Engaged Learning Practice #4

Priority Encoder

Encoders

- 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. As an aggregate, the output lines generate the binary code corresponding to each input value.
- An example of an encoder is the **octal-to-binary encoder** whose truth table is given in Table 4.7.
- The encoder can be implemented with three OR gates whose inputs are determined directly from the truth table.

$$z = D_1 + D_3 + D_5 + D_7$$
$$y = D_2 + D_3 + D_6 + D_7$$
$$x = D_4 + D_5 + D_6 + D_7$$

✓ For the complete truth table of 16x16=256, we have multiple inputs that have a value of 1.

✓ We have to handle the output when x,y and z are equal to all 0.

Table 4.7 Truth Table of an Octal-to-Binary Encoder.

Inputs								Outputs		
D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	x	y	z
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

Priority Encoder

- The operation of the priority encoder is such that if two or more inputs are equal to 1 at the same time, the input having the *highest priority* will take precedence.
- The truth table of a four-input priority encoder is given in Table 4.8.
  - Inputs: x and y, a *valid* bit indicator: V (1 when one or more inputs are equal to 1)

Table 4.8 Truth Table of a Priority Encoder.

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

- According to Table 4.8, the higher the subscript number, the higher the priority of the input is.
  - Input D_3 has the highest priority, so, regardless of the values of the other inputs, when this input is 1, the output for xy is 11.
  - D_2 has the next priority level. The output is 10 if $D_2 = 1$, provided that $D_3 = 0$, regardless of the values of the other two lower priority inputs.
  - The output for D_1 is generated only if higher priority inputs are 0,and so on down the priority levels.

Truth Table of Priority Encoder

- The minterms for the two functions are derived from Table 4.8. Although the table has only five rows, when each X in a row is replaced first by 0 and then by 1, we obtain all 16 possible input combinations
- For example, the fourth row in the table, with inputs XX10, represents the four minterms 0010, 0110, 1010, and 1110.

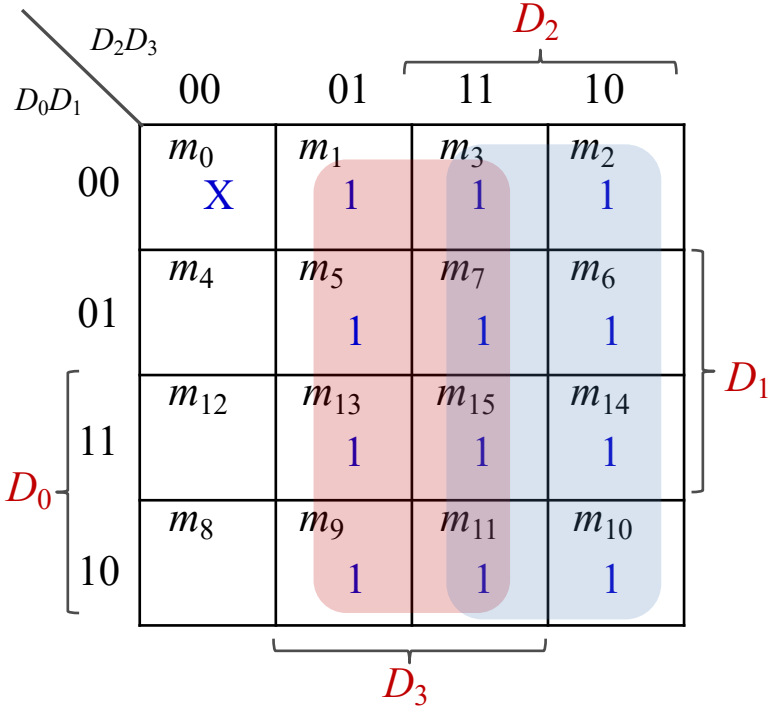
Table 4.8 Truth Table of a Priority Encoder.

