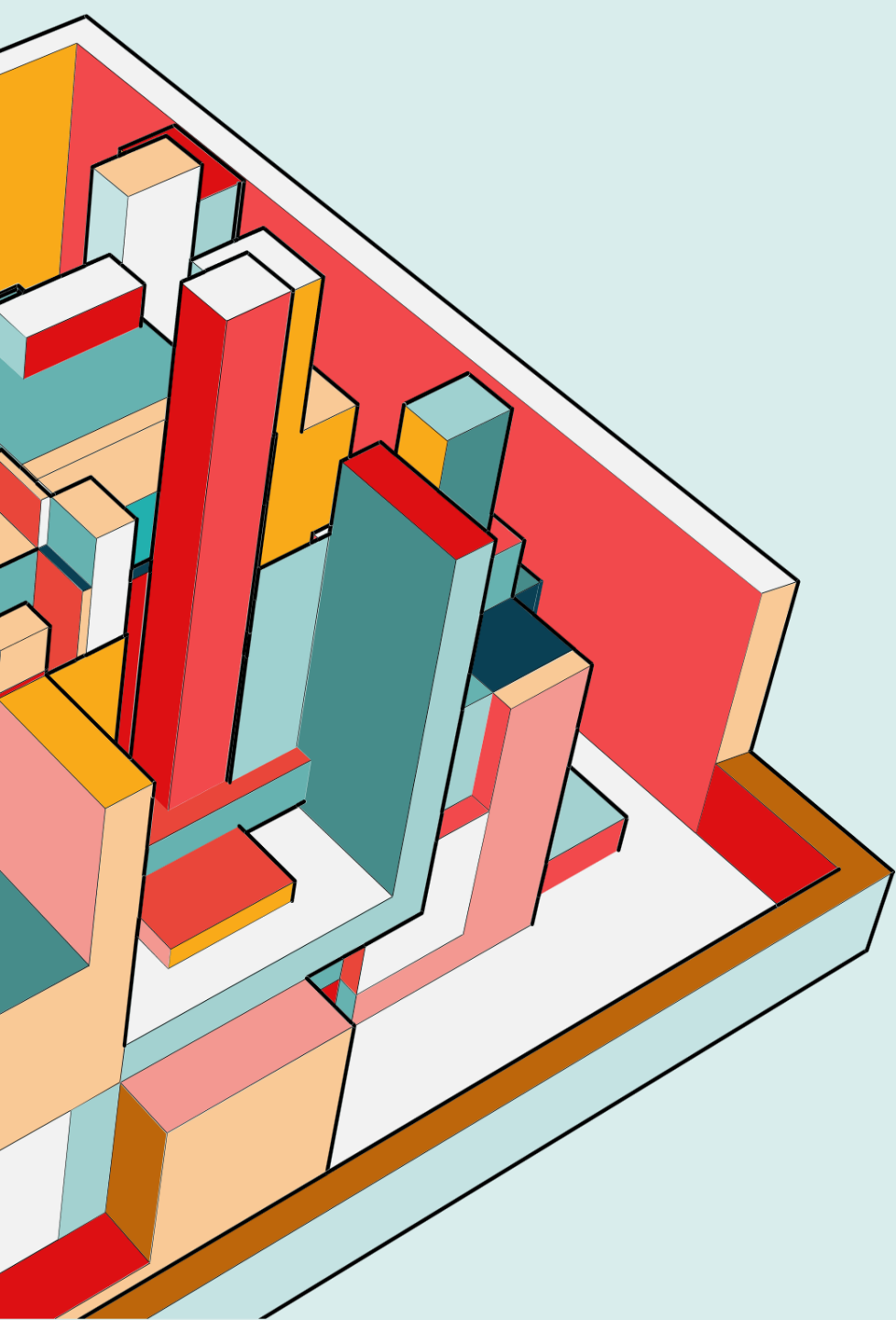


# **CSE231/EEE211/ETE211: DIGITAL LOGIC DESIGN**

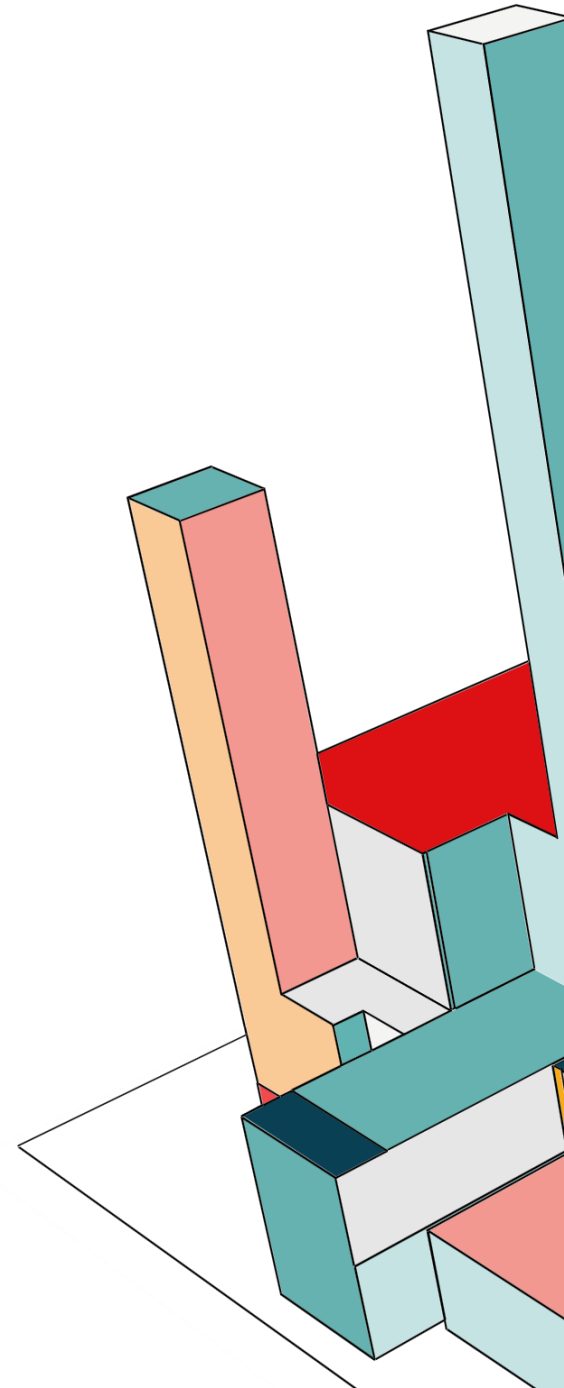


# CHAPTER 7

Memory and Programmable  
Logic

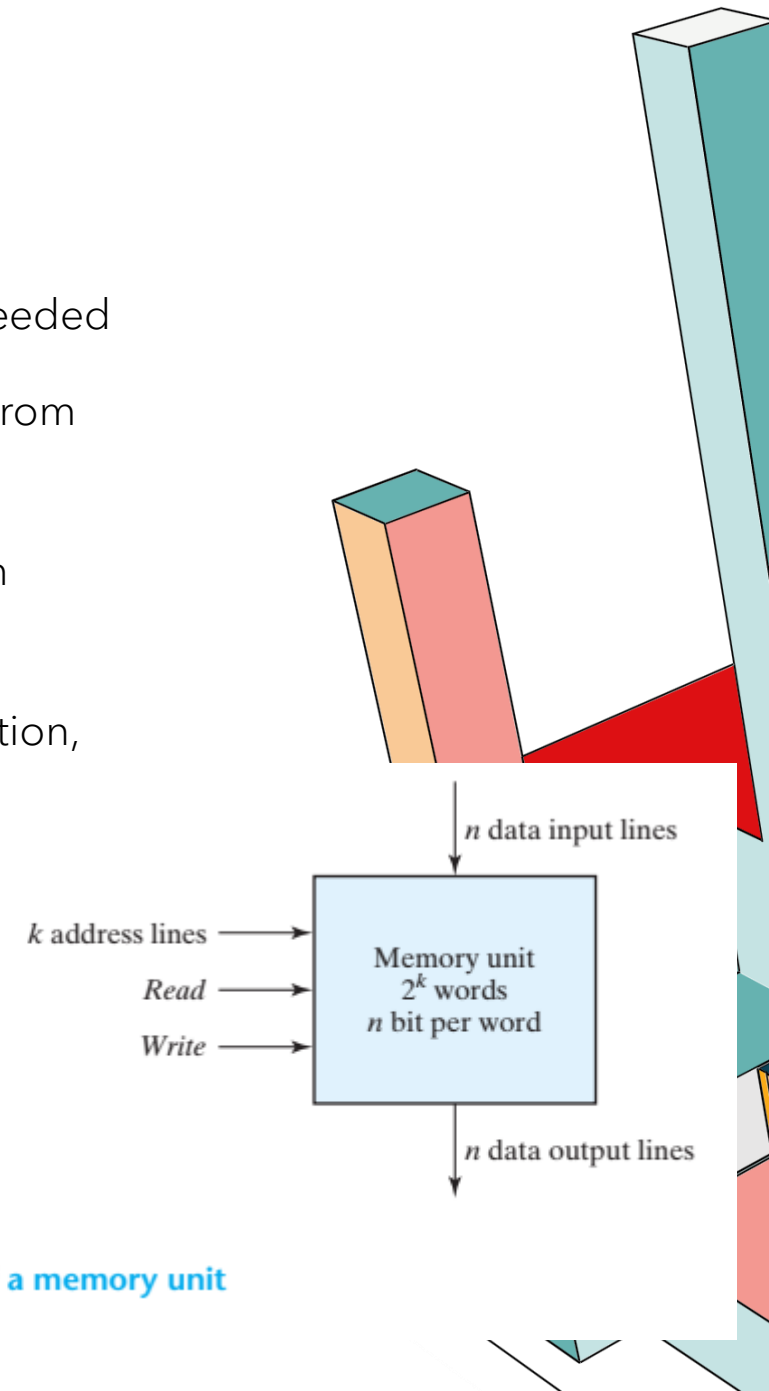
# AGENDA

- RAM
- Programmable logic
  - ROM
  - PLA
  - PAL



# MEMORY

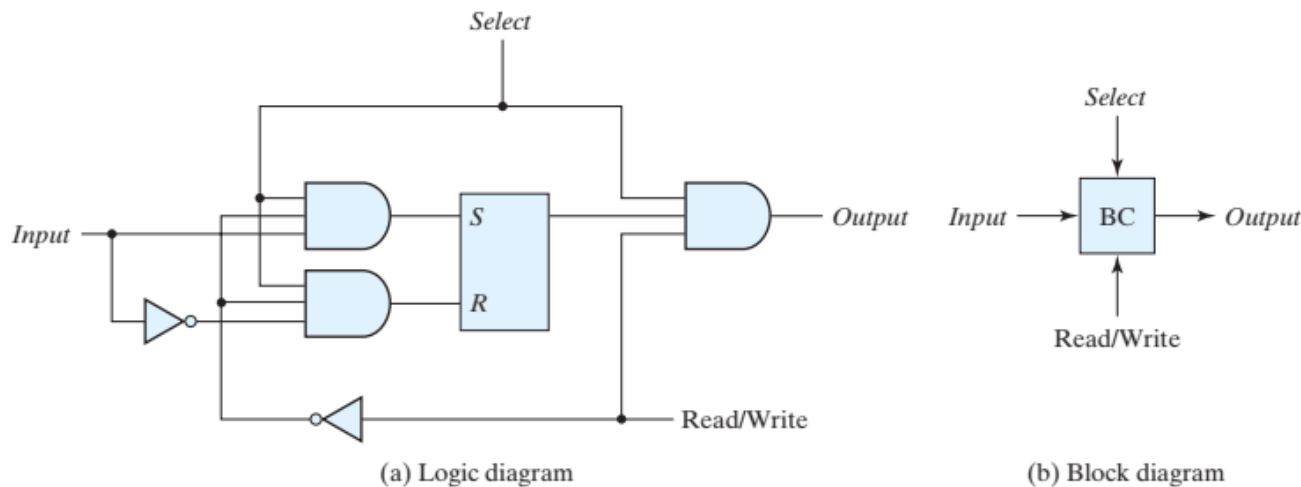
- A memory unit is a collection of storage cells, together with associated circuits needed
- The architecture of memory is such that information can be selectively retrieved from any of its internal locations.
- A memory unit stores binary information in groups of bits called words. A word in memory is an entity of bits that move in and out of storage as a unit.
- A memory word is a group of 1's and 0's and may represent a number, an instruction, one or more alphanumeric characters, or any other binary-coded information.
- A group of 8 bits is called a *byte*. Most computer memories use words that are multiples of 8 bits in length.



