

# Digital Electronics

## CSE 223

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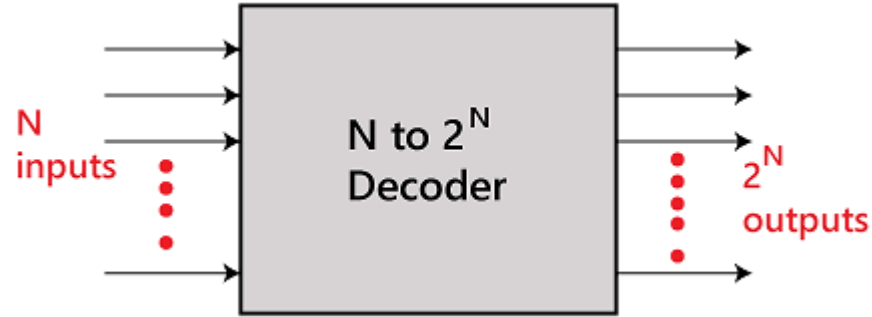
# Chapter 4 Morris Mano (Topic- 4.9)



# Decoder

- ✓ Decoder is combinational circuit.
- ✓ The combinational circuit that change the binary information into  $2^N$  output lines is known as Decoders.
- ✓ Function of decoder is exactly opposite of “Encoder”.
- ✓ A binary code of  $n$  bits is capable of representing up to  $2^n$  distinct elements of coded information. A decoder is a combinational circuit that converts binary information from  $n$  input lines to a maximum of  $2^n$  unique output lines.

# Decoder

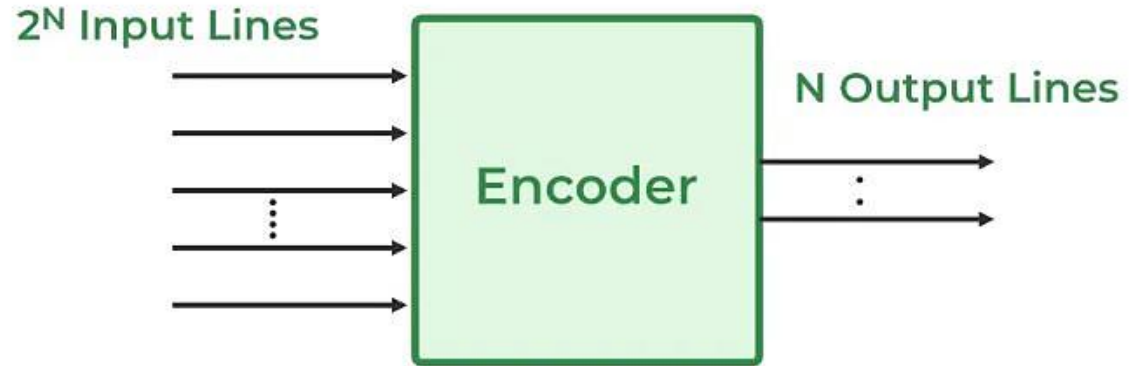


- ✓ There are various types of decoders which are as follows:
- ✓ 2 to 4 line decoder
- ✓ 3 to 8 line decoder
- ✓ 4 to 16 line Decoder

# Concept of Encoder

- ✓ Encoders are devices that take an input signal and encode it into a format suitable for transmission or storage. Decoders are devices that take an encoded input signal and decode it into the original format.
- ✓ An encoder is a combinational circuit that converts binary information in the form of a  $2^N$  input lines into  $N$  output lines, which represent  $N$  bit code for the input. For simple encoders, **it is assumed that only one input line is active at a time.**

# Concept of Encoder



## Types of Encoders:

There are different types of Encoders which are mentioned below.

- 4 to 2 Encoder
- Octal to Binary Encoder (8 to 3 Encoder)
- Decimal to BCD Encoder
- Priority Encoder

# Advantages of Using Encoders in Digital Logic

**Reduction in the number of lines:** Encoders reduce the number of lines required to transmit information from multiple inputs to a single output, which can simplify the design of the system and reduce the cost of components.

**Improved reliability:** By converting multiple inputs into a single serial code, encoders can reduce the possibility of errors in the transmission of information.

**Improved performance:** Encoders can enhance the performance of a digital system by reducing the amount of time required to transmit information from multiple inputs to a single output.



