Digital Design : 2021-22
Lecture 27 : Memory

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Types of memory used in digital systems

RAM (Random Access Memory)

-Can perform both Read and Write Operations

-Stored information is lost when power is turned off

ROM (Read Only Memory)

-Can perform only Read operations

-Suitable information already stored and can be retrieved at any time

-Binary information "Programmed" into ROM by embedded hardware

Hard Disks

Read / Write Non-volatile

Magnetic SSD

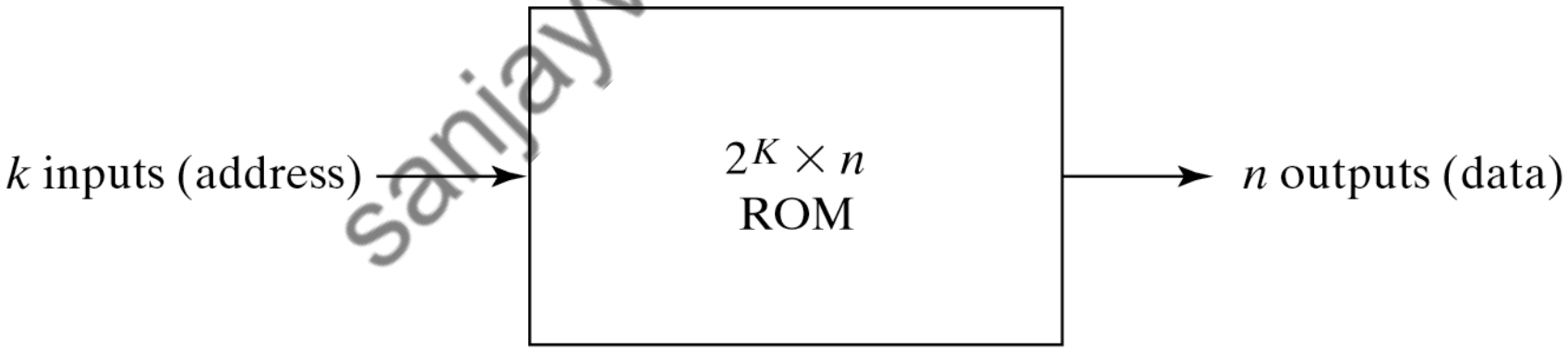
Read-Only Memory

8-bit data is called Byte, 16 bit is called Word

A block diagram of a ROM is shown below. It consists of k address inputs and n data outputs.

The number of words in a ROM is determined from the fact that k address input lines are needed to specify 2^k words.

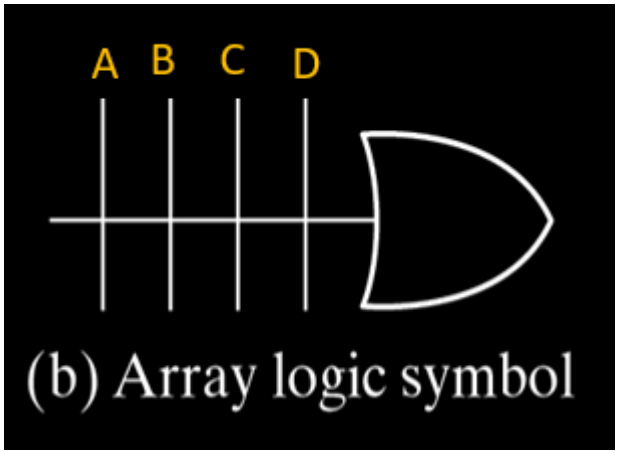
n represents the output data length



Read-Only Memory

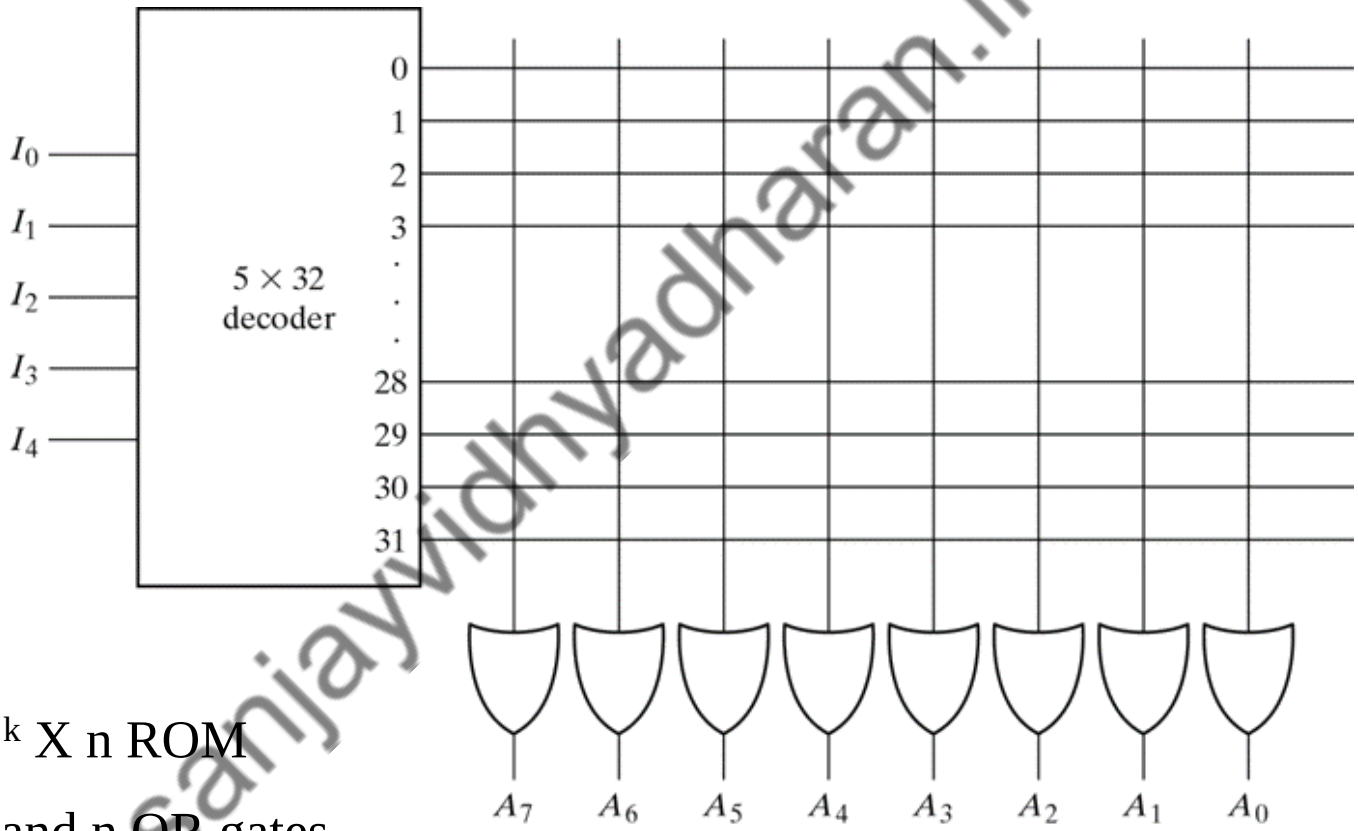
- May have 100s of million gates interconnected through 100s of thousands of internal path

