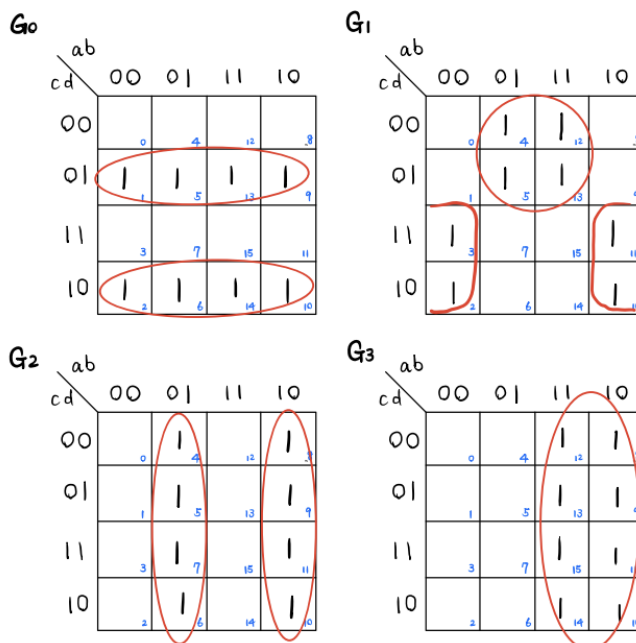


# Logic Design HW3 Answer

1.

	4bit binary code				4bit Gray code			
	a	b	c	d	G <sub>3</sub>	G <sub>2</sub>	G <sub>1</sub>	G <sub>0</sub>
0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	1
2	0	0	1	0	0	0	1	1
3	0	0	1	1	0	0	1	0
4	0	1	0	0	0	1	1	0
5	0	1	0	1	0	1	1	1
6	0	1	1	0	0	1	0	1
7	0	1	1	1	0	1	0	0
8	1	0	0	0	1	1	0	0
9	1	0	0	1	1	1	0	1
10	1	0	1	0	1	1	1	1
11	1	0	1	1	1	1	1	0
12	1	1	0	0	1	0	1	0
13	1	1	0	1	1	0	1	1
14	1	1	1	0	1	0	0	1
15	1	1	1	1	1	0	0	0

K map:



Simplify by Kmap

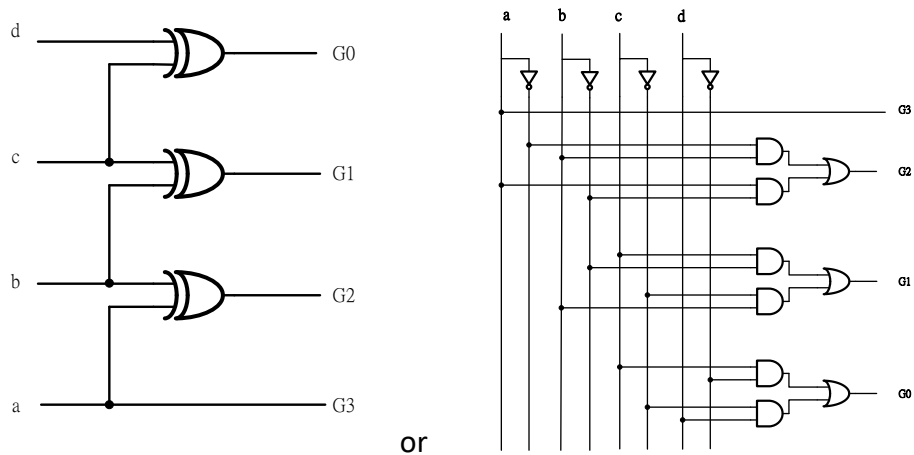
$$G_0 = c'd + cd'$$

$$G_1 = b'c + bc'$$

$$G_2 = a'b + ab'$$

$$G_3 = a$$

Logic circuit:



2.

(a) algebraic manipulation

$$x+y=1, xy=0;$$

$$xz + x'y + yz = z(x+y) + x'y + xy = z(x+y) + y(x+x') = y+z$$

(b) truth table

Because  $xy=0, x+y=1$

X	y	z	$xz + x'y + yz$	$y + z$
0	0	0	x	x
0	0	1	x	x
0	1	0	1	1
0	1	1	1	1
1	0	0	0	0
1	0	1	1	1
1	1	0	x	x
1	1	1	x	x

3.

