AKTU B.Tech II-Year

GATEWAY CLASSES

EC & EC Allied

DSD : Digital System Design

Unit-2 Lec-5



Today's target

- Encoders
- Multiplexers
- PYQ

Gateway Classes

Avinash Sir

UNIT-2 : Combinational circuits:

- Analysis and Design of combinational circuits
- MSI devices like comparators, multiplexers, demultiplexers, encoder, decoder,
- circuit realization using Multiplexers and decoders, half and full adders, subtractors, serial and parallel adders, BCD adder, barrel shifter and ALU.

GatewayClasses

MSI or Medium scale integrated circuits are a set of basic, elementary logic circuits. They are available as ICs (integrated chips) and implement specific, commonly used digital functions such as: Multiplexing and Demultiplexing ,Encoding and Decoding)

Encoders



An encoder is a combinational circuit that performs the reverse operation of a decoder. It usually has 2^n input lines and n output lines. The encoder converts active inputs into a unique binary code representing the position of the active input.

When one of the input lines is active (high), the encoder produces a unique binary output corresponding to that input's position.

Example: In an 8-to-3 encoder, if input I5 is active, the output is the binary code for 5 (101).

Types of Encoders

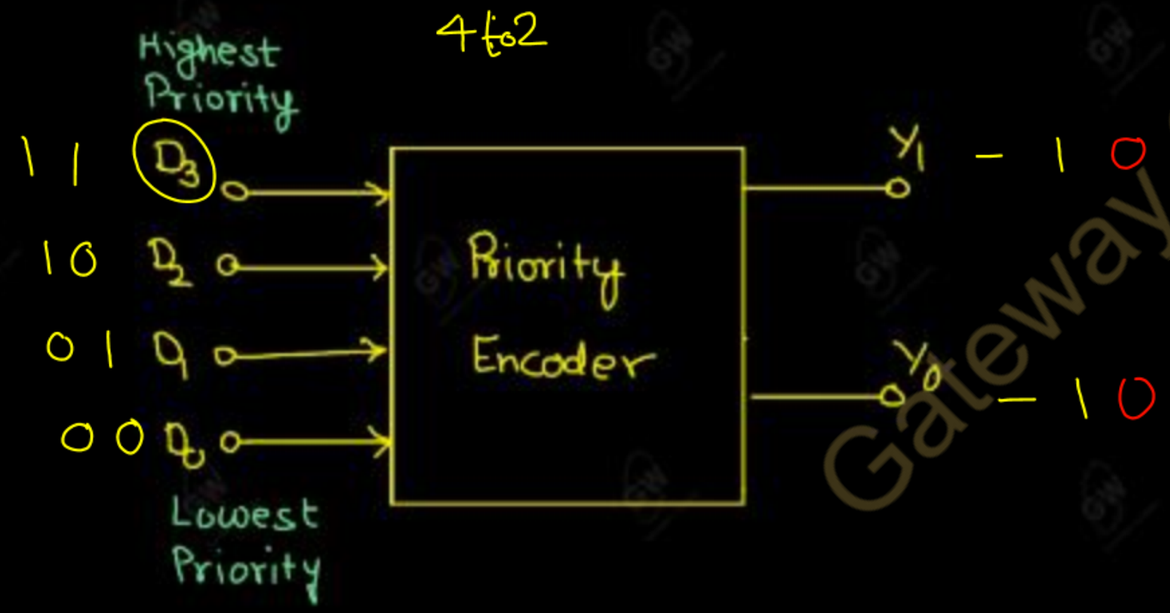
i. Priority Encoder **(ii) Decimal to BCD Encoder** **(iii) Octal/Hexadecimal to Binary Encoder:**

Gateway Classes

Priority Encoders

AKTU-2023-24

This is a special type of encoder. Priority is given to the input lines. If two or more input line are 1 at the same time, then the input line with highest priority will be considered. There are four input D0, D1, D2, D3 and two output Y0, Y1. Out of the four input D3 has the highest priority and D0 has the lowest priority. That means if D3 = 1 then Y1 = 1 irrespective of the other inputs.

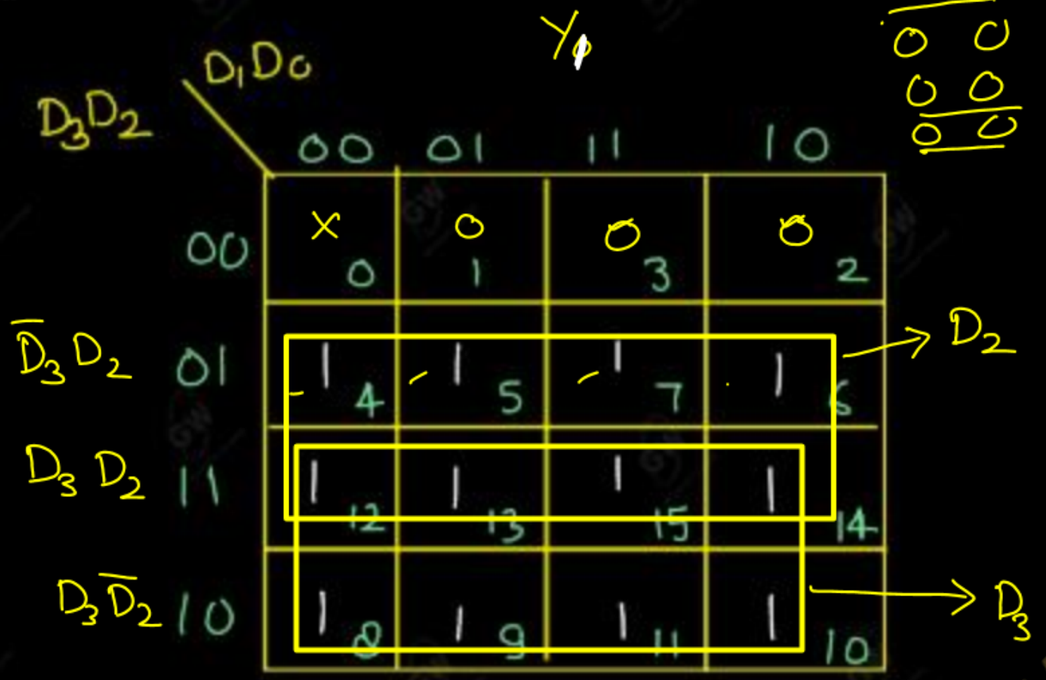


INPUT				OUTPUT	
D3 (Highest)	D2	D1	D0 (Lowest)	Y0	Y1
0	0	0	0	x	x
0	0	0	1	0	0
0	0	1	x	0	1
0	1	x	x	1	0
1	x	x	x	1	1

