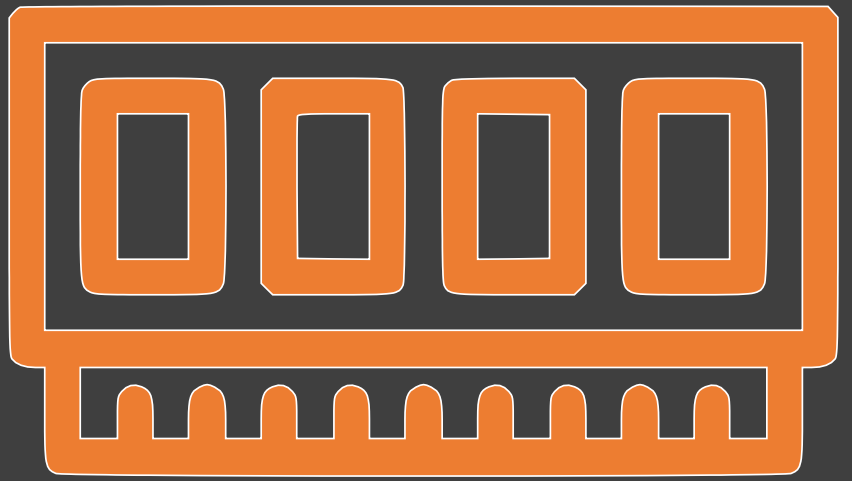
# ECE213: Digital Electronics


Ajmer Singh

9988921373

ajmer.17381@lpu.co.in


# The Course Contents

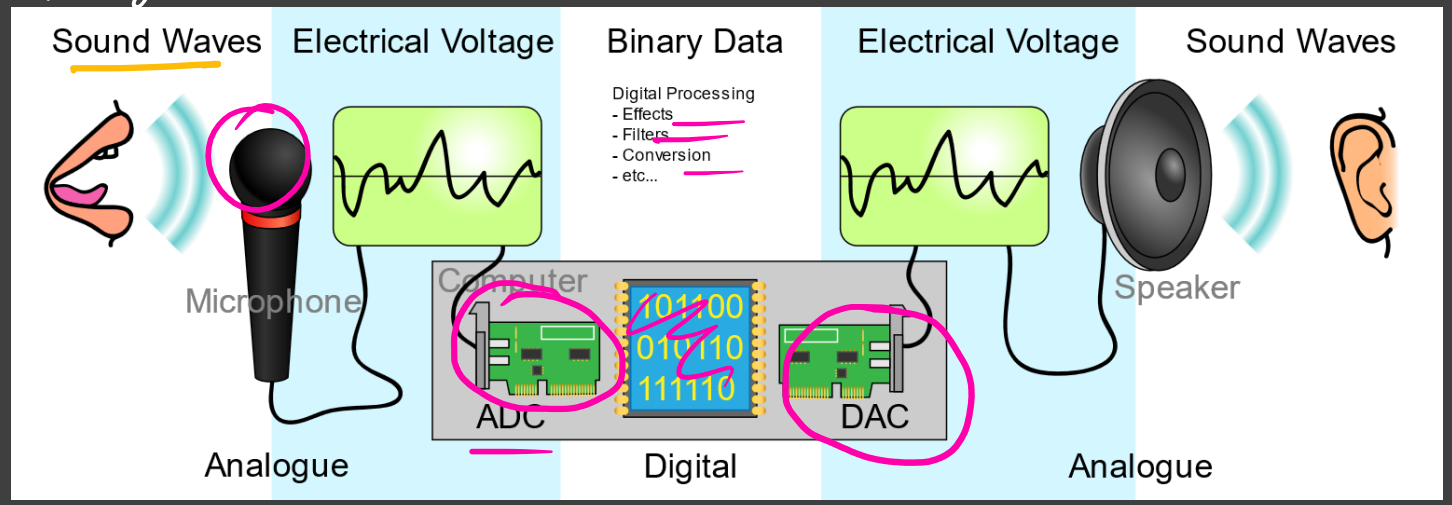


## Unit VI

**Memory :** Read-only memory, read/write memory - SRAM and DRAM, PLAs and their applications, Sequential PLDs and their applications, Introduction to field programmable gate arrays, PALs and their Applications

**Converters :** Analog to Digital Converter, Digital to Analog Converter

DAC ADC



# Memory

Memory

# Memory and Programmable Logic

## Memory Device:

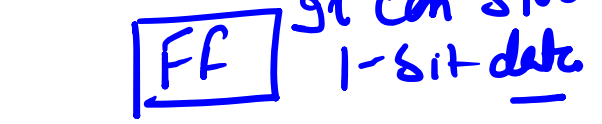
Device to which binary information is transferred for storage, and from which information is available for processing as needed.