-To show internal logic of such a device – employ a special gate symbology applicable to array logic



Read-Only Memory

Internal Logic 32 X 8 ROM



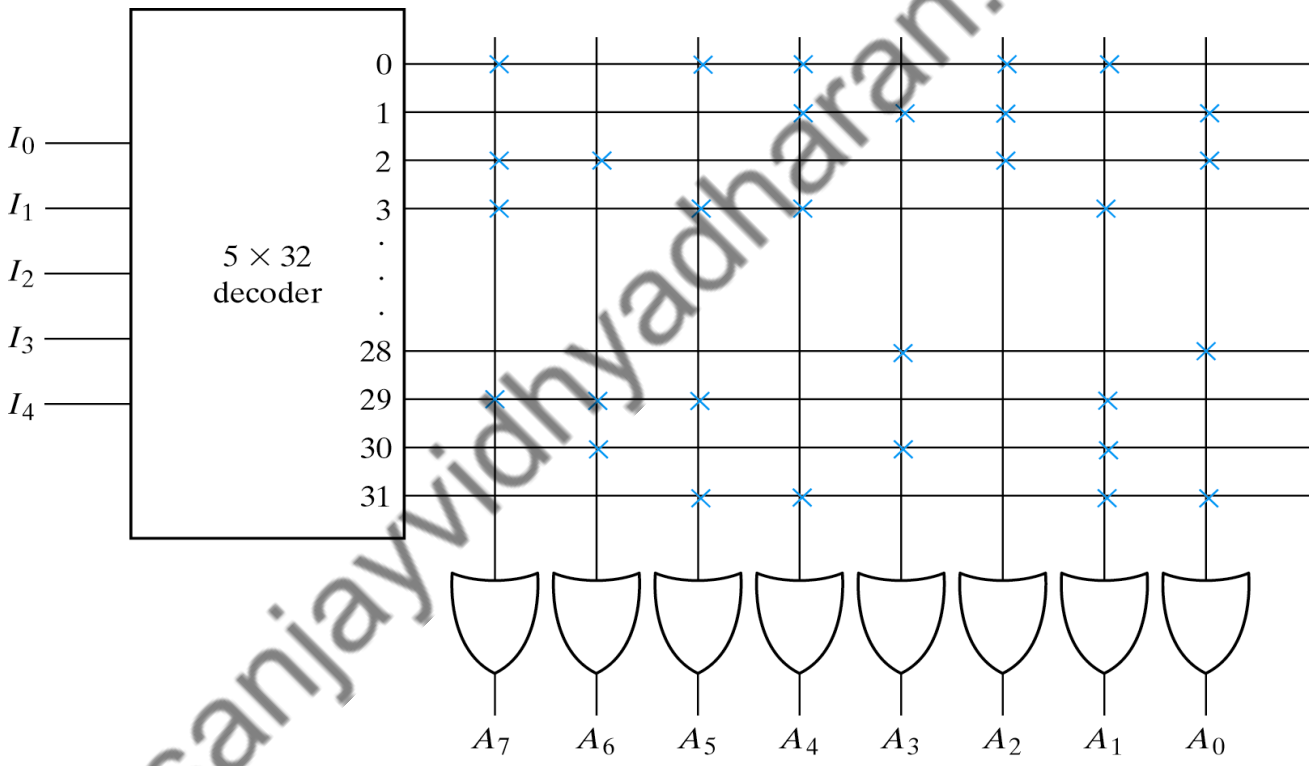
In General for 2^k X n ROM

K x 2^k Decoder and n OR gates

Each OR gate has 2^k inputs

Programming the ROM

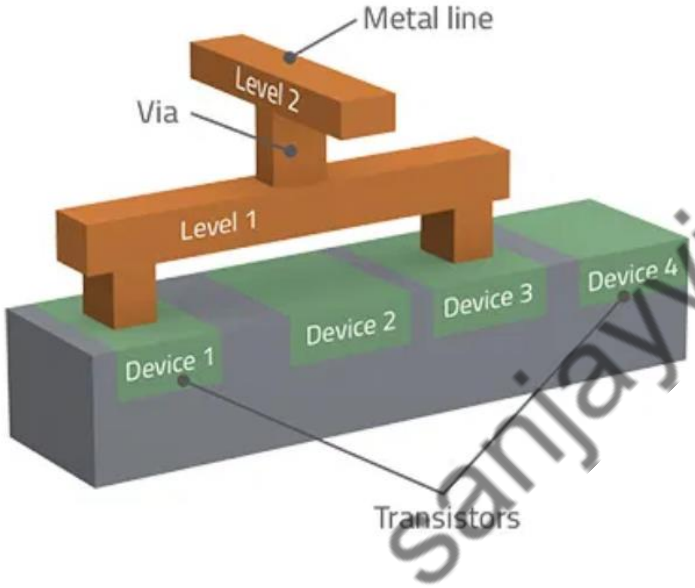
Address 3 = 10110010 is permanent storage using fuse link

