Digital Logic Minimization for Lab 2

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- Don't Care Entry: "x" means the entry is not relevant either at input or output
- In other words, we are free to assign either 0 or 1 to reduce the Boolean expression
- Example:

ID	a	b	c	f(a,b,c)
0	0	0	0	0
1	0	0	1	0
2	0	1	0	1
3	0	1	1	0
4	1	0	0	1
5	1	0	1	1
6	1	1	0	$\boxed{x}$
7	1	1	1	1

- Extending this to our second lab, we get:

#	In3	In2	In1	In0	a	b	c	d	e	f	g
0	0	0	0	0	0	0	0	0	0	0	1
1	0	0	0	1	1	0	0	1	1	1	1
2	0	0	1	0	0	0	1	0	0	1	0
3	0	0	1	1	0	0	0	0	1	1	0
4	0	1	0	0	1	0	0	1	1	0	0
5	0	1	0	1	0	1	0	0	1	0	0
6	0	1	1	0	0	1	0	0	0	0	0
7	0	1	1	1	0	0	0	1	1	1	1
8	1	0	0	0	0	0	0	0	0	0	0
9	1	0	0	1	0	0	0	0	1	0	0

- Here, a 1 represents off and a 0 represents on
- A seven-segment display is an electronic component that displays a 1-digit number from 0-9 and a letter A to F
- In this lab, we will design a circuit to display digits 0 to 9 only using digital logic components
- The circuit we will design is called a Binary Coded Decimal (BCD) decoder
- This circuit takes in a 4-bit input representing the binary equivalent of a digit 0 to 9 and lights up the desired segments to display the corresponding digit
- The segment can be turned on or off by applying a low logic level or high logic level from the FPGA, respectively
- This is according to a 7-segment BCD system, as seen in Figure

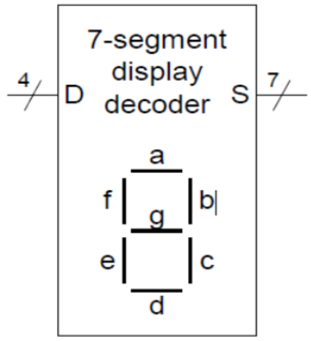

Figure 1: BCD System

- Numbers in a seven segment display are constructed as shown in Figure

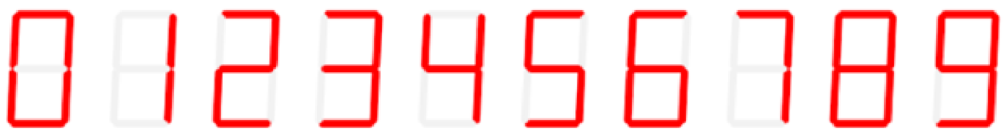

Figure 2: 7-segment displays output digits

- Constructing a Karnaugh map for a in the table above, we get:

In3In2 \In1In0	00	01	11	10
00	0	1	0	0
01	1	0	0	0
11	x	x	x	x
10	0	0	x	x

- Using the table, we can simplify the equation to: In2In1'In0' + In3'In2'In1'In0
- Thus, the boolean equation produced is simplified and correct
- This is written in terms of a sum of products
- The equation has been minimized through graphical means
- Now, the same steps need to be applied to the BCD-based table
- This will have to be done for each variable that is left

- For b:

In3In2 \In1In0	00	01	11	10
00	0	0	0	0
01	0	1	0	1
11	x	x	x	x
10	0	0	x	x

- This results in: In2In1'In0 + In2In1In0'

- For c:

In3In2 \In1In0	00	01	11	10
00	0	0	0	1
01	0	0	0	0
11	x	x	x	x
10	0	0	x	x

- This results in: In3'In2'In1In0'

- For d:

In3In2 \In1In0	00	01	11	10
00	0	1	0	0
01	1	0	1	0
11	x	x	x	x
10	0	0	x	x

- This results in: In2In1'In0' + In3'In2'In1'In0 + In2In1In0

- For e:

In3In2 \In1In0	00	01	11	10
00	0	1	1	0
01	1	1	1	0
11	x	x	x	x
10	0	1	x	x

- This results in: In2In1'In0' + In0

- For f:

In3In2 \In1In0	00	01	11	10
00	0	1	1	1
01	0	0	1	0
11	x	x	x	x
10	0	0	x	x

- This results in: In3'In2'In0 + In3'In2'In1 + In3'In1In0

- For g:

In3In2 \In1In0	00	01	11	10
00	1	1	0	0
01	0	0	1	0
11	x	x	x	x
10	0	0	x	x

- This results in: In3'In2'In1' + In2In1In0