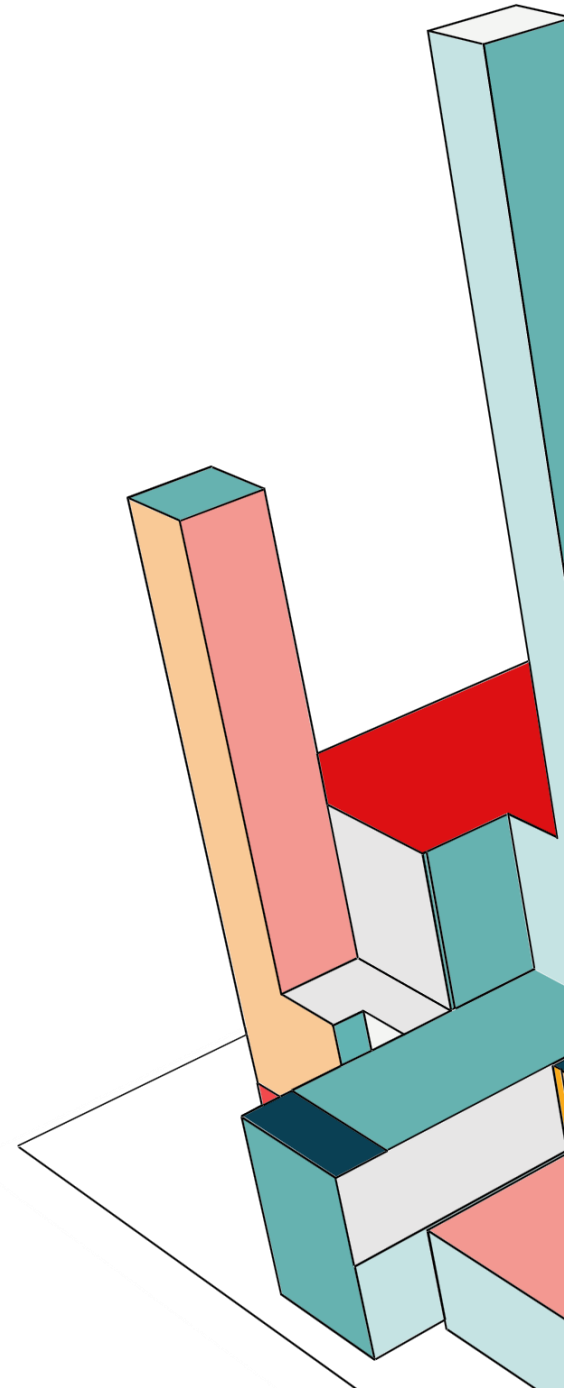
**FIGURE 7.2**  
Block diagram of a memory unit

# RANDOM - ACCESS MEMORY (RAM)

- Random Access Memory (RAM) is a type of computer memory that stores data temporarily while a computer is running. It's called "random access" because the computer can access any part of the memory directly and quickly.
- The binary storage cell is the basic building block of a memory unit

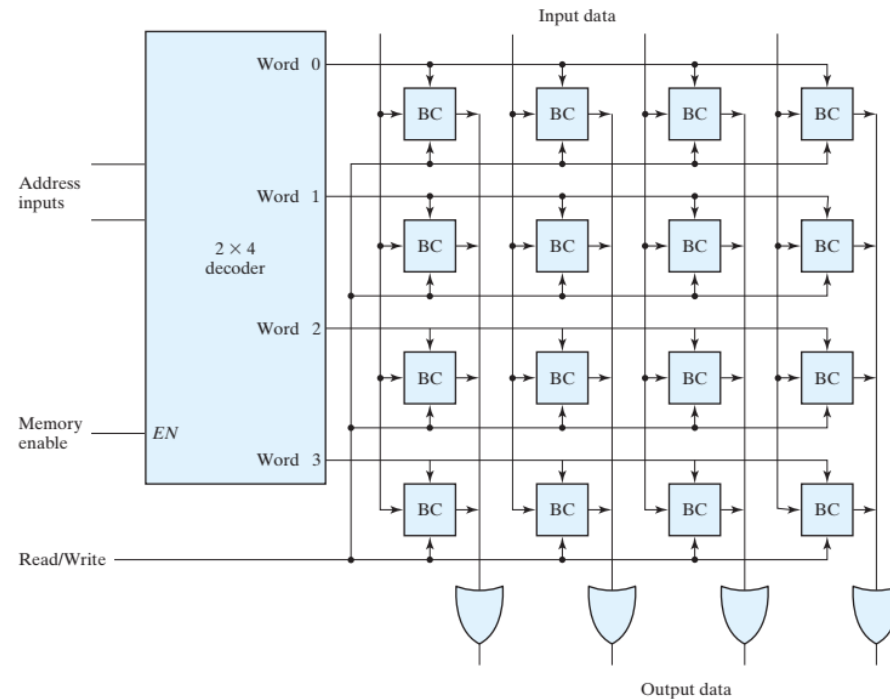


**FIGURE 7.5**  
Memory cell

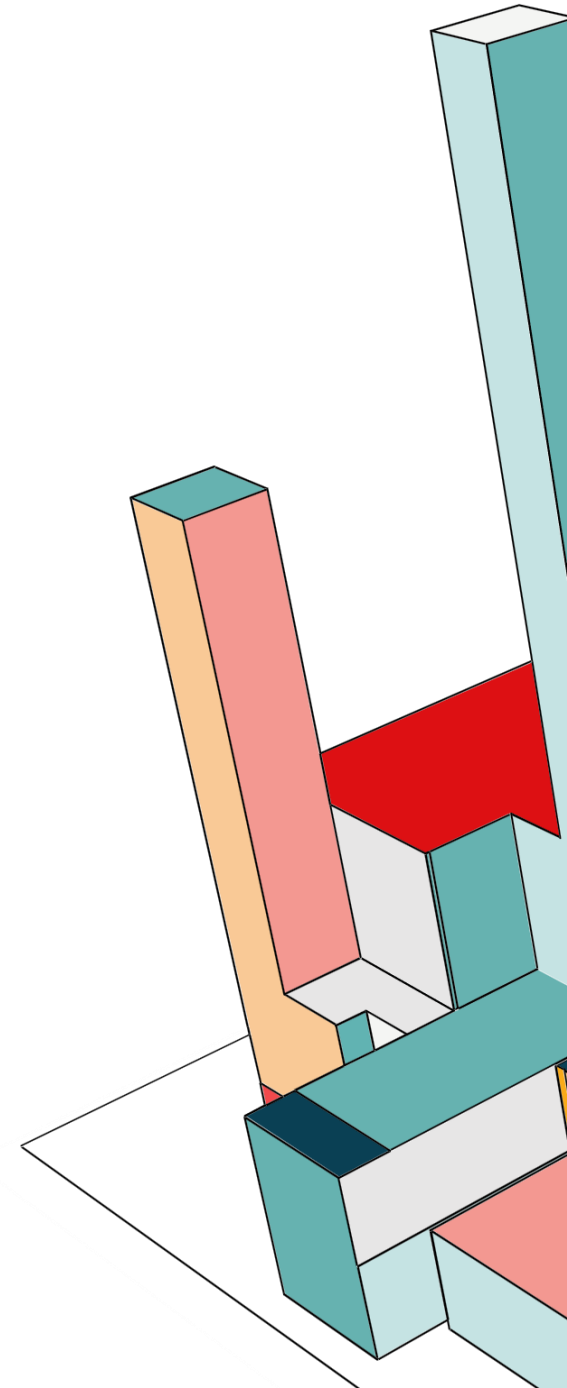


# RANDOM - ACCESS MEMORY (RAM)

- The logical construction of a small RAM is shown.
- This RAM consists of four words of four bits each and has a total of 16 binary cells. The small blocks labeled BC represent the binary cell with its three inputs and one output

