Quaid-e-Awam University of Engineering, Science and Technology


بسم الله الرحمن الرحيم

*In the name of Allah, the Most Merciful, the Most Kind*

Date: 10-11-2021

# BCS 103
# Digital Logic & Computer Architecture

**Lecture 29 and 30**

**Department of Computer Science**

# IN THE LAST LECTURE

We have discussed

**Subtractor**

- **Half Subtractor**
- **Full Subtractor**

**Parallel Binary Subtractor**

# TODAY'S LECTURE

Today we will discuss about:

- **Decoder (2x4)**
- **Decoder (3x8)**

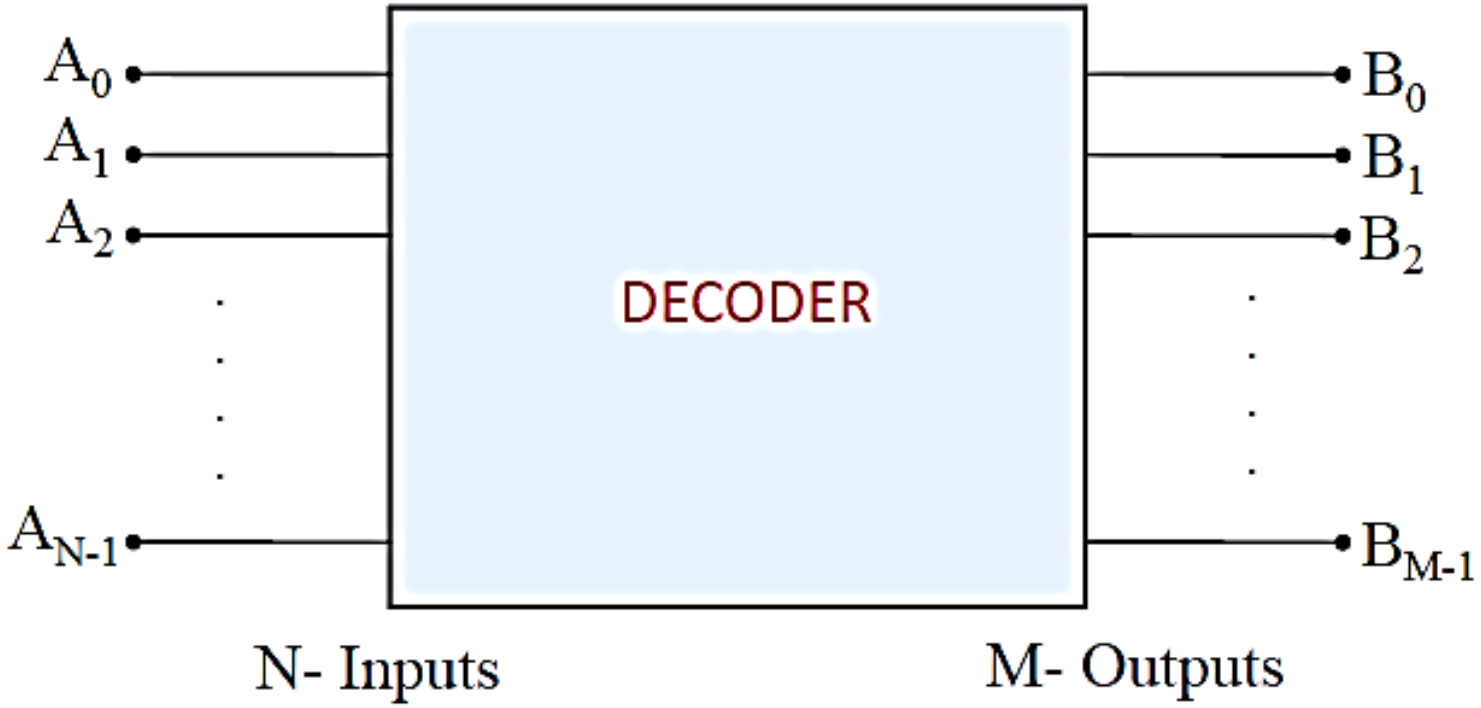
- **Encoder (4x2)**
- **Decimal to BCD Encoder**