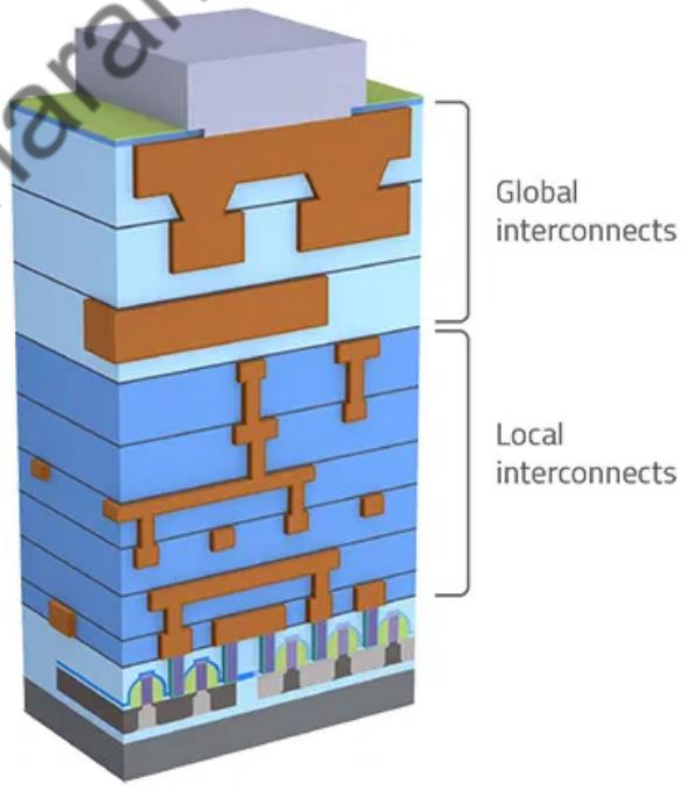


X : means connection

Programming the ROM

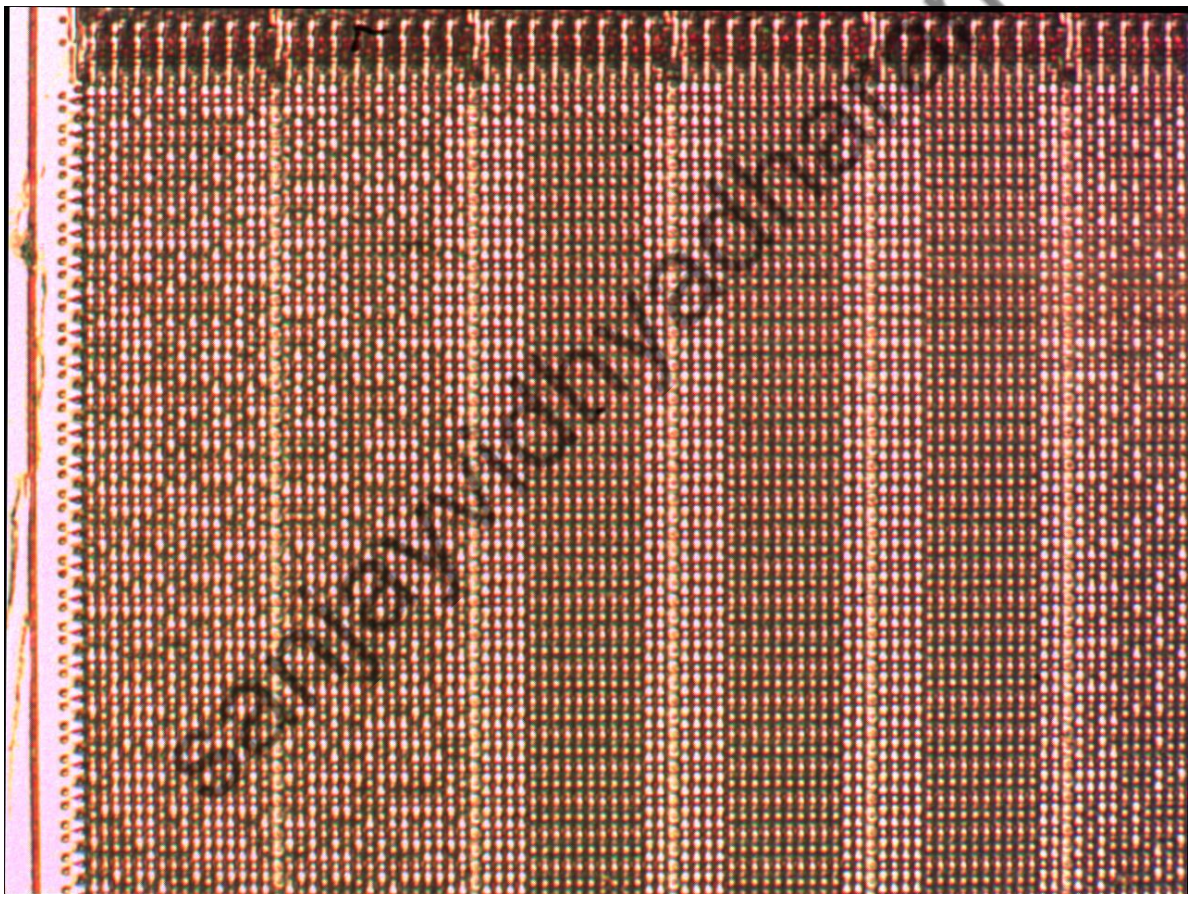
1. Masking During Metallization





