EEE205 – Digital Electronics (II)

Lecture 10

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The Prime Implicant Chart

- The minterms are listed across the top.
- The prime implicants are listed down the side.
- If a prime implicant covers a given minterm, an X is placed at the intersection.

		0	1	2	5	6	7	8	9	10	14
(0, 1, 8, 9)	$b'c'$	×	×					×	⊗		
(0, 2, 8, 10)	$b'd'$	×		×				×		×	
(2, 6, 10, 14)	cd'			×		×				×	⊗
(1, 5)	$a'c'd$		×		×						
(5, 7)	$a'bd$				×		×				
(6, 7)	$a'bc$					×	×				

The Prime Implicant Chart

- If a minterm is covered by only one prime implicant (a column contains only one X), the prime implicant is an *essential prime implicant* and the X is circled.
- Essential prime implicants must be included in the minimum sum of products.

		0	1	2	5	6	7	8	9	10	14
(0, 1, 8, 9)	$b'c'$	×	×					×	⊗		
(0, 2, 8, 10)	$b'd'$	×		×				×		×	
(2, 6, 10, 14)	cd'			×		×				×	⊗
(1, 5)	$a'c'd$		×		×						
(5, 7)	$a'bd$				×		×				
(6, 7)	$a'bc$					×	×				

The Prime Implicant Chart

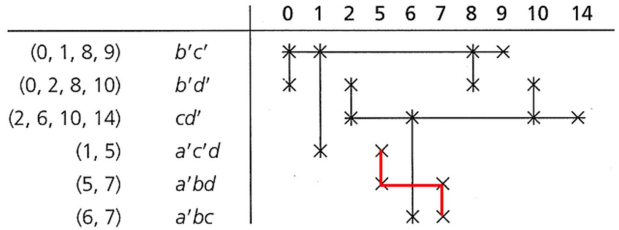
- Each time a prime implicant is selected for inclusion in the minimum sum, cross out:
  - The corresponding row
  - The columns which correspond to all minterms covered by that prime implicant.

		0	1	2	5	6	7	8	9	10	14
(0, 1, 8, 9)	$b'c'$	✳	✳					✳	×		
(0, 2, 8, 10)	$b'd'$	✳		✳				✳		✳	
(2, 6, 10, 14)	cd'			✳		✳				✳	×
(1, 5)	$a'c'd$		✳		×						
(5, 7)	$a'bd$				×		×				
(6, 7)	$a'bc$					✳	×				

The Prime Implicant Chart

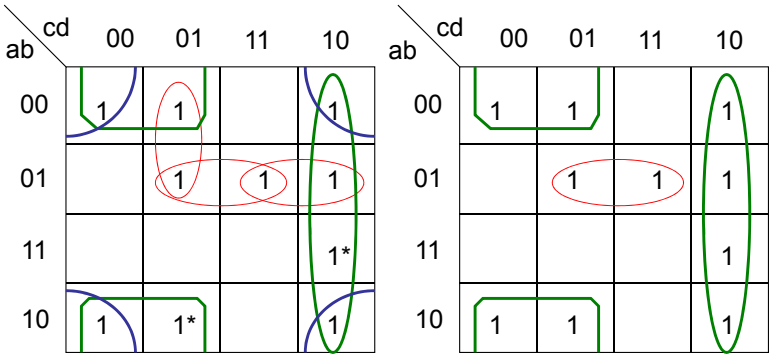
- The essential prime implicants are chosen first.
- Then additional non-essential prime implicants are selected by trial.
- They should cover as many minterms as possible.

$f = b'c' + cd' + a'bd$ (minimum sum of products)



Finding Prime Implicants

Karnaugh Map's View



The Prime Implicant Chart

This example is to show how to select non-essential prime implicants when alternative solutions exist.

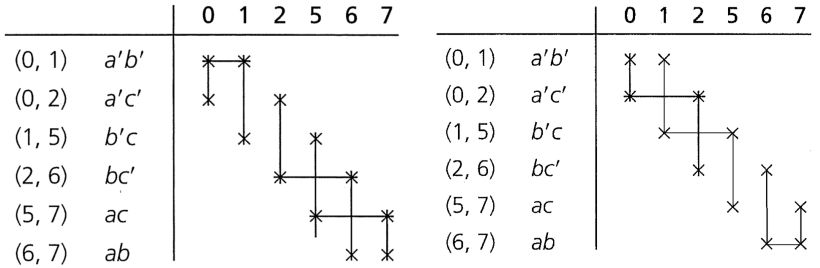
$F = \Sigma\, m(0, 1, 2, 5, 6, 7)$

Step 1

0	000	✓	0, 1	00–
1	001	✓	0, 2	0–0
2	010	✓	1, 5	–01
5	101	✓	2, 6	–10
6	110	✓	5, 7	1–1
7	111	✓	6, 7	11–

The Prime Implicant Chart

Step 2

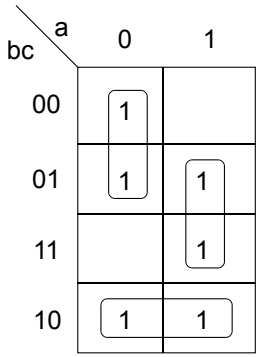


$F = a'b' + bc' + ac.$ $F = a'c' + b'c + ab$

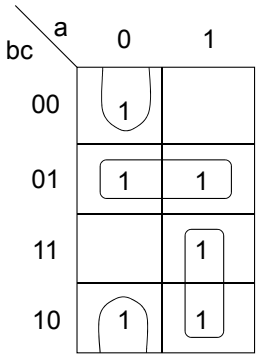
There are two minimum sum-of-products solutions.