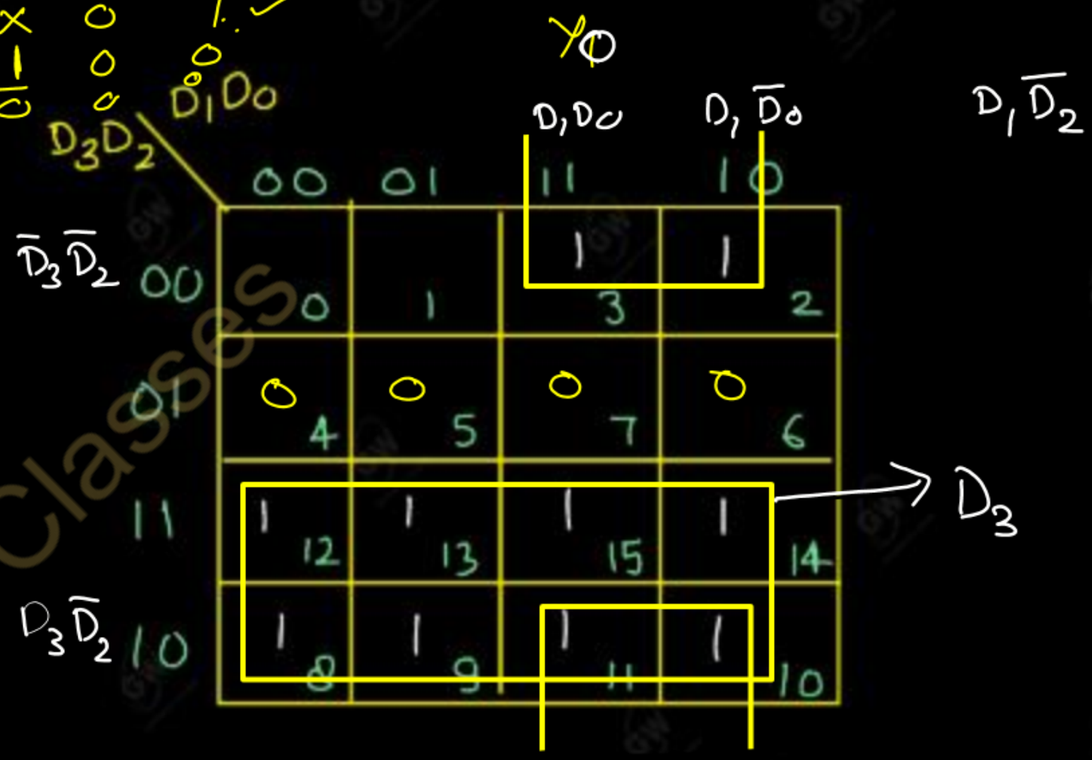
Gateway Classes

Priority Encoders





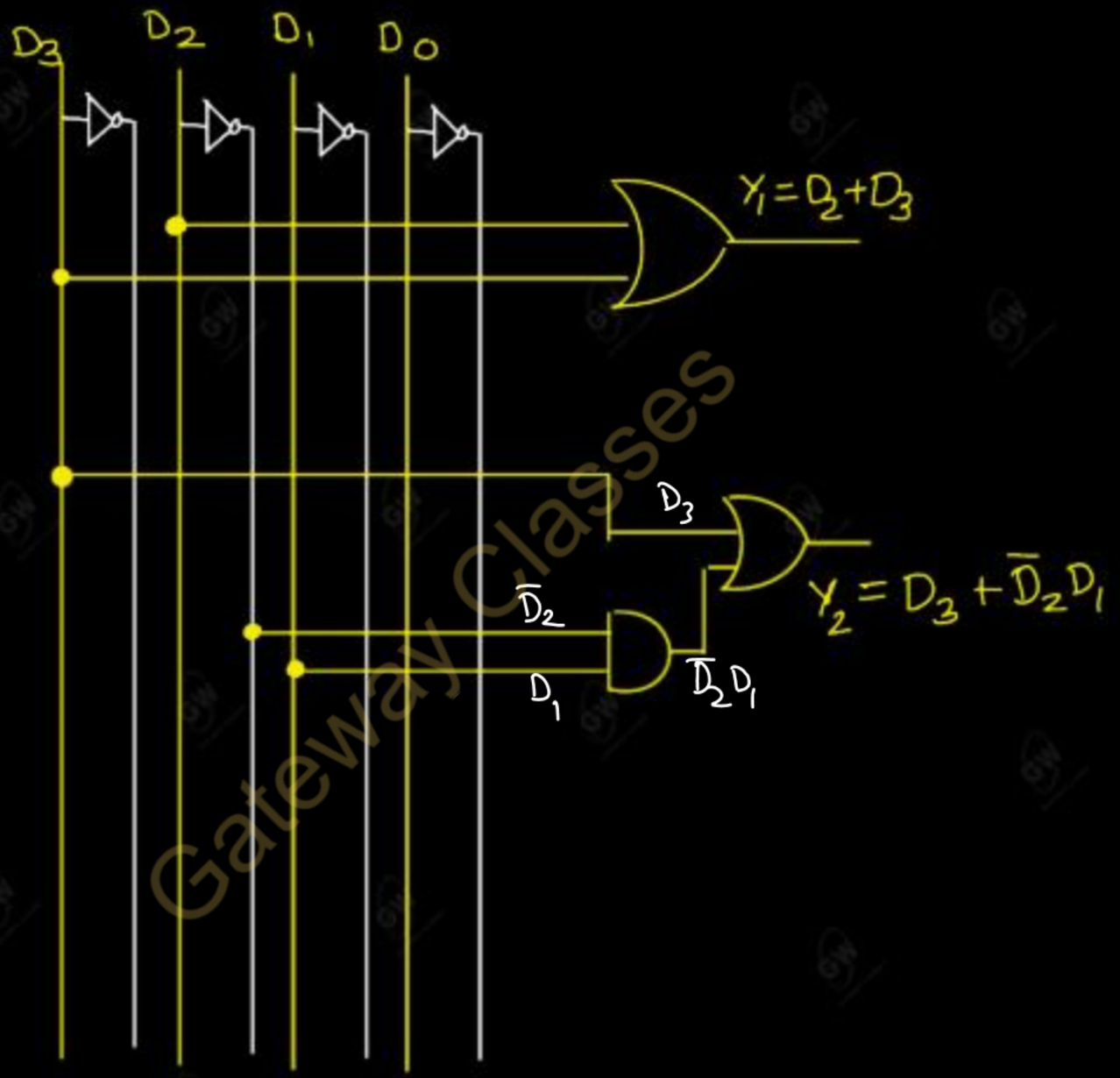
$Y_1 = D_3 + D_2$



$Y_0 = D_3 + \bar{D}_2 D_1$

Gateway Classes

Priority Encoders



Gateway Classes

Octal to Binary Encoder (8 to 3 Encoder)

The 8 to 3 Encoder or octal to Binary encoder consists of 8 inputs: Y7 to Y0 and 3 outputs: A2, A1 & A0. Each input line corresponds to each octal digit value and three outputs generate corresponding binary code.



Input								Output		
D0	D1	D2	D3	D4	D5	D6	D7	Y2	Y1	10