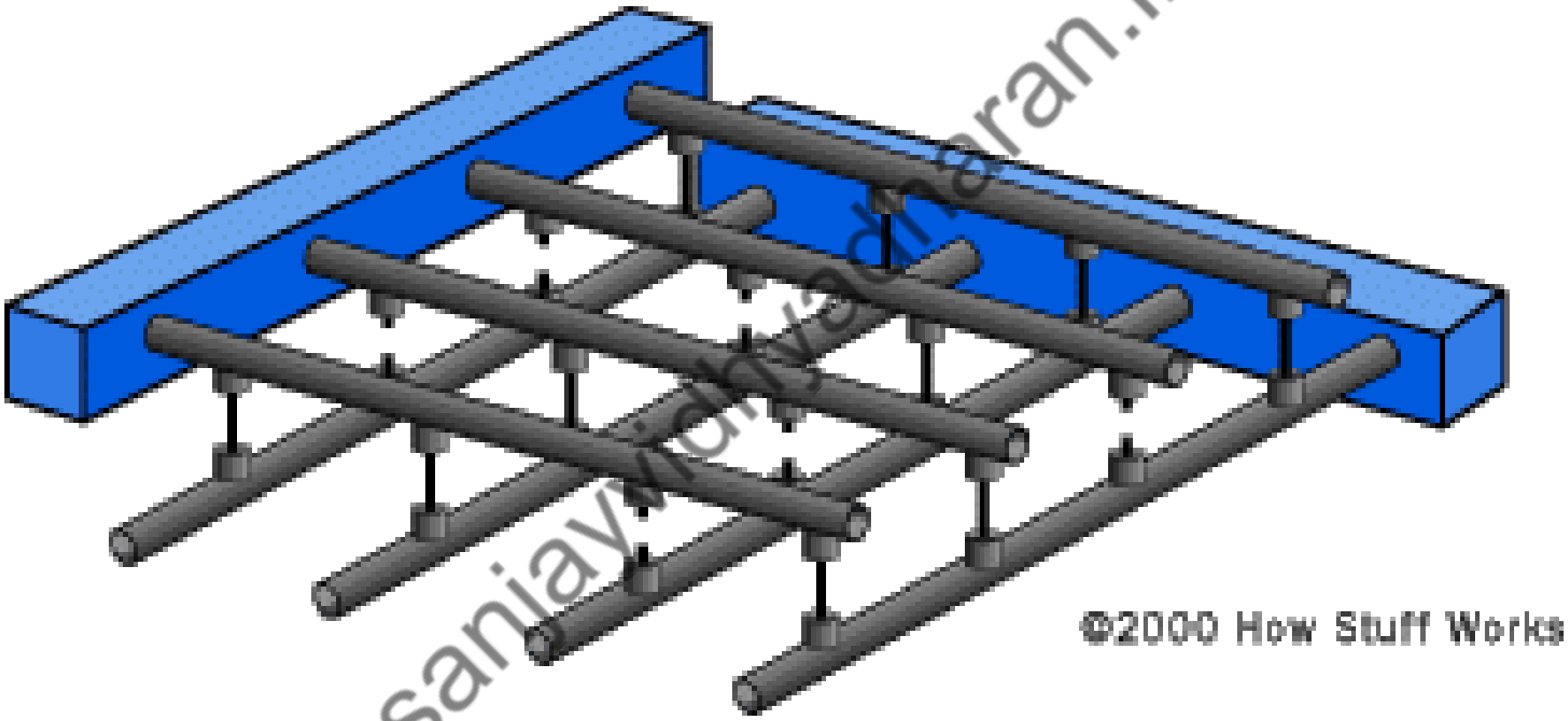
Programming the ROM

1. Masking During Metallization (PROM)



Programming the ROM

2. Fuse (PROM)



PROM