# 2 to 4 line Decoder

# Decoder

- A decoder is a combinational circuit.
- A decoder accepts a set of inputs that represents a binary number and activates only that output corresponding to the input number. All other outputs remain inactive.
- Fig. 1 shows the block diagram of decoder with 'N' inputs and 'M' outputs.
- There are $2^N$ possible input combinations, for each of these input combination only one output will be HIGH (active) all other outputs are LOW
- Some decoder have one or more ENABLE (E) inputs that are used to control the operation of decoder.

# BLOCK DIAGRAM OF DECODER




*Only one output is High for each input*

# 2 to 4 Line Decoder:

- Block diagram of 2 to 4 decoder is shown in fig. 2
- A and B are the inputs. ( No. of inputs =2)
- No. of possible input combinations: $2^2=4$
- No. of Outputs : $2^2=4$, they are indicated by $D_0$, $D_1$, $D_2$ and $D_3$
- From the Truth Table it is clear that each output is "1" for only specific combination of inputs.

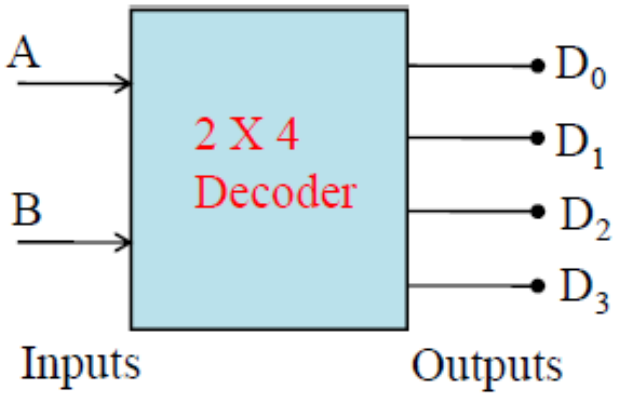



Fig. 2

TRUTH TABLE

| INPUTS | | OUTPUTS | | | |
|---|---|---|---|---|---|
| A | B | $D_0$ | $D_1$ | $D_2$ | $D_3$ |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 |

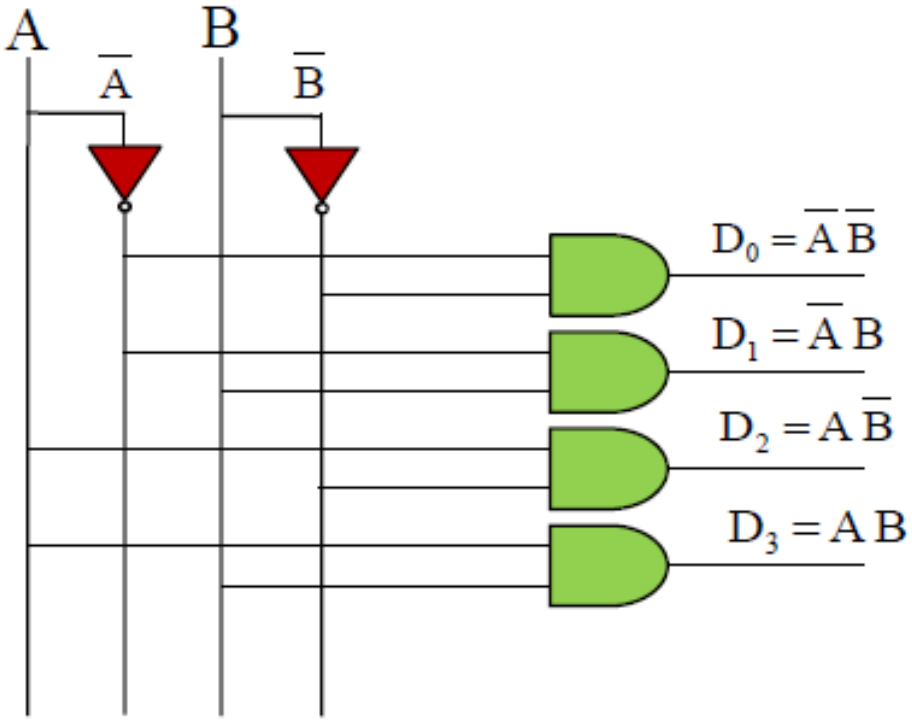
## BOOLEAN EXPRESSION:

