논리회로 과제

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p 74~76 예제 2.34

$s = a'b'c + a'bc' + ab'c' + abc$
$C_{out} = bc + ac + ab$

) NAND 게이트로 나타내라.

풀이 $s = c(\underline{a'b' + ab}) + c'(\underline{a'b + ab'})$

$= c(\underline{a \oplus b})' + c'(\underline{a \oplus b}) = cd' + c'd = c \oplus d = \underline{c \oplus (a \oplus b)}$

$a \oplus b = d$ 라고 한다면

$C_{out} = c(\underline{a+b}) + ab$

a+b에 대한 진리표를 그려보면

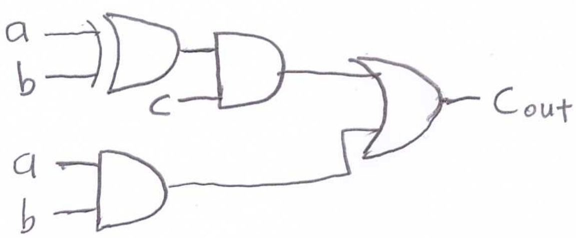
a	b	a+b	a⊕b
0	0	0	0
0	1	1	1
1	0	1	1
1	1	1	0

⇒ a+b와 a⊕b의 차이점은 a가 1, b가 1일때 밖에 차이점이 없다

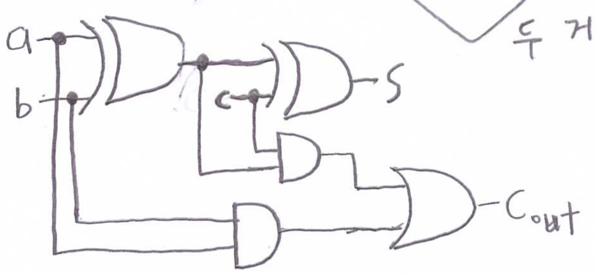
C_{out} 식에서 $c(a+b)+ab$ 에서 a, b가 1일때 결과는 1이다.
$c(a \oplus b) + ab$ 라고 가정하고 a, b가 1일때에도 결과는 1이다.

$\therefore C_{out} = c(a+b) + ab \fallingdotseq c(a \oplus b) + ab$ 이다.