Programming the ROM

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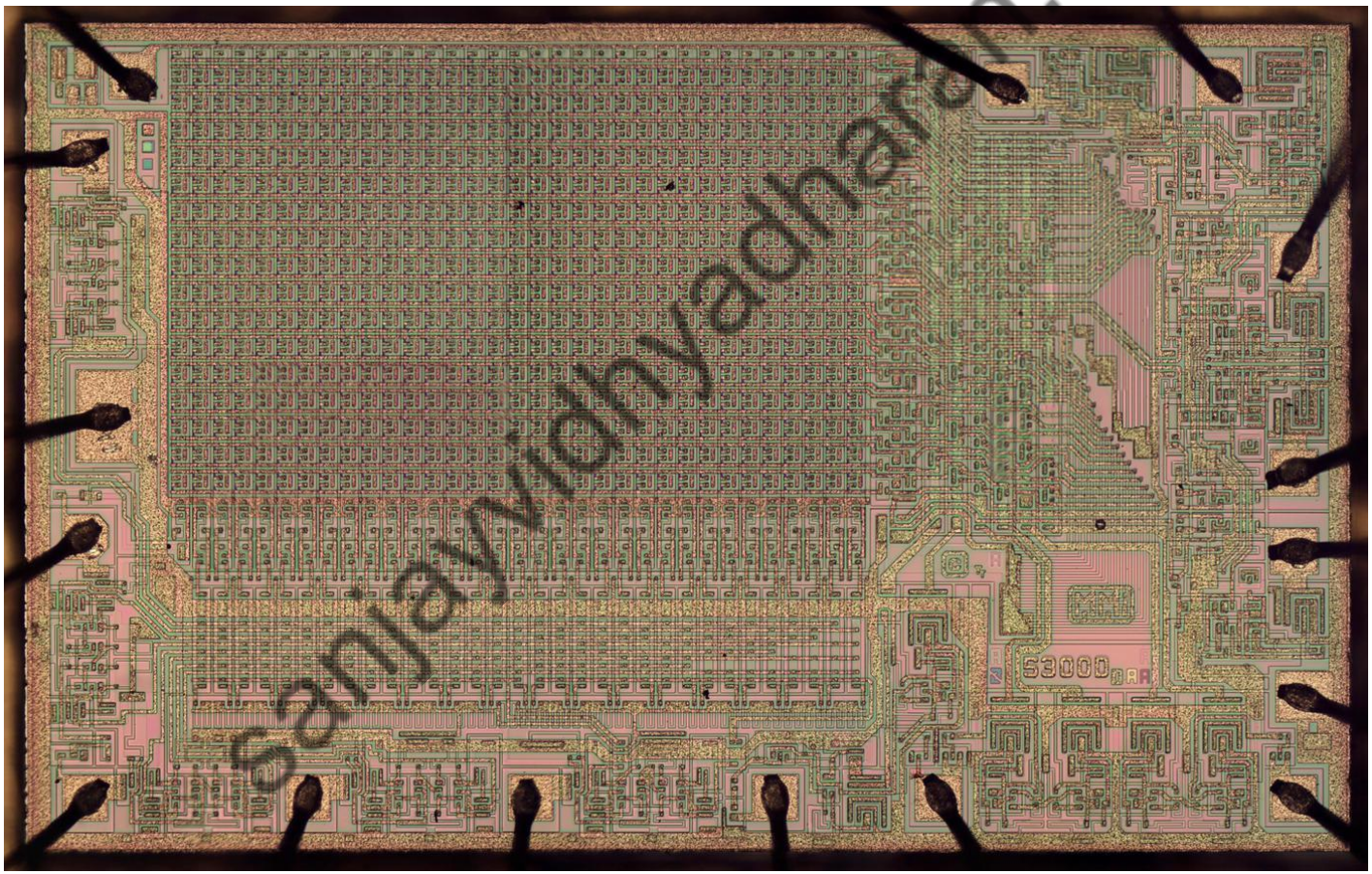
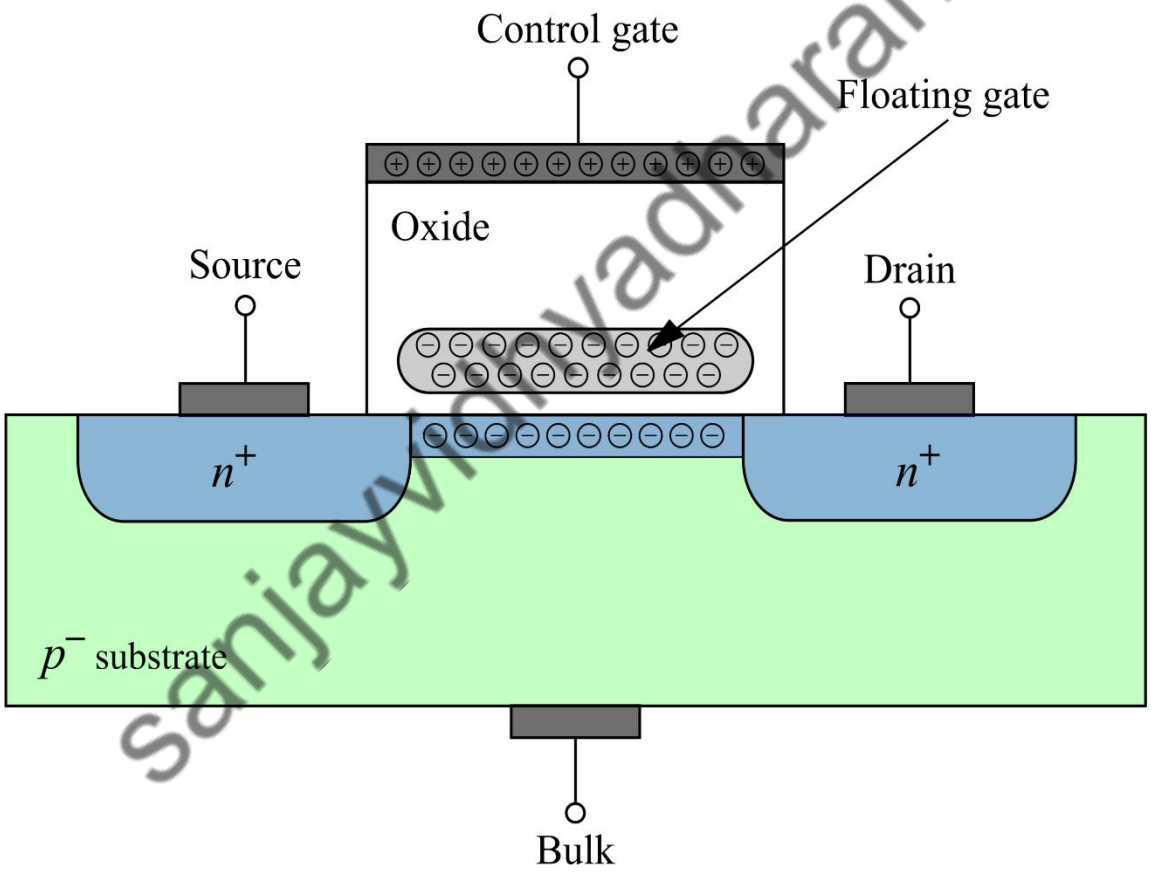