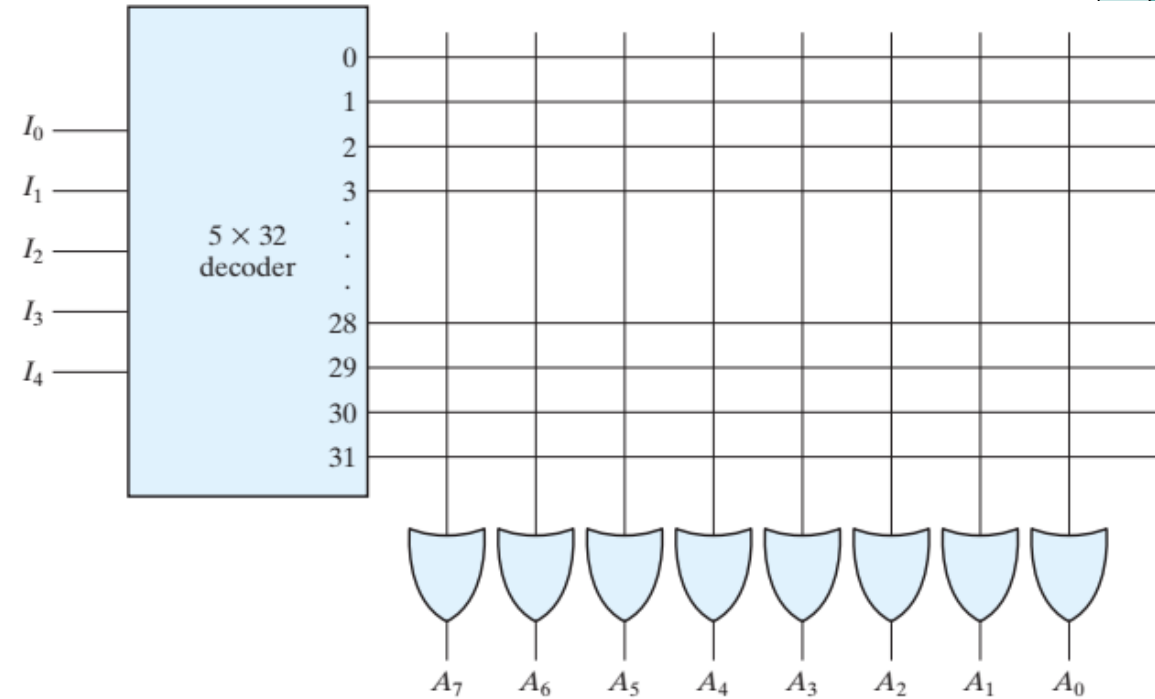


**FIGURE 7.6**  
Diagram of a 4x4 RAM



# READ ONLY MEMORY (ROM)

- A read-only memory (ROM) is essentially a memory device in which permanent binary information is stored.
- A block diagram of a ROM consisting of  $k$  inputs and  $n$  outputs and one output.
- The inputs provide the address for memory, and the outputs give the data bits of the stored word that is selected by the address. The number of words in a ROM is determined from the fact that  $k$  address input lines
- Example, a  $32 * 8$  ROM

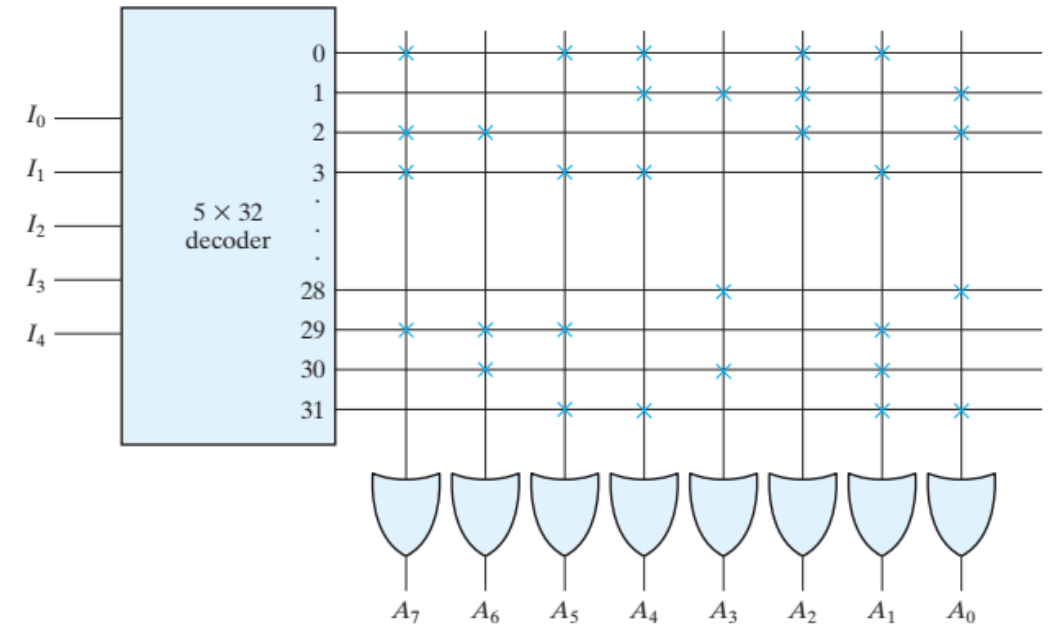


# READ ONLY MEMORY (ROM)

- Programming the ROM according to Example Table :

