

Lecture 5: Incompletely Specified Functions and multi-variable K Maps

CSE 140: Components and Design Techniques for
Digital Systems

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QUIZ – NO TALKING – NO NOTES

Incompletely Specified Function

- Situations where the output of a switching function can be either 0 or 1 for a particular combination of inputs
- This is specified by a don't care in the truth table

Id	a	b	f(a, b)
0	0	0	1
1	0	1	0
2	1	0	1
3	1	1	X: don't care

This happens when

- 1) The input does not happen. For example:

Decimal number 0... 9 uses 4 bits.

(1,1,1,1) does not happen.

- 2) The input may happen but we don't care about the output. For example:

The output driving a seven segment display – we don't care about illegal inputs (greater than 9)

How to show you don't care?

Id	a	b	$g(a,b,c)$
0	0	0	0
1	0	1	X
2	1	0	1
3	1	1	0

We know how to write canonical expressions when the output is either 0 or 1

How to show you don't care?

We have three types of output which divides the input space into three sets:

Onset $\mathcal{F}$: All the input conditions for which the output is 1

Offset $\mathcal{R}$: All the input conditions for which the output is 0

Don't care $\mathcal{D}$: All the input conditions for which the output is a 'don't care'

Id	a	b	$g(a,b,c)$
0	0	0	0
1	0	1	X
2	1	0	1
3	1	1	0

$$\mathcal{F}(a, b) = \Sigma m(2)$$

$$\mathcal{R}(a, b) = \Sigma m(0,3)$$

$$\mathcal{D} = m(1)$$

Don't care! It helps simplify

If $f(a,b)$ is a don't care for the input combination (1,1) it means we CAN assume it is either always true or always false

Id	a	b	$f(a, b)$
0	0	0	0
1	0	1	0
2	1	0	1
3	1	1	X

Does it help to assume $f(1,1)=1$?

A. Yes

B. No

K-Map: Truth Table in 2 Dimensions

ID	A	B	f(A,B)
0	0	0	0
1	0	1	1
2	1	0	1
3	1	1	X

	A = 0	A = 1
B = 0	0 0	2 1
B = 1	1 1	3 X

If we don't include the don't care:
 $f(a,b)=$

If we include the don't care:
 $f(a,b)=$

K-Map: Truth Table in 2 Dimensions

ID	A	B	f(A,B)
0	0	0	0
1	0	1	X
2	1	0	1
3	1	1	1

	A = 0	A = 1
B = 0	0 0	2 1
B = 1	1 X	3 1

If we don't include the don't care:
f(a,b)=

If we include the don't care:
f(a,b)=

Truth table

Id	a	b	c	$f(a,b,c)$
0	0	0	0	1
1	0	0	1	0
2	0	1	0	1
3	0	1	1	0
4	1	0	0	1
5	1	0	1	0
6	1	1	0	1
7	1	1	1	0

Three variable K-maps

		(a,b)			
		(0,0)	(0,1)	(1,1)	(1,0)
$c = 0$		0	2	6	4
$c = 1$		1	3	7	5

Truth table

Id	a	b	c	f(a,b,c)
0	0	0	0	1
1	0	0	1	0
2	0	1	0	1
3	0	1	1	0
4	1	0	0	1
5	1	0	1	0
6	1	1	0	1
7	1	1	1	0

Three variable K-maps

		(a,b)			
		(0,0)	(0,1)	(1,0)	(1,1)
c	= 0	0 1	2 1	4 1	6 1
	= 1	1 0	3 0	5 0	7 0

Is the above K-map correct?

- A. Yes
- B. No

Truth table

Id	a	b	c	f(a,b,c)
0	0	0	0	1
1	0	0	1	0
2	0	1	0	1
3	0	1	1	0
4	1	0	0	1
5	1	0	1	0
6	1	1	0	1
7	1	1	1	0

Reduction in three variable K-maps

Example 1

		(a,b)			
		(0,0)	(0,1)	(1,1)	(1,0)
c	= 0	0 1	2 1	6 1	4 1
	= 1	1 0	3 0	7 0	5 0

Truth table

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	1
4	1	0	0	0
5	1	0	1	0
6	1	1	0	1
7	1	1	1	1

Reduction in three variable K-maps

Example 2

(a,b)		(0,0)	(0,1)	(1,1)	(1,0)
c	0	0 0	2 1	6 1	4 0
	1	1 0	3 1	7 1	5 0

Truth table

Id	a	b	c	f(a,b,c)
0	0	0	0	1
1	0	0	1	1
2	0	1	0	0
3	0	1	1	0
4	1	0	0	1
5	1	0	1	1
6	1	1	0	0
7	1	1	1	0

Three variable K-maps

Example 3

		(a,b)			
		(0,0)	(0,1)	(1,1)	(1,0)
c	= 0	0 1	2 0	6 0	4 1
	= 1	1 1	3 0	7 0	5 1

No class on Monday (Jan 19)

Have a great weekend!