From Truth Table

$$D_0 = \overline{A}\,\overline{B} \qquad D_1 = \overline{A}\,B$$

$$D_2 = A\,\overline{B} \qquad D_3 = AB$$

## LOGIC DIAGRAM:



# 3 to 8 line Decoder

# 3 to 8 Line Decoder:

- Block diagram of 3 to 8 decoder is shown in fig. 4
- A , B and C are the inputs. ( No. of inputs =3)
- No. of possible input combinations: $2^3=8$
- No. of Outputs : $2^3=8$, they are indicated by $D_0$ to $D_7$
- From the Truth Table it is clear that each output is "1" for only specific combination of inputs.

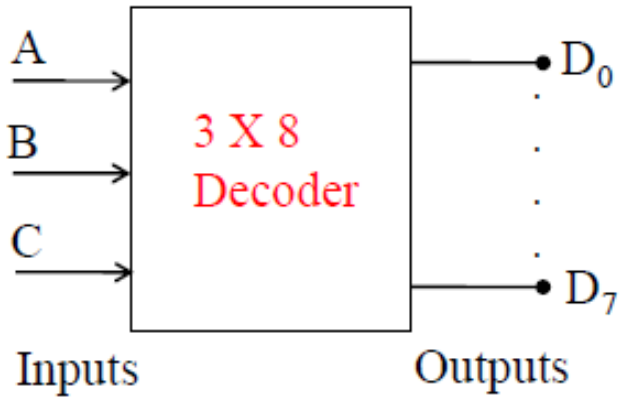



Fig. 4

# TRUTH TABLE FOR 3 X 8 DECODER:

| INPUTS | | | OUTPUTS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | B | C | D0 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $D_0 = \overline{A}\,\overline{B}\,\overline{C}$ |
| 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | $D_1 = \overline{A}\,\overline{B}\,C$ |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | $D_2 = \overline{A}\,B\,\overline{C}$ |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | $D_3 = \overline{A}\,B\,C$ |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | $D_4 = A\,\overline{B}\,\overline{C}$ |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | $D_5 = A\,\overline{B}\,C$ |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | $D_6 = A\,B\,\overline{C}$ |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | $D_7 = A\,B\,C$ |

