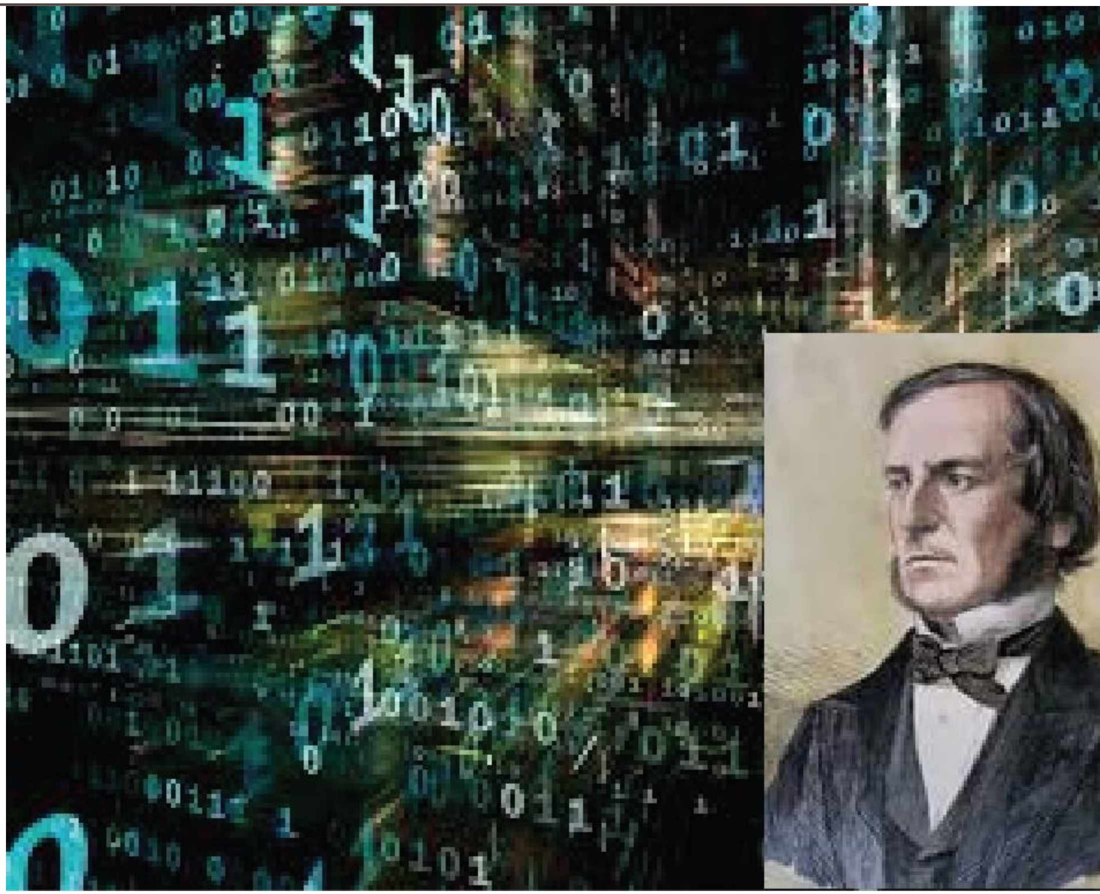
DIGITAL CIRCUITS

Week-8, Lecture-3
Encoders



Sneh Saurabh
28th September, 2018

Digital Circuits: Announcements/Revision

Digital Circuits

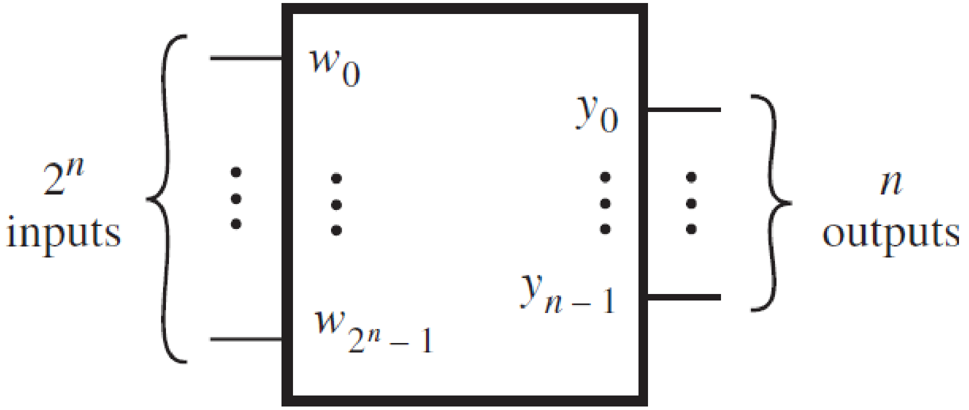
Encoders

Encoder: Basics

- A binary encoder is a combinational circuit with:
  - 2^n inputs: $w_0, w_1, \ldots, w_{2^n-1}$
  - n outputs: $y_0, y_1, \ldots, y_{n-1}$

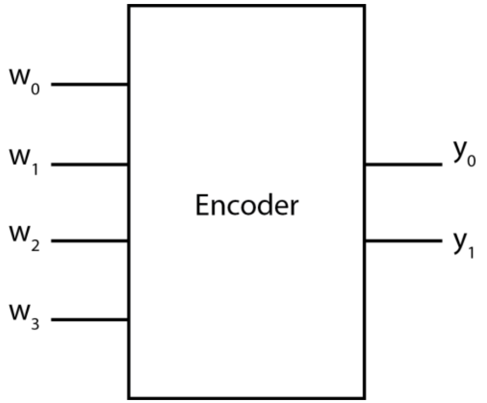
- Exactly one of the input signals should have a value of 1

- The outputs present the binary number that identifies which input is equal to 1



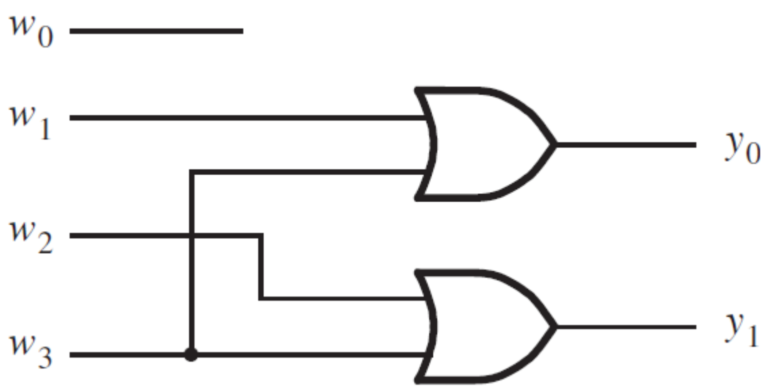
Encoder: 4-to-2 encoder

- Four data inputs w_0,w_1, w_2 and w_3 and two outputs y_0 and y_1
- Only one of w_0,w_1, w_2 and w_3 can have a value of 1