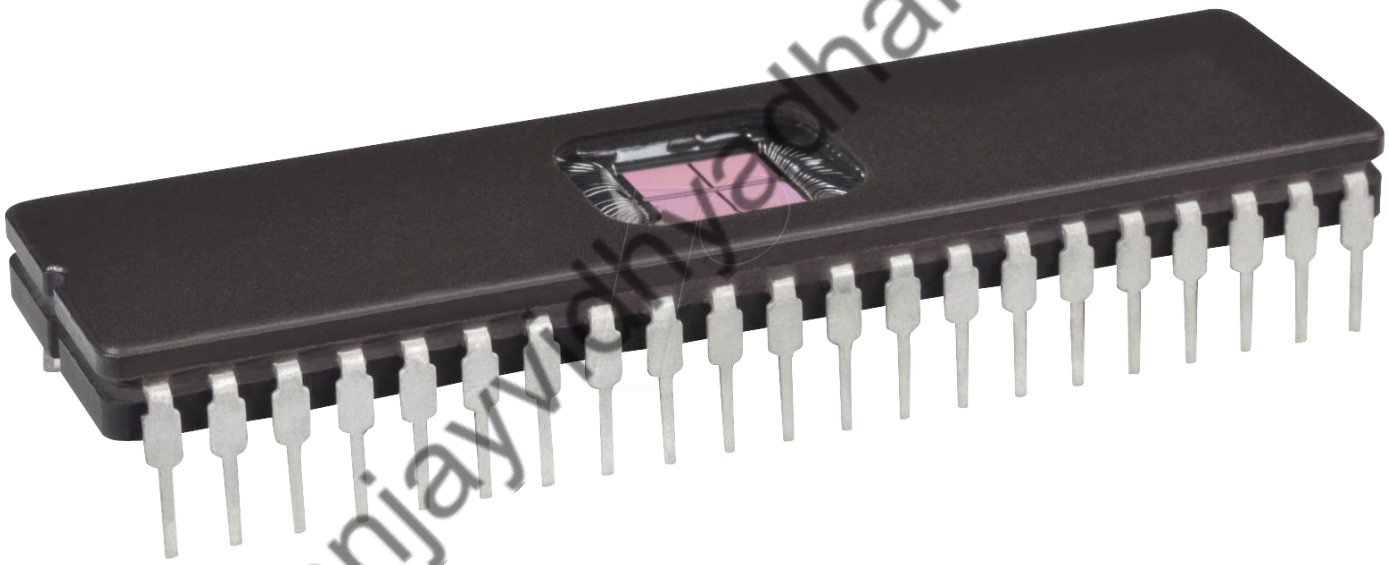
Programming the ROM

3. EPROM



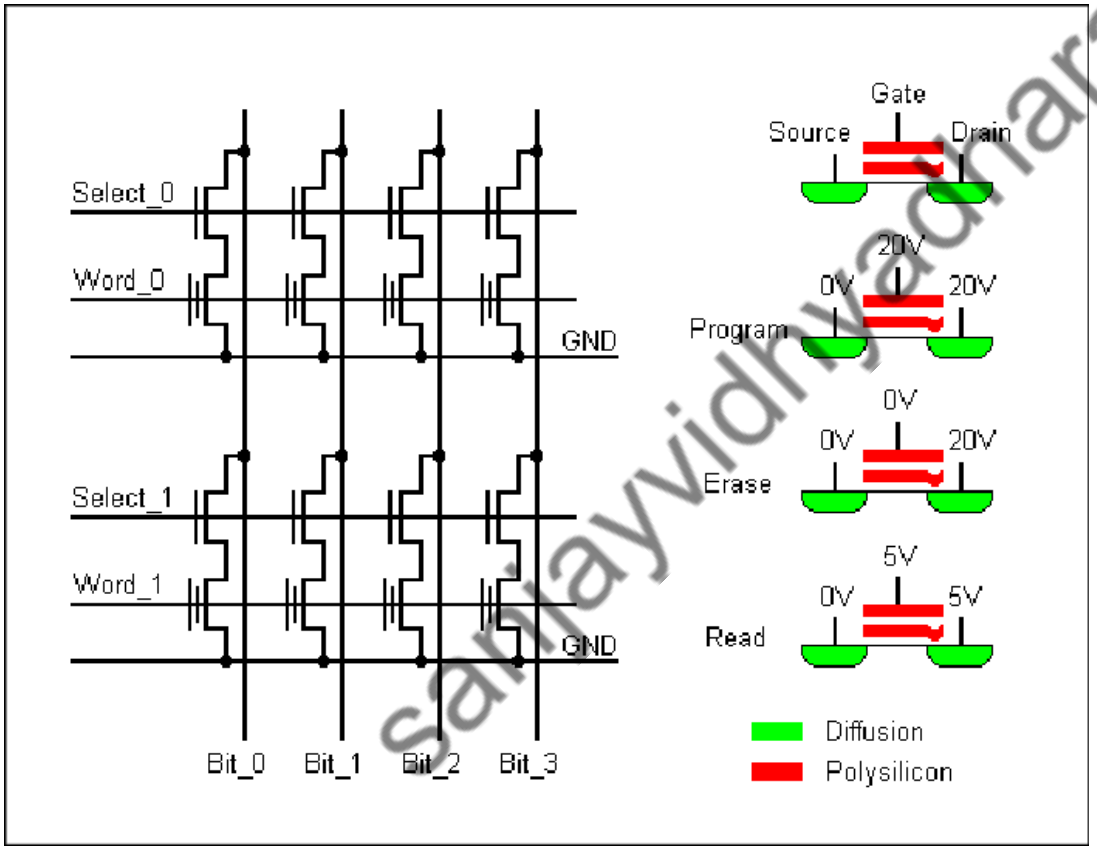
Programming the ROM

3. EPROM



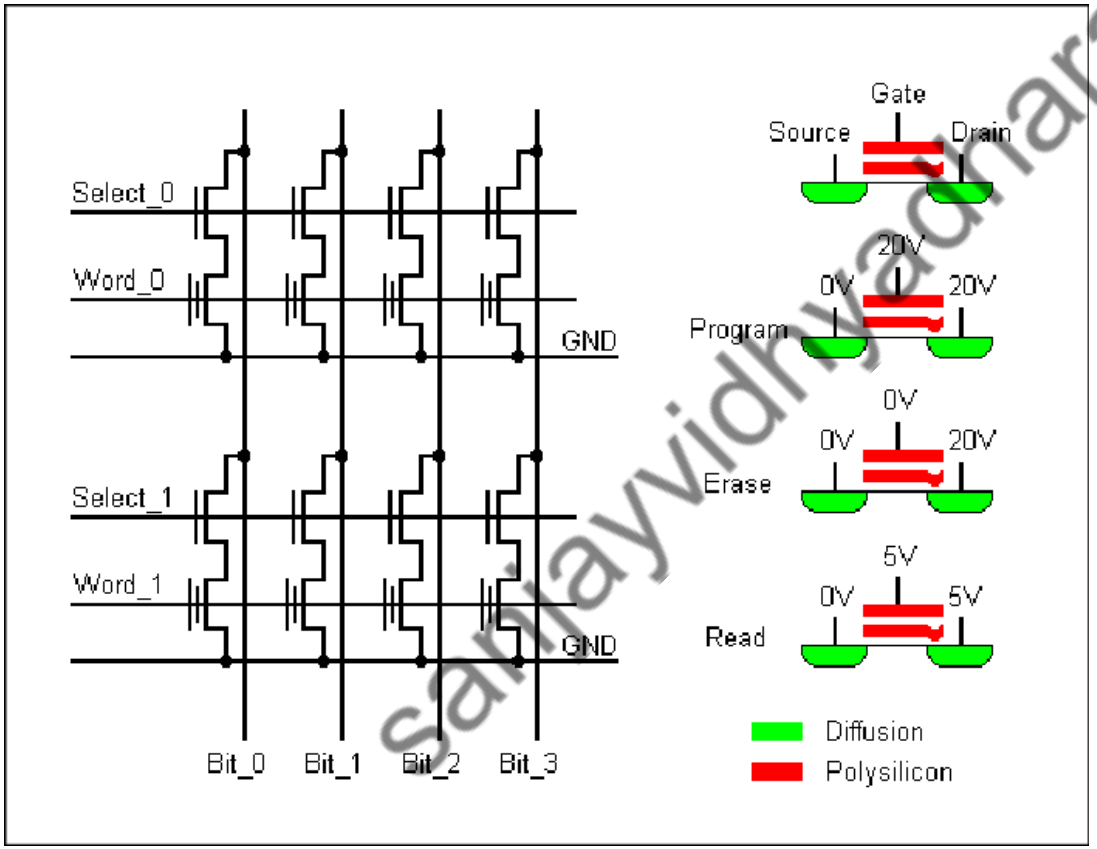
Programming the ROM

4. EEPROM



Programming the ROM

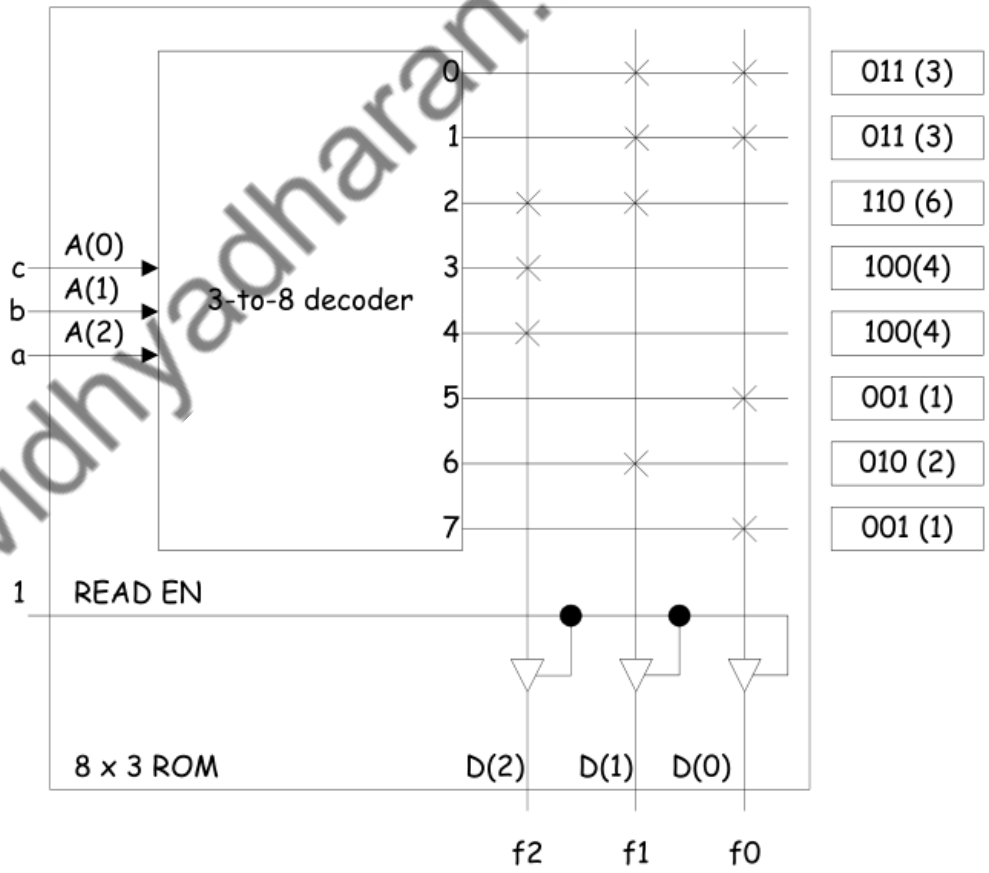
4. EEPROM



Programming the ROM

- E.g., Implement the 3-input logics $f_0 = \Sigma(0,1,5,7)$, $f_1 = \Sigma(0,1,2,6)$ and $f_2 = \Sigma(2,3,4)$ using a ROM.

a	b	c	f_2	f_1	f_0
0	0	0	0	1	1
0	0	1	0	1	1
0	1	0	1	1	0
0	1	1	1	0	0
1	0	0	1	0	0
1	0	1	0	0	1
1	1	0	0	1	0
1	1	1	0	0	1



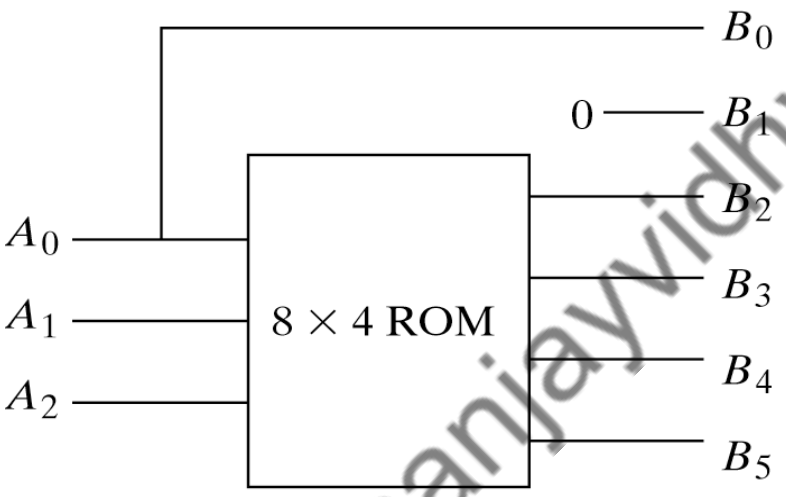
