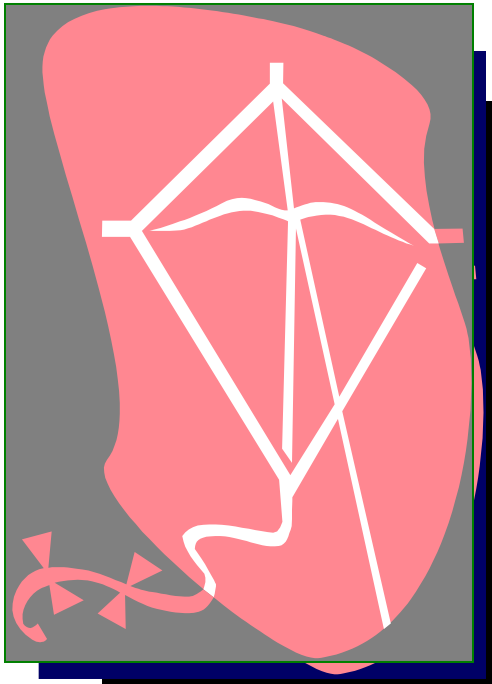
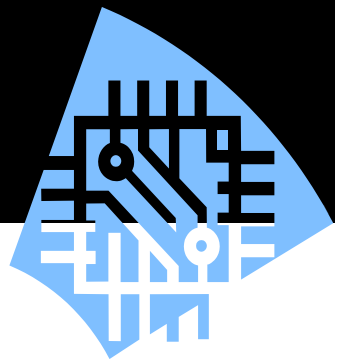


CH – 2
Digital Component



Introduction :

- Logic circuits can broadly classified into
  - (1) Combinational Circuits
  - (2) Sequential Logic Circuits
- Here in this chapter Multiplexer, Demultiplexer, Decoder, Encoder, Register and counters are explained.
- Registers are widely used in digital system. Here types of registers are explained on the base of data transfer.
- Counter is one type of register which count the pulses given to it and stores in the binary form in the memory. In counters mainly JK flip flop are used. Output of the counter is in to decimal form. Output of decoder is given to the display device.

Integrated Circuit :

- In electronics, an integrated circuit (also known as IC, microcircuit, microchip, silicon chip, or chip).
- It containing the electronic components for digital gates.
- The various gates are interconnected inside the chip to form the required circuit.
- Integrated circuits are used for a variety of devices, including microprocessors, audio and video equipment, and automobiles.
- Integrated circuits are classified by the number of transistors and other electronic components they contains.

Types of Integrated Circuit :

- SSI (Small-Scale Integration) :
  - Up to 100 electronic components per chip.
- MSI (Medium-Scale Integration) :
  - From 100 to 3000 electronic components per chip.
- LSI (Large-Scale Integration) :
  - From 3000 to 1,00,000 electronic components per chip.
- VLSI (Very Large-Scale Integration) :
  - From 1,00,000 to 10,00,000 electronic components per chip.
- ULSI (Ultra Large-Scale Integration) :
  - More than 1 million (more than 10,00,000) electronic components per chip.

Decoder :

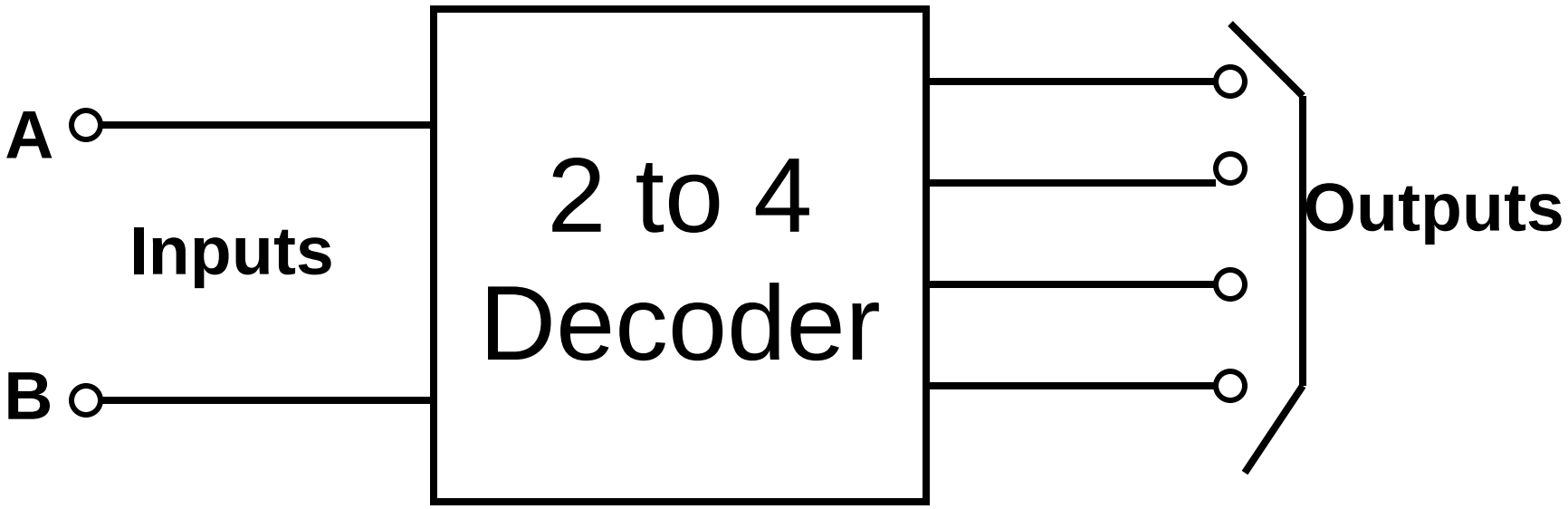
- It is a combinational circuit that converts binary information from n input lines to maximum 2^n unique output lines.
- It has n inputs and m outputs and also referred to as n-to-m line decoders, where $m=2^n$

a) 2-to-4 line Decoder:

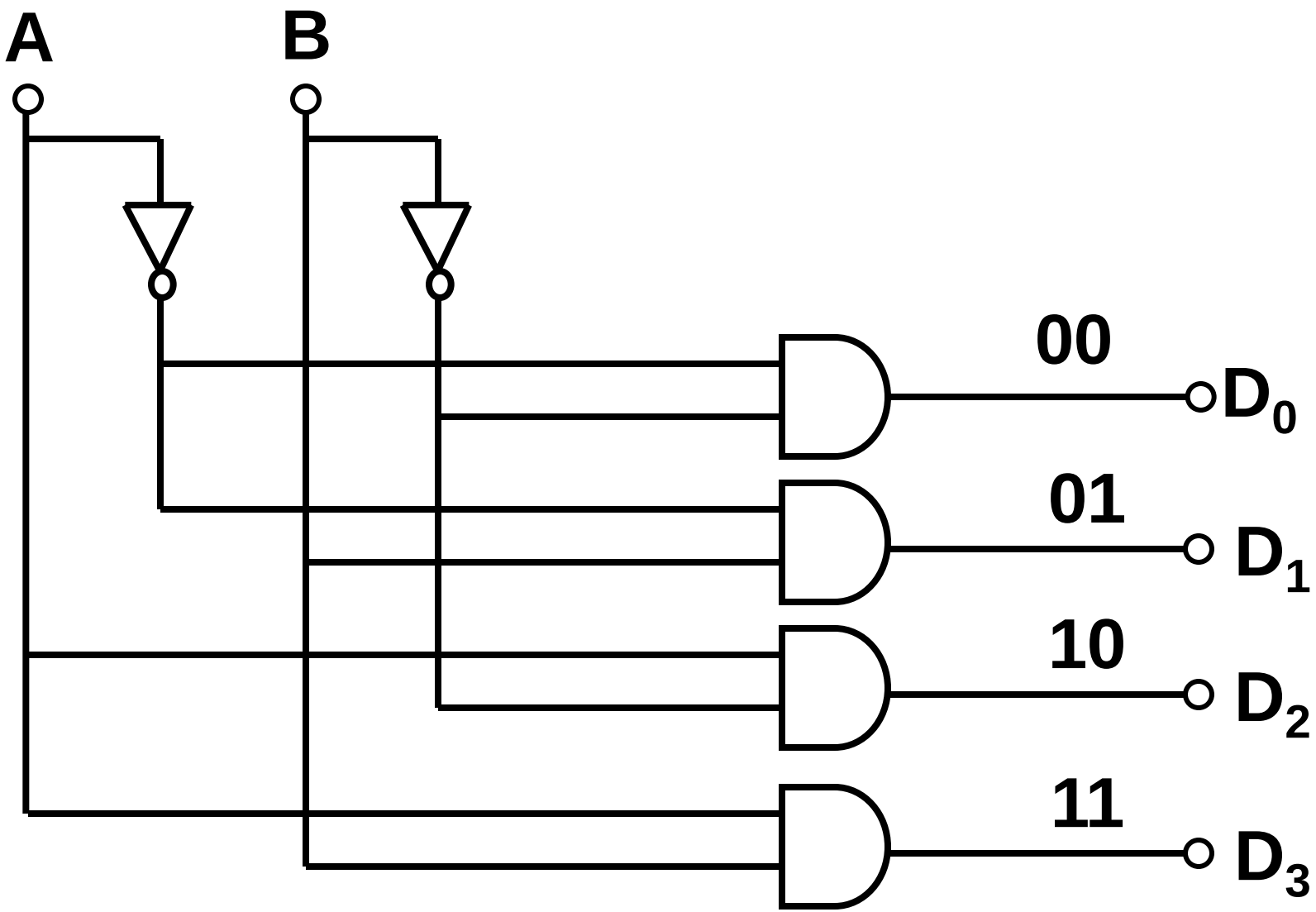
- A 2 to 4 line has two input lines and four output lines.
- Out of 4 output lines the particular lines goes to logic 1 or logic 0 for one of the four possible combinations of inputs A and B.