# Advantages of using Decoders in Digital Logic:

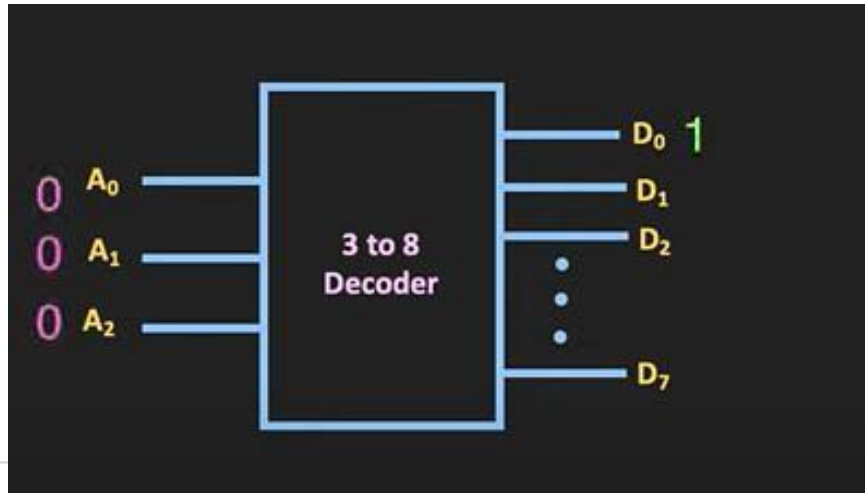
**Increased flexibility:** Binary decoders provide a flexible way to select one of multiple outputs based on a binary code, allowing for a wide range of applications.

**Improved performance:** By converting a serial code into a parallel set of outputs, binary decoders can improve the performance of a digital system by reducing the amount of time required to transmit information from a single input to multiple outputs.

**Improved reliability:** By reducing the number of lines required to transmit information from a single input to multiple outputs, binary decoders can reduce the possibility of errors in the transmission of information.

# Three-to-eight-line decoder (3 to 8 line decoder)

- ✓ Also known “**binary-to-octal conversion**”.
- ✓ The three inputs are decoded into eight outputs, each representing one of the minterms of the three input variables.
- ✓ The input variables represent a binary number, and the outputs represent the eight digits of a number in the octal number.



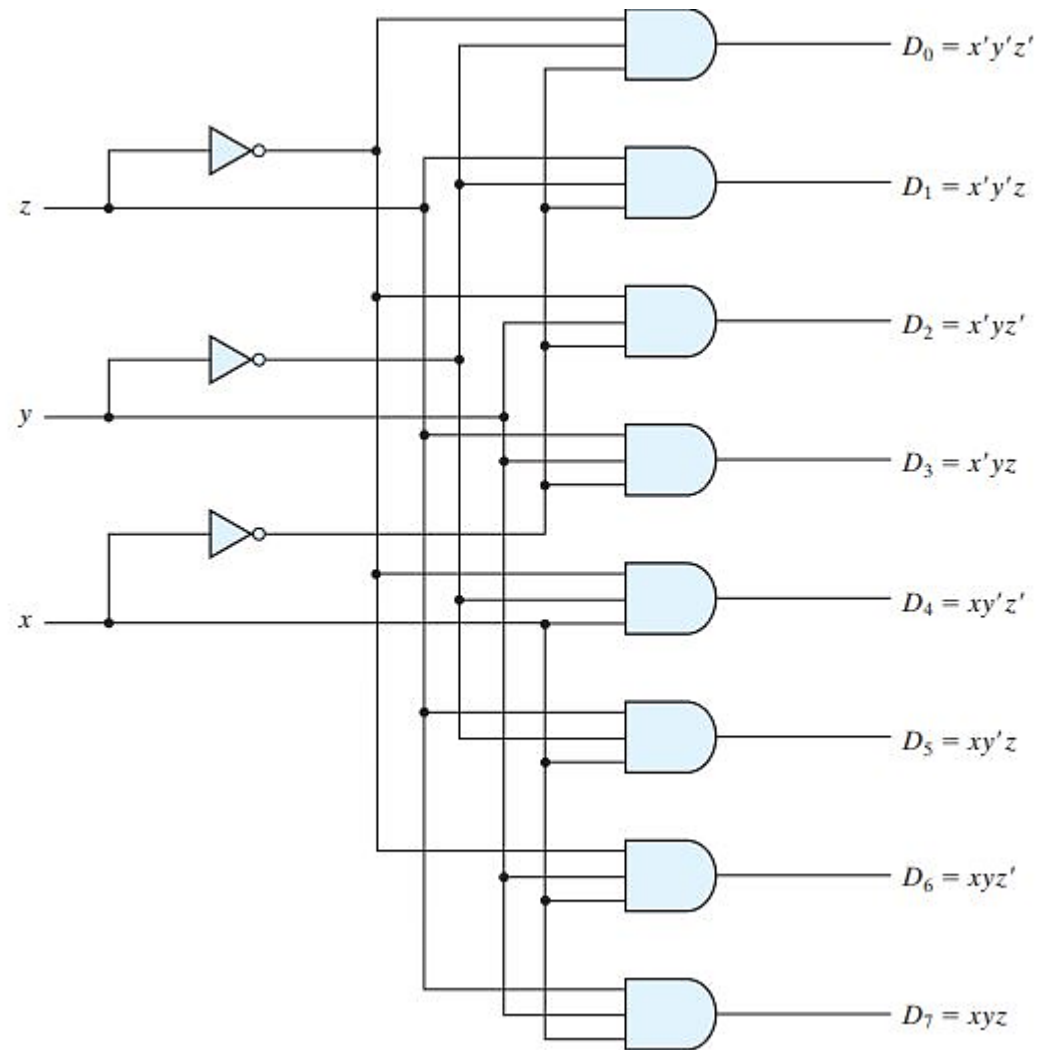
# Three-to-eight-line decoder (3 to 8 line decoder)