*ROM Truth Table (Partial)*

Inputs					Outputs							
$I_4$	$I_3$	$I_2$	$I_1$	$I_0$	$A_7$	$A_6$	$A_5$	$A_4$	$A_3$	$A_2$	$A_1$	$A_0$
0	0	0	0	0	1	0	1	1	0	1	1	0
0	0	0	0	1	0	0	0	1	1	1	0	1
0	0	0	1	0	1	1	0	0	0	1	0	1
0	0	0	1	1	1	0	1	1	0	0	1	0
		⋮						⋮				
1	1	1	0	0	0	0	0	0	1	0	0	1
1	1	1	0	1	1	1	1	0	0	0	1	0
1	1	1	1	0	0	1	0	0	1	0	1	0
1	1	1	1	1	0	0	1	1	0	0	1	1

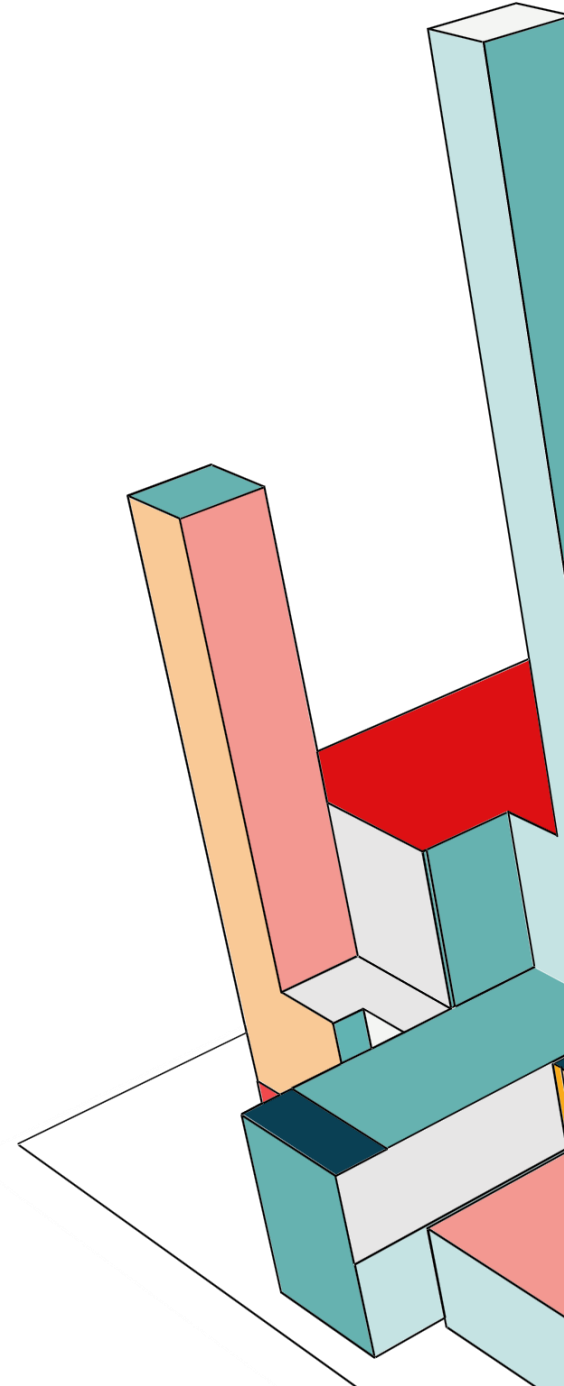




# CLASSIFICATION OF ROM (1)

- Mask ROM

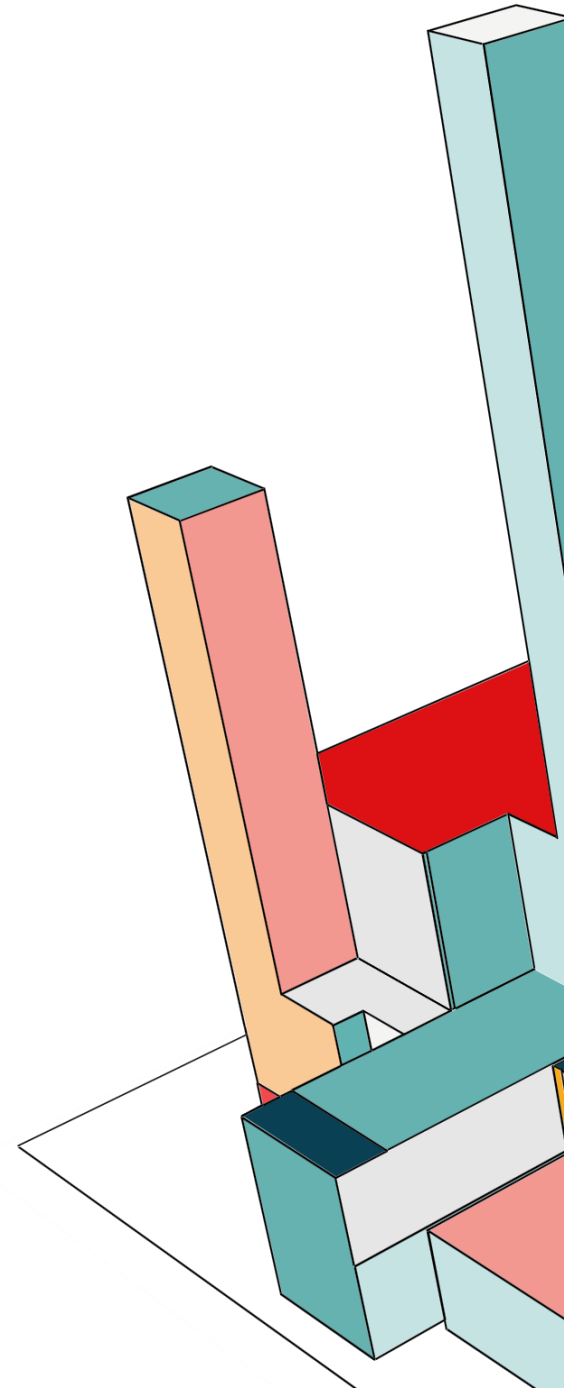
In this type of ROM, the specification of the ROM (its contents and their location), is taken by the manufacturer from the customer in tabular form in a specified format and then makes corresponding masks for the paths to produce the desired output . This is costly, as the vendor charges special fee from the customer for making a particular ROM (recommended, only if large quantity of the same ROM is required).  
Uses - They are used in network operating systems, server operating systems, storing of fonts for laser printers, sound data in electronic musical instruments .