The Prime Implicant Chart

Equivalent Karnaugh Maps



$F = a'b' + bc' + ac.$



$F = a'c' + b'c + ab$

Simplification of Functions with Don't Cares

- In finding the prime implicants, the don't cares are treated as minterms.
- When forming the prime implicant chart, the don't cares are NOT listed at the top.

$$F(A, B, C, D) = \Sigma\, m(2, 3, 7, 9, 11, 13) + \Sigma\, d(1, 10, 15)$$

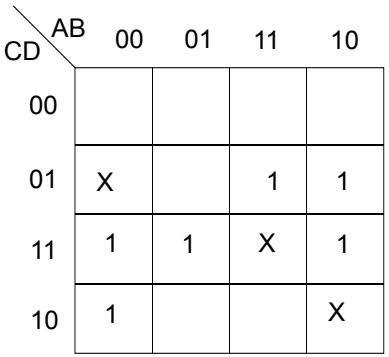
Simplification of Functions with Don't Cares

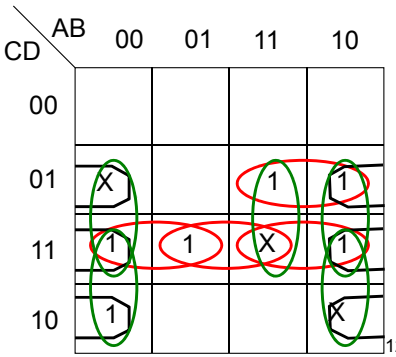
Find Prime Implicants

1	0001 ✓	(1, 3)	00–1 ✓
2	0010 ✓	(1, 9)	–001 ✓
3	0011 ✓	(2, 3)	001– ✓
9	1001 ✓	(2, 10)	–010 ✓
10	1010 ✓	(3, 7)	0–11 ✓
7	0111 ✓	(3, 11)	–011 ✓
11	1011 ✓	(9, 11)	10–1 ✓
13	1101 ✓	(9, 13)	1–01 ✓
15	1111 ✓	(10, 11)	101– ✓
		(7, 15)	–111 ✓
		(11, 15)	1–11 ✓
		(13, 15)	11–1 ✓

Simplification of Functions with Don't Cares

Karnaugh Map's View





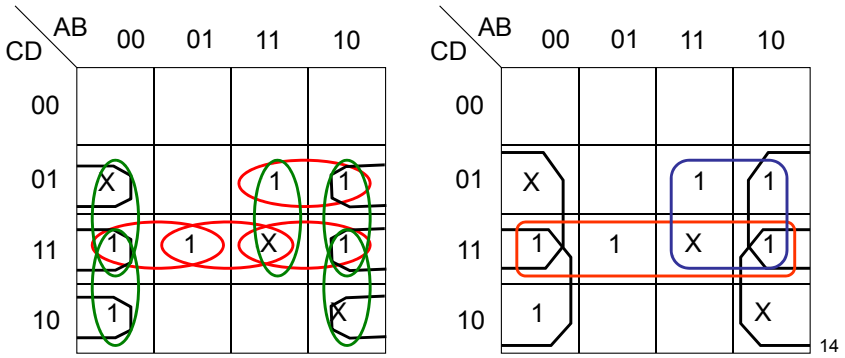
Simplification of Functions with Don't Cares

Find Prime Implicants

1	0001 ✓	(1, 3)	00–1 ✓	(1, 3, 9, 11)	–0–1
2	0010 ✓	(1, 9)	–001 ✓	(2, 3, 10,11)	–01–
3	0011 ✓	(2, 3)	001– ✓	(3, 7, 11, 15)	- - 1 1
9	1001 ✓	(2, 10)	–010 ✓	(9, 11, 13, 15)	1 - - 1
10	1010 ✓	(3, 7)	0–11 ✓		
7	0111 ✓	(3, 11)	–011 ✓		
11	1011 ✓	(9, 11)	10–1 ✓		
13	1101 ✓	(9, 13)	1–01 ✓		
15	1111 ✓	(10, 11)	101– ✓		
		(7, 15)	–111 ✓		
		(11, 15)	1–11 ✓		
		(13, 15)	11–1 ✓		

Simplification of Functions with Don't Cares

Karnaugh Map's View



Simplification of Functions with Don't Cares

Prime Implicant Chart

- This is to find the minimum set of prime implicants.
- Always start from essential prime implicants.

	2	3	7	9	11	13
(1, 3, 9, 11)		X		X	X	
*(2, 3, 10, 11)	X	X			X	
*(3, 7, 11, 15)		X	X		X	
*(9, 11, 13, 15)				X	X	X

*indicates an essential prime implicant.

Simplification of Functions with Don't Cares

Karnaugh Map's View