Decoder :

a) 2-to-4 line Decoder:



2-to-4 line Decoder:



❑ 2-to-4 line Decoder's Truth Table Using Don't Care condition :

Inputs		Logic Function	Output			
A	B		D_0	D_1	D_2	D_3
0	0	A'B'	1	0	0	0
0	1	A'B	0	1	0	0
1	0	AB'	0	0	1	0
1	1	AB	0	0	0	1

Decoder :

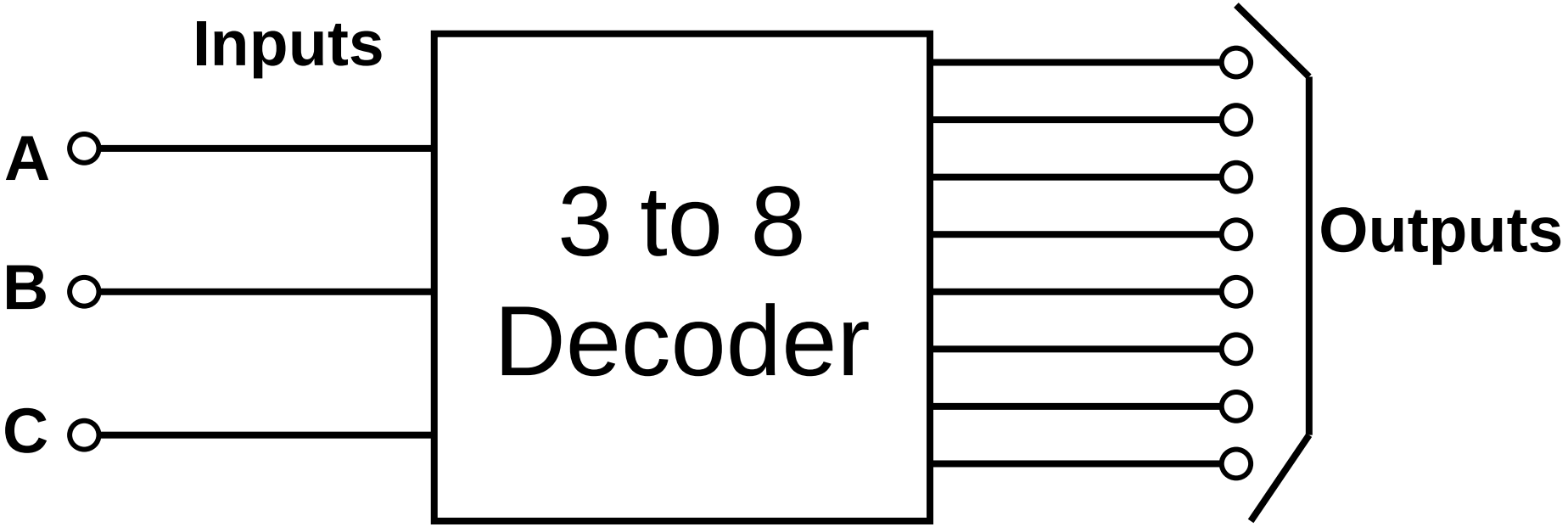
b) 3-to-8 line Decoder:

- This decoder has three input lines and eight output lines, so it is known as 3-to-8 line decoder.
- It is also called binary to octal decoder because it takes a 3-bit binary input code and activates one of the eight (Octal) outputs.
- The three inputs A_0, A_1, A_2 are decoded into 8 outputs.
- Each output representing one of the combinations of the 3 binary input variables.

Decoder :

b) 3-to-8 line Decoder:

- The three NOT gates provide the complement of the inputs and each of the eight AND gates generates one of the binary combination.



❑ 3-to-8 line Decoder's Truth Table Using Don't Care condition :

Input			Output							
A	B	C	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
0	0	0	**1**	0	0	0	0	0	0	0
0	0	1	0	**1**	0	0	0	0	0	0
0	1	0	0	0	**1**	0	0	0	0	0
0	1	1	0	0	0	**1**	0	0	0	0
1	0	0	0	0	0	0	**1**	0	0	0
1	0	1	0	0	0	0	0	**1**	0	0
1	1	0	0	0	0	0	0	0	**1**	0
1	1	1	0	0	0	0	0	0	0	**1**

3-to-8 line Decoder's Truth Table Using Don't Care condition :

b) 3-to-8 line Decoder:

- From truth table the logic expression for output are:

D_0 = A'B'C' 000

D_1 = A'B'C 001

D_2 = A'BC' 010

D_3 = A'BC 011

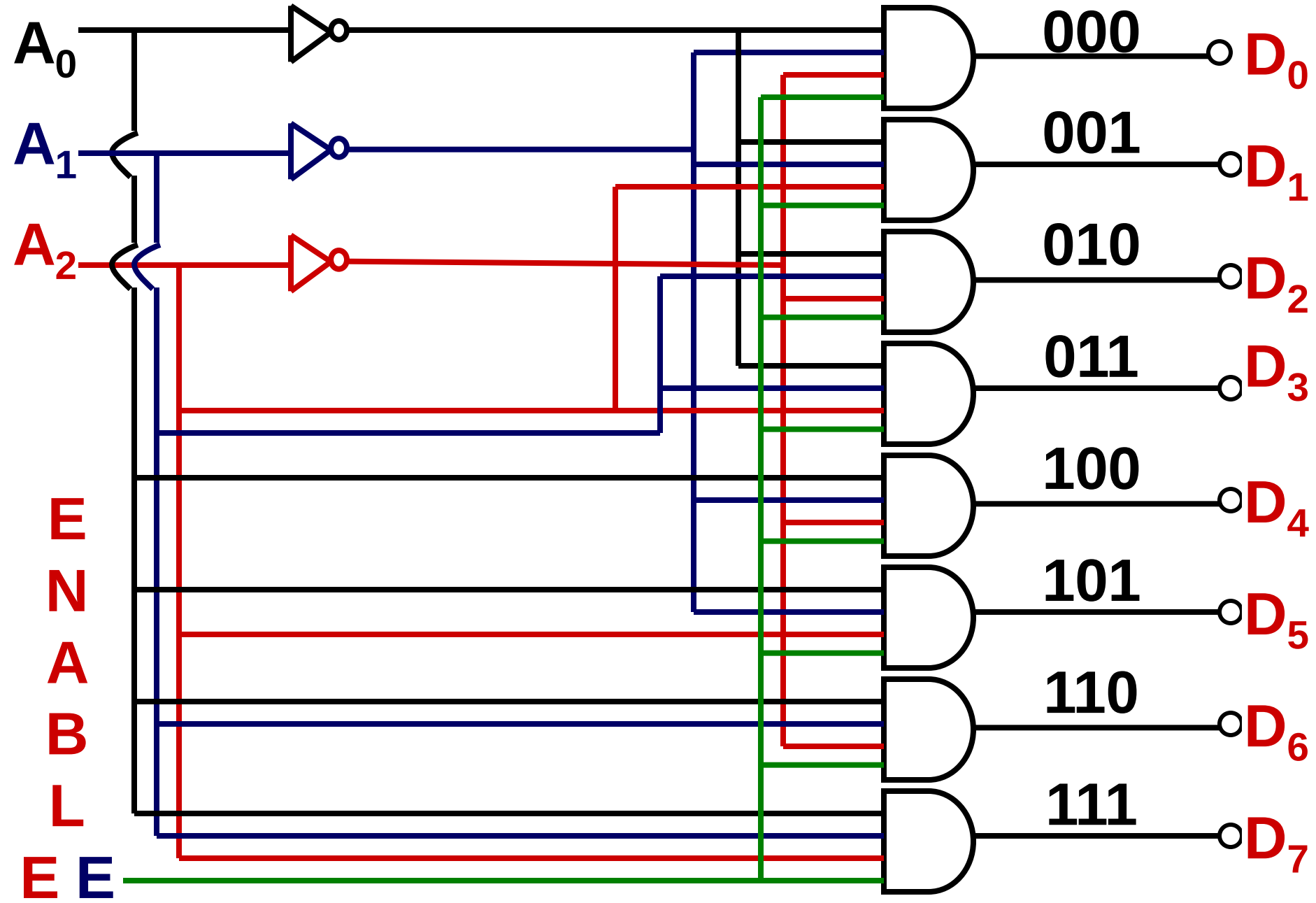
D_4 = AB'C' 100

D_5 = AB'C 101

D_6 = ABC' 110

D_7 = ABC 111

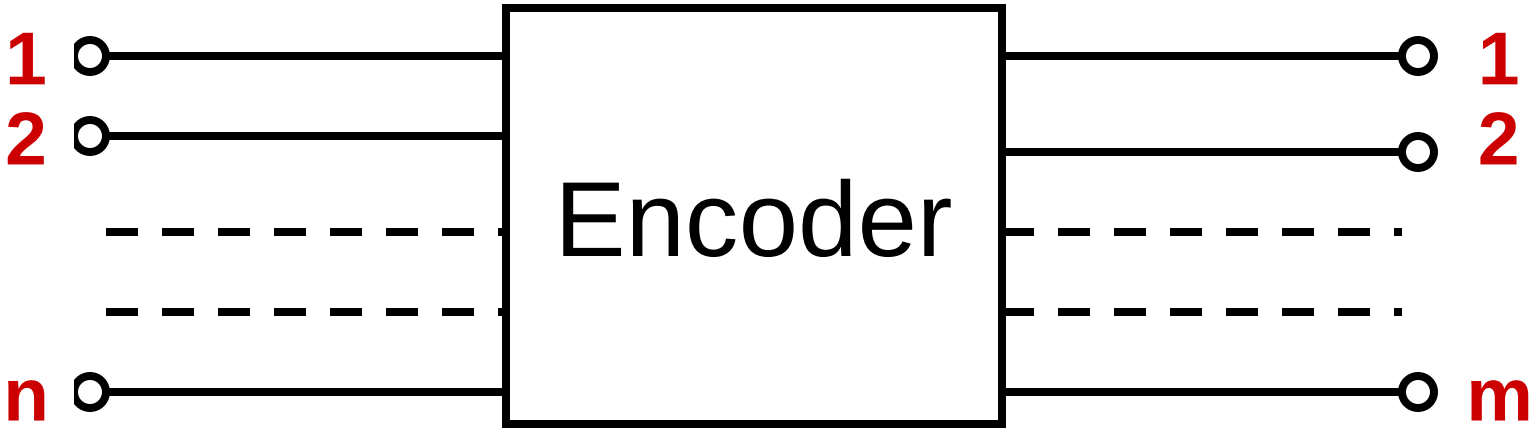
Decoder :


A0
A1
A2
E
N
A
B
L
E E
000
001
010
011
100
101
110
111
D0
D1
D2
D3
D4
D5
D6
D7

Encoder :

- Function of encoder is opposite to that of the decoder.
- A decoder converts the number into digital system whereas as encoder convert decimal signal into equivalent to binary signal.
- There are ***n*** input lines and ***m*** output lines. Number of ***m*** is less than ***n***.
- In Octal to Binary encoder there are 8 input lines and 3 output lines.
- Similar in decimal to BCD encoder there are 10 input lines and 4 output lines.

Encoder :



Block Diagram of Encoder

1) Octal to Binary Encoder :

- There are 8 input lines and 3 output lines.

1) Octal to Binary Encoder :

1) Octal to Binary Encoder :

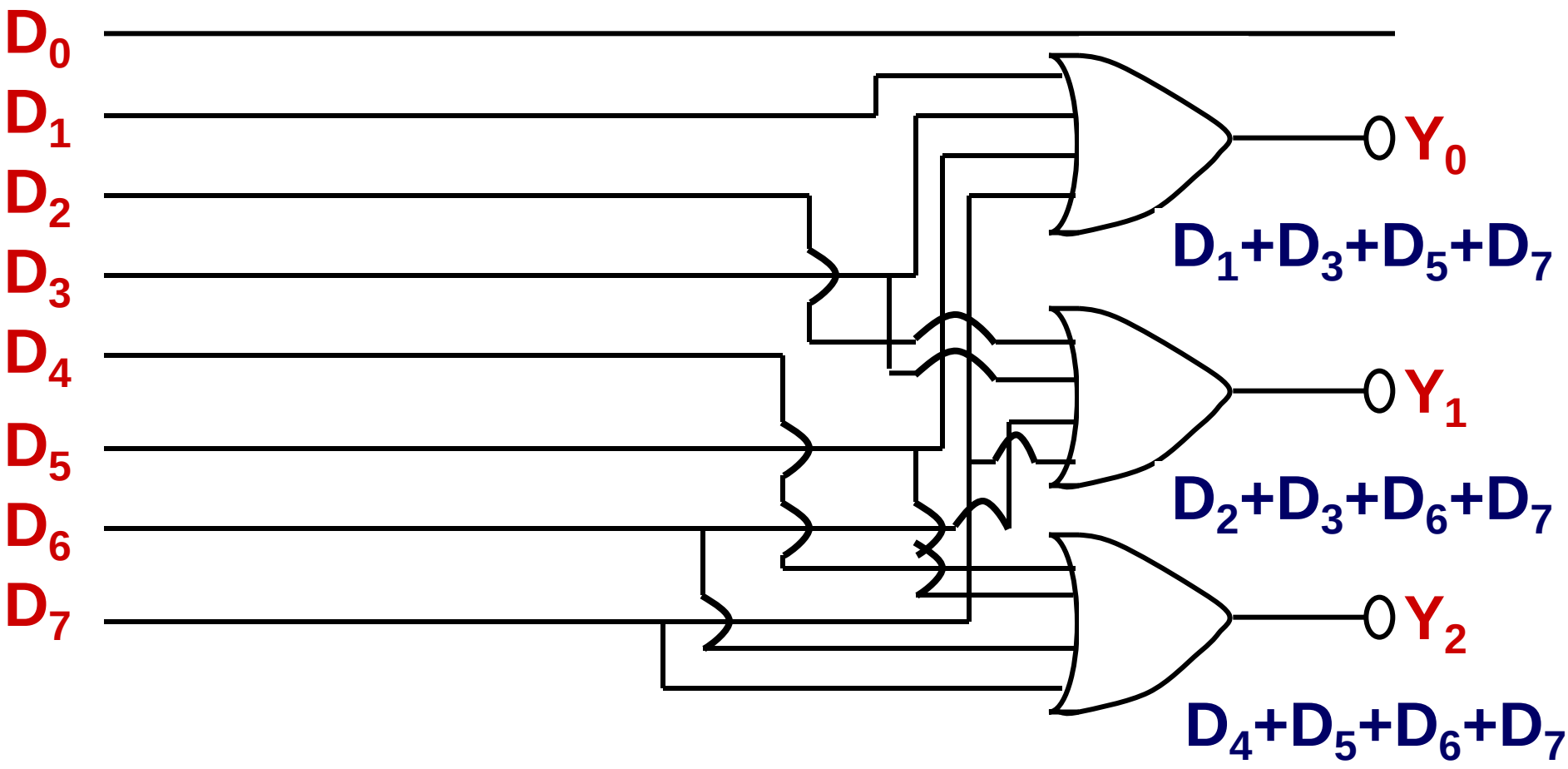
- There are 8 input lines and 3 output lines.

Decimal Digit	Octal Input								Binary Output		
	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	Y2	Y1	Y0
0	**1**	0	0	0	0	0	0	0	0	0	0
1	0	**1**	0	0	0	0	0	0	0	0	1
2	0	0	**1**	0	0	0	0	0	0	1	0
3	0	0	0	**1**	0	0	0	0	0	1	1
4	0	0	0	0	**1**	0	0	0	1	0	0
5	0	0	0	0	0	**1**	0	0	1	0	1
6	0	0	0	0	0	0	**1**	0	1	1	0
7	0	0	0	0	0	0	0	**1**	1	1	1

1) Octal to Binary Encoder :

1) Octal to Binary Encoder :

- There are 8 input lines and 3 output lines.