1	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	0	1	0	0	1	0	1
0	0	0	0	0	0	1	0	1	1	0
0	0	0	0	0	0	0	1	1	1	1

$Y2 = D7 + D6 + D5 + D4$

$Y1 = D7 + D6 + D3 + D2$

$Y0 = D7 + D5 + D3 + D1$

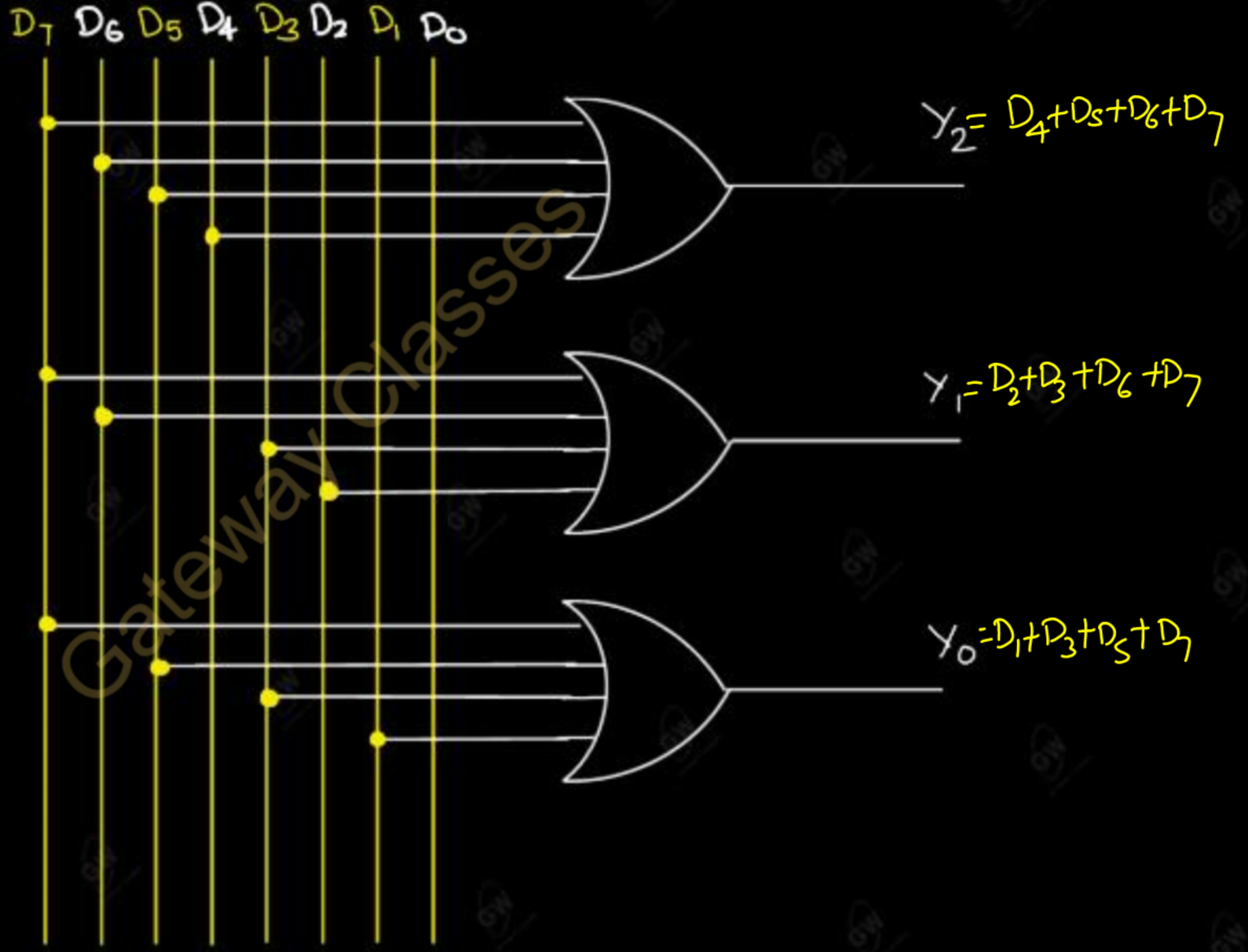
Gateway classes

Octal to Binary Encoder (8 to 3 Encoder)

$Y2 = D7 + D6 + D5 + D4$

$Y1 = D7 + D6 + D3 + D2$

$Y0 = D7 + D5 + D3 + D1$



Gateway Classes

Decimal to BCD Encoder

The decimal-to-binary encoder usually consists of 10 input lines and 4 output lines. Each input line corresponds to each decimal digit and 4 outputs correspond to the BCD code.

