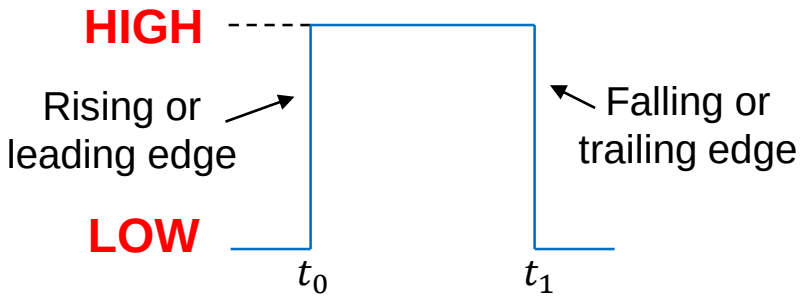
Bit 0: 0 – 0.8 V (LOW)

DIGITAL WAVEFORMS

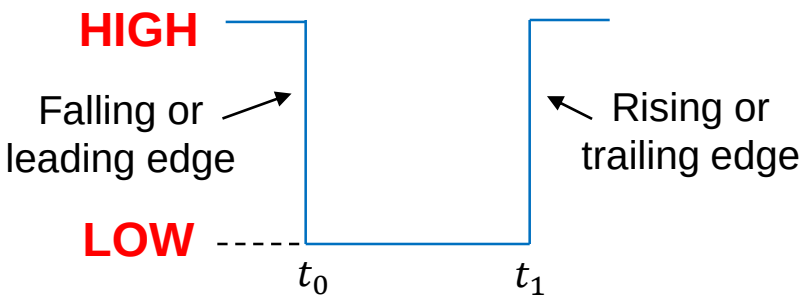
DEFINITION

- **Digital waveform** consists of voltage levels that are changing back and forth between **HIGH** or **LOW**.

Positive Logic (Active High)



Negative Logic (Active Low)

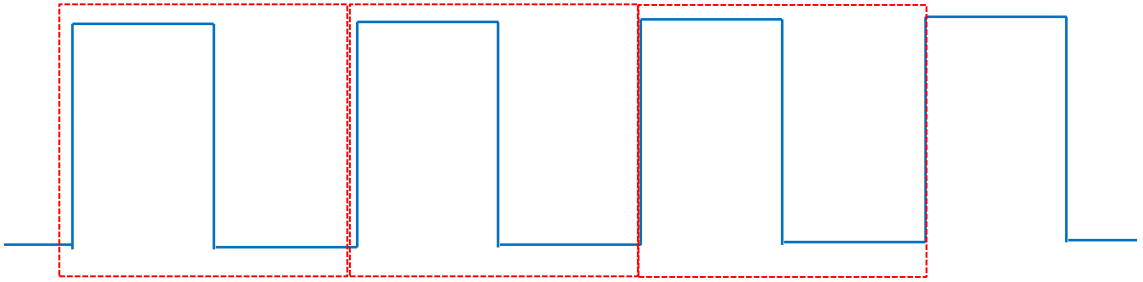


DIGITAL WAVEFORMS

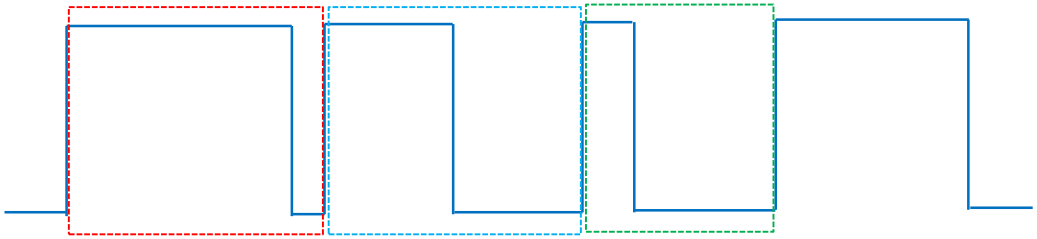
TYPES OF DIGITAL WAVEFORMS

- Two types of digital Waveform:

1. **Periodic**: Signal keep repeating after period of time



2. **Non Periodic**: Signal that does not have period



FREQUENCY AND PERIOD

DEFINITION

Frequency (f)

- The rate at which the pulse waveform repeat itself.
- Measured in **cycles per second** or **Hertz (Hz)**.

$$f = \frac{1}{T}$$

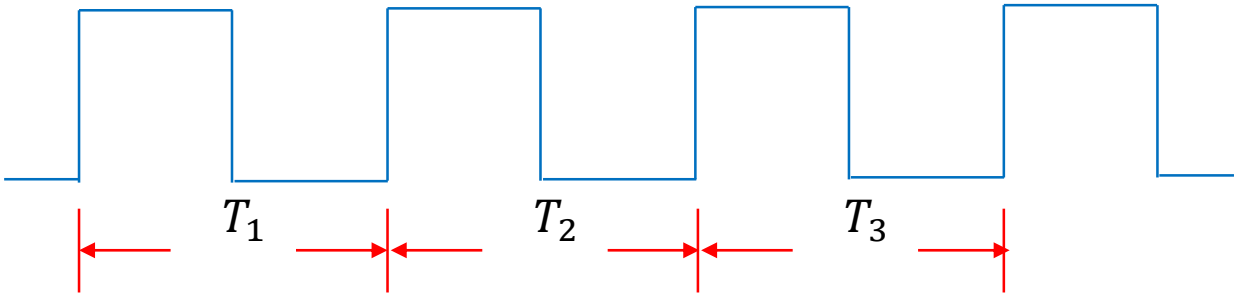
Period (T)

- The time the edge of one pulse to corresponding edge of next pulse.
- Measured in **Seconds (s)**.

$$T = \frac{1}{f}$$

FREQUENCY AND PERIOD

DEFINITION



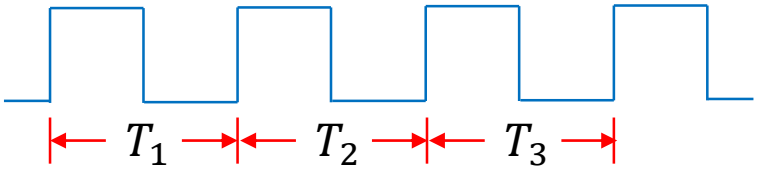
$$Period = T_1 = T_2 = T_3 = T_n$$

$$Frequency = \frac{1}{T}$$

FREQUENCY AND PERIOD

Examples

1. Find the frequency of the waveform shown below:



$$T_1 = T_2 = T_3 = 2\ mS$$

$$f = \frac{1}{T} = \frac{1}{2mS} = 500Hz$$

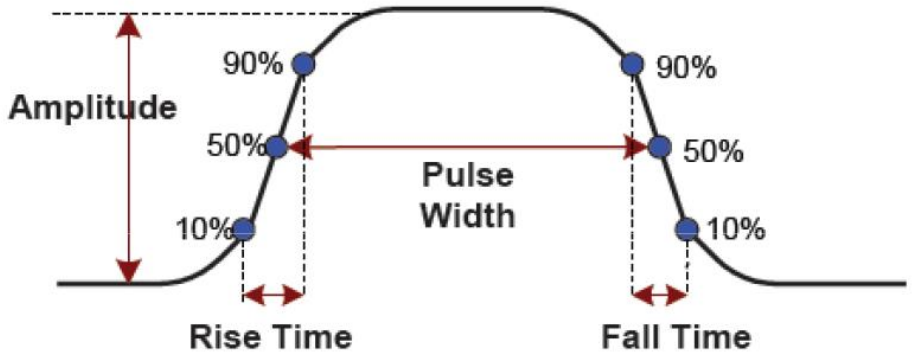
2. If the frequency of a waveform is 5.42 MHz, what is its period?

$$T = \frac{1}{f} = \frac{1}{5.42MHz} = 185nS$$

PULSE WIDTH

DEFINITION

- **Pulse width (t_w)**: A measure of the duration of pulse.