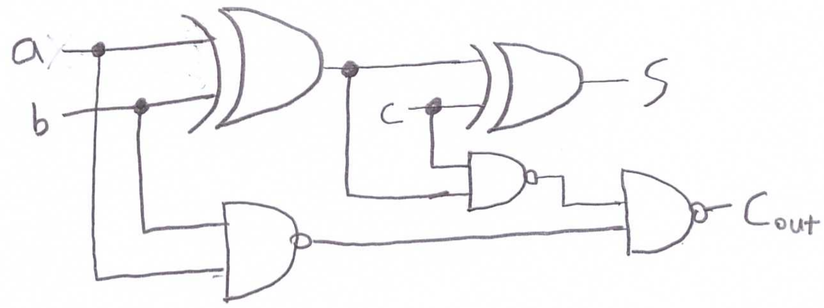
S 와 C_{out} 에 대한 게이트

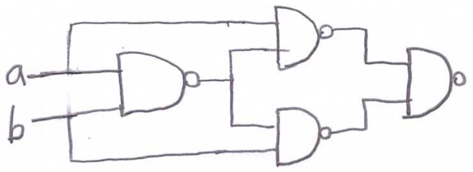


두 게이트를 합치면

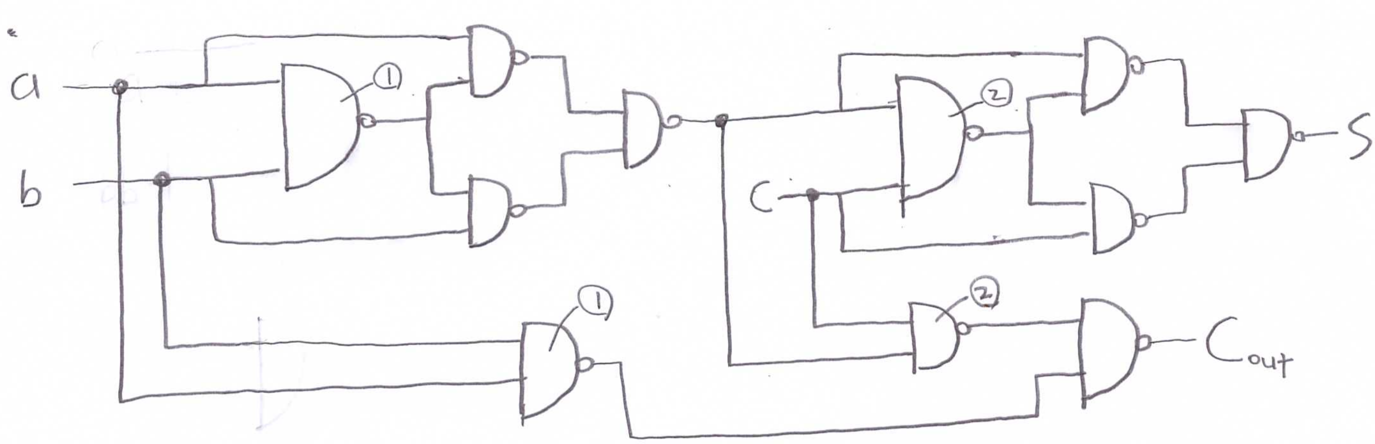


⇒ NAND로 변형

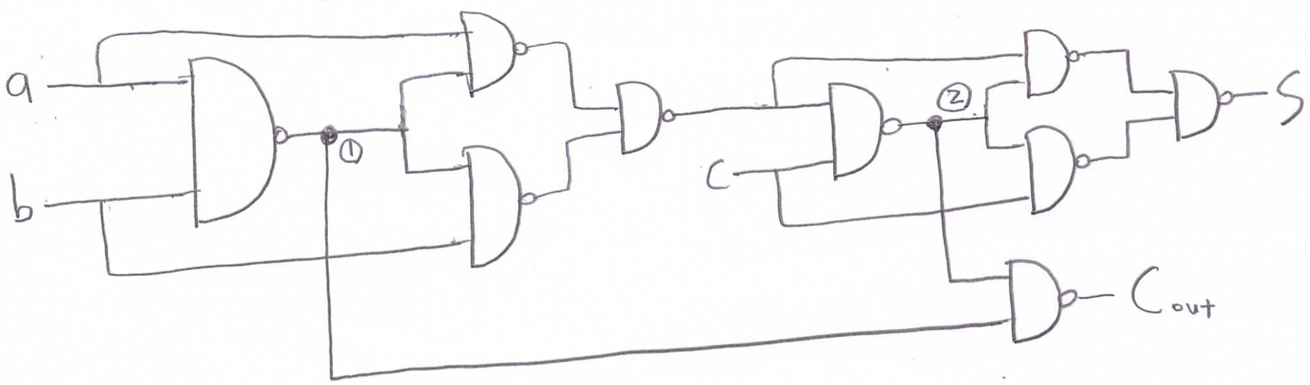


참고 여기서 XOR은 

로 표현 된다.



⇒ 게이트 수를 줄이기 위해서 ①과 ②는 같은결과 이므로



⇒ 9개의 NAND 게이트로
표현이 가능하다!

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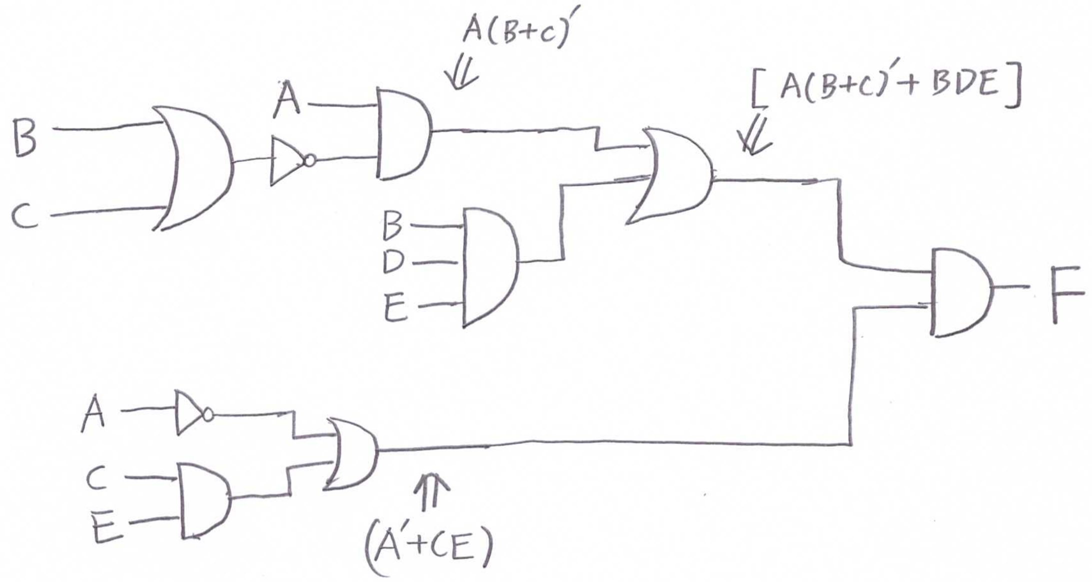
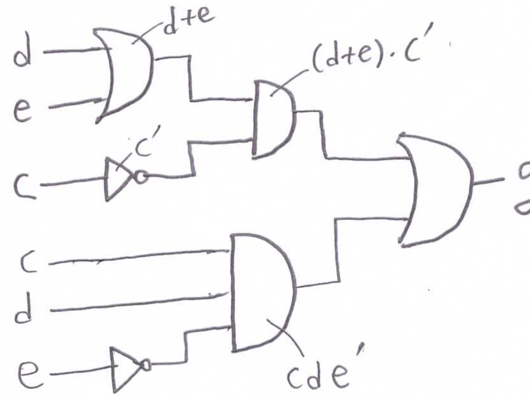
10. $F = [A(B+C)' + BDE] \cdot (A' + CE)$ ⇒ 게이트로 표현