- The outputs $\{y_1 y_0\}$ gets the binary number that identifies which inputs $\{w_0$,w_1, w_2 or $w_3\}$ is equal to 1



w_3	w_2	w_1	w_0	y_1	y_0
0	0	0	1	0	0
0	0	1	0	0	1
0	1	0	0	1	0
1	0	0	0	1	1

- $y_0 = w_1 + w_3$
- $y_1 = w_2 + w_3$



Encoder-Decoder: Application

- Encoders are used to ***reduce the number of bits*** needed to represent given information.
- A practical use of encoders is for transmitting information in a digital system.
- Encoding the information allows the transmission link to be built using ***fewer wires***.

Encoder: 8-to-3 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

Find an implementation of the 8:3 encoder using OR gates.

$$x = D_4 + D_5 + D_6 + D_7$$

$$y = D_2 + D_3 + D_6 + D_7$$

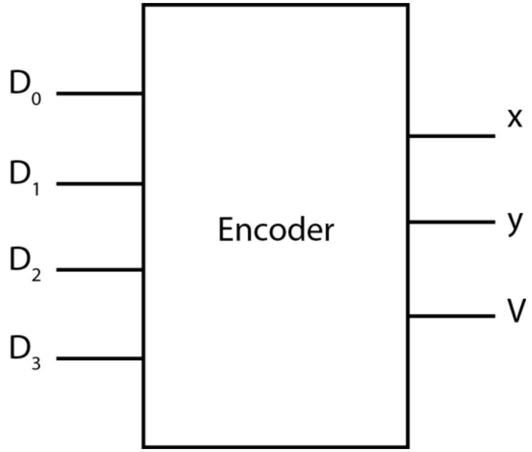
$$z = D_1 + D_3 + D_5 + D_7$$

Issues:

1. If two inputs are active simultaneously, the output produces an undefined combination
   - If D_3 and D_6 are 1 simultaneously, the output of the encoder will be 111
   - The output 111 does not represent either binary 3 or binary 6
2. If all the inputs are 0, then output is 0: This is same as when $D_0 = 1$ and all other bits are 1

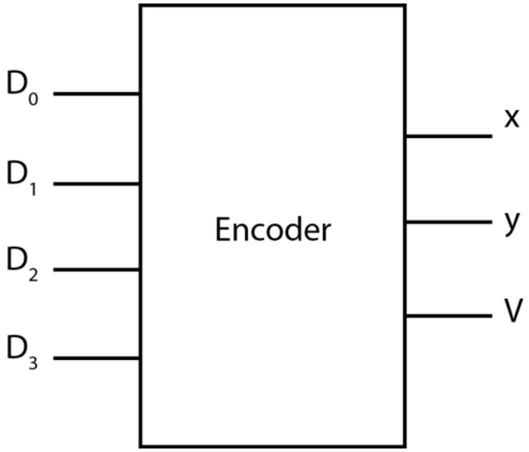
Priority Encoder: Basics

- A priority encoder is an encoder circuit that includes the priority function.
- 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.



- In addition to the normal outputs of an encoder, the circuit has a third output designated by V
  - This is a valid bit indicator that is set to 1 when one or more inputs are equal to 1
  - The other outputs are not inspected when V equals 0 and are specified as don't care conditions

Priority Encoder: 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

Priority Encoder: Implementation

Problem:

Implement the priority encoder (as shown in the truth table) using AND/OR/NOT gates

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

$$x = D_3 + D_2 D_3'$$

$$= (D_3 + D_2).(D_3 + D_3')$$

$$= (D_3 + D_2)$$

$$y = D_3 + D_1 D_2' D_3'$$

$$= (D_3 + D_1 D_2').(D_3 + D_3')$$

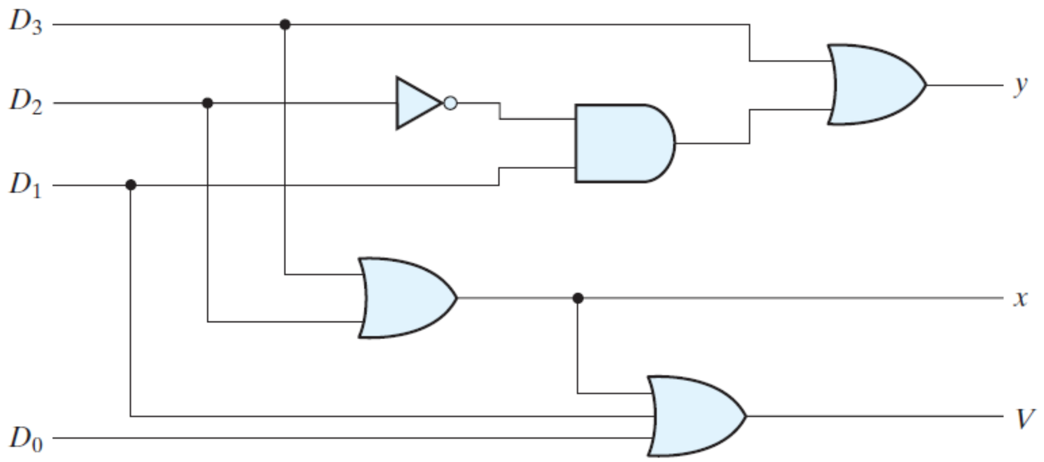
$$= (D_3 + D_1 D_2')$$

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

Priority Encoder: Implementation

Problem:

Implement the priority encoder (as shown in the truth table0 using AND/OR/NOT gates



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

Digital Circuits: Practice Problems

Problems 4.29-4.30

from “Digital Design”– M. Morris Mano & Michael D. Ciletti, Ed-5, Pearson (Prentice-Hall).