**Table 4.6**

*Truth Table of a Three-to-Eight-Line Decoder*

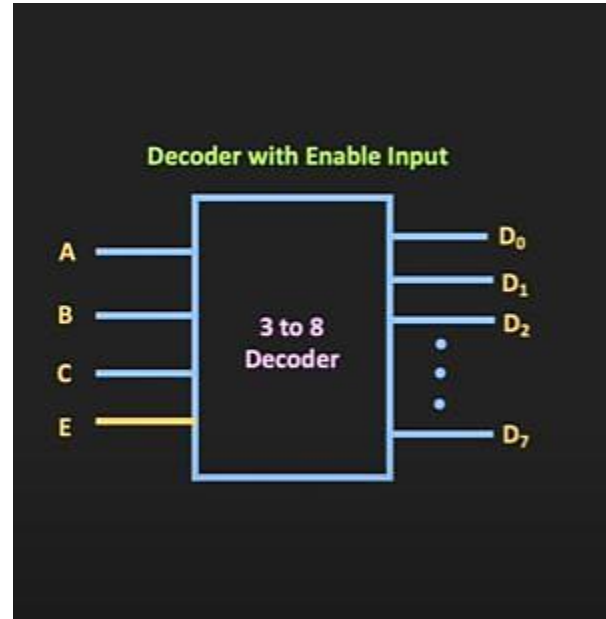
Inputs			Outputs							
<i>x</i>	<i>y</i>	<i>z</i>	<i>D</i> <sub>0</sub>	<i>D</i> <sub>1</sub>	<i>D</i> <sub>2</sub>	<i>D</i> <sub>3</sub>	<i>D</i> <sub>4</sub>	<i>D</i> <sub>5</sub>	<i>D</i> <sub>6</sub>	<i>D</i> <sub>7</sub>
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	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

Fig: the three-  
to-eight-line  
decoder circuit



# Three-to-eight-line decoder (3 to 8 line decoder)

- ✓ Using Enable Input
- ✓ Assume, Enable Input is ACTIVE HIGH which means when the enable input is HIGH then the decoder will get Enabled.