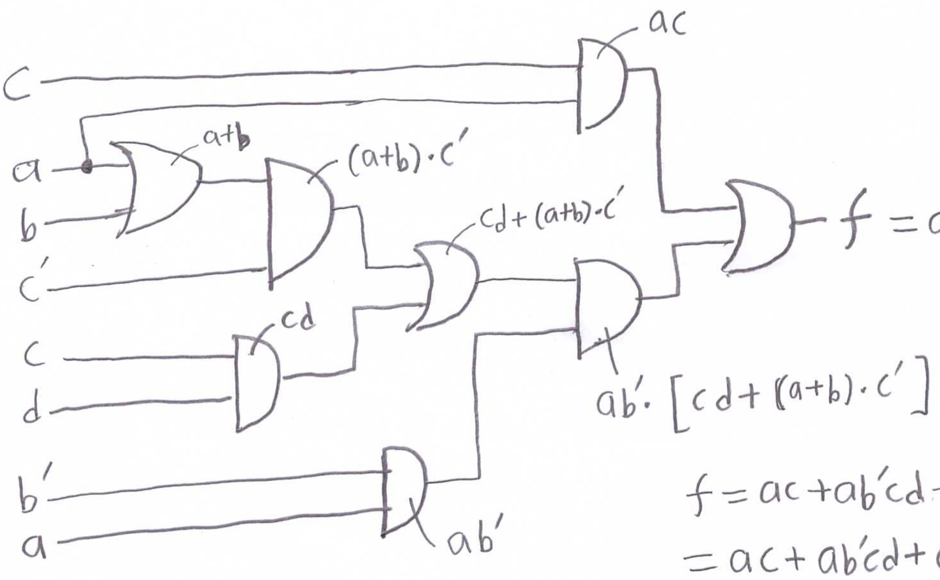
11. a.



$g = (d+e) \cdot c' + cde'$

$= c'd + c'e + cde'$

b.