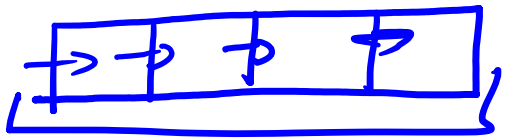
## Memory Unit:

is a collection of cells capable of storing a large quantity of binary information.

⇒ In digital systems, there are two types of memories:

1. RAM
2. ROM

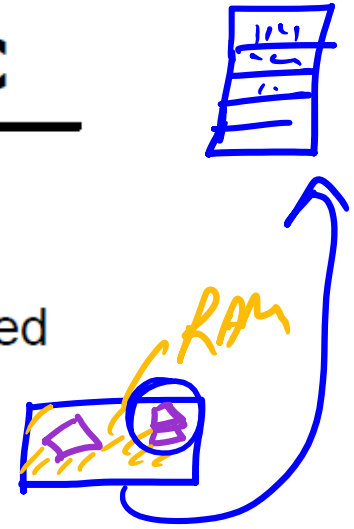


# Memory and Programmable Logic

**1.** *Random-Access Memory* (RAM)

RAM is the place in a computer where the operating system , application programs, and data in current use are kept so that they can be quickly reached by the computer's processor.




**2.** *Read-Only Memory* (ROM):

ROM is a type of memory that is as fast as RAM, but has two important differences: It can not be changed, and it retains its contents even when the computer is shut off. It is generally used to start your computer up and load the operating system.

Using a ROM as a PLD: A programmable logic device or PLD is an electronic component used to build digital circuits . Before the PLD can be used in a circuit it must be programmed.

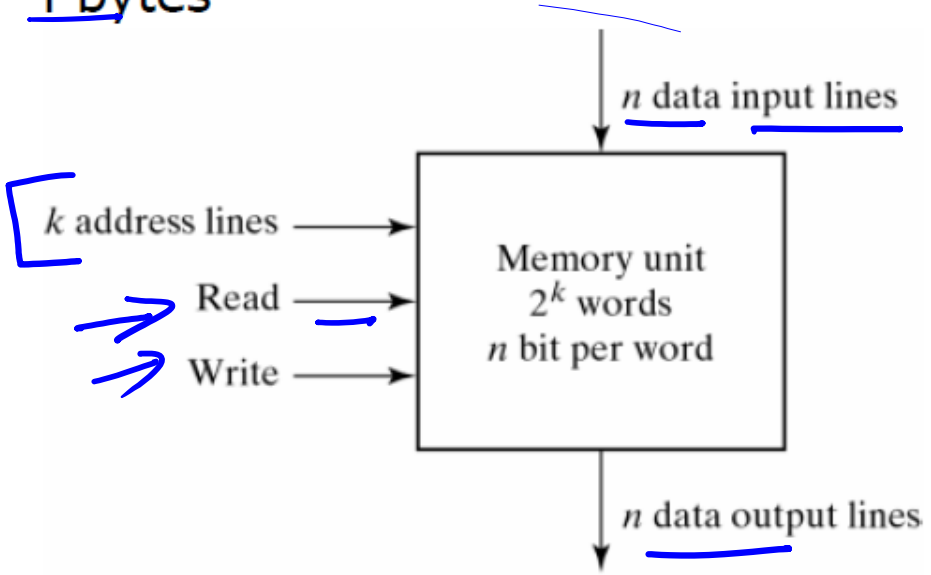
Examples of PLDs : programmable logic array (PLA), programmable array logic (PAL), and *field-programmable logic gate array* (FPGA). (PAL: Program. AND, fixed OR, PLA: Program. AND/OR)

# Random-Access Memory

Memory unit:
Stores binary information in groups of bits called *words*.

Memory word:
group of 1's and 0's and may represent a number,
character(s), instruction, or other binary-coded information.

Most computer memories use words that are multiples of 8 bits (*byte*).
32-bit word → 4 bytes




4-bit address
0000
1111
16 locations

# Random-Access Memory

Each word in memory is assigned an address 0 up to $2^k - 1$ ($k$ = # of address lines).