$B3 = D9 + D7 + D5 + D3 + D1$

$B2 = D7 + D6 + D3 + D2$

$B1 = D7 + D6 + D5 + D4$

$B0 = D9 + D8$

Input										Output			
D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	B0	B1	B2	B3
1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0	0	0	0	0	1	1
0	0	0	0	1	0	0	0	0	0	0	1	0	0
0	0	0	0	0	1	0	0	0	0	0	1	0	1
0	0	0	0	0	0	1	0	0	0	0	1	1	0
0	0	0	0	0	0	0	1	0	0	0	1	1	1
0	0	0	0	0	0	0	0	1	0	1	0	0	0
0	0	0	0	0	0	0	0	0	1	1	0	0	1

Gateway Classes

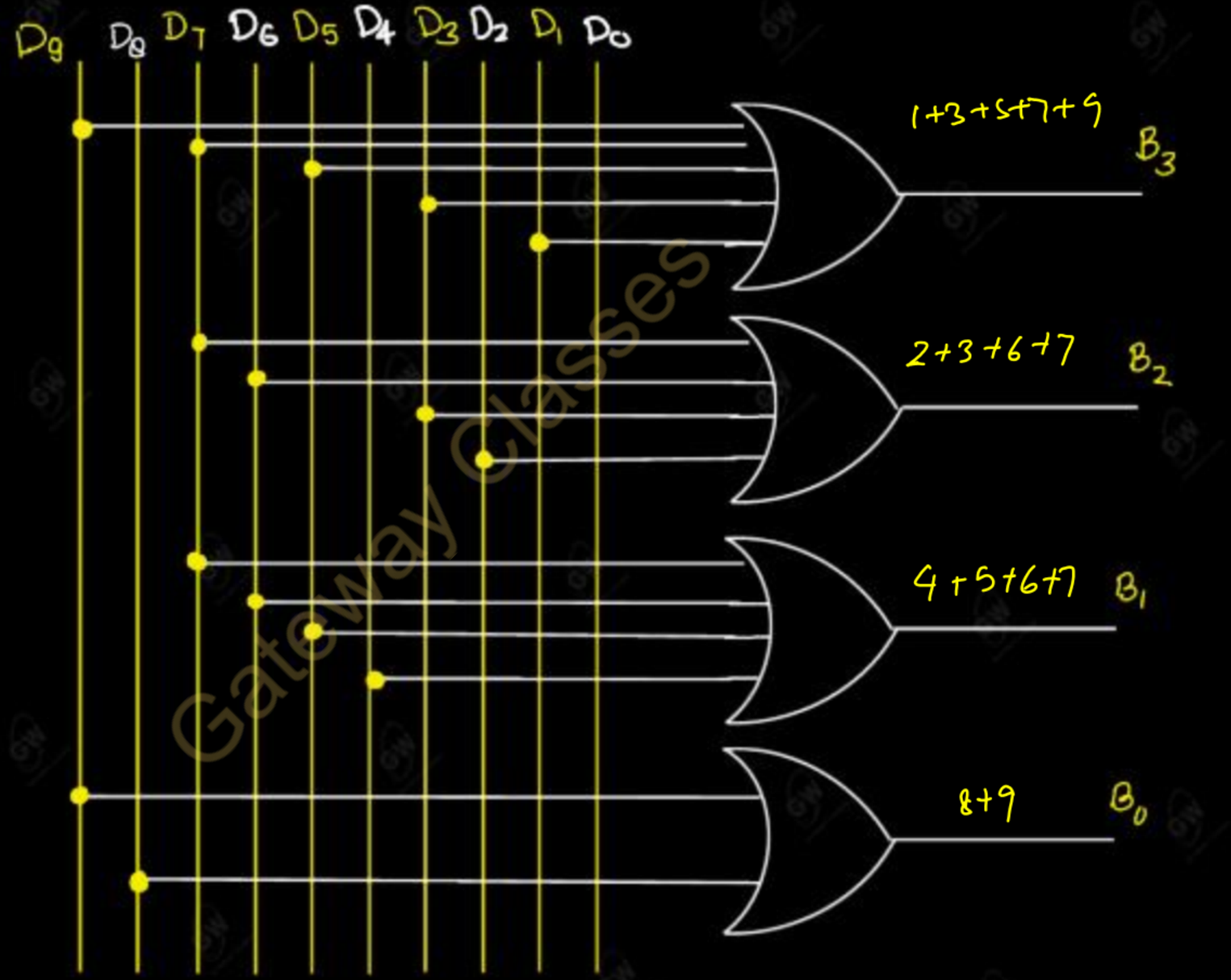
Decimal to BCD Encoder

B3 = D9 + D7 +D5 +D3 + D1

B2 = D7 + D6 + D3 +D2

B1 = D7 + D6 + D5 +D4

B0 = D9 + D8



Gateway Classes

Application of Encoders

- Encoders are used to translate the decimal values to the binary in order to perform binary functions such as addition, subtraction, multiplication, etc.
- Other applications especially for Priority Encoders may include detecting interrupts in microprocessor applications.

