

Encoders

Lecture by
Prof. Ganaraj P S

School of Electronics Engineering, KIIT University

What is an Encoder?

- An encoder is a digital circuit that performs the inverse operation of a decoder.
- An encoder has 2^n (or fewer) input lines and n output lines.
- For example, 4-to-2 line encoder, 8-to-3 line encoder (also known as Octal-to-Binary encoder)

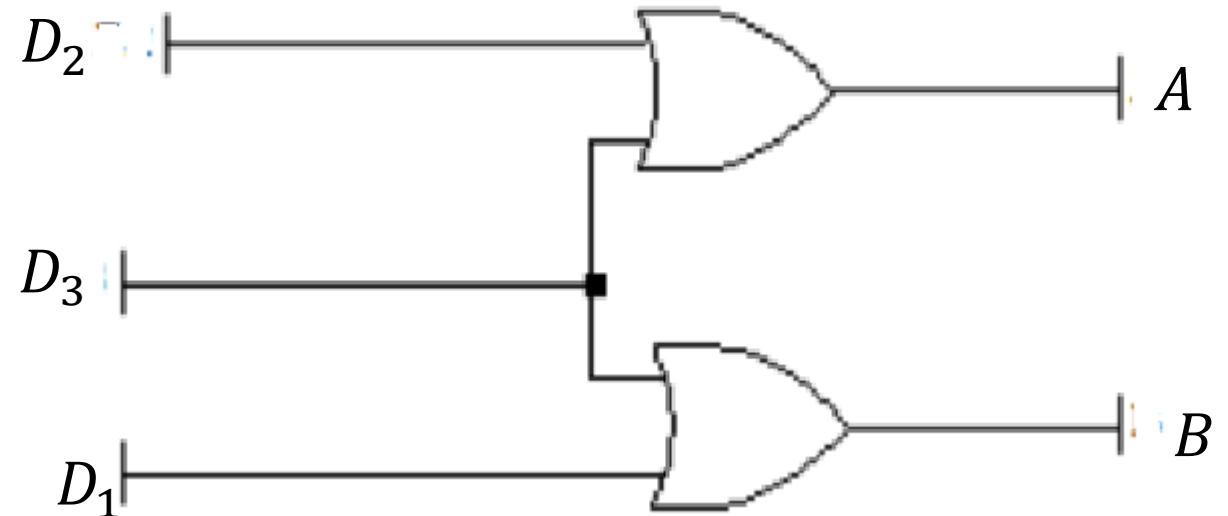
4-to-2 line Encoder

- The encoder has 4 input lines denoted as D_3, D_2, D_1, D_0
- It has 2 output lines denoted as A and B .

Truth table

Inputs				Outputs	
D_0	D_1	D_2	D_3	A	B
1	0	0	0	0	0
0	1	0	0	0	1
0	0	1	0	1	0
0	0	0	1	1	1

$$A = D_2 + D_3 \qquad B = D_1 + D_3$$



Limitation 1

- The encoder defined in the previous slide has the limitation that only one input can be active at any given time.
- If two inputs are active simultaneously, the output produces an undefined combination.
- For example, if D_2 and D_3 are 1 simultaneously, the output of the encoder will be 11 because all two outputs are equal to 1.
- In this case, the output 11 does not represent correct functionality.

Limitation 2

- Another ambiguity in the encoder is that an output with all 0's is generated when all the inputs are 0.
- But the output 00 is also produced when input D_0 is equal to 1.

Solution to the Limitations

- Limitation 1 can be resolved
 - by establishing an input priority in the encoder circuits
 - Input priority ensures that only one input is encoded.
- Limitation 2 can be resolved
 - by providing one more output to indicate whether at least one input is equal to 1.
 - This additional output is called a **valid bit**.
- Features such as, input priority and valid bit are incorporated in the design of encoder.
- Such encoders are called **priority encoders**.