$f = ac + ab' \cdot [cd + (a+b) \cdot$

$ac' + b$

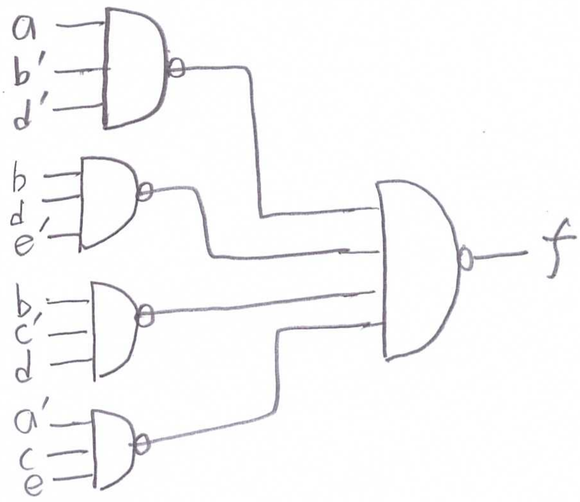
$f = ac + ab'cd + ab'c' + abb'c'$

$= ac + ab'cd + ab'c'(1+b)$

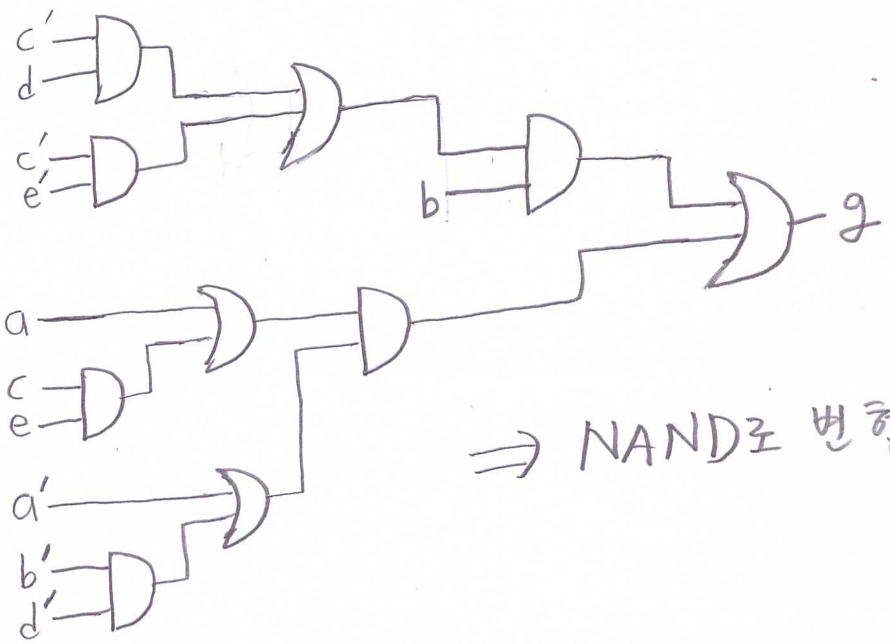
$= ac + ab'(cd + c')$

$= \boxed{ac + ab'c' + ab'd}$

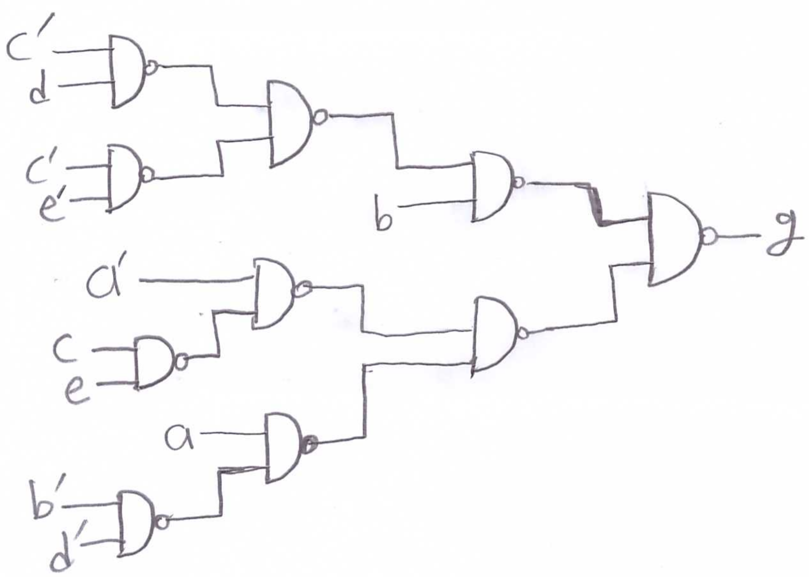
15. a. $f = ab'd' + bde' + bc'd + a'ce$



b. $g = b(c'd + c'e') + (a+ce)(a'+b'd')$



⇒ NAND로 변형



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2.a

w	x	y	z	1	2	3	
0	0	0	0	1	1	1	
0	0	0	1	1	1	1	
0	0	1	0	1	1	1	
0	0	1	1	1	1	1	
0	1	0	0	1	1	1	
0	1	0	1			1	
0	1	1	0	1	1		→ C
0	1	1	1	0	1	1	
1	0	0	0	0	1	1	
1	0	0	1	0	1	1	
1	0	1	0	0	1	1	→ F
1	0	1	1	0	0	1	
1	1	0	0	0	0	0	
1	1	0	1	0	1	0	→ Satisfactory
1	1	1	0	0	0	0	
1	1	1	1	0	1	0	→ Pass

8. a. $x'z + xy'z + xyz$ (1항, 1리터럴)
$= x'z + xz(y+y') = z(x+x') = z$

b. $x'y'z' + x'yz + xyz$ (2항, 5리터럴)
$= x'y'z + yz(x'+x) = x'y'z + yz$

c. $x'y'z' + x'y'z + xy' + xyz'$ (3항 7리터럴)
$= x'y'(z+z') + xy' + xyz' = x'y' + xy' + xyz'$

d. $a'b'c' + a'b'c + abc + ab'c$ (2항 4리터럴)
$= a'b'(c+c') + ac(b+b') = a'b' + ac$

e. $x'y'z' + x'yz' + x'yz + xyz$ (2항 4리터럴)
$= x'z'(y'+y) + yz(x'+x) = x'z' + yz$

f. $x'y'z' + x'y'z + x'yz + xyz + xyz'$ (2해, 3항, 6리터럴)
$= x'y'(z+z') + yz(x'+x) + xyz' = x'y' + yz + xyz'$
$= x'y' + y(z+xz') = x'y' + y(z+x) = x'y' + xy + yz$

f. 두번째 해.