# Three-to-eight-line decoder (3 to 8 line decoder)

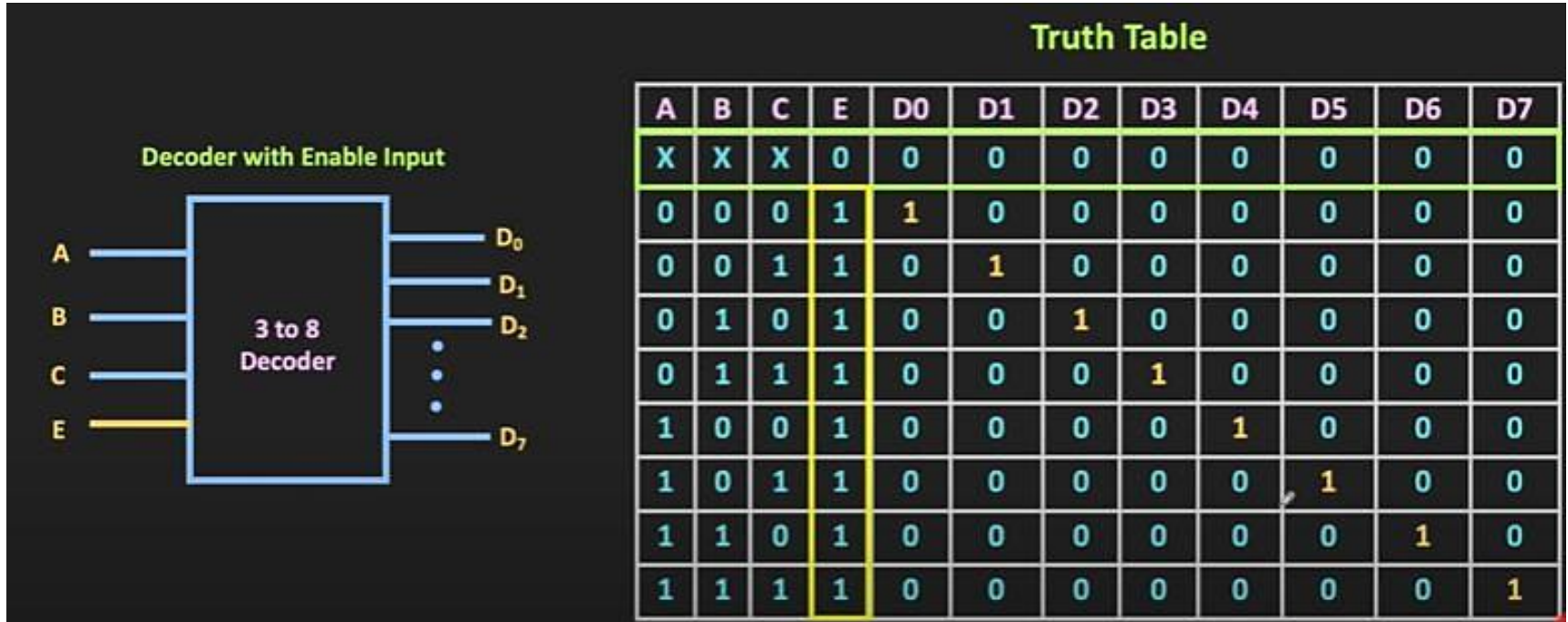
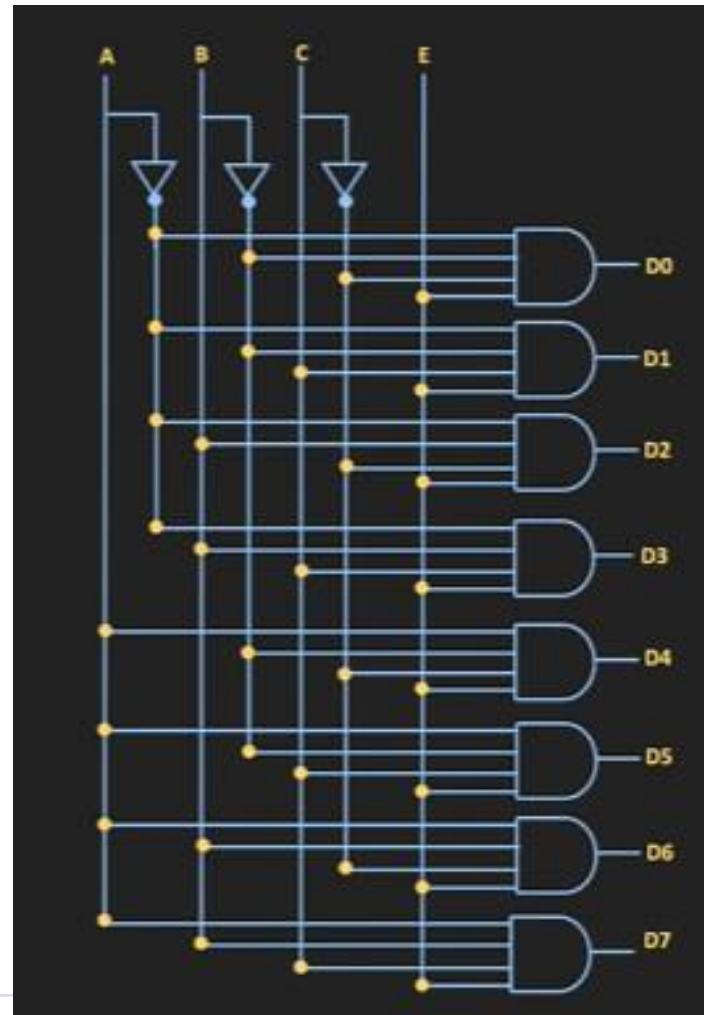