Advantages of Encoders in Digital Logic

- Reduction in the number of lines to transmit information from multiple I/p to a single o/p.
- Improved reliability By converting multiple inputs into a single serial code
- Improve performance by reducing time required to transmit information.

Disadvantages of Encoders in Digital Logic

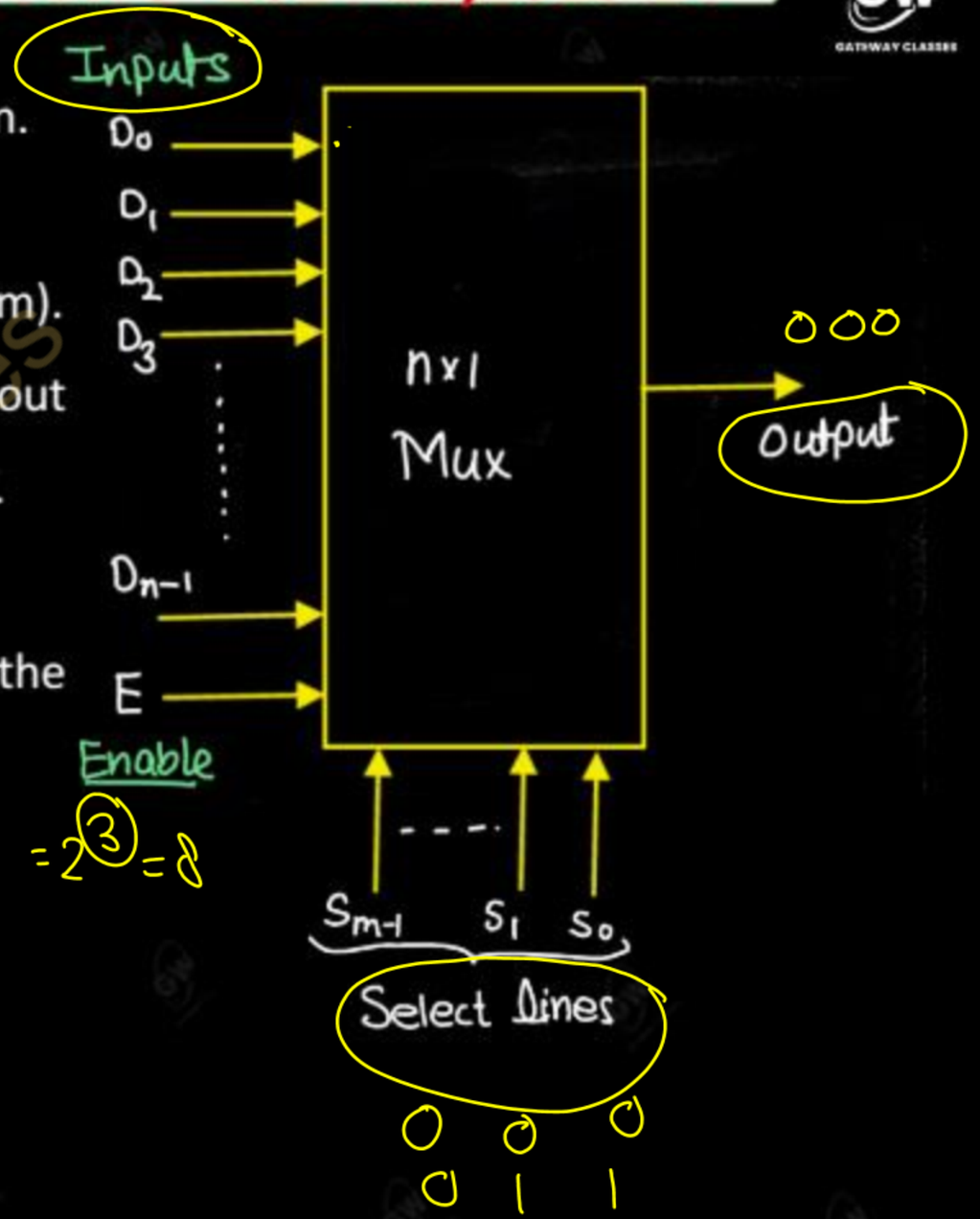
- Encoders are typically more complex than multiplexers , and require additional components.
- Suitable for applications where a parallel set of inputs must be converted into a serial code.
- Limited flexibility

Gateway Classes

GW GATEWAY CLASSES

Multiplexers (Data Selector / Many to one)

- There are n-data inputs, one output and m select inputs with $2^m = n$.
- It selects one of the n data inputs and routes it to the output.
- The selection of one of the n inputs is done by the selected inputs(m).
- Depending on the digital code applied at the selected inputs, one out of n data sources is selected and transmitted to the single output Y.
- E is enable (strobe) input which is useful for the cascading.
- E is generally an active low terminal that means it will perform the required operation when it is low.