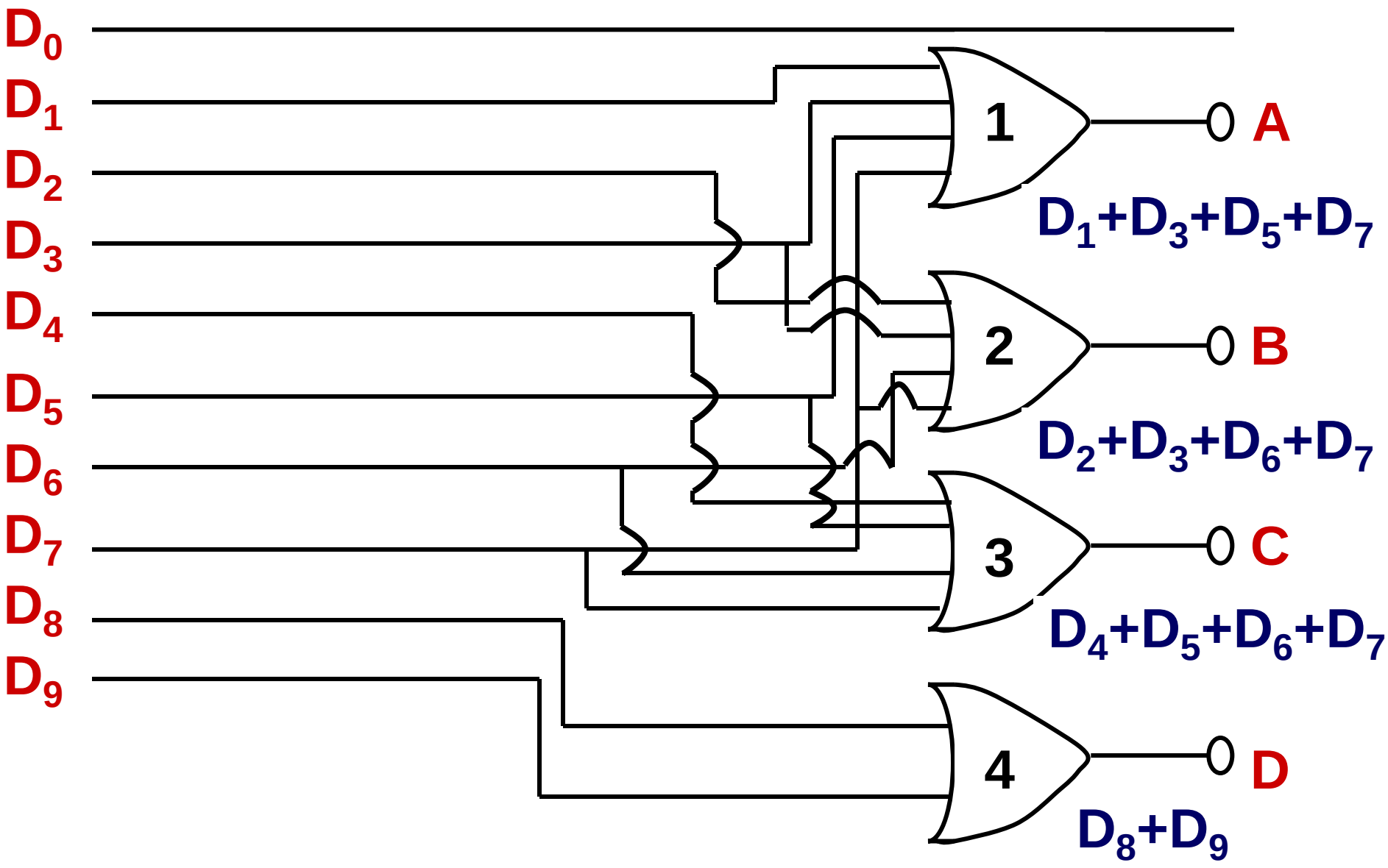


2) Decimal to BCD Encoder :

- There are 10 input lines which are numerals 0 to 9.

Decimal Digit	Decimal Input										Binary Output			
	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D	C	B	A
0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	**1**	0	0	0	0	0	0	0	0	0	0	0	1
2	0	0	**1**	0	0	0	0	0	0	0	0	0	1	0
3	0	0	0	**1**	0	0	0	0	0	0	0	0	1	1
4	0	0	0	0	**1**	0	0	0	0	0	0	1	0	0
5	0	0	0	0	0	**1**	0	0	0	0	0	1	0	1
6	0	0	0	0	0	0	**1**	0	0	0	0	1	1	0

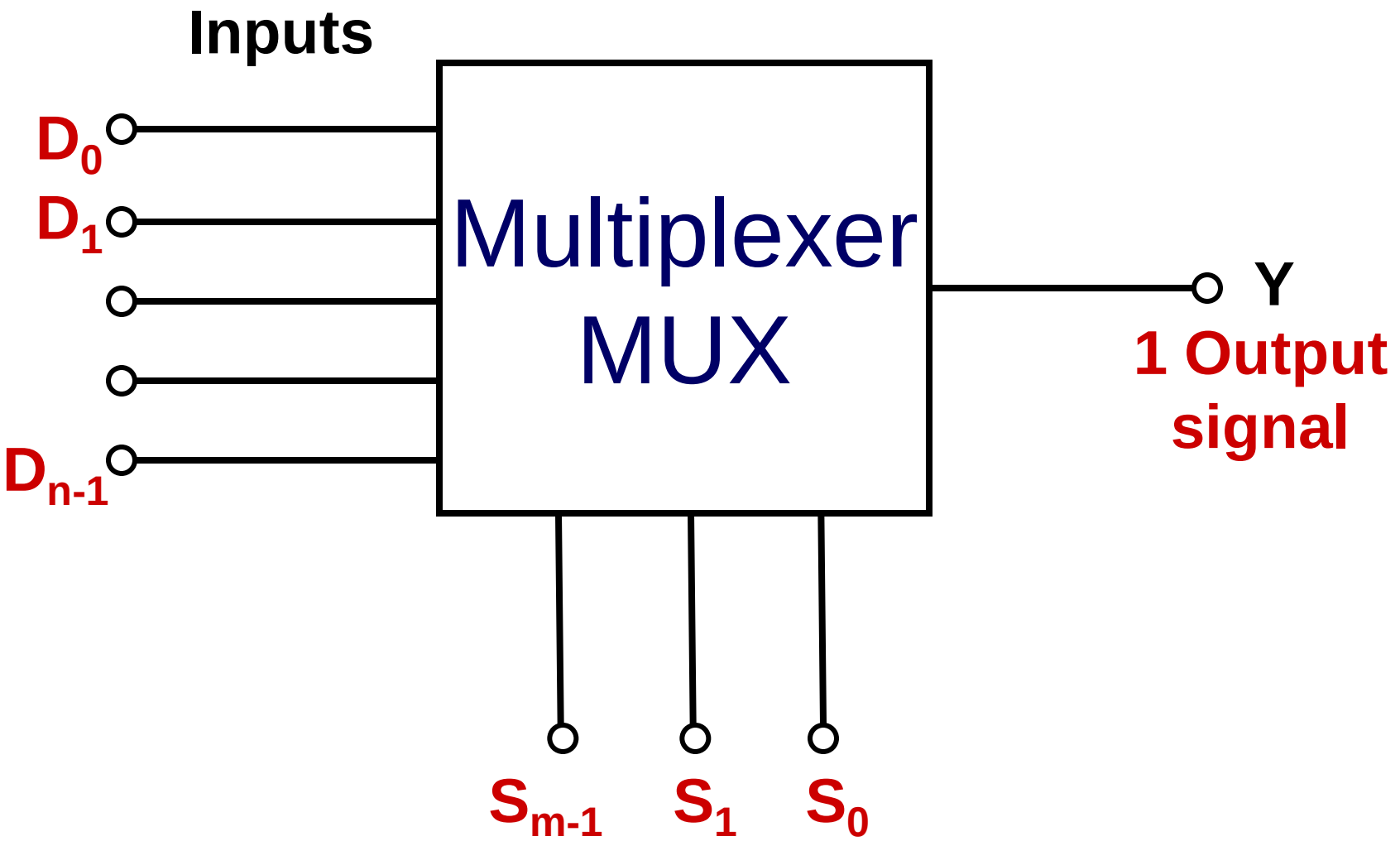
2) Decimal to BCD Encoder :



Multiplexer :

- Multiplexing means many into one.
- Multiplexer is digital circuit having no. of input lines and only one output line.
- It selects the information in binary form from various inputs and gives it at the output.
- It also called as **Data Selector** as it selects one out of many inputs.