4-to-2 line Priority Encoder

Input priority: $D_3 > D_2 > D_1 > D_0$

Truth table

Inputs				Outputs		
D_0	D_1	D_2	D_3	x	y	V
0	0	0	0	X	X	0
1	0	0	0	0	0	1
X	1	0	0	0	1	1
X	X	1	0	1	0	1
X	X	X	1	1	1	1

Boolean expressions

$$x = D_2 + D_3$$

$$y = D_3 + D_1 D_2'$$

$$V = D_0 + D_1 + D_2 + D_3$$

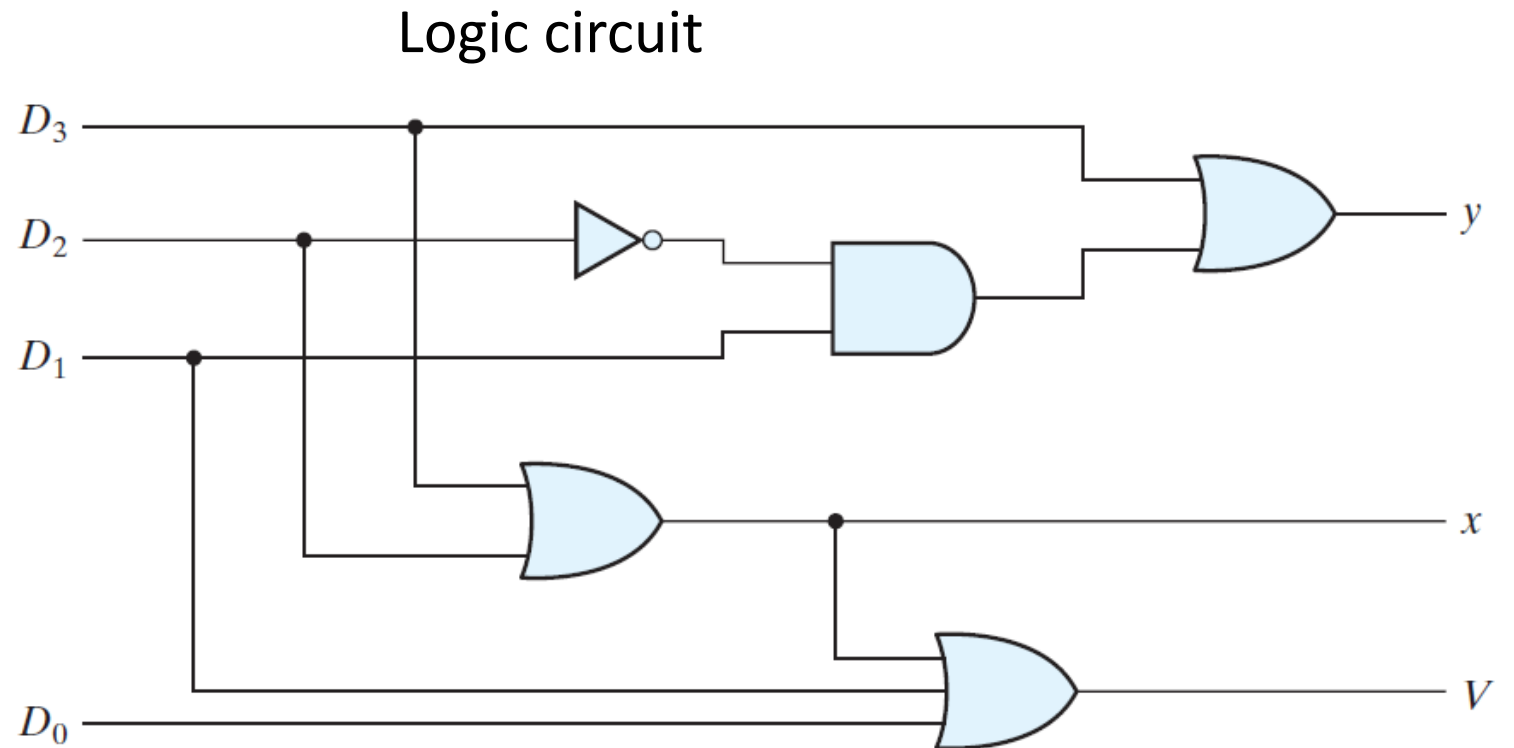
4-to-2 line Priority Encoder

Boolean expressions

$$x = D_2 + D_3$$

$$y = D_3 + D_1 D_2'$$

$$V = D_0 + D_1 + D_2 + D_3$$



Design Problem

- Design a four-input priority encoder with inputs as D_0, D_1, D_2, D_3 . The input priority is $D_0 > D_2 > D_1 > D_3$.
- Solution: Given, input priority, $D_0 > D_2 > D_1 > D_3$