# LOGIC DIAGRAM OF 3 X 8 DECODER:

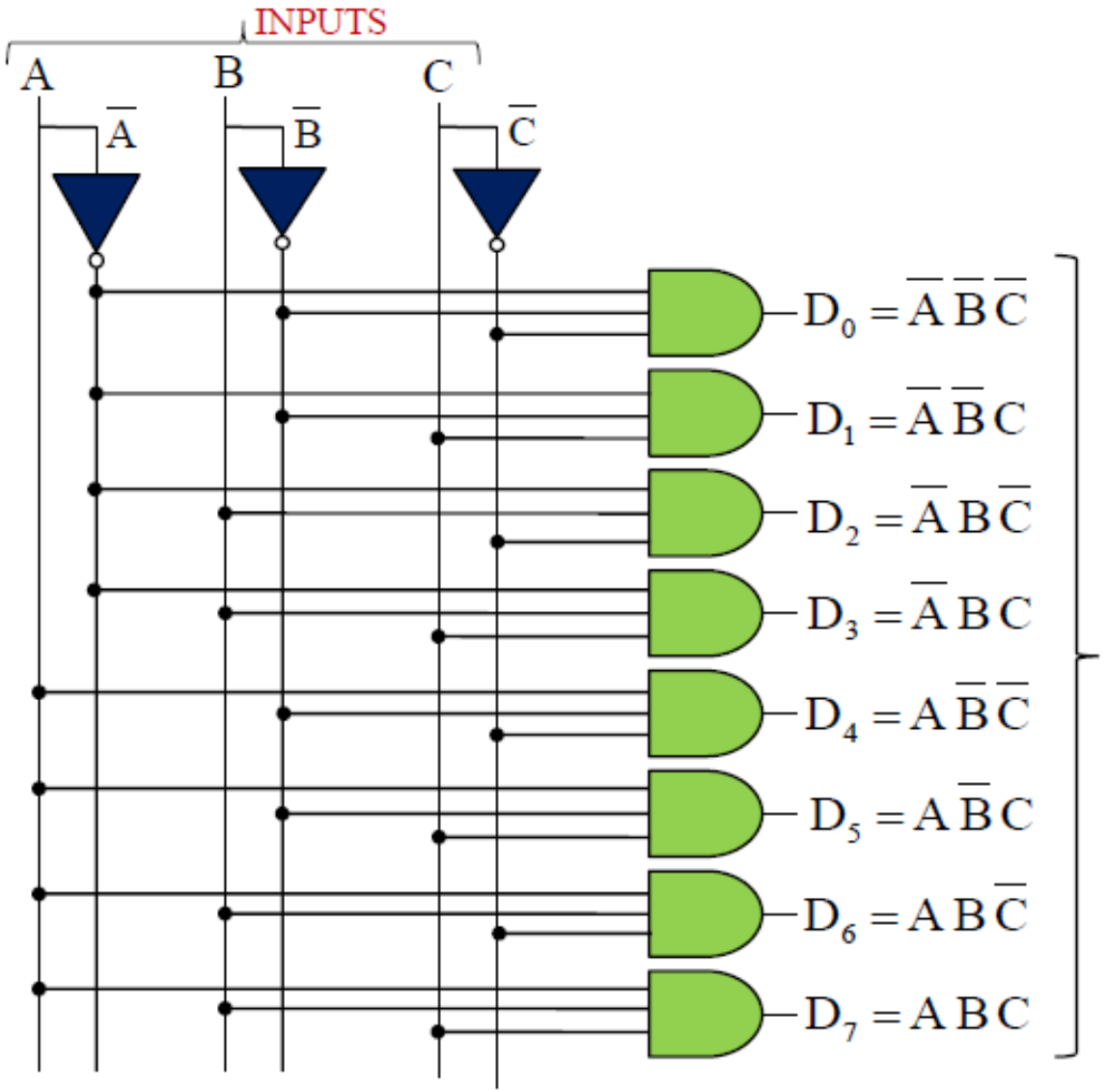



Fig. 5

# Encoder

# Encoder

- An Encoder is a combinational logic circuit.
- It performs the inverse operation of Decoder.
- The opposite process of decoding is known as Encoding.
- An Encoder converts an active input signal into a coded output signal.
- Block diagram of Encoder is shown in Fig.10. It has 'M' inputs and 'N' outputs.
- An Encoder has 'M' input lines, only one of which is activated at a given time, and produces an N-bit output code, depending on which input is activated.