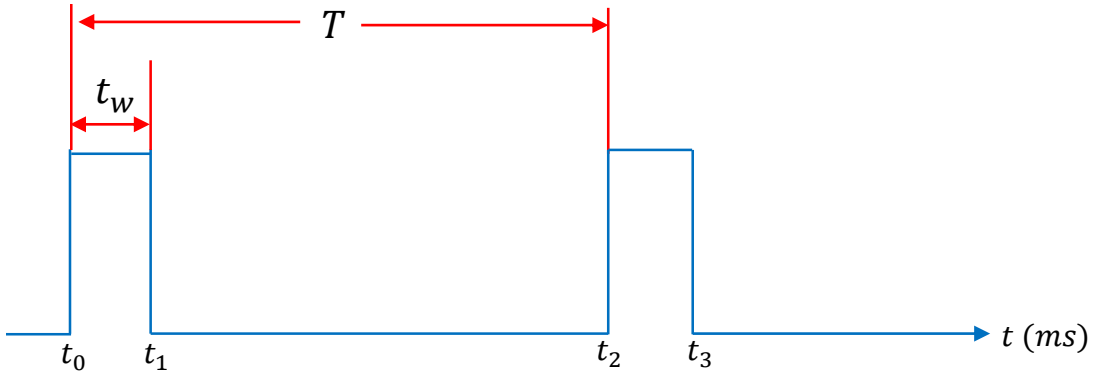


- **Rise time**: Time for a pulse to go from **LOW** level to its **HIGH** level.
- **Fall time**: Time for the transition from **HIGH** level to **LOW** level.

DUTY CYCLE

DEFINITION

- **Duty cycle**: The fraction of time that a system is in an **active** state (operated).

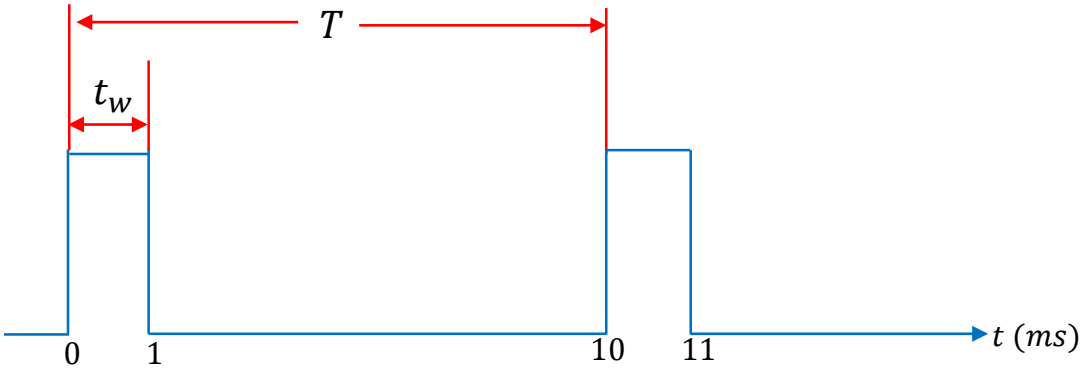


$$Duty\ cycle = \frac{t_w}{T} \times 100\%$$

DUTY CYCLE

Example

A periodic digital waveform has a pulse width of $1\,ms$ and a period time of $10\,ms$ as shown below. Find the duty cycle.



$$Duty\ cycle = \frac{t_w}{T} \times 100\%$$

$$Duty\ cycle = \frac{1\ ms}{10\ ms} \times 100\%$$

$$Duty\ cycle = 10\%$$

TIMING DIAGRAM

DEFINITION

Timing Diagram

- A graph of digital waveform showing the actual time relationship of two or more waveform and how each waveform changes in relation to the other
- In digital system, the emphasis is usually the timing not the amplitude because amplitude is predefined.