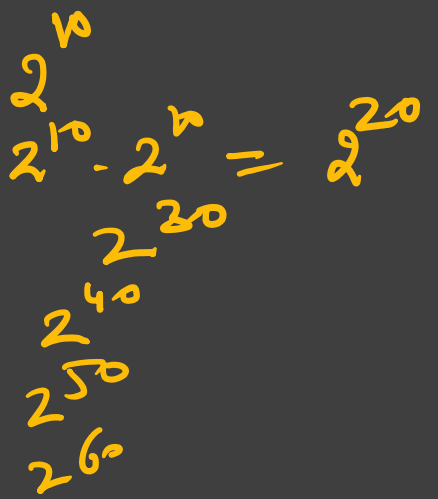
| Memory address | | Memory contest |
|---|---|---|
| Binary | decimal | memory content |
| 0000000000 | 0 | 1010101110001001 |
| 0000000001 | 1 | 0000110101000110 |
| 0000000010 | 2 | |
| ⋮ | ⋮ | ⋮ |
| 1111111101 | 1021 | 1001110100010100 |
| 1111111110 | 1022 | 0000110100011110 |
| 1111111111 | 1023 | 1101111000100101 |

Fig. 7-3 Content of a 1024 × 16 Memory

How many bytes is this memory module?

A) 16 byte
B) 2 x 16 byte
C) 1 K byte
D) 2 K byte

| Unit | Shortened | Capacity |
| --- | --- | --- |
| Bit | b | 1 or 0 (on or off) |
| Byte | B | 8 bits |
| Kilobyte | KB | 1024 bytes |
| Megabyte | MB | 1024 kilobytes |
| Gigabyte | GB | 1024 megabytes |
| Terabyte | TB | 1024 gigabytes |
| Petabyte | PB | 1024 terabytes |
| Exabyte | EB | 1024 petabytes |
| Zettabyte | ZB | 1024 exabytes |
| Yottabyte | YB | 1024 zettabytes |



# RAM: Write and Read Operations

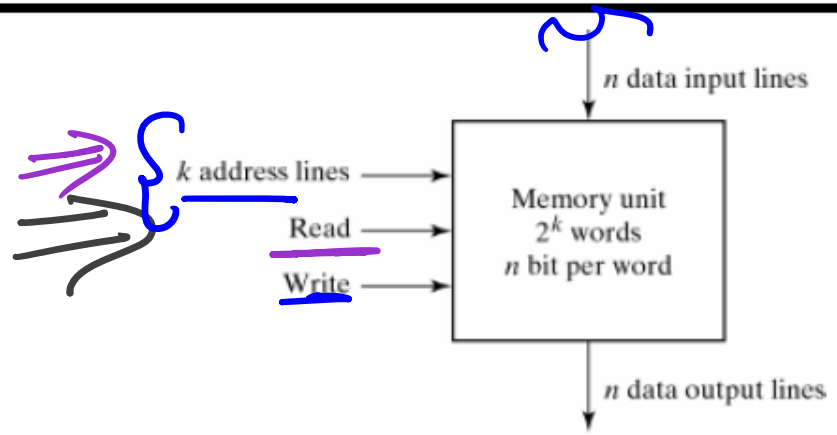



Fig. 7-2 Block Diagram of a Memory Unit

To transfer a new word to be stored into memory: (Writing operation)

1. Apply the binary address of the word to address lines.
2. Apply the data bits that must be stored in memory to the data input lines.
3. Activate the *write* input.

To transfer a stored word out of memory: (Read operation)

1. Apply the binary address of the word to address lines.
2. Activate the *read* input.

# Memory Types

Integrated circuit RAM units are available in two possible operating modes: *static* and *dynamic*.

***Static RAM* (SRAM)** consists of of internal latches that store the binary information. The stored information remains valid as long as power is applied to the unit.

***Dynamic RAM* (DRAM)** stores the binary information in the form of electric charges on capacitors provided by the MOS transistors. The charge on the capacitors tends to decay with time and the capacitors must be periodically recharged by *refreshing* of the dynamic memory every few milliseconds.

- DRAM offers reduced power consumption, large integration of units on chip.
- SRAM is faster; has shorter read and write cycles, SRAM is used in cache. Disadvantages: high power consumption, low density, expensive.