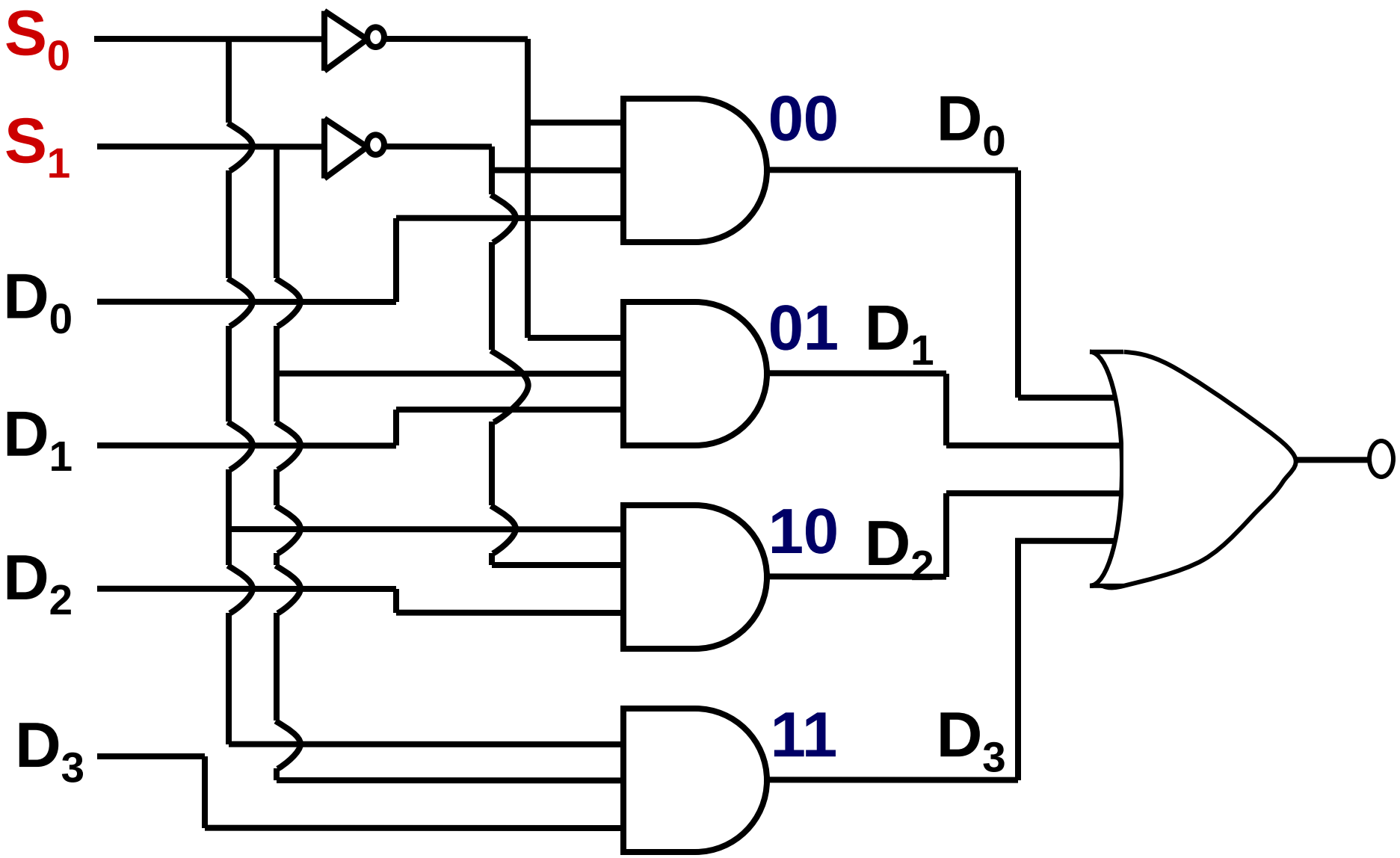
Multiplexer :



Multiplexer :

Selected input		Output
S_0	S_1	Y
0	0	D_0
0	1	D_1
1	0	D_2
1	1	D_3

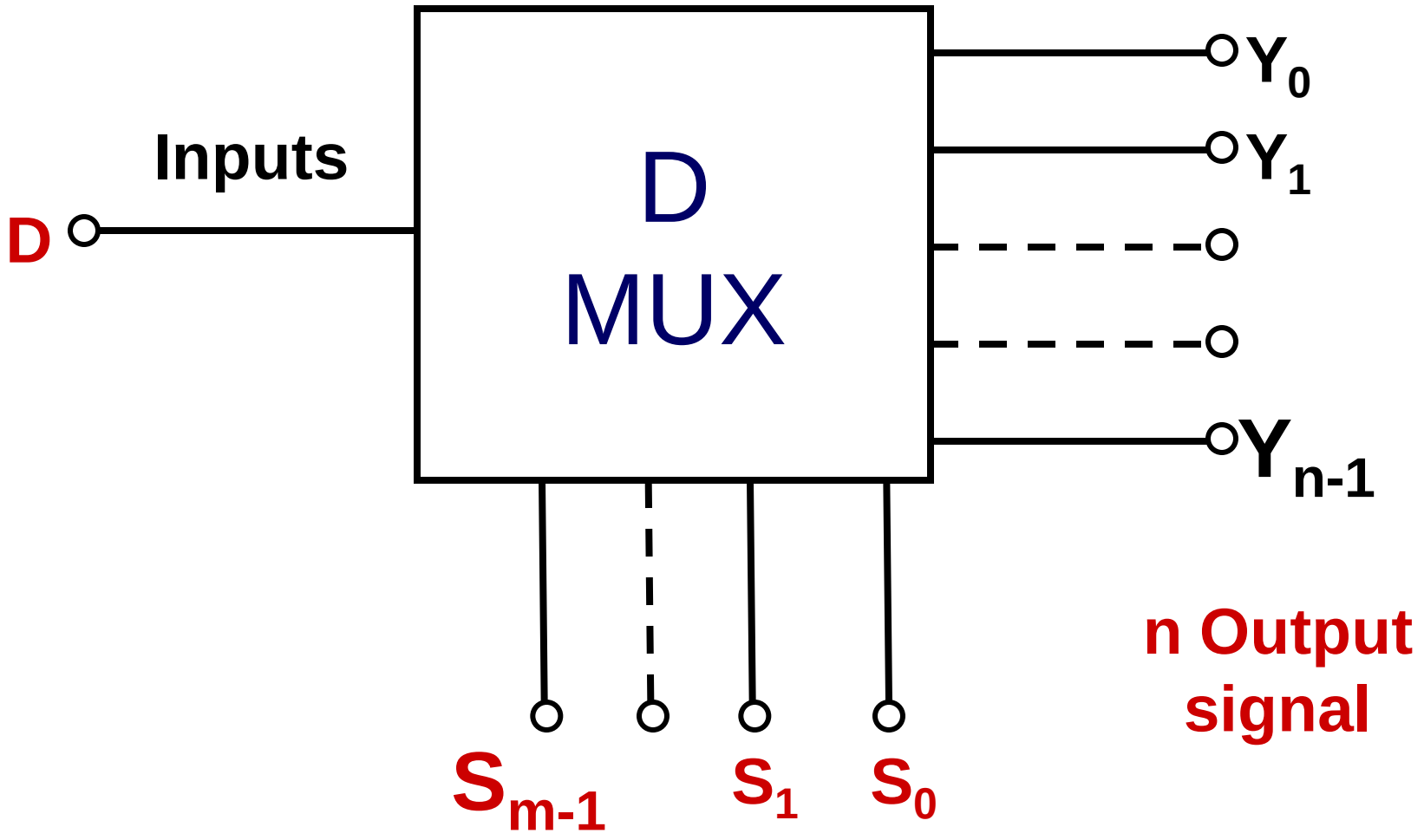
Multiplexer :



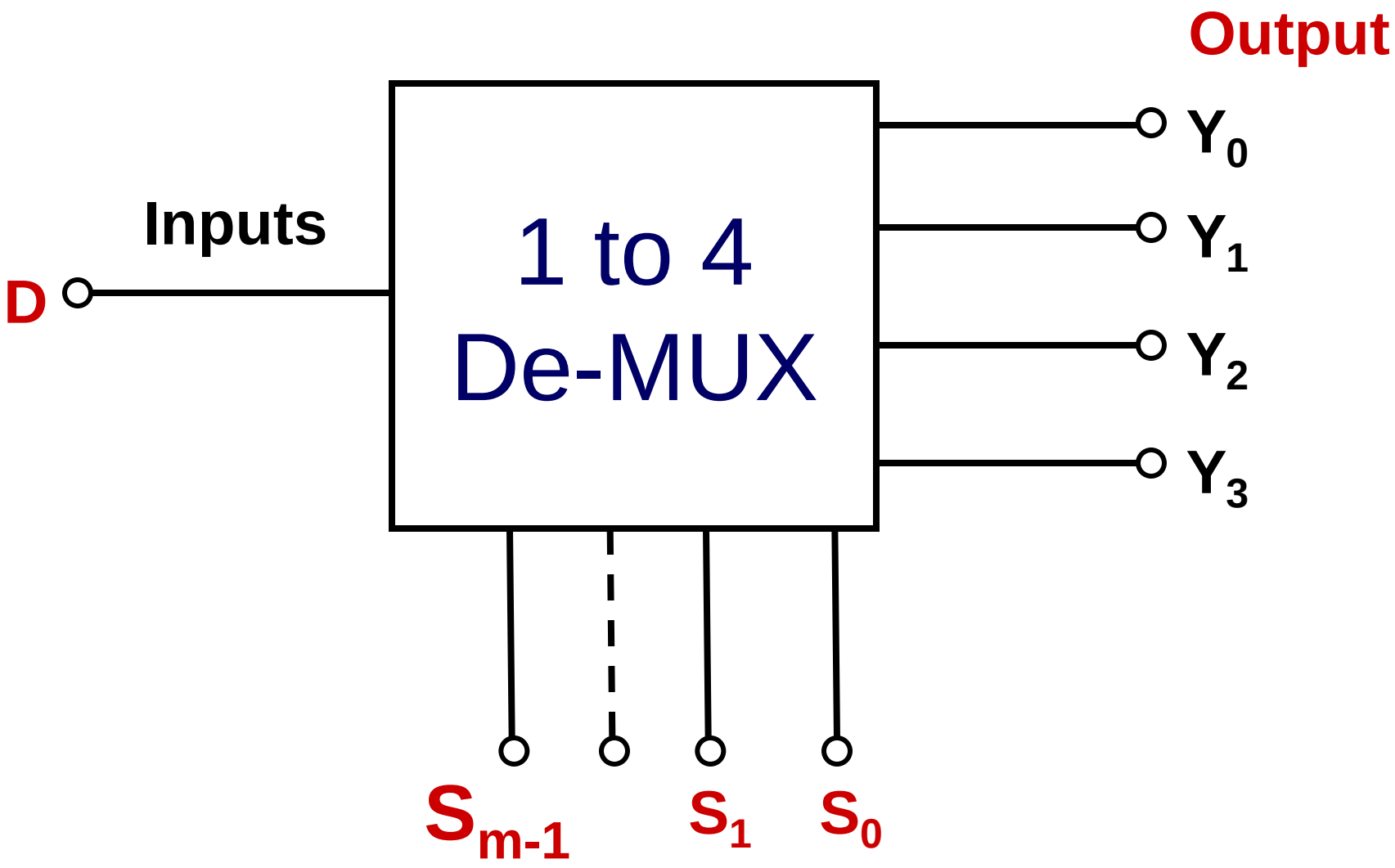
De-Multiplexer :