Fig: Logic Circuit



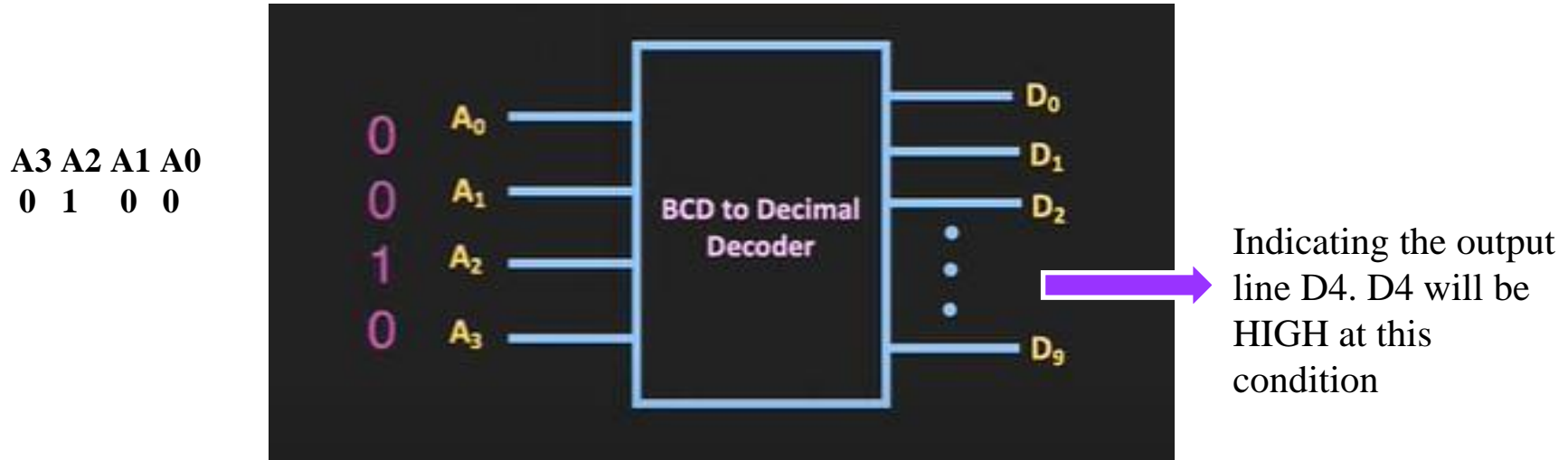
# Enable Pin

- ✓ Some binary decoders have an additional input pin labelled “Enable” that controls the outputs from the device.
- ✓ This extra input allows the decoders outputs to be turned “ON” or “OFF” as required.
- ✓ Output is only generated when the Enable input has value 1; otherwise, all outputs are 0.



# BCD-to-Decimal decoder (4 to 10 line decoder)

- ✓ Also known “4 to 10 line decoder”.
- ✓ The four inputs are decoded into ten outputs, each representing one of the minterms of the three input variables.



