Basic Electronics

Tutorial on Digital Logic

(12EC14/24)

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1 (a)

$$Y = \overline{\overline{(A\bar{B} + ABC)} + A(B + A\bar{B})}$$

$$= \overline{\overline{A(\bar{B} + BC)} + A(B + A)}$$

$$= \overline{\overline{A(\bar{B} + C)} + A(B + A)}$$

$$= \overline{\overline{A\bar{B} + AC} + A(B + A)}$$

$$= \overline{\overline{A\bar{B}} \cdot \overline{AC} + AB + A}$$

$$= \overline{(\bar{A} + \bar{\bar{B}}) \cdot (\bar{A} + \bar{C}) + AB + A}$$

$$= \overline{((\bar{A} + B) \cdot (\bar{A} + \bar{C}) + AB + A)}$$

$$= \overline{\bar{A}\bar{A} + \bar{A}\bar{C} + B\bar{A} + B\bar{C} + AB + A}$$

$$= \overline{\bar{A} + \bar{A}\bar{C} + B\bar{A} + B\bar{C} + AB + A}$$

$$= \overline{\bar{A} + B\bar{A} + B\bar{C} + AB + A}$$

$$= \overline{\bar{A} + B\bar{C} + AB + A}$$

$$= \overline{\bar{A} + B\bar{C} + A\cancel{(B+1)}}$$

$$= \overline{B\bar{C} + 1}$$

$$= \bar{1} = \underline{\underline{0}}$$

1(b) $y = AB + (\overline{AC}) + ABC\,(AB + C)$

$= AB + \bar{A} + \bar{C} + ABC \cdot \cancel{AB} + ABC \cdot C$

$= AB + \bar{A} + \bar{C} + ABC + ABC$

$= AB + \bar{A} + \bar{C} + ABC$

$= AB\,\cancel{(1 + C)}^{\,1} + \bar{A} + \bar{C}$

$= AB + \bar{A} + \bar{C}$

$= \bar{A} + B + \bar{C}$

1(c) $y = \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}\bar{C} + \bar{A}\bar{B}C$

$= \bar{A}\bar{C}(\bar{B} + B) + \bar{B}(A\bar{C} + \bar{A}C)$

$= \bar{A}\bar{C} + A\bar{B}\bar{C} + \bar{A}\bar{B}C$

$= \bar{A}(\bar{C} + \bar{B}C) + A\bar{B}\bar{C}$

$= \bar{A}(\bar{C} + \bar{B}) + A\bar{B}\bar{C}$

$= \bar{A}\bar{C} + \bar{A}\bar{B} + A\bar{B}\bar{C}$

$= \bar{A}\bar{C} + \bar{B}(\bar{A} + A\bar{C})$

$= \bar{A}\bar{C} + \bar{B}(\bar{A} + \bar{C})$

$= \bar{A}\bar{C} + \bar{A}\bar{B} + \bar{B}\bar{C}$

$$Y = (A + \bar{B} + C) \cdot (\bar{A} + \bar{B} + \bar{C}) \cdot (\bar{A} + B)$$

$$= (A+\bar{B}+C)(\bar{A}\bar{A} + \bar{A}\bar{B} + \bar{A}\bar{C} + \bar{A}B + \cancel{B}\bar{B}^{0} + B\bar{C})$$

$$= (A+\bar{B}+C)(\bar{A} + \bar{A}\bar{B} + \bar{A}\bar{C} + \bar{A}B + B\bar{C})$$

$$= (A+\bar{B}+C)(\bar{A}(\cancel{1+\bar{B}})^{1} + \bar{A}\bar{C} + \bar{A}B + B\bar{C})$$

$$= (A+\bar{B}+C)(\underbrace{\bar{A} + \bar{A}\bar{C}} + \bar{A}B + B\bar{C})$$

$$= (A+\bar{B}+C)(\underbrace{\bar{A} + \bar{A}B} + B\bar{C})$$

$$= (A+\bar{B}+C)(\bar{A} + B\bar{C})$$

$$= \cancel{A}\bar{A}^{0} + \bar{A}\bar{B} + \bar{A}C + AB\bar{C} + \cancel{B}\bar{B}\bar{C}^{0} + B\cancel{C}\bar{C}^{0}$$

$$= \bar{A}\bar{B} + \bar{A}C + AB\bar{C}$$

$$= \underline{\underline{\bar{A}(\bar{B}+C) + AB\bar{C}}}$$

(e) $Y = AB + \bar{A}C + \bar{B}C$

$$= AB + C(\bar{A}+\bar{B})$$

$$= AB + C(\overline{AB})$$

$$= \underline{\underline{AB + C}}$$

A \ BC	00	01	11	10
0		1	1	
1		1	1	1

$= \underline{\underline{AB + C}}$

(f) $Y = \overline{\left[\overline{(A+B)\cdot(CD)} + E + \bar{F}\right]}$

$$= \overline{\overline{(A+B)} + \overline{CD} + E + \bar{F}}$$

$$= \overline{\overline{A+B} + \bar{C} + \bar{D} + E + \bar{F}}$$

$$= \overline{\overline{A+B}} \cdot \bar{\bar{C}} \cdot \bar{\bar{D}} \cdot \bar{E} \cdot \bar{\bar{F}}$$

$$= (A+B)\,C\,D\,\bar{E}\,F = \underline{\underline{ACD\bar{E}F + BCD\bar{E}F}}$$