Programming the ROM

Example: Design a combinational circuit using a ROM. The circuit accepts a 3-bit number and generates an output binary number equal to the square of the input number.

Inputs			Outputs						
A_1	A_1	A_0	B_5	B_4	B_3	B_2	B_1	B_0	Decimal
0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	1	1
0	1	0	0	0	0	1	0	0	4
0	1	1	0	0	1	0	0	1	9
1	0	0	0	1	0	0	0	0	16
1	0	1	0	1	1	0	0	1	25
1	1	0	1	0	0	1	0	0	36
1	1	1	1	1	0	0	0	1	49

Programming the ROM

Example: Design a combinational circuit using a ROM. The circuit accepts a 3-bit number and generates an output binary number equal to the square of the input number.



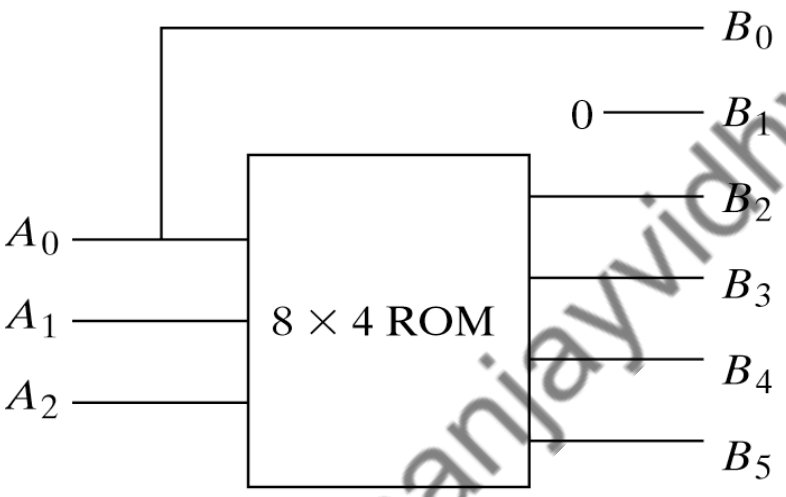
(a) Block diagram

A_2	A_1	A_0	B_5	B_4	B_3	B_2
0	0	0	0	0	0	0
0	0	1	0	0	0	0
0	1	0	0	0	0	1
0	1	1	0	0	1	0
1	0	0	0	1	0	0
1	0	1	0	1	1	0
1	1	0	1	0	0	1
1	1	1	1	1	0	0

(b) ROM truth table

Programming the ROM

Example: Design a combinational circuit using a ROM. The circuit accepts a 3-bit number and generates an output binary number equal to the square of the input number.



(a) Block diagram

A_2	A_1	A_0	B_5	B_4	B_3	B_2
0	0	0	0	0	0	0
0	0	1	0	0	0	0
0	1	0	0	0	0	1
0	1	1	0	0	1	0
1	0	0	0	1	0	0
1	0	1	0	1	1	0
1	1	0	1	0	0	1
1	1	1	1	1	0	0

(b) ROM truth table

Thank you