# BCD-to-Decimal decoder (4 to 10 line decoder)

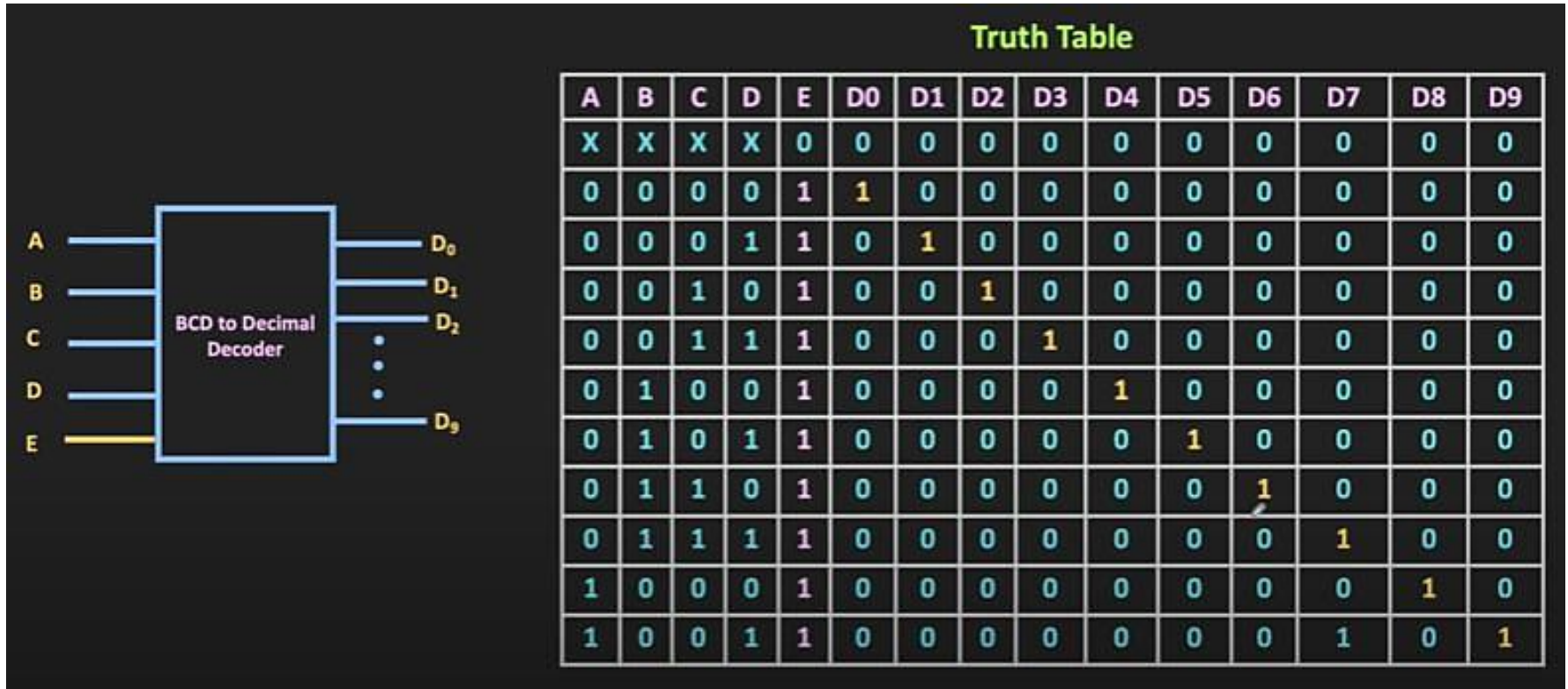
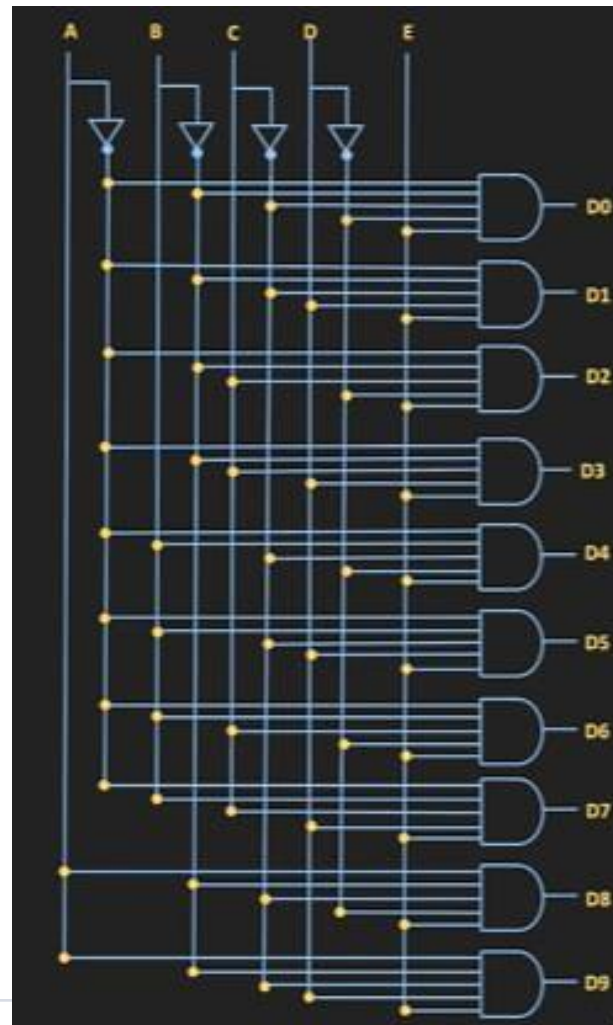