$2^{(m)}$ = Input $= 2^{(3)} = 8$

m = Select line

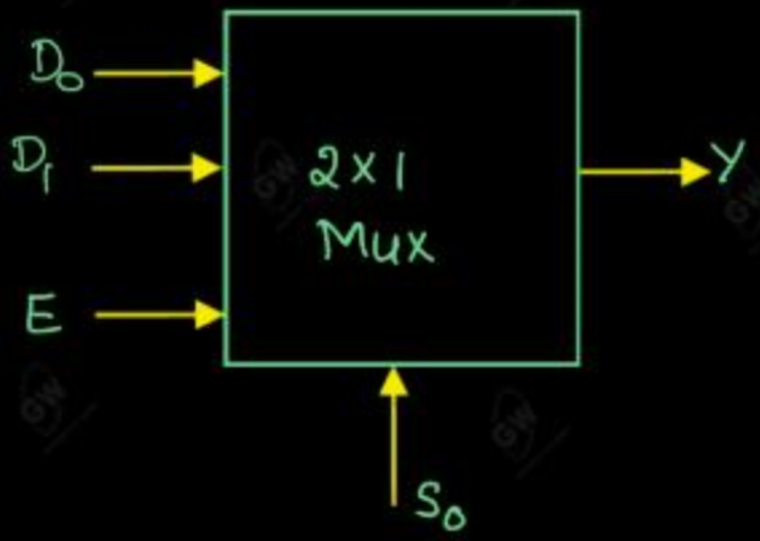
- Multiplexers are classified As

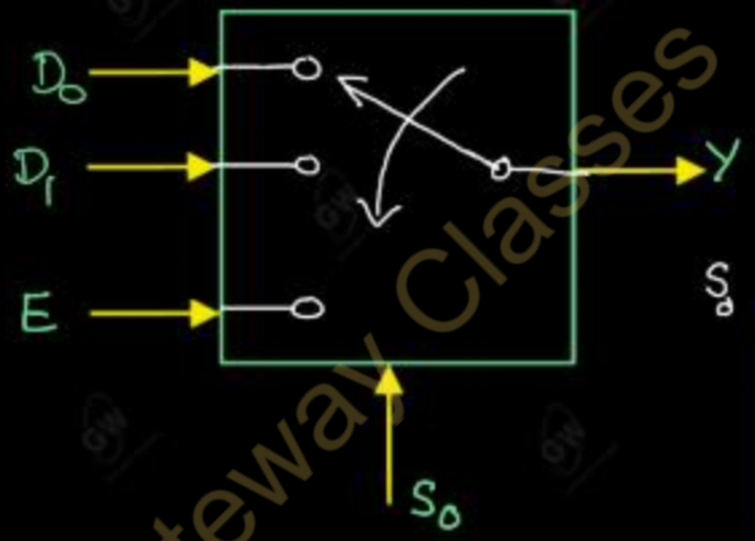
  2:1 , 4:1 , 8:1 , 16: 1 , 32:1 Mux

Gateway Classes

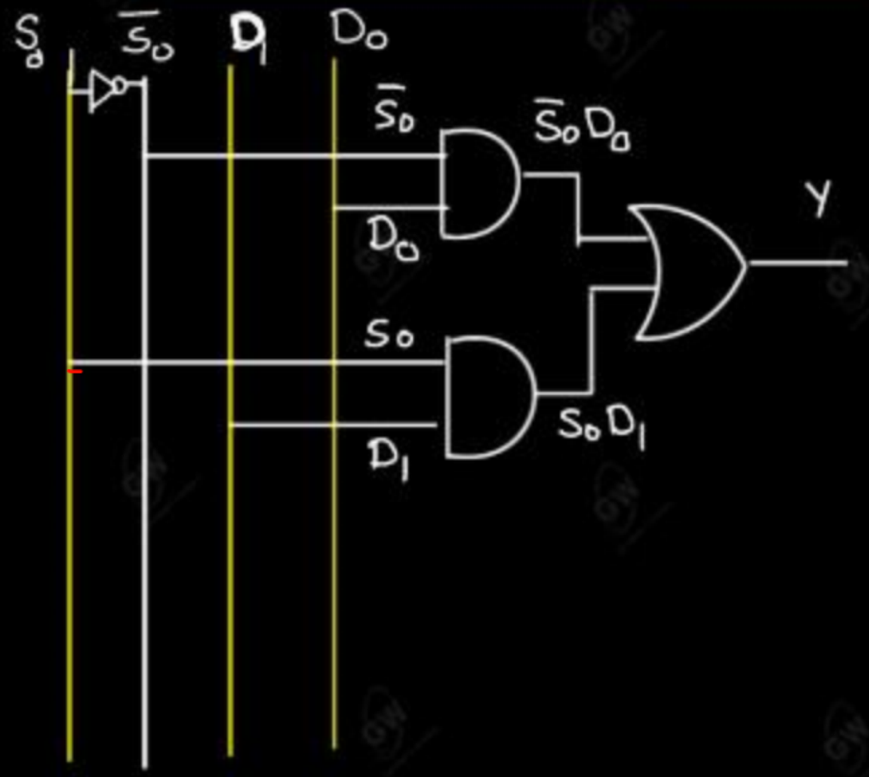
2:1 Multiplexer

The 2x1 mux has two input lines, one output line, and a single selection line.





INPUT			OUTPUT
S0	D_0	D_1	Y
0	0	x	0
0	1	x	1
1	x	0	0
1	x	1	1



Logical Expression of 2x1 Mux

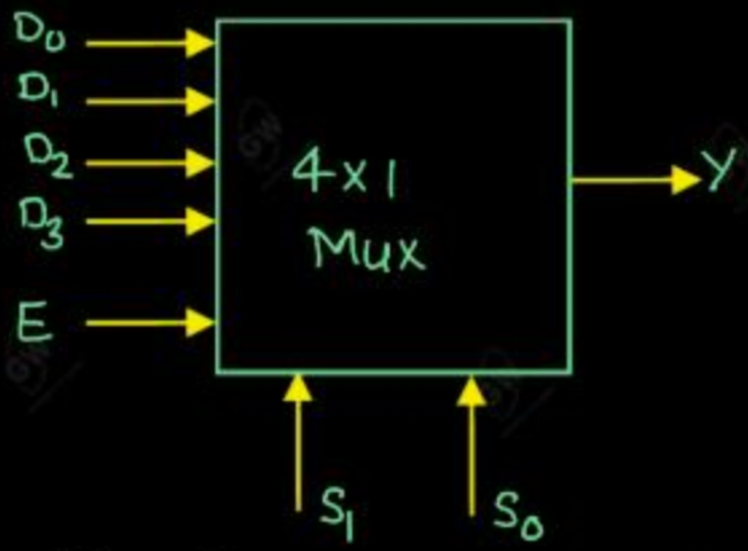
$$Y = \bar{S}_0 D_0 + S_0 D_1$$

Gateway Classes

4:1 Multiplexer

It is a multiplexer that has 4 inputs and a single output and 2 select lines. $4 = 2^{2} \rightarrow$ S.L