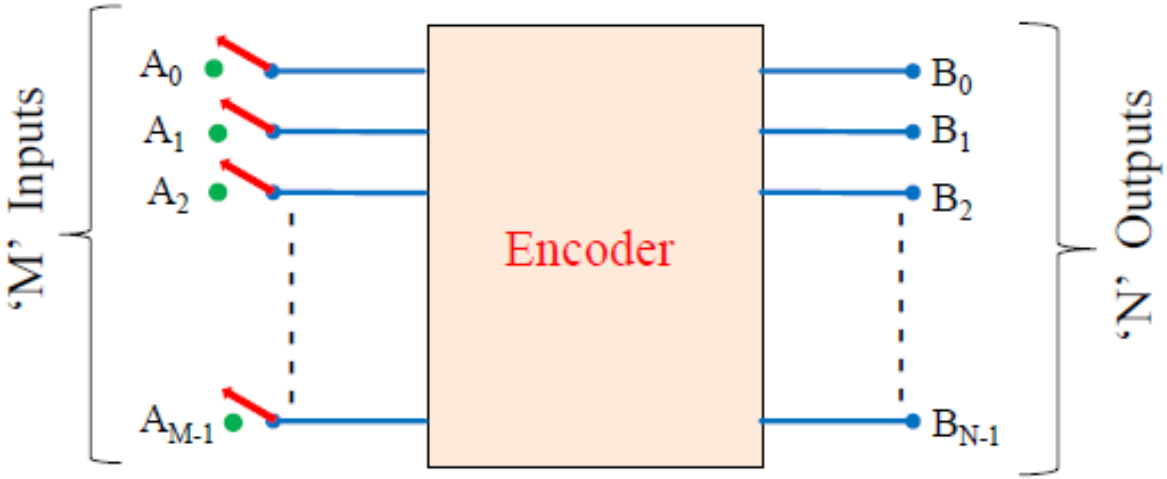



Fig. 10

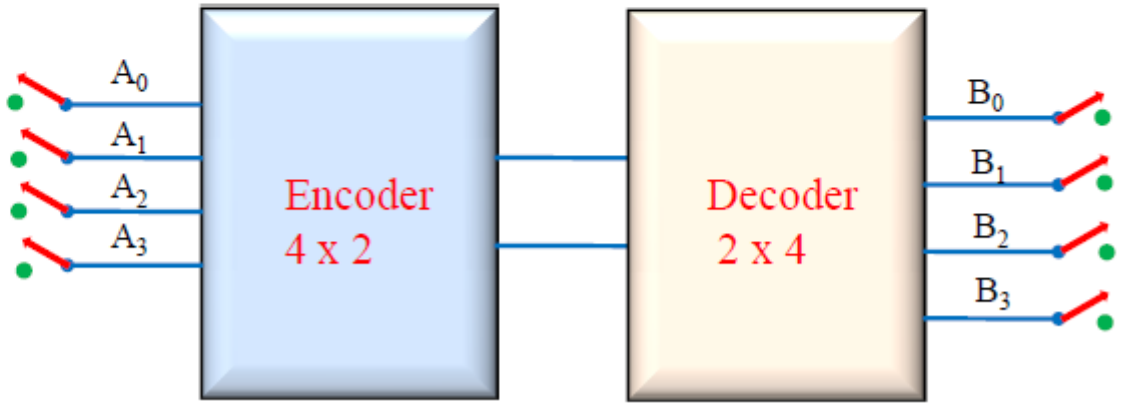
# Encoder

- Encoders are used to translate the rotary or linear motion into a digital signal.
- The difference between Decoder and Encoder is that Decoder has Binary Code as an input while Encoder has Binary Code as an output.
- Encoder is an Electronics device that converts the analog signal to digital signal such as BCD Code.
- Types of Encoders

i. Priority Encoder
ii. Decimal to BCD Encoder
iii. Octal to Binary Encoder
iv. Hexadecimal to Binary Encoder