- Demultiplexer means one to into many, opposite of multiplexer.
- Demultiplexer is a logical circuit which receives information on a single input line and sends it one of several output lines.
- Block diagram of De-MUX is shown below:

De-Multiplexer :



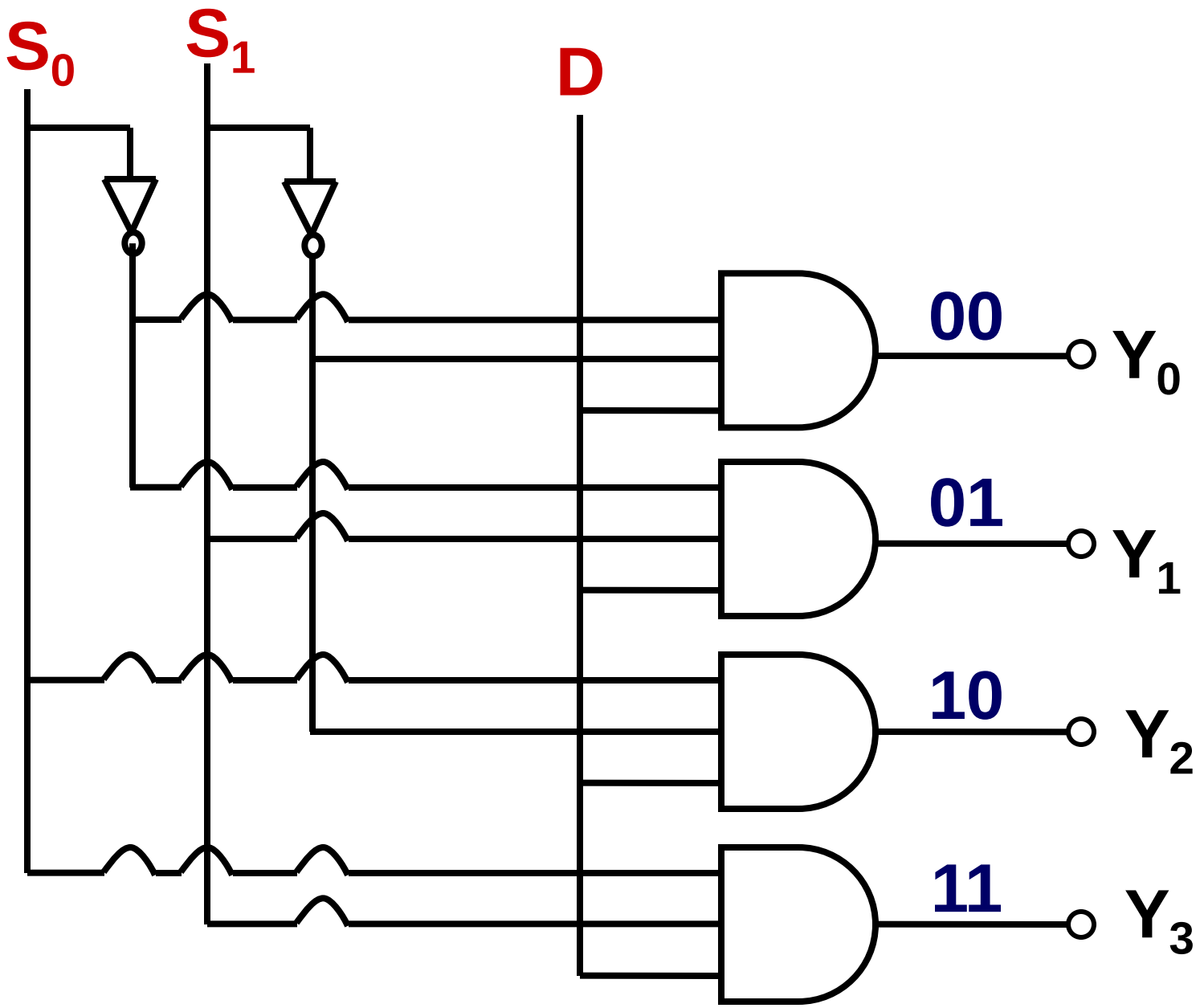
[1] 1 to 4 De-Multiplexer :



[1] 1 to 4 De-Multiplexer :

Data Input	Selects Inputs		Outputs			
D	**S_0**	**S_1**	**Y_0**	**Y_1**	**Y_2**	**Y_3**
D	0	0	**D**	0	0	0
D	0	1	0	**D**	0	0
D	1	0	0	0	**D**	0
D	1	1	0	0	0	**D**

De-Multiplexer Logical circuit :



Registers :

- Registers are widely used in digital systems.
- One Flip Flop can store 1 bit information. In Register more than one flip flops are used.
- Registers are used to store binary information temporarily.
- Registers are used in micro processors and in digital computers and in other digital systems.
- Register which are used only to store the binary information are known as **memory register.**
- The Register which can shift the data to right of left are known as the **shift registers**.

Classification of Register :

1) **Classification based on whether data entered into register remains stationary or shifts.**
   1. Memory Register or Buffer Register
   2. Shift Register
2) **Classification based on how data is entered in to register and how it is taken out of the register.**

   Data can be taken in to register serially (ક્રમબદ્ધ) or in parallel (સમાતર). Similarly the data can be taken out of the register serially or in parallel. So there are following types of register.

Classification of Register :

1. **Serial In Serial Out Register :** In which data is taken in to the register serially and taken out of the register also serially.
2. **Serial In Parallel Out Register :** In which the data is taken in to the register serially but taken out in parallel.
3. **Parallel In Serial Out Register :** In which the data is taken in to the register in parallel and taken out serially.
4. **Parallel In Parallel Out Register :** In which the data is taken in the register in parallel and taken out also parallel.

Classification of Register :

3) **Classification based on shifting of data :**
   1. **Shift left Register**
   2. **Shift right Register**
   3. **Bi directional shift register**
   4. **Universal register**
4) **Classification on the basis of circuit technology :**
   1. **Static Shift Register**
   2. **Dynamic Shift Register**

Shift Register :

- In shift register the data stored can be shifted either to the left or to the right. There are two methods of shifting data.

1) **Serial shifting**
2) **Parallel shifting**

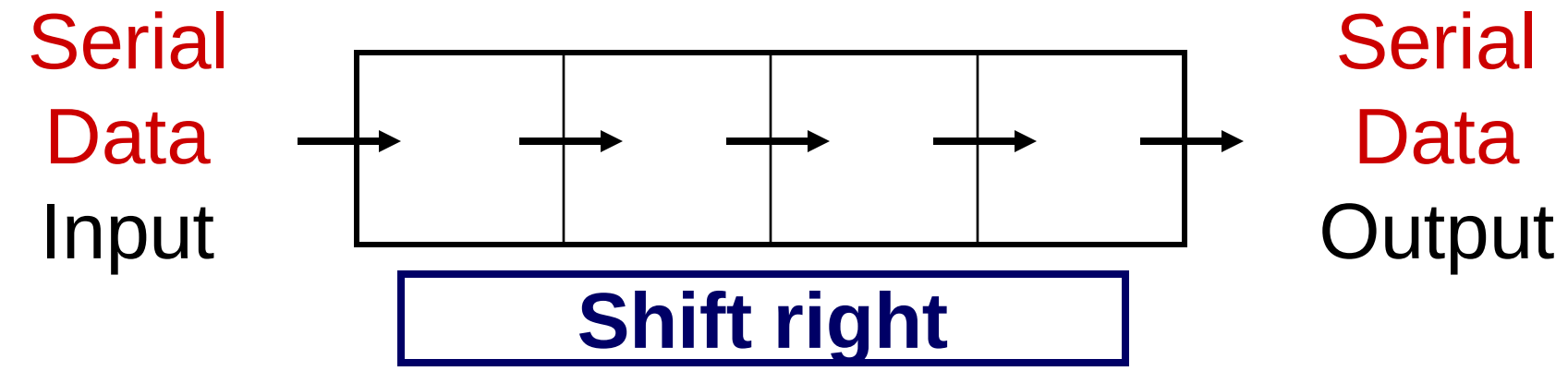
- The following are the types of registers on basis of how the data is entered in to register and taken out of the register.