The number of the Selection lines given by $m = \log_2 n$



INPUT		OUTPUT
S0	S1	Y
0	0	D0
0	1	D1
1	0	D2
1	1	D3

From Truth table

$Y = D_0$ for $S_1S_0 = 00$

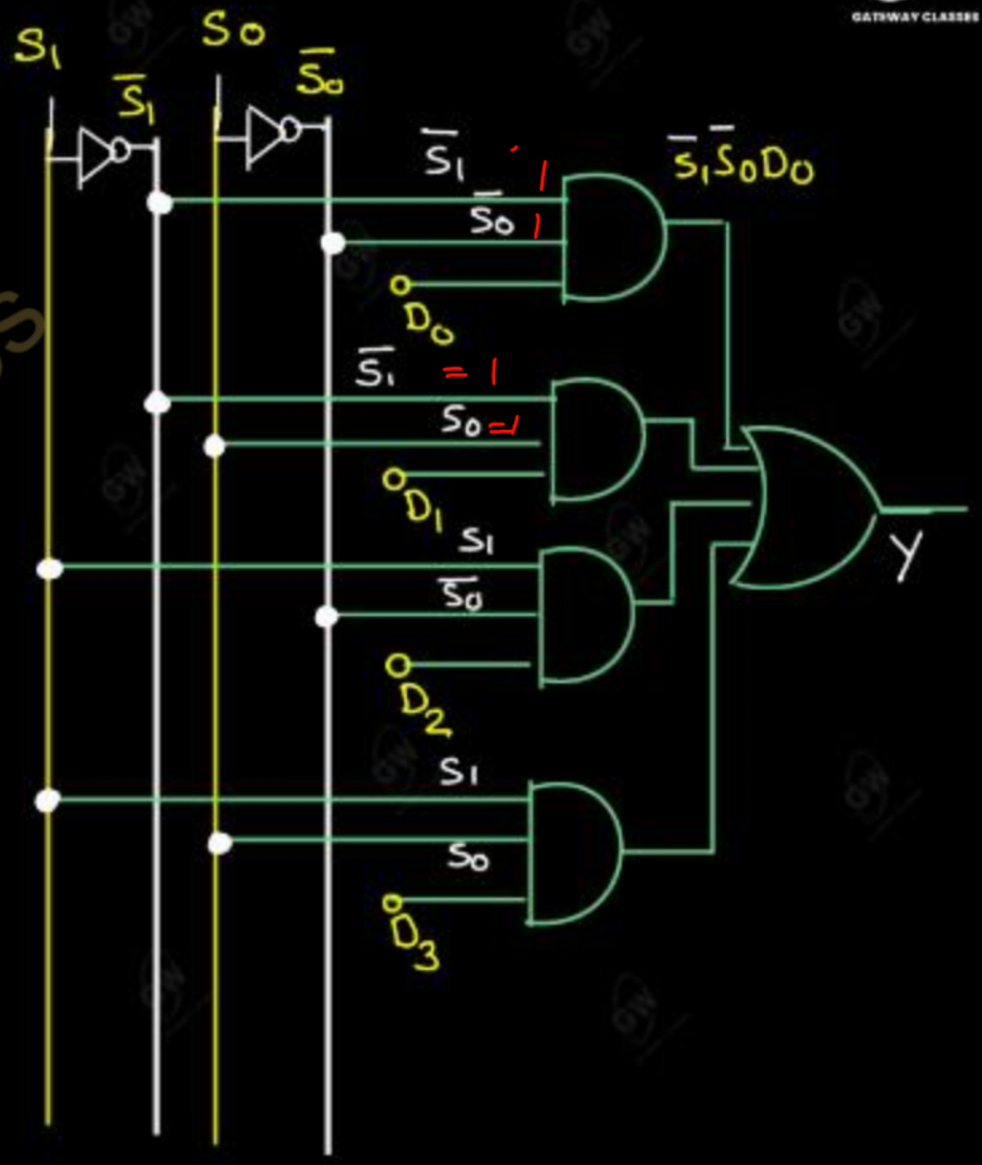
$Y = D_1$ for $S_1S_0 = 01$

$Y = D_2$ for $S_1S_0 = 10$

$Y = D_3$ for $S_1S_0 = 11$

S0 output will be high when Select input is high (D_0, D_1, D_2 ---)
So the output is in SOP form as