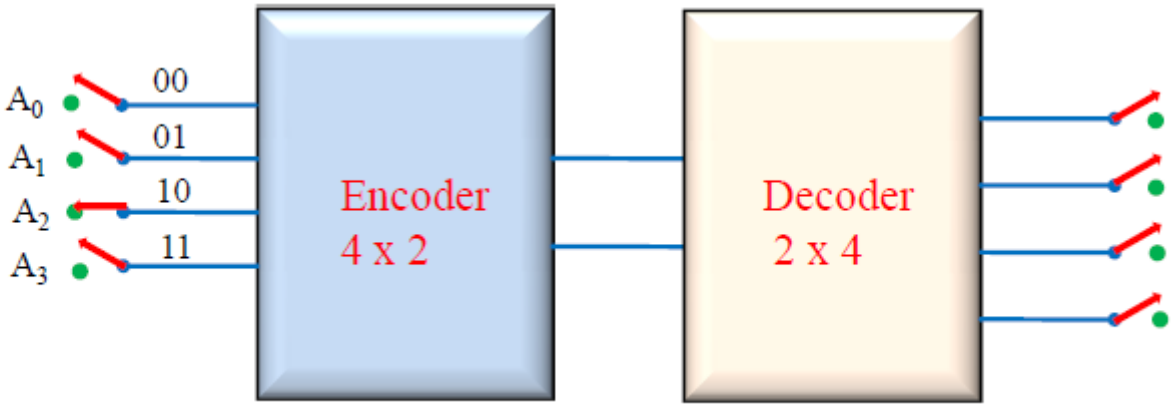
# Encoder

M=4
$M=2^2$
$M=2^N$
'M' is the input and
'N' is the output



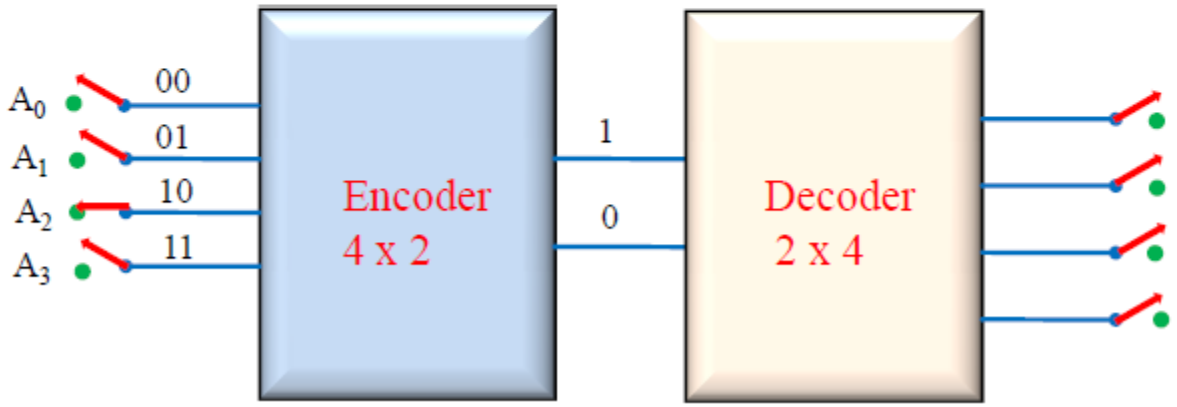
# Encoder

M=4
$M=2^2$
$M=2^N$
'M' is the input and
'N' is the output



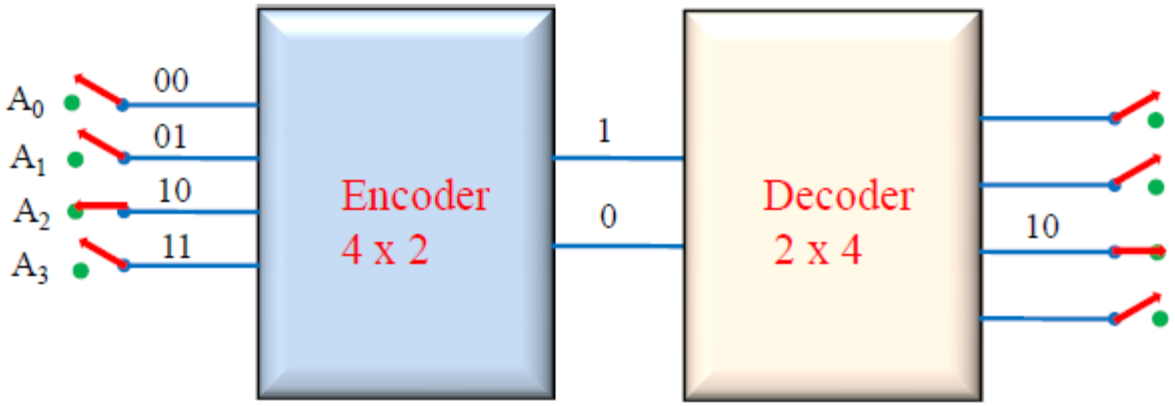
# Encoder

M=4
$M=2^2$
$M=2^N$
'M' is the input and
'N' is the output



# Encoder

M=4
$M=2^2$
$M=2^N$
'M' is the input and
'N' is the output



# Decimal to BCD Encoder

# DECIMAL TO BCD ENCODER:

- It has ten inputs