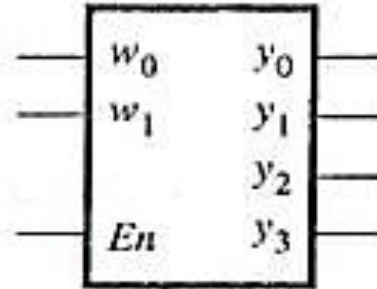
Fig: BCD-to-Decimal decoder



# 2-to-4 decoder

Truth table

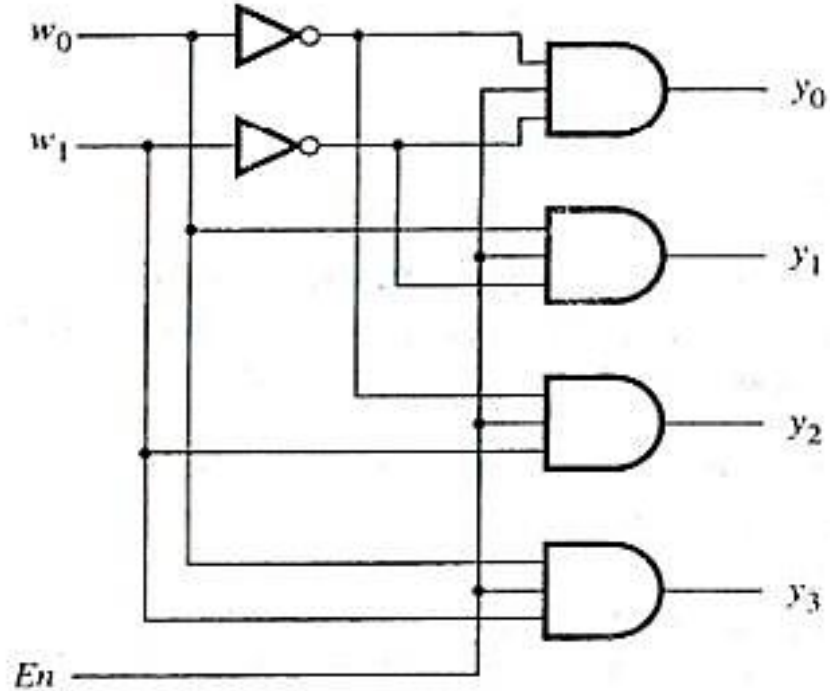
$En$	$w_1$	$w_0$	$y_0$	$y_1$	$y_2$	$y_3$
1	0	0	1	0	0	0
1	0	1	0	1	0	0
1	1	0	0	0	1	0
1	1	1	0	0	0	1
0	x	x	0	0	0	0



# 2-to-4 decoder

Truth table

$En$	$w_1$	$w_0$	$y_0$	$y_1$	$y_2$	$y_3$
1	0	0	1	0	0	0
1	0	1	0	1	0	0
1	1	0	0	0	1	0
1	1	1	0	0	0	1
0	x	x	0	0	0	0



# 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 and three outputs generate corresponding binary code.

# Octal to Binary Encoder (8 to 3 Encoder)

- ✓ The figure below shows the logic symbol of octal to the binary encoder.



INPUTS								OUTPUTS		
Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0	A2	A1	A0
0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0	0	1
0	0	0	0	0	1	0	0	0	1	0
0	0	0	0	1	0	0	0	0	1	1
0	0	0	1	0	0	0	0	1	0	0
0	0	1	0	0	0	0	0	1	0	1
0	1	0	0	0	0	0	0	1	1	0
1	0	0	0	0	0	0	0	1	1	1