## CLASSIFICATION OF ROM (2)

- PROM

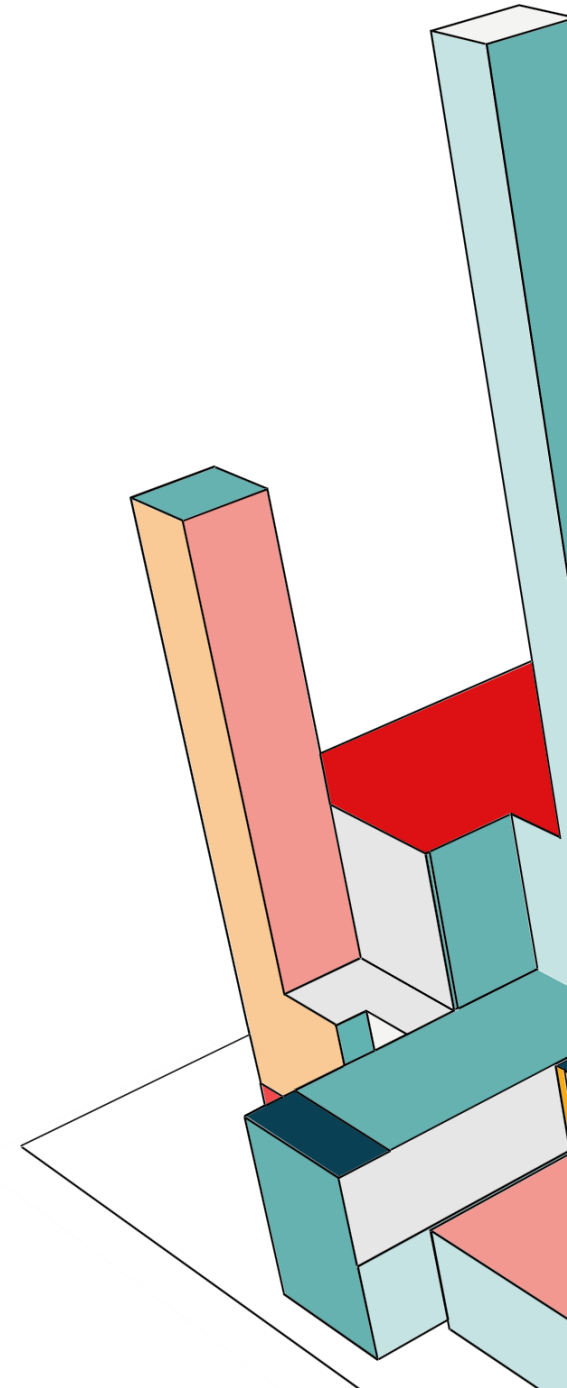
It stands for Programmable Read-Only Memory . It is first prepared as blank memory, and then it is programmed to store the information . The difference between PROM and Mask ROM is that PROM is manufactured as blank memory and programmed after manufacturing, whereas a Mask ROM is programmed during the manufacturing process. To program the PROM, a PROM programmer or PROM burner is used . The process of programming the PROM is called as burning the PROM . Also, the data stored in it cannot be modified, so it is called as one - time programmable device. **Uses** – They have several different applications, including cell phones, video game consoles, RFID tags, medical devices, and other electronics.



## CLASSIFICATION OF ROM (3)

- EPROM

It stands for Erasable Programmable Read-Only Memory . It overcomes the disadvantage of PROM that once programmed, the fixed pattern is permanent and cannot be altered . If a bit pattern has been established, the PROM becomes unusable, if the bit pattern has to be changed . This problem has been overcome by the EPROM, as when the EPROM is placed under a special ultraviolet light for a length of time, the shortwave radiation makes the EPROM return to its initial state, which then can be programmed accordingly . Again for erasing the content, PROM programmer or PROM burner is used. **Uses** –Before the advent of EEPROMs, some micro-controllers, like some versions of Intel 8048, the Freescale 68HC11 used EPROM to store their program .



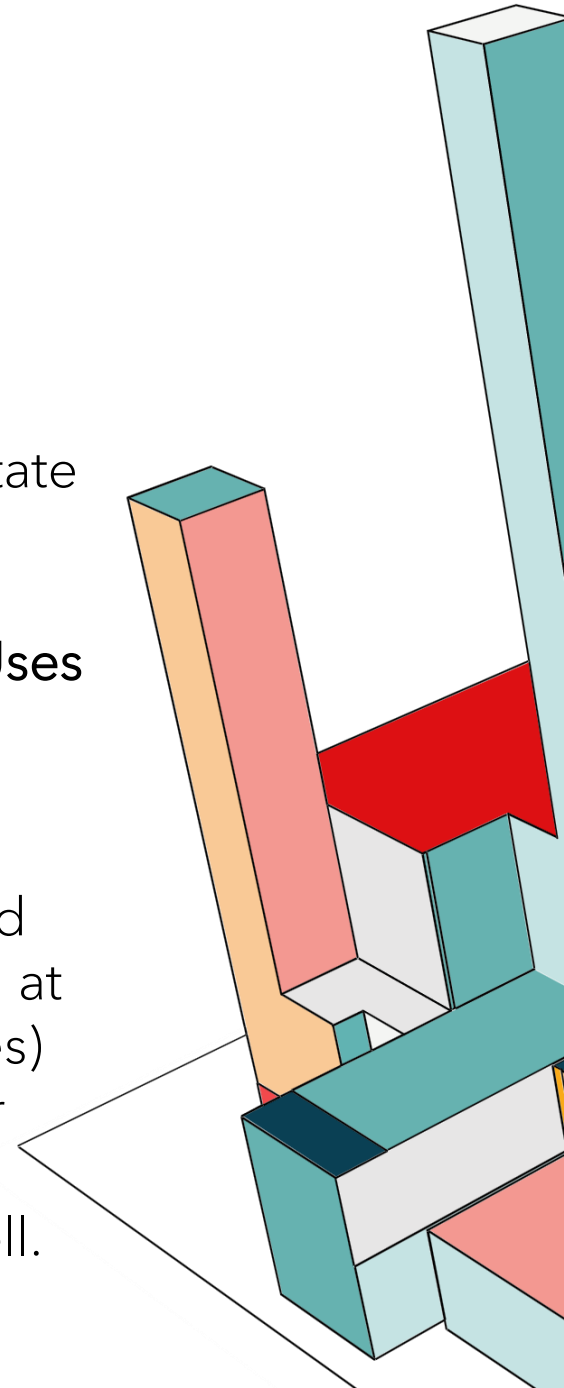
# CLASSIFICATION OF ROM (4)

- EEPROM

It stands for Electrically Erasable Programmable Read-Only Memory . It is similar to EPROM, except that in this, the EEPROM is returned to its initial state by application of an electrical signal, in place of ultraviolet light . Thus, it provides the ease of erasing, as this can be done, even if the memory is positioned in the computer. It erases or writes one byte of data at a time . **Uses** – It is used for storing the computer system BIOS.

