

**EE 2000 Logic Circuit Design**  
Semester A 2024/25

Tutorial 2

1. (a) Use a K-map to convert the following canonical SOP expression into a minimum POS expression.

$$f(a,b,c,d) = \sum m(0,1,5,6,8,10,13,14)$$

<div><div><div><div><div></div><div>ab</div></div></div><div><div>cd</div><div></div></div></div></div> <th>00</th> <th>01</th> <th>11</th> <th>10</th>	00	01	11	10
00	1	0	0	1
01	1	1	1	0
11	0	0	0	0
10	0	1	1	1

$$f(a,b,c,d) = (b' + c + d)(a' + b + d')(a + b + c')(c' + d')$$

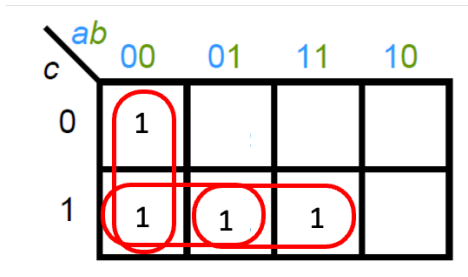
- (b) Use a K-map to convert the following canonical POS expression into a minimum SOP expression.

$$f(a,b,c,d) = \prod M(0,2,5,6,8,9,13)$$

	<i>ab</i>	00	01	11	10
<i>cd</i>					
00			1	1	
01		1			
11		1	1	1	1
10				1	1

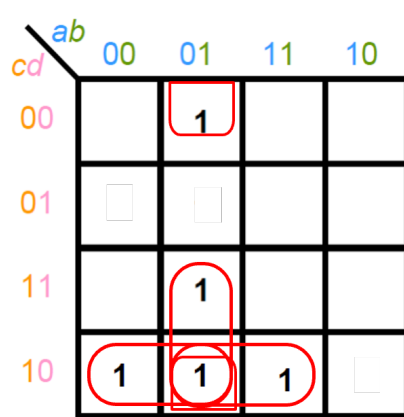
$$f(a,b,c,d) = bc'd' + a'b'd + cd + ac$$

2. (a) Plot the following functions on the K-map.
- (i)  $f(a, b, c) = \sum m(0, 1, 3, 7)$
- (ii)  $f(a, b, c, d) = \sum m(2, 4, 6, 7, 14)$
- (b) Identify the prime implicants and the essential prime implicants.



Prime implicants:  $a'b'$ ,  $a'c$  and  $bc$

Essential prime implicants:  $a'b'$  and  $bc$



Prime implicants:  $a'bd'$ ,  $a'bc$ ,  $a'cd'$ ,  $bcd'$

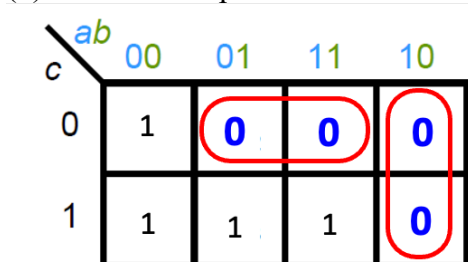
Essential prime implicants:  $a'bd'$ ,  $a'bc$ ,  $a'cd'$ ,  $bcd'$

- (c) Find the simplest SOP form of the above functions from the K-maps.

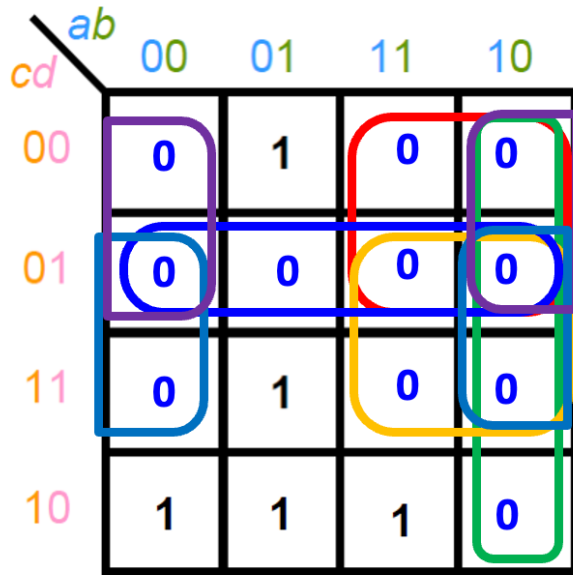
$$f(a, b, c) = a'b' + bc$$

$$f(a, b, c, d) = a'bd' + a'bc + a'cd' + bcd'$$

- (d) Find the simplest POS form of the above functions from the K-maps.



