DIGITAL CIRCUITS

Week-7, Lecture-3
Revision

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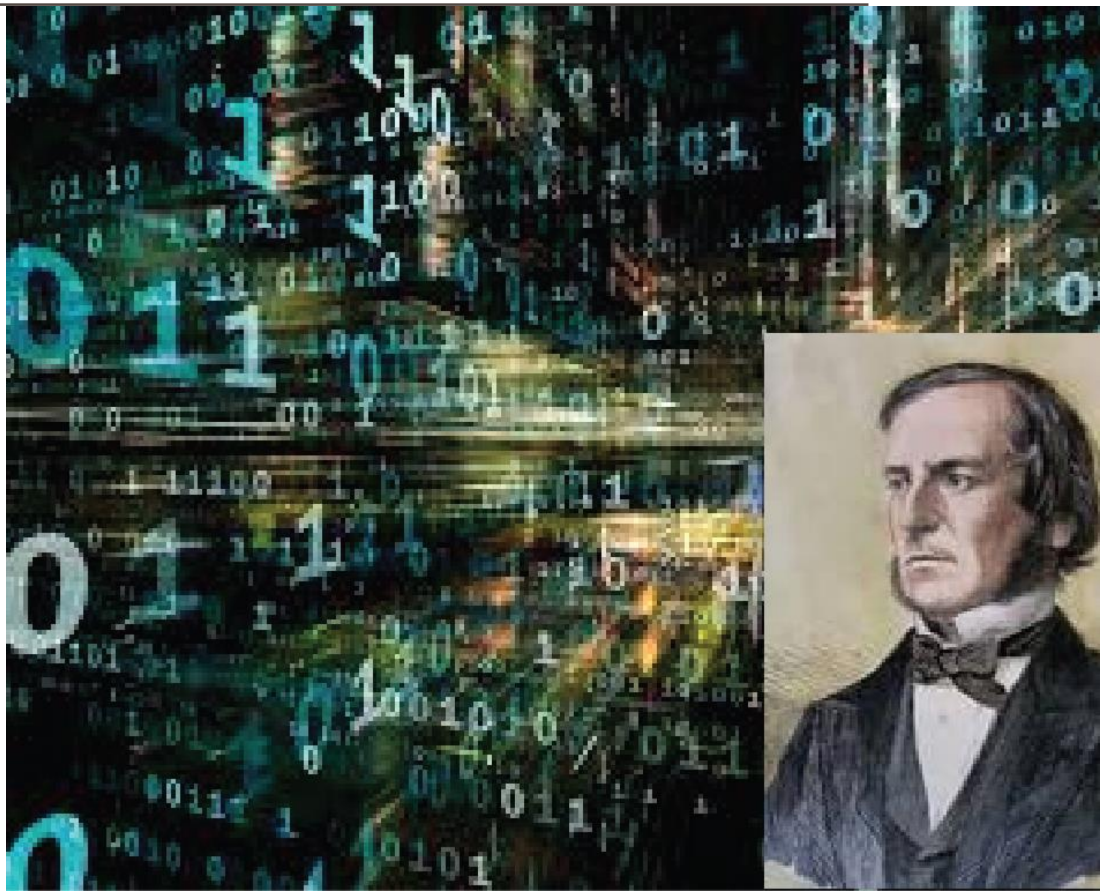


Digital Circuits: Announcements/Revision

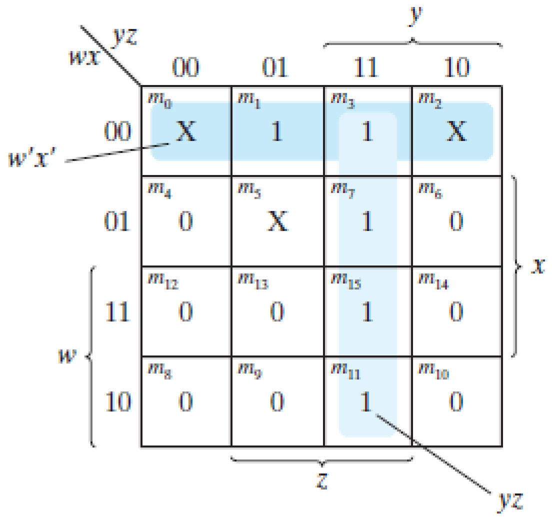
Principles of Logic Optimization: Example

Problem:

Simplify the function: $F(w, x, y, z) = \Sigma m(1,3,7,11,15)$ which has don't care conditions as: $d(w, x, y, z) = \Sigma m(0,2,5)$

Problem:

For the function specified in the previous slide, find the minimized expression for $F'(w, x, y, z)$. Thereafter, find the minimized $F(w, x, y, z)$ in POS form.