$$x'y'(z'+z)+x'yz+xy(z+z')$$
$$=x'y'+x'yz+xy=x'(y'+yz)+xy=x'(y'+z)+xy$$
$$=\underline{x'y'+x'z+xy}$$

g. $x'y'z'+x'y'z+x'yz+xy'z+xyz+xyz'$ (3항 5리터럴)

$$=x'y'(z'+z)+x'yz+xy'z+xy(z+z')$$
$$=x'y'+x'yz+xy'z+xy=x'(y'+yz)+x(y'z+y)$$
$$=x'(y'+z)+x(y+z)=x'y'+x'z+xy+xz=x'y'+xy+z(x+x')$$
$$=\underline{x'y'+xy+z}$$

h. $a'b'c'+a'bc'+a'bc+ab'c+abc'+abc$ (3항 5리터럴)

$$=a'c'(b'+b)+bc(a'+a)+ab'c+abc'$$
$$=a'c'+bc+ab'c+abc'=c'(a'+ab)+c(b+ab')$$
$$=c'(a'+b)+c(b+a)=a'c'+bc'+bc+ac=a'c'+ac+b(c'+c)$$
$$=\underline{a'c'+ac+b}$$

9. a. $(a+b+c)(a+b'+c)(a+b'+c')(a'+b'+c')$ (2항 4리터럴)

$a+c=k$, $b'+c'=r$

$$\Rightarrow (k+b)(k+b')(a+r)(a'+r)$$
$$=(k+(b\cdot b'))\cdot(r+(a\cdot a'))=k\cdot r=\underline{(a+c)\cdot(b'+c')}$$

b. $(x+y+z)(x+y+z')(x+y'+z)(x+y'+z')$ (1항 1리터럴)

$x+y=k$, $x+y'=r$

$$=(k+z)(k+z')(r+z)(r+z')=(k+(z\cdot z'))\cdot(r+(z\cdot z'))=k\cdot r$$
$$=(x+y)\cdot(x+y')=x+(y\cdot y')=\underline{x}$$

c. $(a+b+c')(a+b'+c')(a'+b'+c')(a'+b'+c)(a'+b+c)$ (2해 3항 6리터럴)

$b'+c'=k$, $a'+c=r$

$$=(a+b+c')(a+k)(a'+k)(r+b')(r+b)$$
$$=(a+b+c')\cdot(k+(a\cdot a'))\cdot(r+(b\cdot b'))=(a+b+c')\cdot(k)\cdot(r)$$
$$=(a+b+c')(b'+c')(a'+c)=(c'+[(a+b)\cdot b'])\cdot(a'+c)$$
$$=(c'+ab')\cdot(a'+c)=\underline{(c'+a)\cdot(c'+b')\cdot(a'+c)}$$

c. 두번째 해

$(a+b+c')(a+b'+c')(a'+b'+c')(a'+b'+c)(a'+b+c)$

$a+c'=k,\ a'+b'=r$

$= (k+b)(k+b')(r+c')(r+c)(a'+b+c) = (k+(b\cdot b'))\cdot(r+(c\cdot c'))\cdot(a'+b+c)$

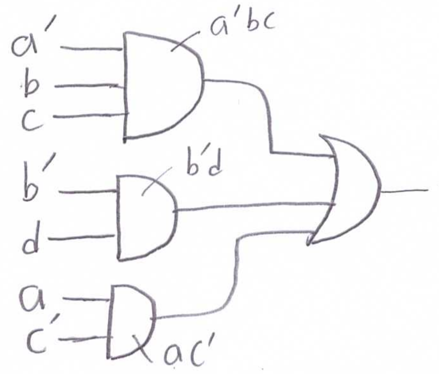
$=(k)\cdot(r)\cdot(a'+b+c) = (a+c')\cdot(a'+b')\cdot(a'+b+c)$

$=(a+c')\cdot(a'+b'\cdot(b+c)) = (a+c')\cdot(a'+b'c)$

$=\underline{(a+c')\cdot(a'+b')\cdot(a'+c)}$

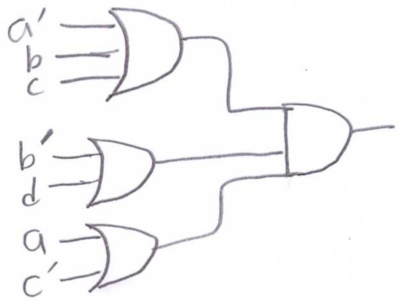
11. 대수식 구하고 곱의 합 형태로

a.