- Flash ROM

It is an enhanced version of EEPROM .The difference between EEPROM and Flash ROM is that in EEPROM, only 1 byte of data can be deleted or written at a particular time, whereas, in flash memory, blocks of data (usually 512 bytes) can be deleted or written at a particular time . So, Flash ROM is much faster than EEPROM . **Uses** – Many modern PCs have their BIOS stored on a flash memory chip, called as flash BIOS and they are also used in modems as well.



# PROGRAMMABLE LOGIC DEVICES (PLD)



(a) Programmable read-only memory (PROM)

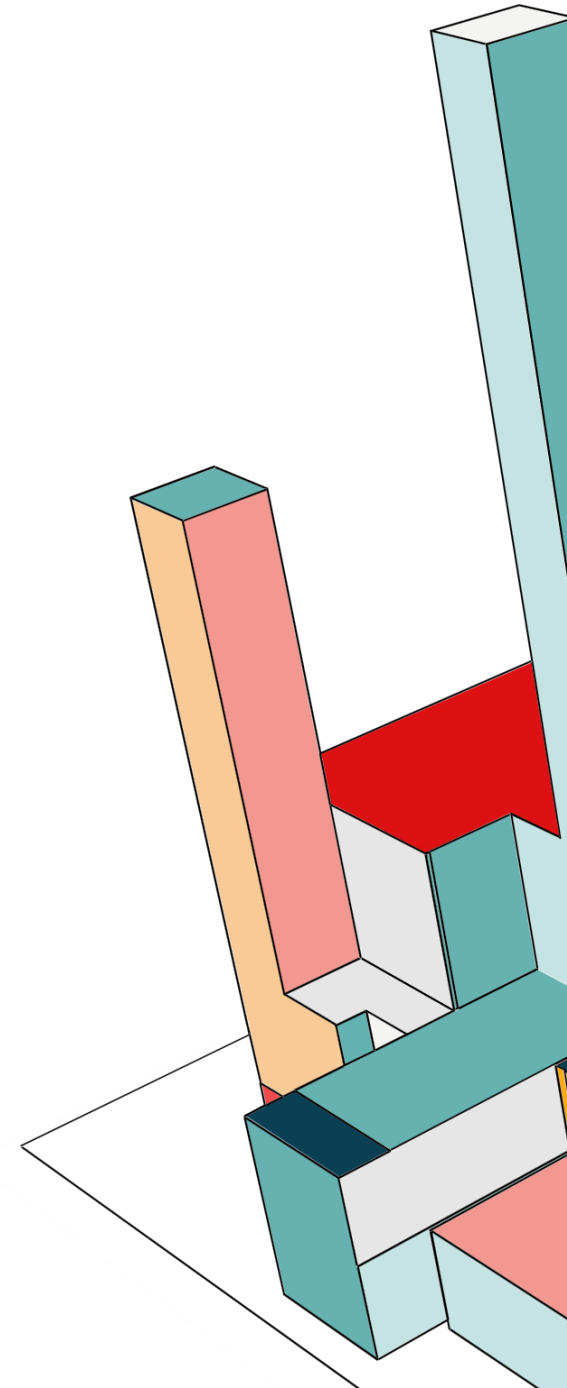


(b) Programmable array logic (PAL)



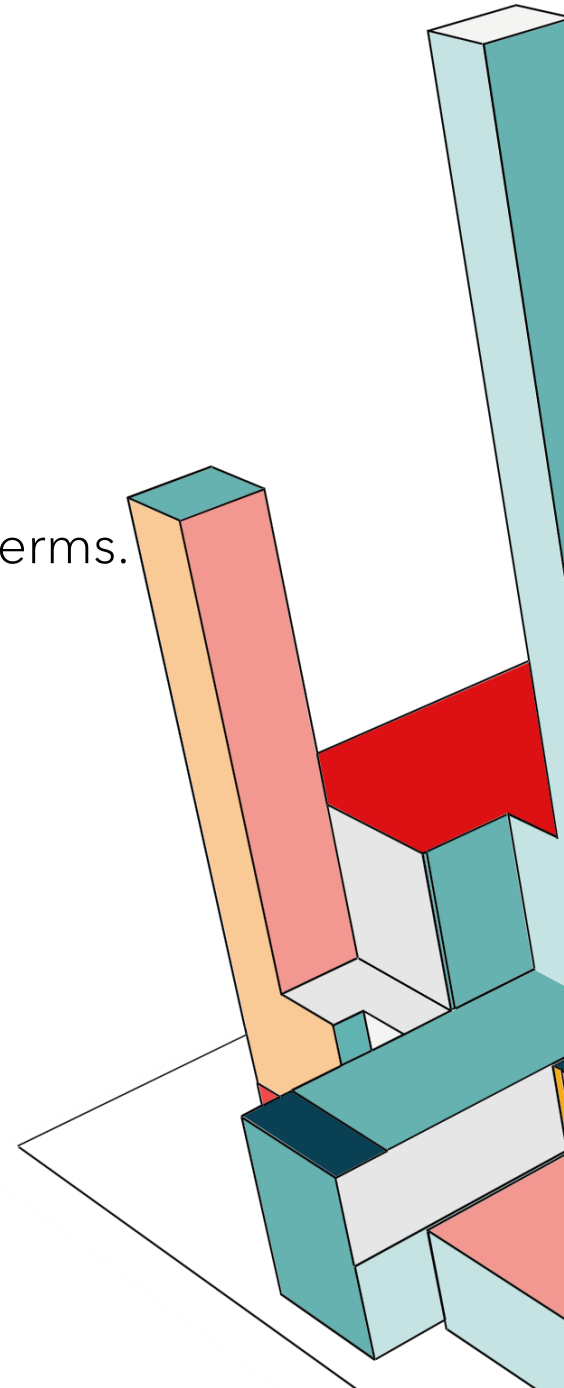
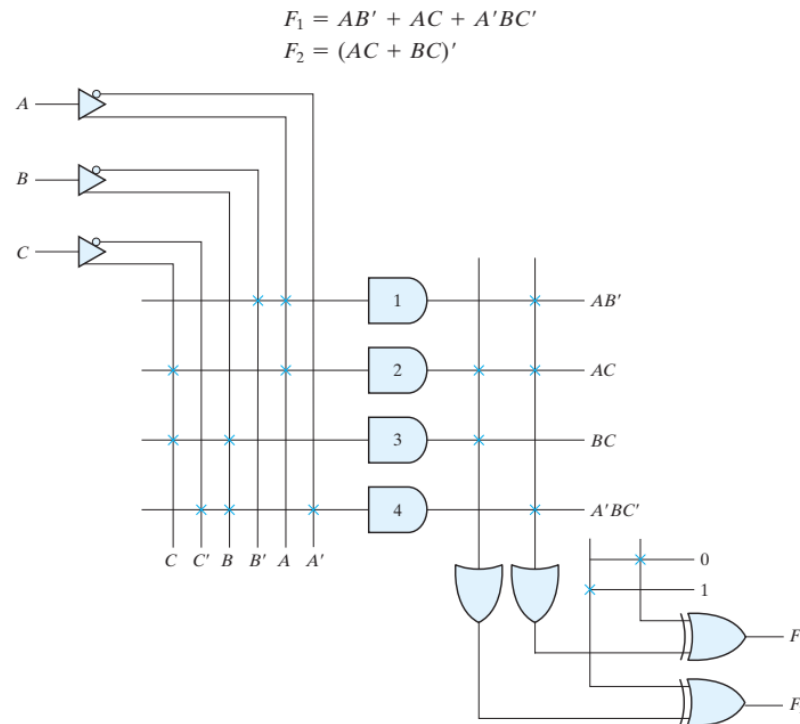
(c) Programmable logic array (PLA)