# Octal to Binary Encoder (8 to 3 Encoder)

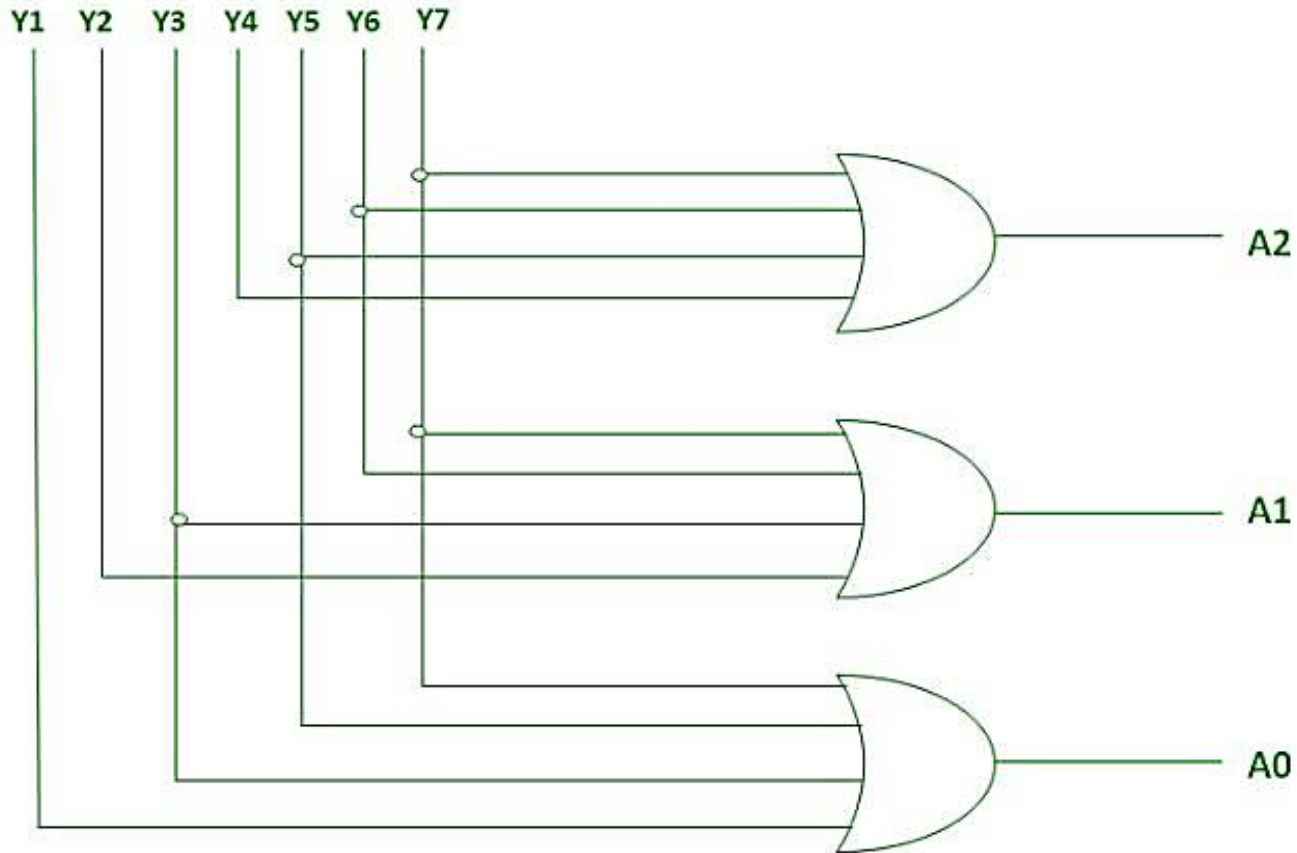
✓ Logical expression for A2, A1, and A0:

✓  $A2 = Y7 + Y6 + Y5 + Y4$

✓  $A1 = Y7 + Y6 + Y3 + Y2$

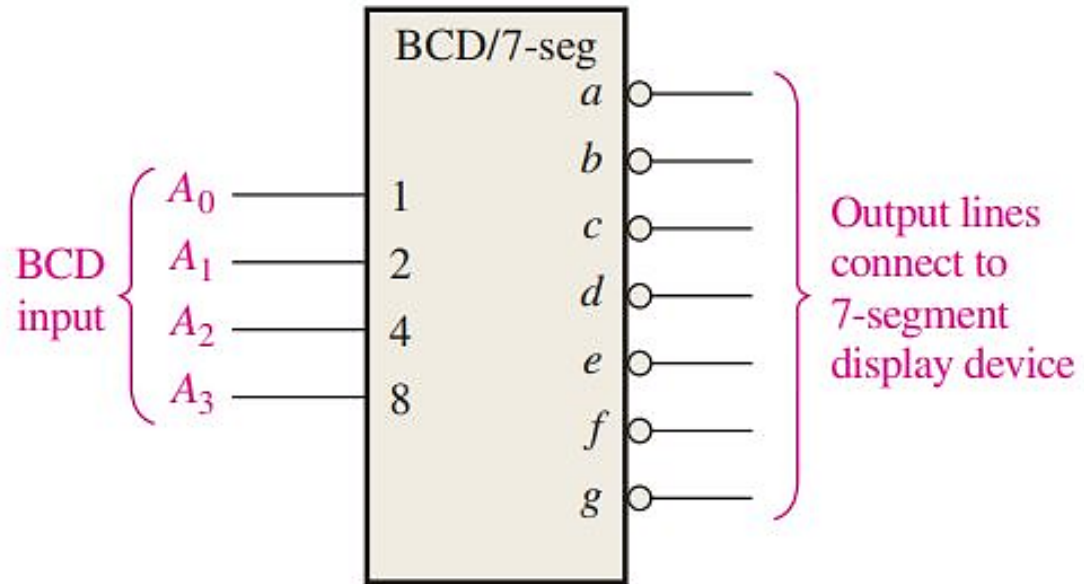
✓  $A0 = Y7 + Y5 + Y3 + Y1$

# Octal to Binary Encoder (Logic Circuit)



# BCD-to-seven-segment decoder

- ✓ The BCD-to-7-segment decoder accepts the BCD code on its inputs and provides outputs to drive 7-segment display devices to produce a decimal readout.



# 4 to 16 Decoder using 3 to 8 Decoders

# 3 to 8 Decoder using 2 to 4 Decoder

# Implementation of Full Adder using Decoder