$f = a'bc + b'd + ac'$

b.



$g = (a'+b+c)\cdot(b'+d)\cdot(a+c')$

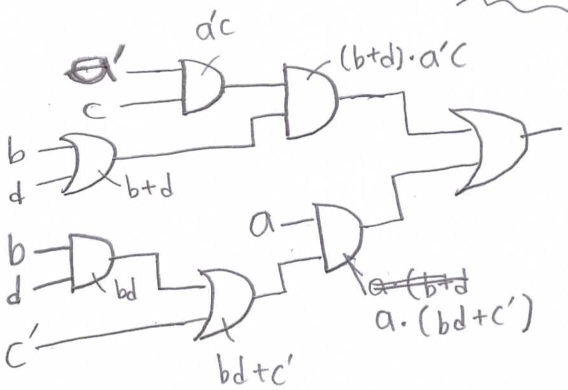
$=(a'b'+a'd+bb'+bd+b'c+cd)\cdot(a+c')$

$=(a'b'+a'd+bd+b'c+cd)\cdot(a+c')$

$= a'ab'+a'b'c'+a'ad+a'c'd+abd+bc'd+ab'c+b'c$
$+acd+cc'd$

$= \underline{a'b'c'+a'c'd+abd+bc'd+ab'c+acd}$

c.