5 (a) $f(a,b,c,d) = \sum m(1,3,4,6,9,11,12,14)$

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

$f = b\bar{d} + \bar{b}d$

(b) $f(a,b,c,d) = \sum m(1,3,4,5,7,8,9,11,15)$

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

$f = CD + \bar{A}D + \bar{A}B\bar{C} + A\bar{B}\bar{C}$

(c) $f(w,x,y,z) = \sum m(1,3,13,15) + d(8,9,10,11)$

wx \ yz	00	01	11	10
00		1	1	
01				
11		1	1	
10	X	X	X	X

$f = \bar{x}z + wz$

(d) $f(wxyz) = \sum m(1,3,8,9,10) + d(7,13,15)$

wx \ yz	00	01	11	10
00		1	1	
01			X	
11		X	X	
10	1	1		1

$f = w\bar{x}\bar{y} + \bar{w}\bar{x}z + w\bar{x}\bar{z}$

$f(wxyz) = \sum m(1,4,5,7,8,10,12,13,14) + d(3,6,11)$

wx \ yz	00	01	11	10
00		1	X	
01	1	1	1	X
11	1	1		1
10	1			1

$f = \bar{w}z + x\bar{y} + w\bar{z}$

(f) $f(wxyz) = \bar{w}\bar{x}z + xyz + w\bar{x}z + x\bar{y}\bar{z}$

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

$f = yz + x\bar{y}\bar{z} + \bar{x}z$

(2)

A	B	C	x	y
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	0

carry full adder exp

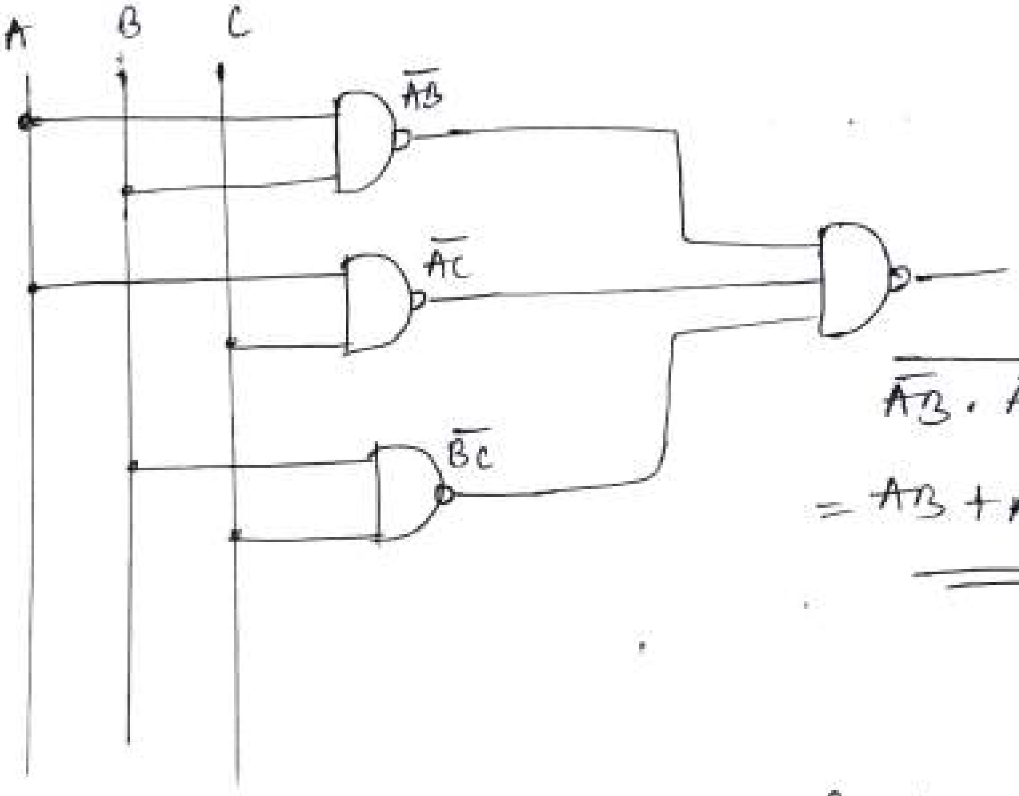
$x = \bar{A}BC + A\bar{B}C + AB\bar{C} + ABC$

$= AB + AC + BC$

$y = \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C}$

$= \bar{A}\bar{B}C + \bar{C}(\bar{A}B + A\bar{B})$

Realize using only NAND.



$$\overline{\overline{AB}\cdot\overline{AC}\cdot\overline{BC}}$$

$$= AB + AC + BC$$

(3)

A	B	C	D	X	Y	Z
0	0	0	0	0	0	0
0	0	0	1	0	1	0
0	0	1	0	0	1	0
0	0	1	1	1	0	0
0	1	0	0	0	1	0
0	1	0	1	1	0	0
0	1	1	0	1	0	0
0	1	1	1	0	0	1
1	0	0	0	0	1	0
1	0	0	1	1	0	0
1	0	1	0	1	0	0
1	0	1	1	0	0	1
1	1	0	0	1	0	0
1	1	0	1	0	0	1
1	1	1	0	0	0	1
1	1	1	1	0	0	1

Expⁿ :- Realize using NOR

$x = AB + AC + AD + BC + BD + CD$.

$y = \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}B\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D}$

$z = ABC + BCD + ACD + ABD$