

EE1001 - Tutorial 4

1. Simplify the following expressions using boolean algebra

$$\begin{aligned} \text{(i)} \quad f(x, y, z) &= \bar{x}y + yz + x\bar{y}z + xy\bar{z} \\ &= \bar{x}y + x\bar{y}z + y(z + x\bar{z}) \\ &= \bar{x}y + x\bar{y}z + y(z + x) \\ &= \bar{x}y + xy + x\bar{y}z + yz \\ &= y + yz + x\bar{y}z \\ &= y + z(y + x\bar{y}) \\ &= y + z(x + y) \\ &= y + xz \end{aligned}$$

$$\begin{aligned} \text{(ii)} \quad f(A, X, Z) &= \bar{A}B(\bar{B} + \bar{C})(B + C) \\ &= \bar{A}B(\bar{B} + \bar{C})(\overline{\bar{B} + \bar{C}}) \\ &= \bar{A}B(\bar{B}\bar{B} + \bar{B}\bar{C} + C\bar{B} + C\bar{C}) \\ &= \bar{A}B\bar{B}\bar{C} + \bar{A}B\bar{C}\bar{B} \\ &= \bar{A}B\bar{C} \end{aligned}$$

$$\begin{aligned} \text{(iii)} \quad f(M, N, Q) &= (M + Q)(M + N + Q) \\ &= (M + Q) + N(M + Q) \\ &= M + Q \end{aligned}$$

2. Plot the following functions on the K-map

$$\text{(i)} \quad f(A, B, C) = \bar{A}\bar{B} + \bar{A}C + \bar{A}BC$$

	AB			
C	00	01	11	10
0	1			
1	1	1		1

$$\text{(ii)} \quad f(A, B, C, D) = \bar{A}\bar{B}\bar{C} + \bar{A}C\bar{D} + \bar{A}\bar{C} + \bar{B}\bar{C}$$

	AB			
CD	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11				
10	1	1		

3. Simplify the following expressions using k-map.

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

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

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

(b) $f(w,x,y,z) = wy + xy + w'y'z + wx'y$

	wx			
yz	00	01	11	10
00				
01	1	1		
11		1	1	1
10		1	1	1

$f(w,x,y,z) = wy + xy + w'y'z$

(c) $f(a,b,c,d) = \Sigma m(0,2,3,4,8,9,10,12,14)$

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

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

(d) $f(a,b,c,d) = \prod M(3,5,7,11,12,13,14)$ in POS form

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

$f(a,b,c,d) = (a'+b'+d)(b+c'+d)[(b'+c+d) \text{ or } (a+b'+d)]$

(e) $f(a,b,c,d) = \Sigma m(0,5,6,8,11,12,14) + \Sigma d(2,4,10,15)$

cd	ab			
	00	01	11	10
00	1	d	1	1
01		1		
11			d	1
10	d	1	1	d

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

(f) $f(a,b,c,d) = \prod M(1,3,5,6,10,15) + \Sigma d(4,8,12,13)$ in POS form

cd	ab			
	00	01	11	10
00		d	d	d
01	0	0	d	
11	0		0	
10		0		0

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

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

$$f(a,b,c,d) = \prod M(0,1,3,7,8,10,12,14)$$

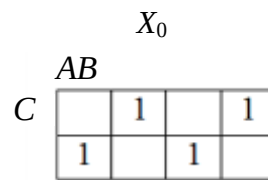
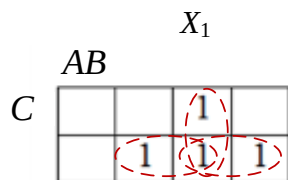
$$f(a,b,c,d) = \Sigma m(2,4,5,6,9,11,13,15)$$

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

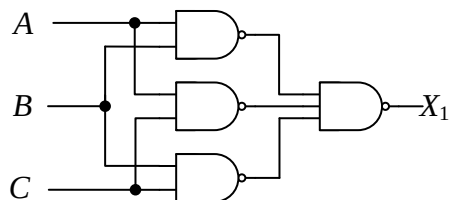
$$f(a,b,c,d) = ad + a'bc' + a'cd'$$

5. Design a circuit that counts the number of 1's present in 3 inputs A , B and C . Its output is a two-bit number X_1X_0 , representing that count in binary. Design (i) a minimum SOP form circuit, and (ii) NAND-gate only circuit.

A	B	C	X_1	X_0
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1



$$\begin{aligned}
 X_1 &= AB + AC + BC \\
 &= \overline{\overline{AB} + \overline{AC} + \overline{BC}} \\
 &= \overline{\overline{AB} \overline{AC} \overline{BC}}
 \end{aligned}$$



$$\begin{aligned}
 X_0 &= A'B'C + A'BC' + ABC + AB'C' \\
 &= \overline{\overline{A'B'C} + \overline{A'BC'} + \overline{ABC} + \overline{AB'C'}} \\
 &= \overline{\overline{A'B'C} \overline{A'BC'} \overline{ABC} \overline{AB'C'}}
 \end{aligned}$$