$F'(w, x, y, z) = z' + wy'$

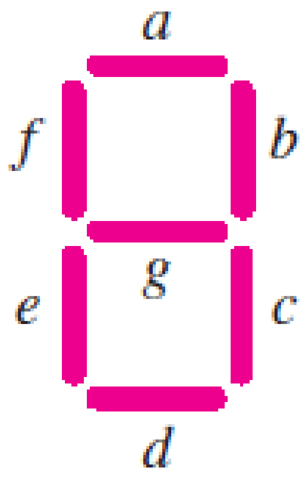
$F(w, x, y, z) = z(w' + y)$

- Without use of don't care: $F(w, x, y, z) = yz + w'x'z$
- With including X in first row: $F_1(w, x, y, z) = yz + w'x'$
- With including X in m_5: $F_2(w, x, y, z) = yz + w'z$

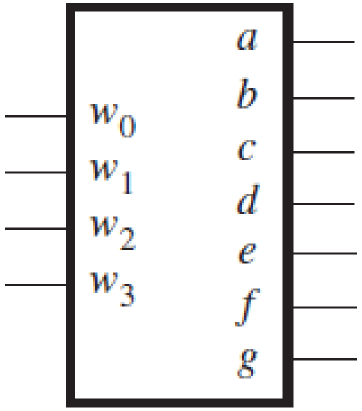
7-segment display: Description

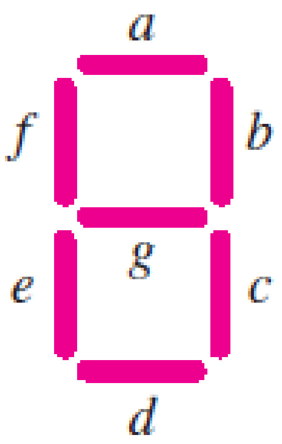
7-segment display:

- Digit-oriented display
- Seven signals that are used to drive the segments in the display
- Each segment is a small light-emitting diode (LED), which glows when driven by an electrical signal
- The segments are labeled from ‘a’ to ‘g’ in the figure



7-segment display: Driver





BCD to 7-segment signal

w_3	w_2	w_1	w_0	a	b	c	d	e	f	g
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	1	0	1	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	1	0	1	1

7-segment display: Driver Design

Problem:

Derive minimal sum-of-products expressions for the output a, b, c of the 7-segment display

w_3	w_2	w_1	w_0	a	b	c	d	e	f	g
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	1	0	1	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	1	0	1	1

w_1w_0 \ w_3w_2	00	01	11	10
00	1	0	1	1
01	0	1	1	1
11	X	X	X	X
10	1	1	X	X

$$a = w_1 + w_3 + w_0w_2 + w_0'w_2'$$

Practice yourself:

$$b = w_0'w_1' + w_0w_1 + w_2'$$

$$c = w_2 + w_1' + w_0$$

Base of a number system: Problem

Problem:

The first expedition to Mars found only the ruins of a civilization. From the artifacts and pictures, the explorers deduced that the creatures who produced this civilization were four-legged beings with a tentacle that branched out at the end with a number of grasping "fingers". After much study, the explorers were able to translate Martian mathematics. They found the following equation:

$$5x^2 - 50x + 125 = 0$$

with the indicated solutions $x = 5$ and $x = 8$.

The value $x = 5$ seemed legitimate enough, but $x = 8$ required some explanation.

Then the explorers reflected on the way in which Earth's number system developed, and found evidence that the Martian system had a similar history. How many fingers would you say the Martians had?

(From *The Bent of Tau Beta Pi*, Feb 1956)

Base of a number system: Solution

Solution:

Let the base be N.

Therefore, $(50)_N = (5N + 0)_{10}$ and $(125)_N = (1 * N * N + 2N + 5)_{10}$

Given equation is in base N: $5x^2 - 50x + 125 = 0$

Converting this equation to base 10:

$5x^2 - 5Nx + N^2 + 2N + 5 = 0$

This equation should hold true for both $x = 5$ and $x = 8$

$For\ x = 5$

$125 - 25N + N^2 + 2N + 5 = 0$

$N^2 - 23N + 130 = 0$

$(N - 13)(N - 10) = 0$

$N = 13$

Checking $x = 8$

$5 * 64 - 5 * 13 * 8 + 169 + 2 * 13 + 5$

$= 320 - 520 + 200 = 0$