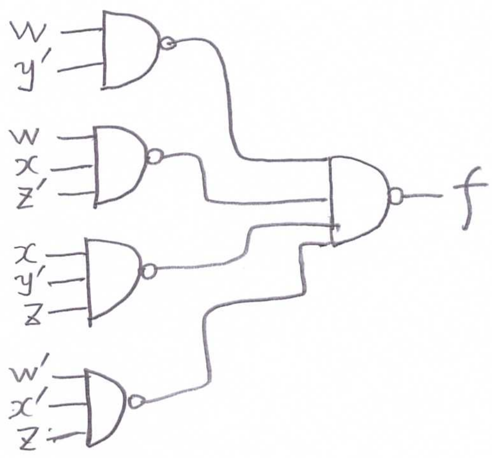


$h = (b+d)\cdot a'c + a\cdot(bd+c')$

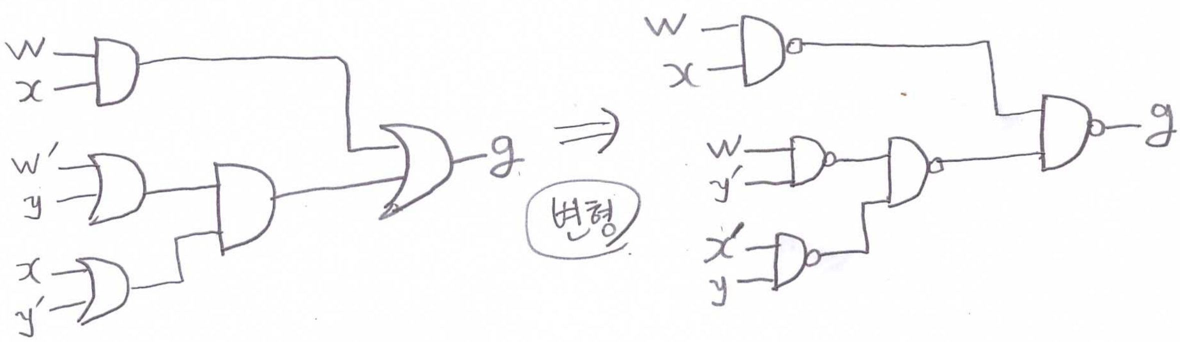
$= \underline{a'bc+a'cd+abd+ac'}$

19. NAND 게이트로 표현

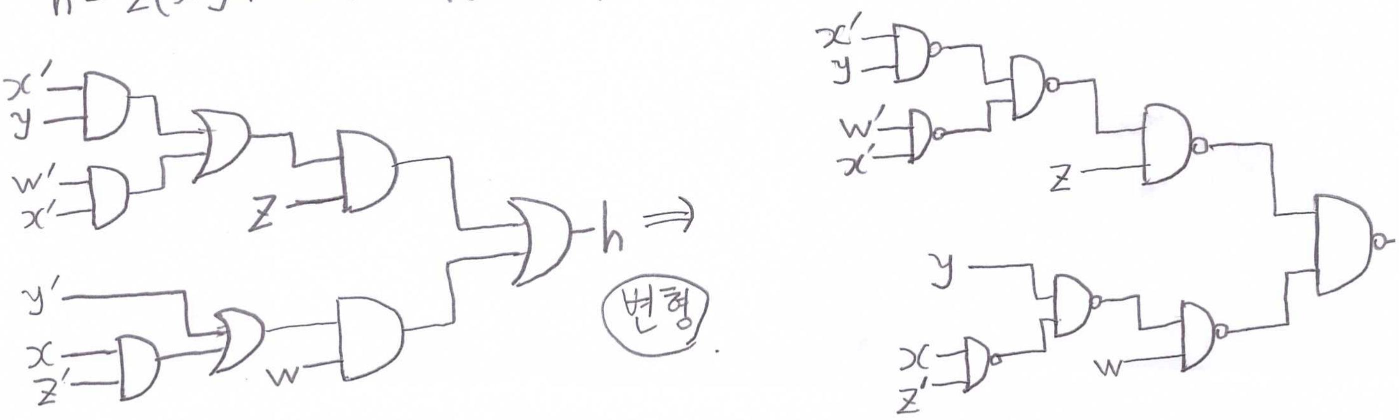
a. $f = wy' + wxz' + xy'z + w'x'z$



b. $g = wx + (w'+y)(x+y')$

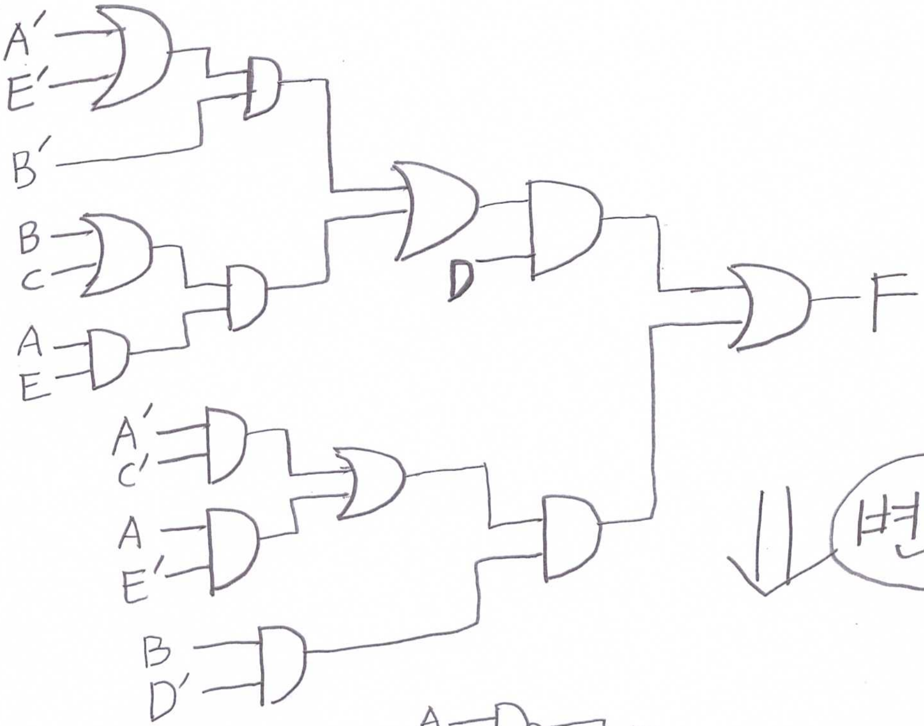


c. $h = z(x'y + w'x') + w(y' + xz')$

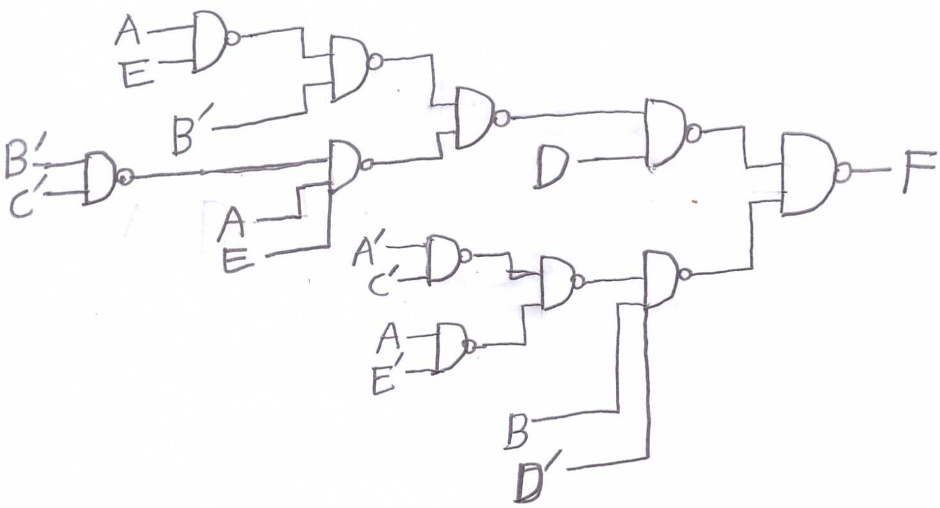


d. $F = D[B'(A'+E') + AE(B+C)] + BD'(A'C' + AE')$

(회로는 다음장)



⇓ 변형



20. a. $h = ab'c + bd + bcd' + ab'c' + abc'd$ (3항 6리터럴)

$= ab'(c+c') + bd(1+ac') + bcd' = ab' + bd + bcd'$

$= ab' + b(d+cd') = ab' + b(d+c) = ab' + bd + cb$

b. $h = ab' + bc'd' + abc'd + bc$ (3항 5리터럴)

$= ab' + bc'(d'+ad) + bc = ab' + bc'(d'+a) + bc$

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

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

c. $f = ab + a'bd + bcd + abc' + a'bd' + a'c$ (2항 3리터럴)

$= ab(1+c') + a'b(d+d') + bcd + a'c = ab + a'b + bcd + a'c$