$$f(a, b, c) = (b' + c)(a' + b)$$

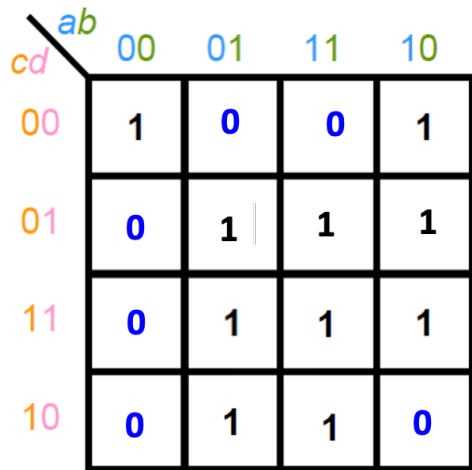


$$f(a, b, c, d) = (b + c)(b + d')(c + d')(a' + c)(a' + d')(a' + b)$$

3. (a) Plot the following function on the K-map.

$$f(A, B, C, D) =$$

$$(A' + B' + C + D)(A + B' + C + D)(A + B + C + D')(A + B + C' + D')(A' + B + C' + D)(A + B + C' + D)$$



- (b) Convert the standard POS expression in part (a) into

- (i) Minimum POS expression.

$$f(A, B, C, D) = (B' + C + D)(A + B + D')(B + C' + D)$$

- (ii) Canonical sum expression.

$$f(A, B, C, D) = \Sigma m(0, 5, 6, 7, 8, 9, 11, 13, 14, 15)$$

- (iii) Minimum SOP expression.

$$f(A, B, C, D) = BD + BC + AD + B'C'D'$$

4. Simplify the following function to SOP form using Q-M method:  
 $f(a,b,c,d) = \Sigma m(4, 5, 6, 8, 11, 13, 14) + \Sigma d(2, 10, 15)$

Minterms	wxyz
$m_0$	0000
$m_1$	0001
$m_2$	0010
$m_4$	0100
$m_8$	1000
$m_3$	0011
$m_5$	0101
$m_6$	0110
$m_9$	1001
$m_{10}$	1010
$m_{12}$	1100
$m_7$	0111
$m_{11}$	1011
$m_{13}$	1101
$m_{14}$	1110
$m_{15}$	1111

Minterms	wxyz
$m_2$	0010
$m_4$	0100
$m_8$	1000
$m_5$	0101
$m_6$	0110
$m_{10}$	1010
$m_{11}$	1011
$m_{13}$	1101
$m_{14}$	1110
$m_{15}$	1111

Minterms	wxyz
$m_2$	0010 ✓
$m_4$	0100 ✓
$m_8$	1000 ✓
$m_5$	0101 ✓
$m_6$	0110 ✓
$m_{10}$	1010 ✓
$m_{11}$	1011 ✓
$m_{13}$	1101 ✓
$m_{14}$	1110 ✓
$m_{15}$	1111 ✓

Minterms	abcd
$m_2, m_6$	0-10 ✓
$m_2, m_{10}$	-010 ✓
$m_4, m_5$	010- $PI_3$
$m_4, m_6$	01-0 $PI_4$
$m_8, m_{10}$	10-0 $PI_5$
$m_5, m_{13}$	-101 $PI_6$
$m_6, m_{14}$	-110 ✓
$m_{10}, m_{11}$	101- ✓
$m_{10}, m_{14}$	1-10 ✓
$m_{11}, m_{15}$	1-11 ✓
$m_{13}, m_{15}$	11-1 $PI_7$
$m_{14}, m_{15}$	111- ✓

Minterms	abcd
$m_2, m_6, m_{10}, m_{14}$	--10 $PI_1$
$m_{10}, m_{11}, m_{14}, m_{15}$	1-1- $PI_2$

PI	Minterms	<i>abcd</i>	4	5	6	8	11	13	14
PI <sub>1</sub>	$m_2, m_6, m_{10}, m_{14}$	--10			x				x
PI <sub>2</sub>	$m_{10}, m_{11}, m_{14}, m_{15}$	1-1-					x		x
PI <sub>3</sub>	$m_4, m_5$	010-	x	x					
PI <sub>4</sub>	$m_4, m_6$	01-0	x		x				
PI <sub>5</sub>	$m_8, m_{10}$	10-0				x			
PI <sub>6</sub>	$m_5, m_{13}$	-101		x				x	
PI <sub>7</sub>	$m_{13}, m_{15}$	11-1						x	

PI	Minterms	<i>abcd</i>	4	5	6	13
PI <sub>1</sub>	$m_2, m_6, m_{10}, m_{14}$	--10			x	
PI <sub>3</sub>	$m_4, m_5$	010-	x	x		
PI <sub>4</sub>	$m_4, m_6$	01-0	x		x	
PI <sub>6</sub>	$m_5, m_{13}$	-101		x		x
PI <sub>7</sub>	$m_{13}, m_{15}$	11-1				x

$$f(a, b, c, d) = \text{PI}_2 + \text{PI}_5 + \text{PI}_4 + \text{PI}_6$$

$$f(a, b, c, d) = ac + ab'd' + a'bd' + bc'd$$