Truth table

Inputs				Outputs		
D_0	D_1	D_2	D_3	x	y	V
0	0	0	0	X	X	0
0	0	0	1	0	0	1
0	1	0	X	0	1	1
0	X	1	X	1	0	1
1	X	X	X	1	1	1

Boolean expressions

$$x = D_0 + D_2$$

$$y = D_0 + D_1 \overline{D_2}$$

$$V = D_0 + D_1 + D_2 + D_3$$

Design Problem

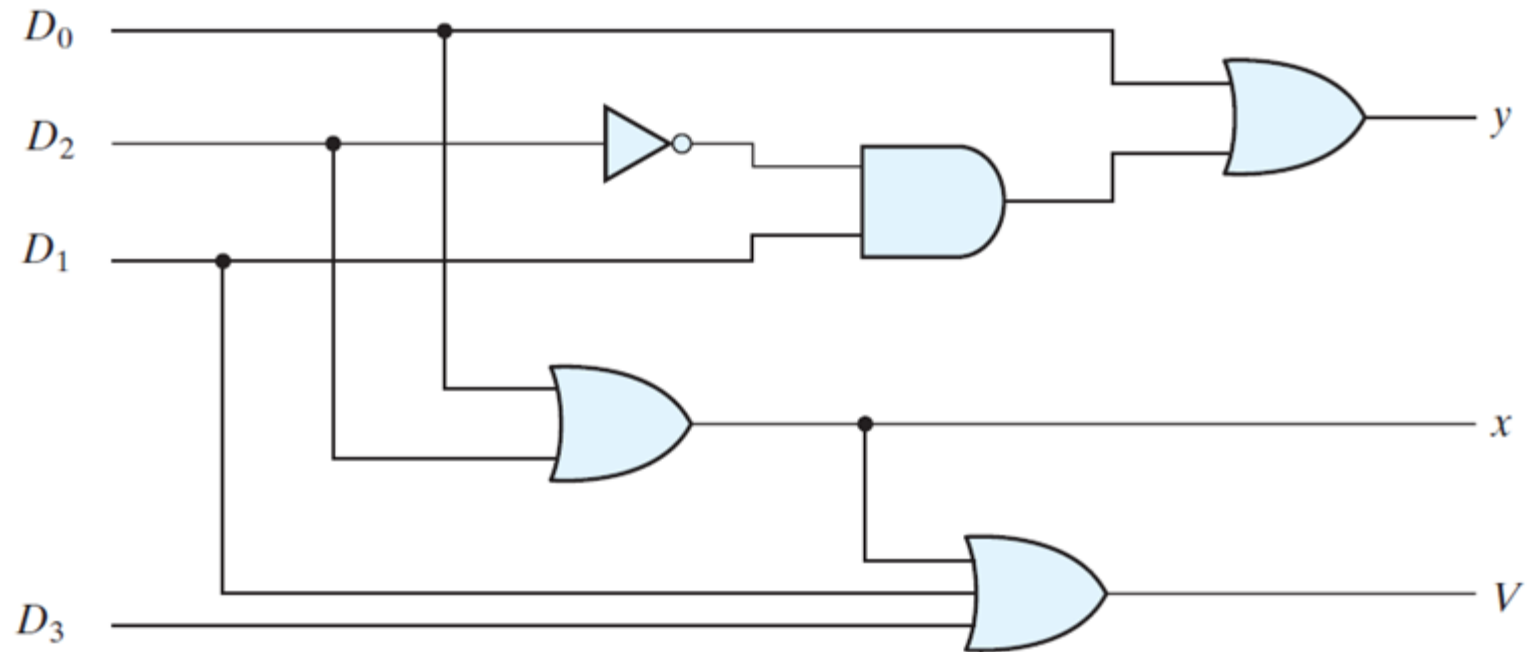
- Design a four-input priority encoder with inputs as D_0, D_1, D_2, D_3 . The input priority is $D_0 > D_2 > D_1 > D_3$.
- Solution: Given, input priority, $D_0 > D_2 > D_1 > D_3$

Boolean expressions

$$x = D_0 + D_2$$

$$y = D_0 + D_1 \overline{D_2}$$

$$V = D_0 + D_1 + D_2 + D_3$$



END