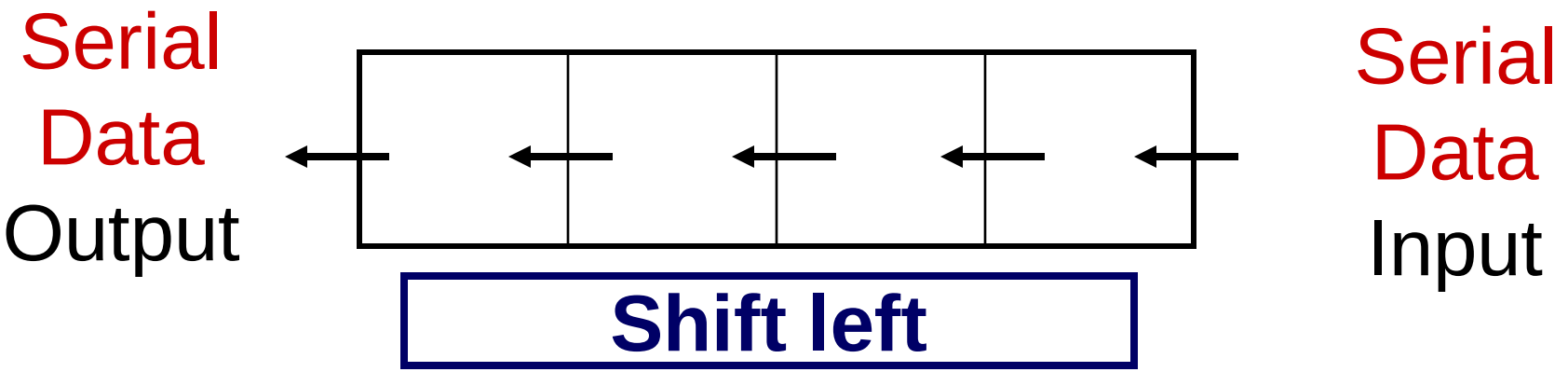
Shift Register :

1) Serial In Serial Out (SISO) shift register.
2) Serial In Parallel Out (SIPO) shift register.
3) Parallel In Parallel Out (PIPO) shift register.
4) Parallel In Serial Out (PISO) shift register.

Types of Shift Register :

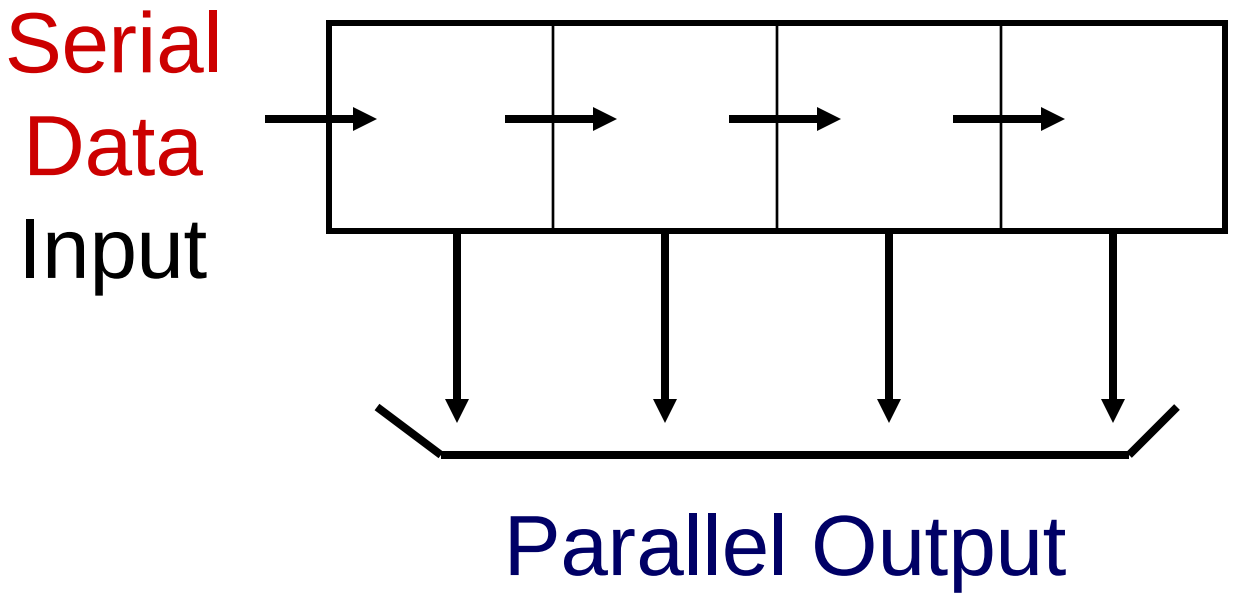
1) Serial In Serial Out (SISO) shift register.





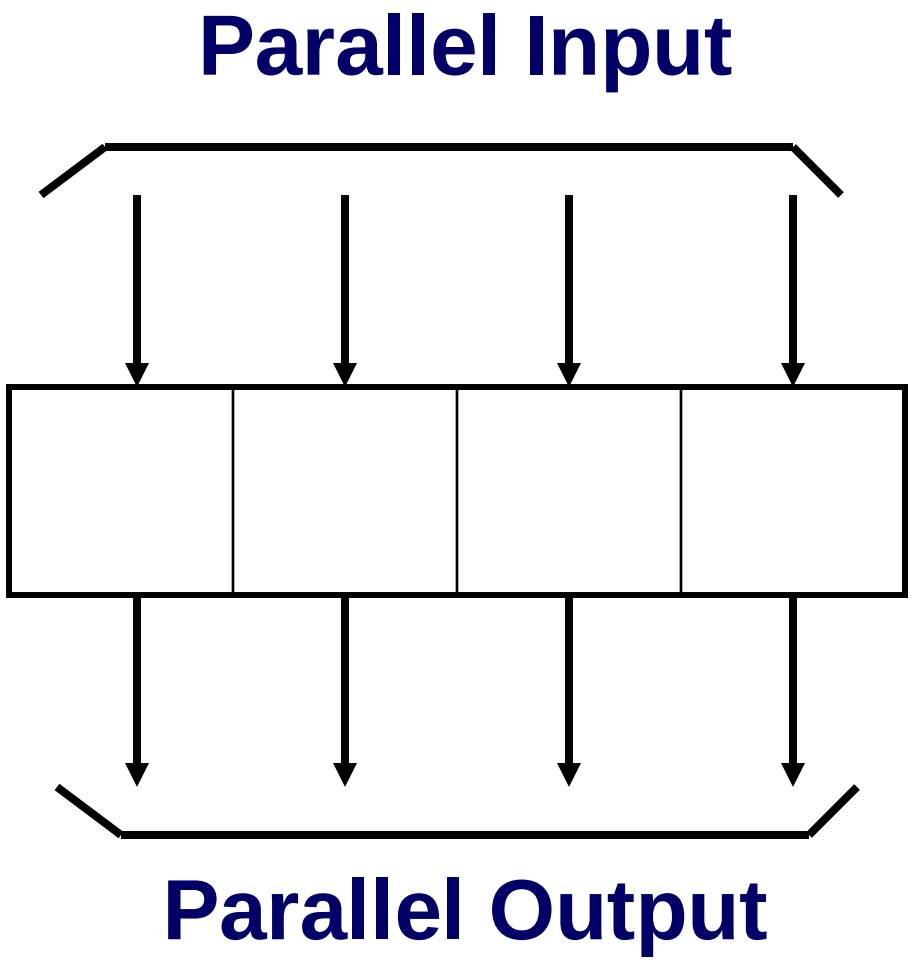
Types of Shift Register :

2) Serial In Parallel Out (SIPO) shift register.



