

EE 2000 Logic Circuit Design
Semester B 2022/23

Tutorial 2

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

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

	<i>ab</i>	00	01	11	10
<i>cd</i>	00	1	0	0	1
	01	1	1	1	0
	11	0	0	0	0
	10	0	1	1	1

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

- (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	0	1	1	0
	01	1	0	0	0
	11	1	1	1	1
	10	0	0	1	1

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

2. (a) Plot the following functions on the K-map.

(i) $f(a, b, c) = \sum m(0, 1, 3, 7)$

Ans:

		<i>ab</i>			
		00	01	11	10
<i>c</i>	0	1			
	1	1	1	1	

(ii) $f(a, b, c, d) = \sum m(2, 4, 6, 7, 14)$

Ans:

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

(b) Identify the prime implicants and the essential prime implicants.

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

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

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

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

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

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

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

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

(Hint: Group all zeros and apply DeMorgan's Theorem)

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

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

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

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

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

Ans:

	ab	00	01	11	10
cd					
00		1	0	0	1
01		0	1	1	1
11		0	1	1	1
10		0	1	1	0

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

- (i) Minimum POS expression.

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

- (ii) Canonical sum expression.

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

- (iii) Minimum SOP expression.

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

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_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

$$f(a,b,c,d) = PI_2 + PI_5 + PI_4 + PI_6$$

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