corresponding to ten decimal digits (from 0 to 9) and four outputs (A,B,C,D) representing the BCD.
- The block diagram is shown in fig.18 and Truth table in fig.19

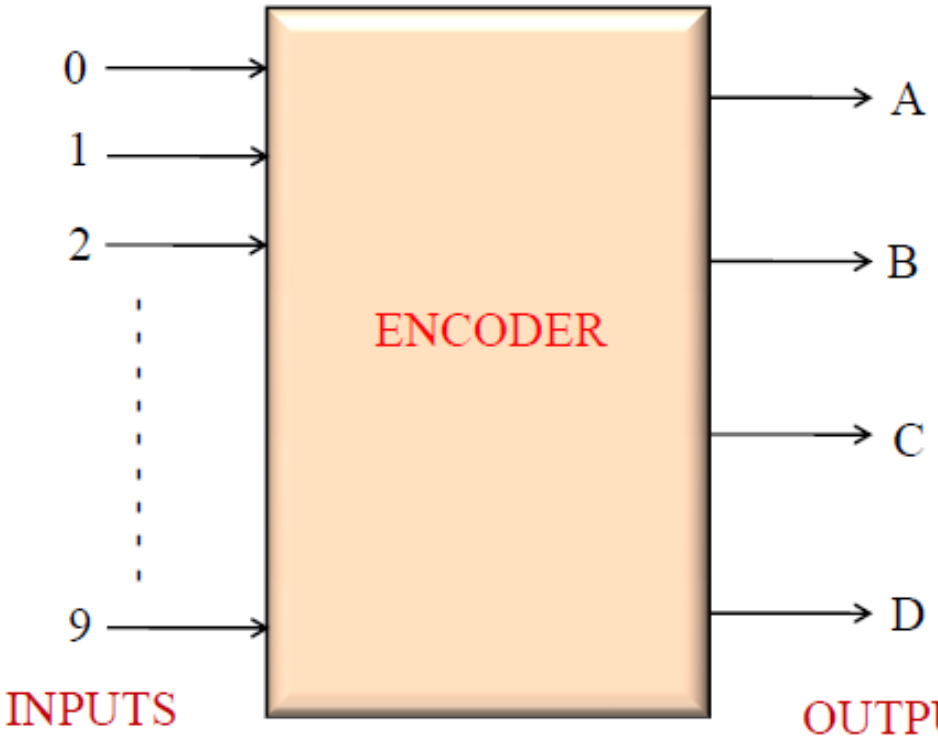



Fig. 18

# Truth Table

| INPUTS | | | | | | | | | | BCD OUTPUTS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D |
| 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 |

# DECIMAL TO BCD ENCODER

- From Truth Table it is clear that the output A is HIGH when input is 8 OR 9 is HIGH