$= b(a+a') + bcd + a'c = b(1+cd) + a'c = a'c + b$

d. $g = abc + abd + bc'd'$ (2항 5리터럴)

$= ab(c+d) + bc'd' \rightarrow c+d=k.$

$= abk + bk' = b(ak+k') = b(k'+a) = b(c'd'+a) = \underline{ab + bc'd'}.$

e. $f = xy + w'y'z + w'xy' + wxyz' + w'yz + wz$ (3항 5리터럴)

$= xy(1+wz') + z(w+w'y) + w'y'z + w'xy'$

$= xy + z(w+y) + w'y'z + w'xy' = xy + wz + yz + w'y'z + w'xy'$

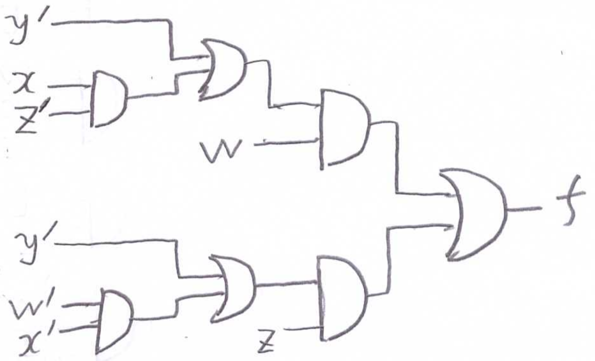
$= x(y+w'y') + z(w+w'y') + yz = x(y+w') + z(w+y') + yz$

$= xy + xw' + zw + zy' + yz = xy + xw' + zw + z(y+y')$

$= xy + xw' + z(w+1) = \underline{xy + xw' + z}.$

26. a. $f = wy' + wxz' + y'z + w'x'z$ (7게이트)

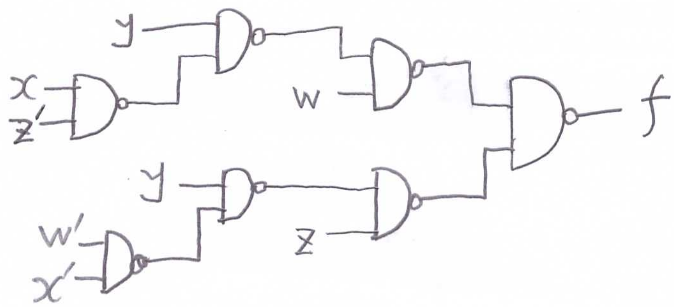
$= w(y' + xz') + z(y' + w'x')$



7게이트

⇓

변환



<BONUS>

XOR 게이트를 NAND로 표현

$$f = x \oplus y$$
$$= x'y + xy' + xx' + yy'$$
$$= (x+y)(x'+y')$$
$$= (x+y)(xy)'$$

전체에 보수

$\Downarrow$

$$f' = (x(xy)')' \cdot (y(xy)')'$$

$\Downarrow$ 다시 전체 보수

$$f = ((x(xy)')' \cdot (y(xy)')')'$$

$\Downarrow$ NAND로 표현