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

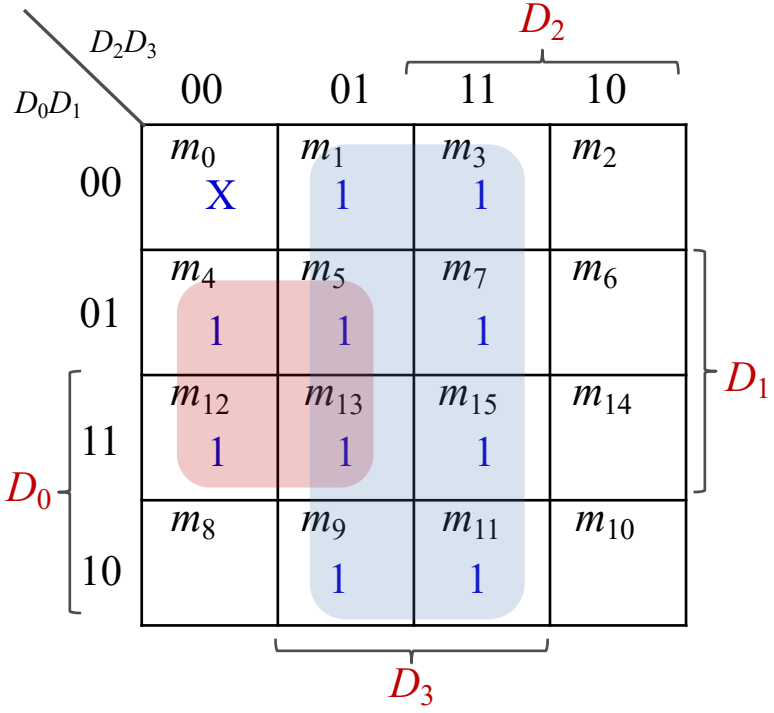
Truth Table of a Priority Encoder.

	Inputs				Outputs		
	D_0	D_1	D_2	D_3	x	y	V
m_0	0	0	0	0	X	X	0
m_1	0	0	0	1	1	1	1
m_2	0	0	1	0	1	0	1
m_3	0	0	1	1	1	1	1
m_4	0	1	0	0	0	1	1
m_5	0	1	0	1	1	1	1
m_6	0	1	1	0	1	0	1
m_7	0	1	1	1	1	1	1
m_8	1	0	0	0	0	0	1
m_9	1	0	0	1	1	1	1
m_{10}	1	0	1	0	1	0	1
m_{11}	1	0	1	1	1	1	1
m_{12}	1	1	0	0	0	1	1
m_{13}	1	1	0	1	1	1	1
m_{14}	1	1	1	0	1	0	1
m_{15}	1	1	1	1	1	1	1

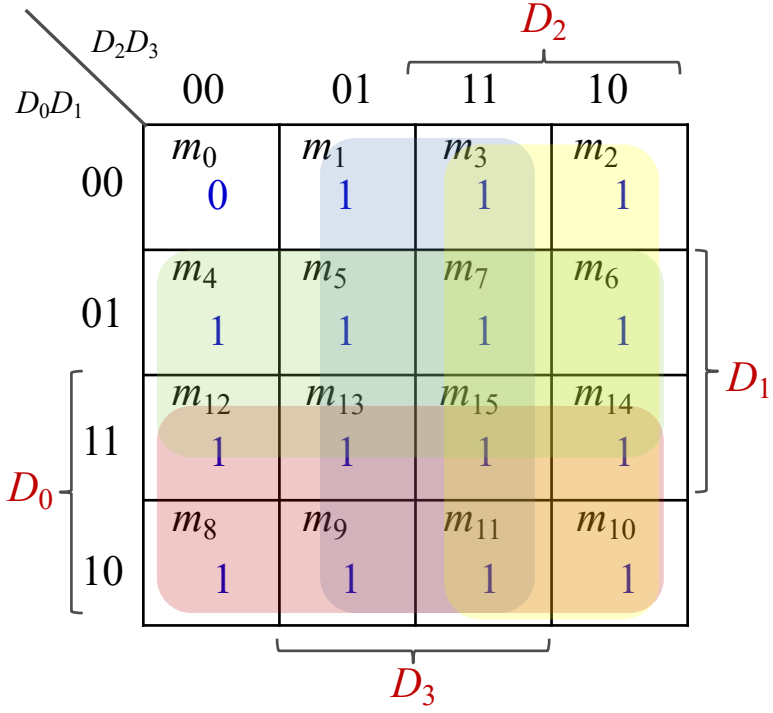
K-Maps for Priority Encoder



$$x = D_2 + D_3$$



$$y = D_3 + D_1D'_2$$



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

Four-Input Priority Encoder

- The Boolean functions pf the priority encoder:

$$x = D_2 + D_3$$

$$y = D_3 + D_1 D'_2$$

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

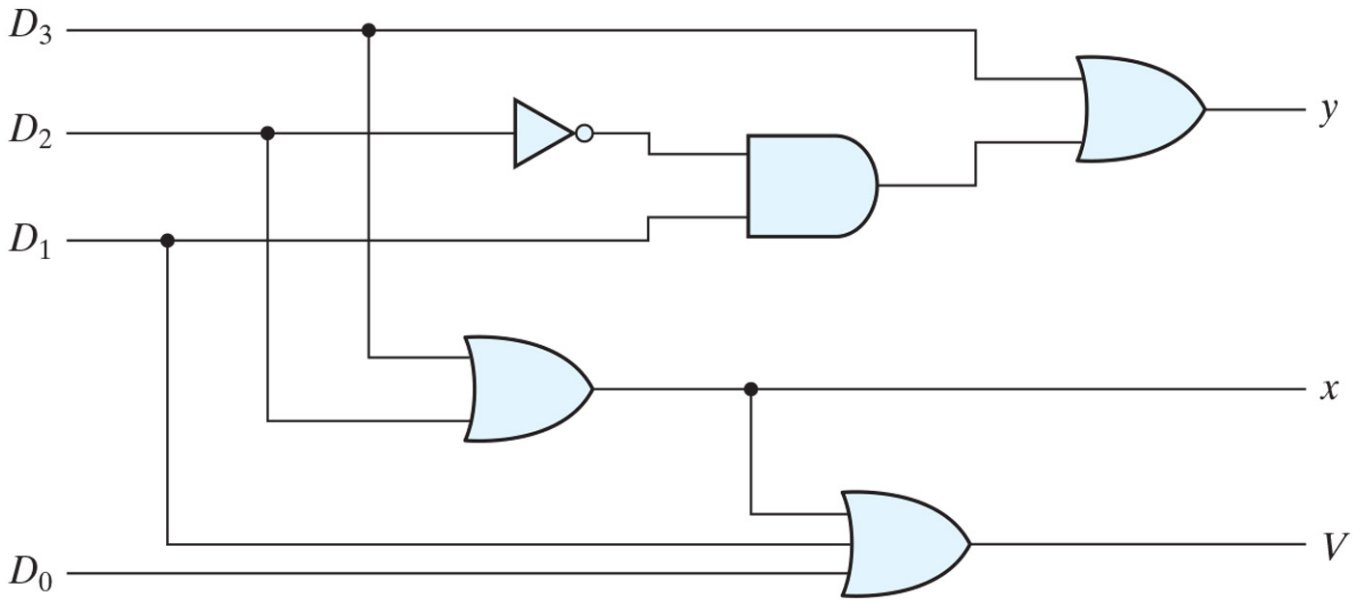


Figure 4.23 Four-input priority encoder.

Practice #1: Design a four-input priority encoder

Design a four-input priority encoder with inputs as in Table 4.8,
but with input D_0 having the highest priority and input D_3 the lowest priority.

Table 4.8 Truth Table of a Priority Encoder.

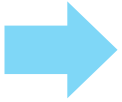
Inputs				Outputs		
D_0	D_1	D_2	D_3	x	y	V
0	0	0	0	X	X	0
1	0	0	0	0	0	1
X	1	0	0	0	1	1
X	X	1	0	1	0	1
X	X	X	1	1	1	1

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

Solution to Practice #1 (1/3)

- Finding truth table of priority encoder:

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

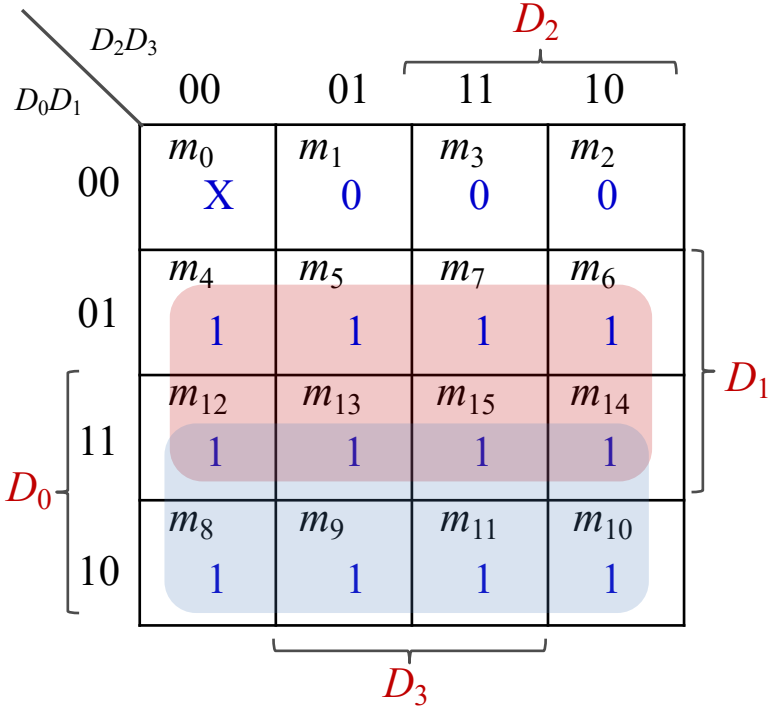


Truth Table of a Priority Encoder.

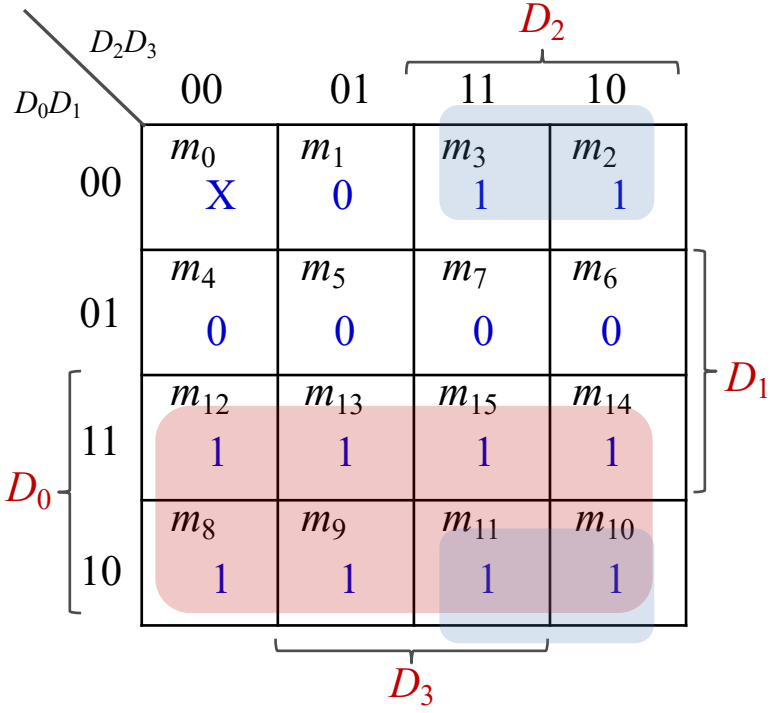
	Inputs				Outputs		
	D_0	D_1	D_2	D_3	x	y	V
m_0	0	0	0	0	X	X	0
m_1	0	0	0	1	0	0	1
m_2	0	0	1	0	0	1	1
m_3	0	0	1	1	0	1	1
m_4	0	1	0	0	1	0	1
m_5	0	1	0	1	1	0	1
m_6	0	1	1	0	1	0	1
m_7	0	1	1	1	1	0	1
m_8	1	0	0	0	1	1	1
m_9	1	0	0	1	1	1	1
m_{10}	1	0	1	0	1	1	1
m_{11}	1	0	1	1	1	1	1
m_{12}	1	1	0	0	1	1	1
m_{13}	1	1	0	1	1	1	1
m_{14}	1	1	1	0	1	1	1
m_{15}	1	1	1	1	1	1	1

Solution to Practice #1 (2/3)