**FIGURE 7.13**  
Basic configuration of three PLDs



# PROGRAMMABLE LOGIC ARRAY (PLA)

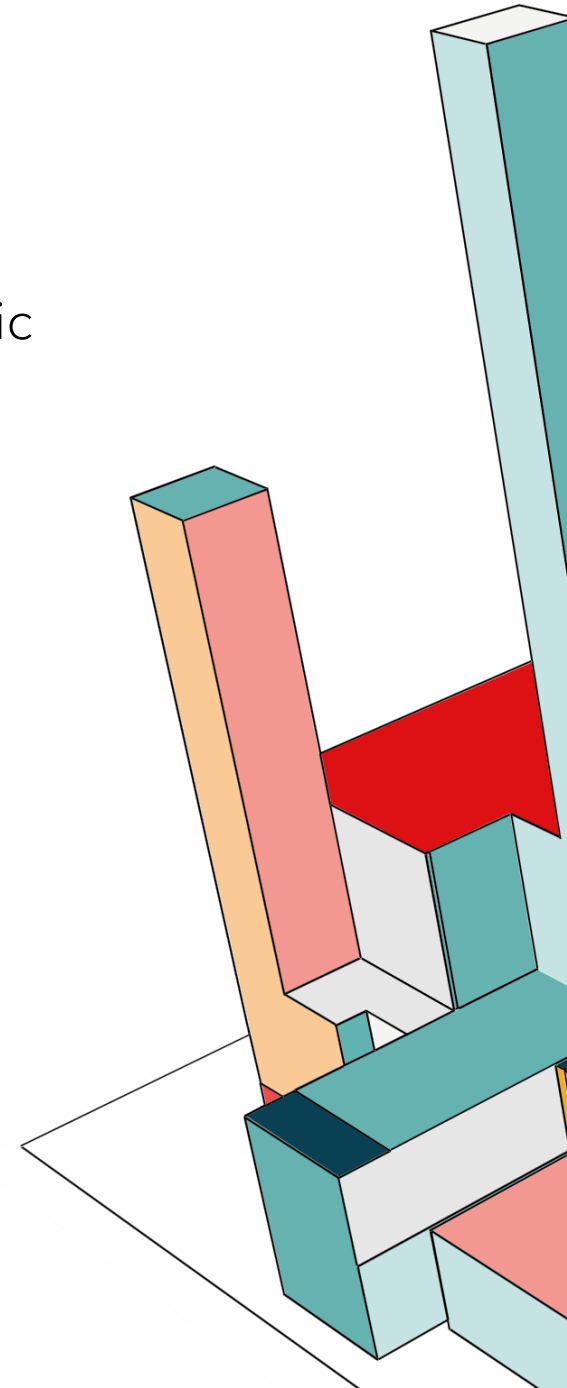
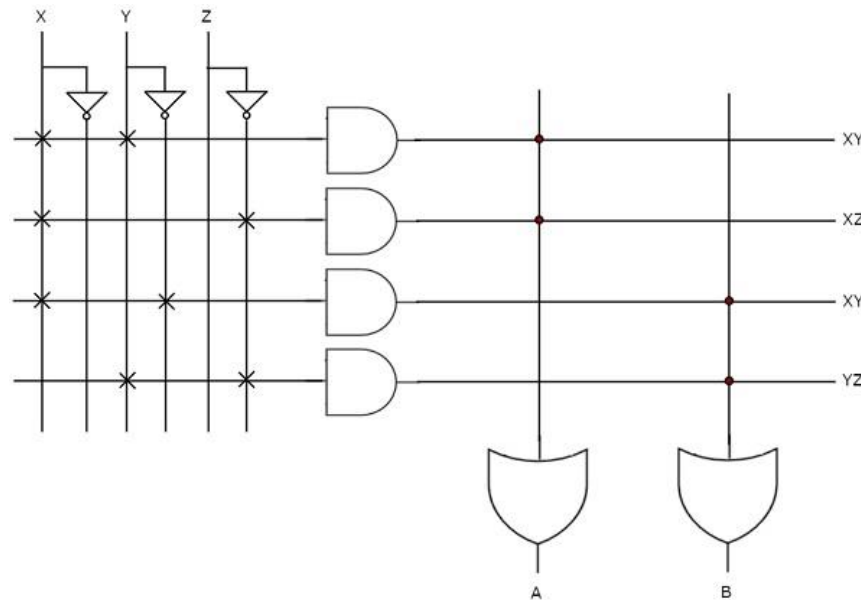
- Pre-fabricated building block of many AND/OR gates (or NOR, NAND)  
"Personalized" by making/ breaking connections among the gates.
- The PLA is similar in concept to the PROM, except that the PLA does not provide full decoding of the variables and does not generate all the minterms.



# PROGRAMMABLE LOGIC ARRAY (PLA)

- Programmable Array Logic (PAL) is a commonly used programmable logic device (PLD).
- It has programmable AND array and fixed OR array.
- Because only the AND array is programmable, it is easier to use but not flexible as compared to Programmable Logic Array (PLA).

$$A = XY + XZ'$$
$$B = XY' + YZ'$$



# THANK YOU

Digital Design, With an Introduction to the  
Verilog HDL  
M. Morris Mano