$$Y = \bar{S}_1\bar{S}_0D_0 + \bar{S}_1S_0D_1 + S_1\bar{S}_0D_2 + S_1S_0D_3$$



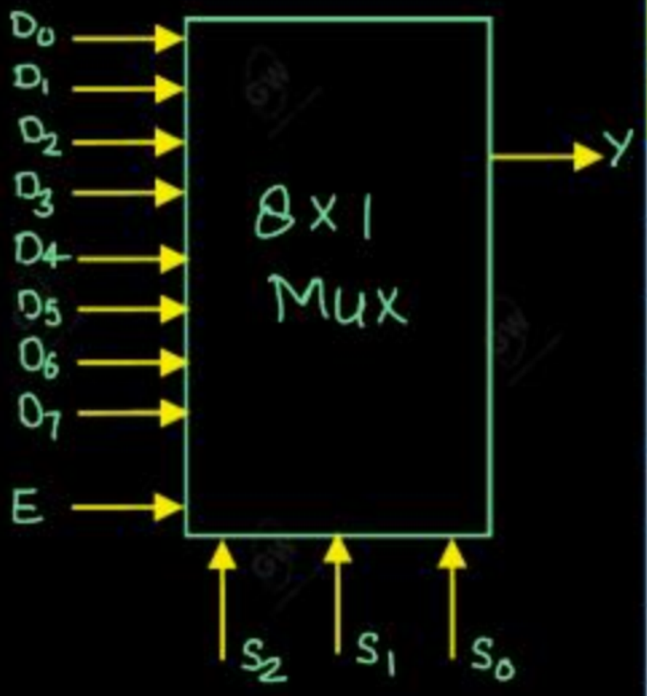
Gatewayclasses

8:1 Multiplexer

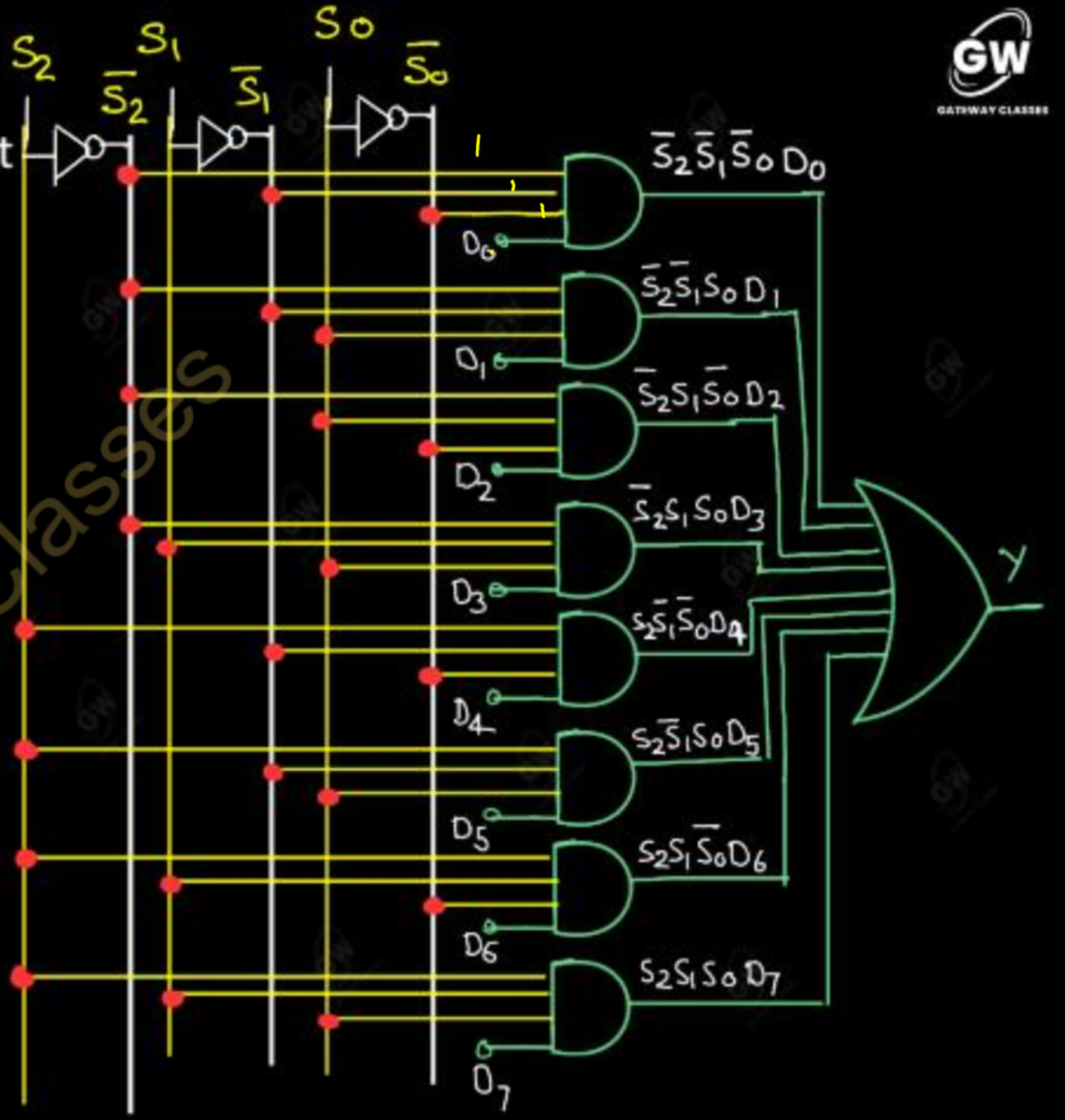
$Y = \bar{S}_0\bar{S}_1\bar{S}_2D_0 + S_0\bar{S}_1\bar{S}_2D_1 + \bar{S}_0S_1\bar{S}_2D_2 + \bar{S}_0S_1S_2D_3 + S_0\bar{S}_1\bar{S}_2D_4 + S_0\bar{S}_1S_2D_5 + S_0S_1\bar{S}_2D_6 + S_0S_1S_2D_7$

It is a multiplexer that has 8 inputs and a single output and 3 select lines. $8 = 2^{3} \rightarrow$ S.L.

The number of the Selection lines given by $m = \log_2 n$



INPUT			OUTPUT
S0	S1	S2	Y
0	0	0	D0
0	0	1	D1
0	1	0	D2
0	1	1	D3
1	0	0	D4
1	0	1	D5
1	1	0	D6
1	1	1	D7



Gateway Classes

16:1 Multiplexer

It is a multiplexer that has 16 inputs and a single output and 4 select lines. $16 = 2^{\oplus}$ → S.L

The number of the Selection lines given by $m = \log_2 n$



INPUT				OUTPUT
S0	S1	S2	S3	Y
0	0	0	0	D0
0	0	0	1	D1
0	0	1	0	D2
0	0	1	1	D3
0	1	0	0	D4
0	1	0	1	D5
0	1	1	0	D6
0	1	1	1	D7
1	0	0	0	D8
1	0	0	1	D9
1	0	1	0	D10
1	0	1	1	D11
1	1	0	0	D12
1	1	0	1	D13
1	1	1	0	D14
1	1	1	1	D15

$\bar{S}_0\bar{S}_1\bar{S}_2\bar{S}_3 D_0$

$\bar{S}_0 S_1 \bar{S}_2 S_3 D_1$

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