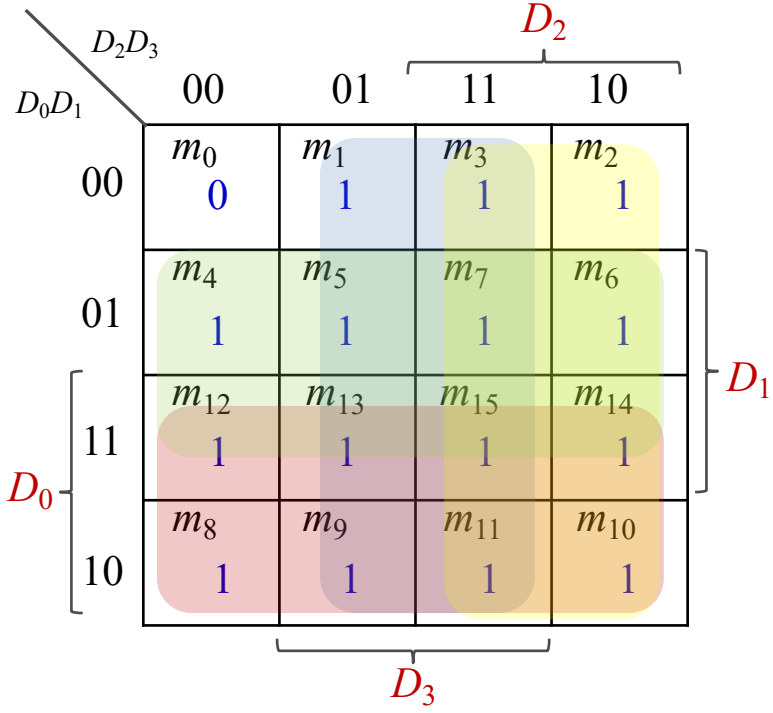
- The K-maps for simplifying outputs x and y are as follows



$$x = D_0 + D_1$$



$$y = D_0 + D'_1 D_2$$



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

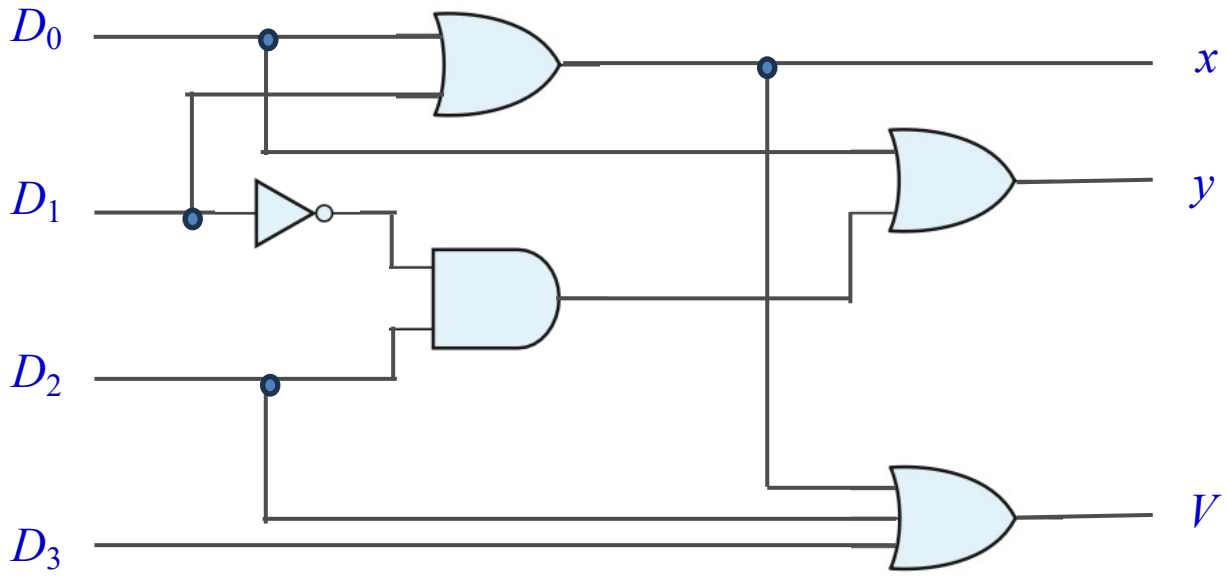
Solution to Practice #1 (3/3)

- The Boolean functions and implementation of the priority encoder.

$$x = D_0 + D_1$$

$$y = D_0 + D'_1 D_2$$

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



Four-input priority encoder.

https://www.cardsnacks.com/