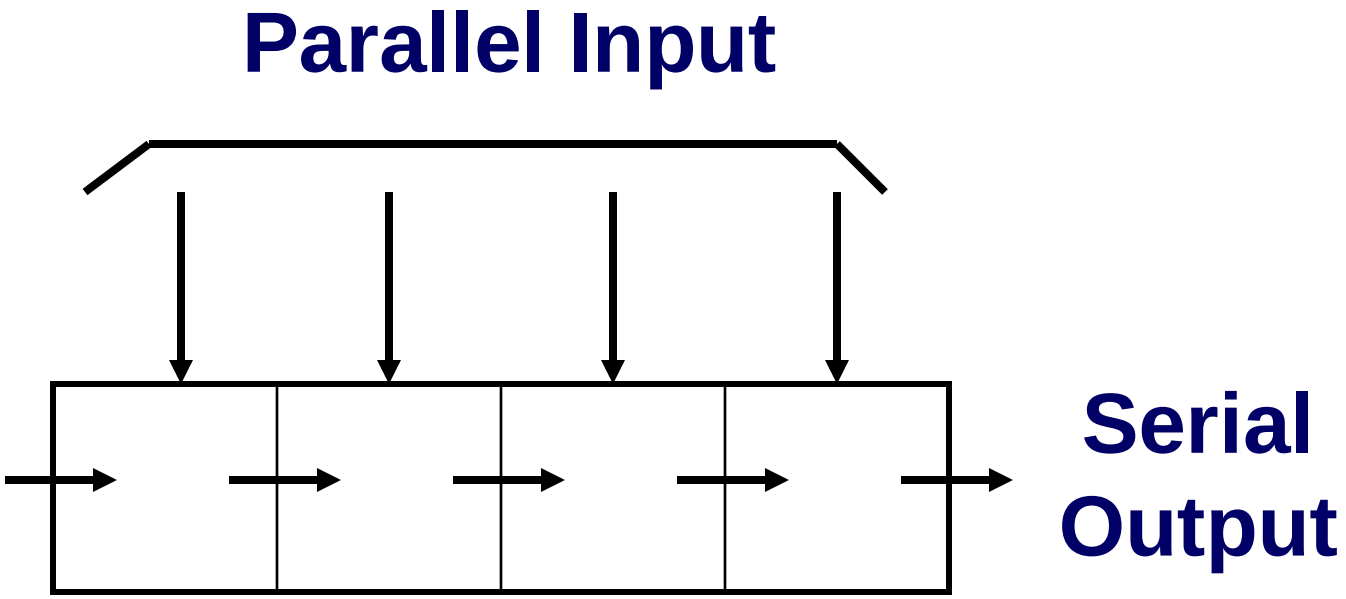
Types of Shift Register :

3) Parallel In Parallel Out (PIPO) shift register.



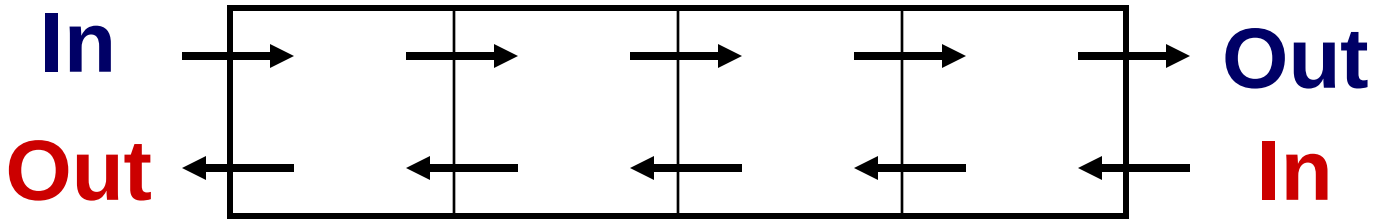
Types of Shift Register :

4) Parallel In Serial Out (PISO) shift register.



Types of Shift Register :

- Bi direction shift register.



Counter :

- Counter is one type of register which count the pulse given to it and stores it in the binary form in the memory.
- In counters mainly JK FF are used.
- Output of counter is in the binary form.
- To know the count decoding circuit is used which converts the binary count in to decimal form.
- Output of decoder is given to display device.

Types of Counter :

1) Asynchronous Counter
2) Ripple Counter
3) Synchronous Counter
4) Bit Synchronous Counter

Types of Counter :

1) Asynchronous Counter (Ripple counter)

- Asynchronous counter ripple counter flip flop are connected in sequence.
- Pulses to be counted are applied to the first Flip Flop.
- Second flip flop is triggered by output from first flip flop.
- It is also known as Binary Counter in which the number of flip flops are connected in series.

Types of Counter :

2) Ripple counter

- Ripple counters are sometimes called asynchronous counter.
- The term asynchronous refers to the events that do not occur at the same time.
- It means that all the flip flops in this counter are not simultaneously clocked.

Types of Counter :

3) Synchronous counter

- Limitation of asynchronous or ripple counter is that its flip flops used. So counting speed is limited.
- To overcome this limitation synchronous or parallel counters were developed.
- In this all the flip flops are given the clock pulses simultaneously.

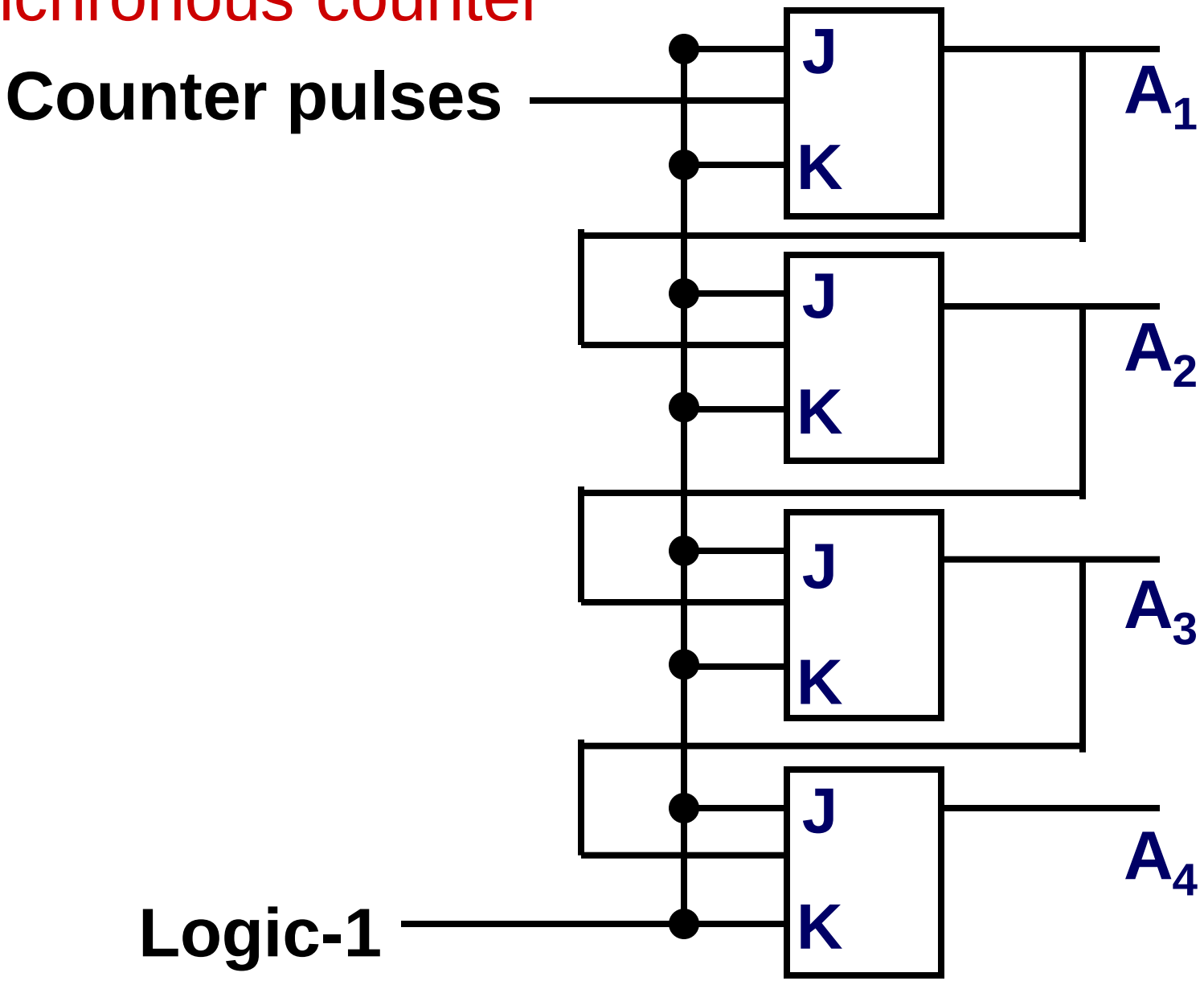
Types of Counter :

4) Bit Synchronous counter

- Circuit of 4 bit synchronous counter with parallel carry is shown in figure.
- Four JK flip flop are used as a 4 bit counter.
- Input of each flip flop is joined together and connected to clock line so all the flip flop received the clock pulse simultaneously.

Types of Counter :

4) Bit Synchronous counter



Difference between Asynchronous counter & Synchronous Counter :

Asynchronous Counter	Synchronous Counter
1. Flip flops are connected in sequence	**1.** Flip flops are connected simultaneously
2. Counting process is slower than synchronous counter	**2.** Counting process become fast than asynchronous counter.
3. This type of counter is also known as the serial counter.	**3.** It is also called as single mode or multi mode counter.

Applications of Counter :

- It is used as object counter in industry.
- It is used for counting in package.
- It can be used to count visitors in exhibition.
- It is used in digital instruments like clock, digital frequency meter, digital voltmeter, etc.
- It is used in digital timer.
- It is used in washing machine, microwave oven, etc for down counting.