  Therefore A=8+9
- The output B is HIGH when 4 OR 5 OR 6 OR 7 is HIGH

  Therefore B=4+5+6+7
- The output C is HIGH when 2 OR 3 OR 6 OR 7 is HIGH

  Therefore C=2+3+6+7
- Similarly D=1+3+5+7+9

  Logic Diagram is shown in fig.20

# DECIMAL TO BCD ENCODER

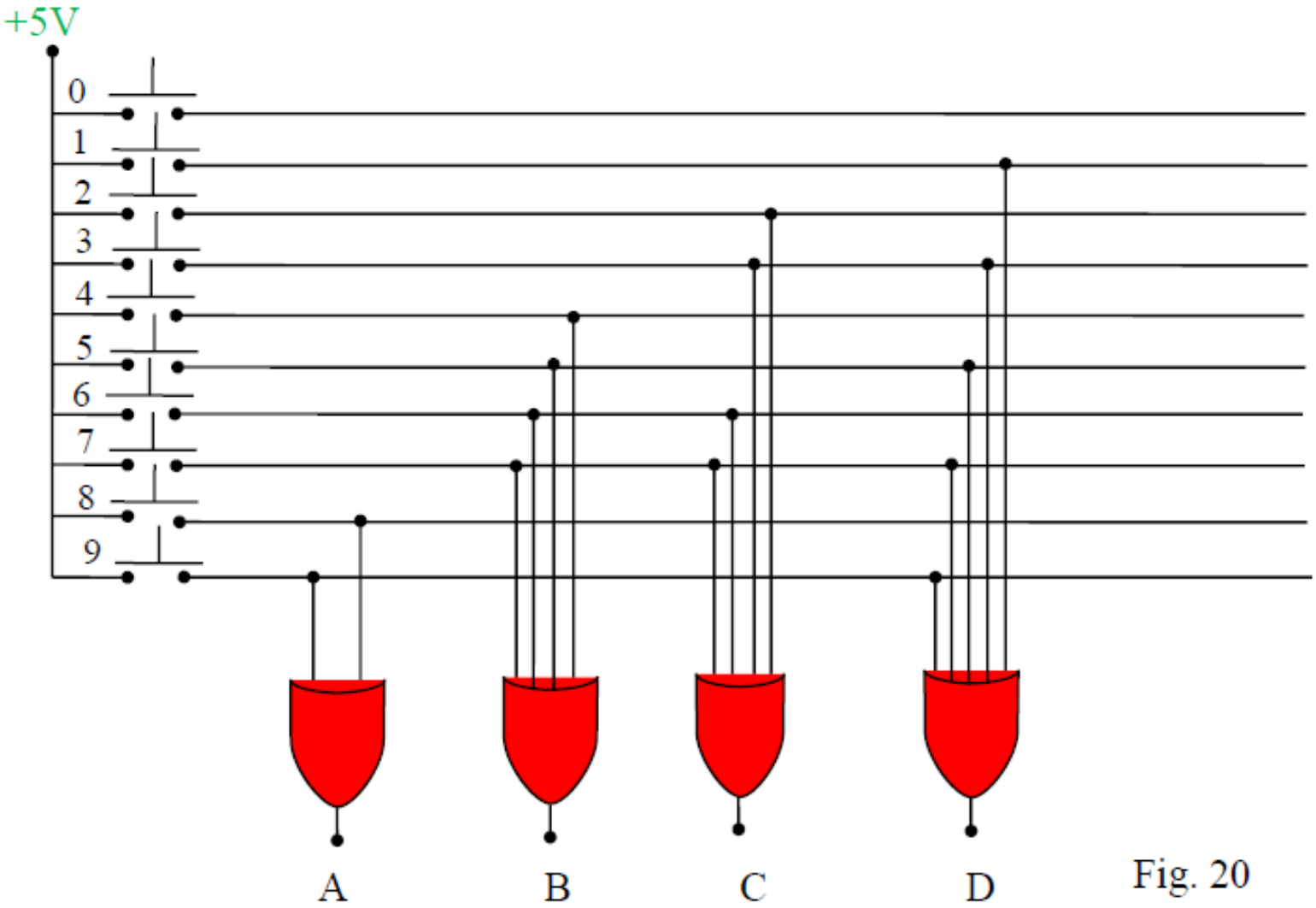



Fig. 20

# Thanks