(a)

minterms		maxterms	
<b>f</b>	$(a'bc), (ab'c), (abc'), (abc)$	<b>f</b>	$(a+b+c), (a+b+c'), (a+b'+c), (a'+b+c)$
<b>g</b>	$(a'b'c), (a'bc'), (ab'c'), (abc)$	<b>g</b>	$(a+b+c), (a+b'+c'), (a'+b+c'), (a'+b'+c)$
<b>f'</b>	$(a'b'c'), (a'bc), (ab'c'), (ab'c')$	<b>f'</b>	$(a+b'+c'), (a'+b+c'), (a'+b'+c), (a'+b'+c')$
<b>g'</b>	$(a'b'c'), (a'bc), (ab'c), (abc')$	<b>g'</b>	$(a+b+c'), (a+b'+c), (a'+b+c), (a'+b'+c')$

(b)

f in sum of minterms (som) algebraic form

$$f = a'bc + ab'c + abc' + abc = \Sigma(3,5,6,7)$$

K map simplify  $f = ac + bc + ab$

a \ bc	00	01	11	10
0	0	1	1	2
1	4	5	7	6

Red circles and arrows indicate groupings for simplification: a vertical circle for 'bc' (minterms 3, 7), a horizontal circle for 'ac' (minterms 5, 7), and a horizontal circle for 'ab' (minterms 6, 7).

or

ab \ c	0	1
00	0	1
01	2	3
11	6	7
10	4	5

Red circles and arrows indicate groupings for simplification: a vertical circle for 'bc' (minterms 3, 7), a horizontal circle for 'ab' (minterms 6, 7), and a vertical circle for 'ac' (minterms 5, 7).

g in sum of minterms algebraic form

$$g = a'b'c + a'bc' + ab'c' + abc = \Sigma(1,2,4,7)$$

a \ bc	00	01	11	10
0	0	1	3	2
1	4	5	7	6

Blue '1's are placed in cells (0,1), (0,2), (1,4), and (1,7) representing minterms 1, 2, 4, and 7.

or

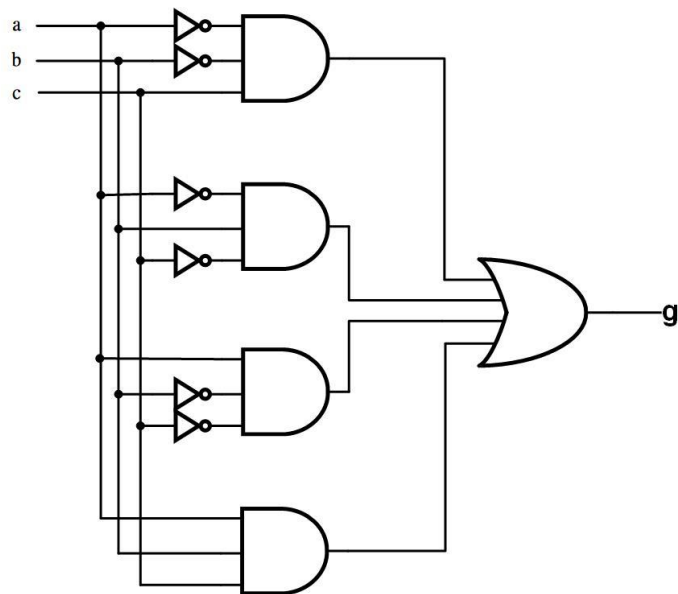
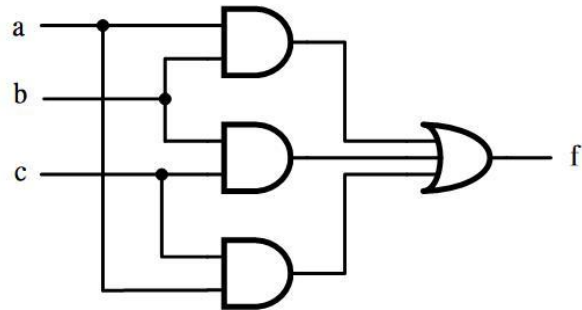
ab \ c	0	1
00	0	1
01	2	3
11	6	7
10	4	5

Blue '1's are placed in cells (0,1), (0,3), (1,6), and (1,7) representing minterms 1, 2, 4, and 7.

(c)

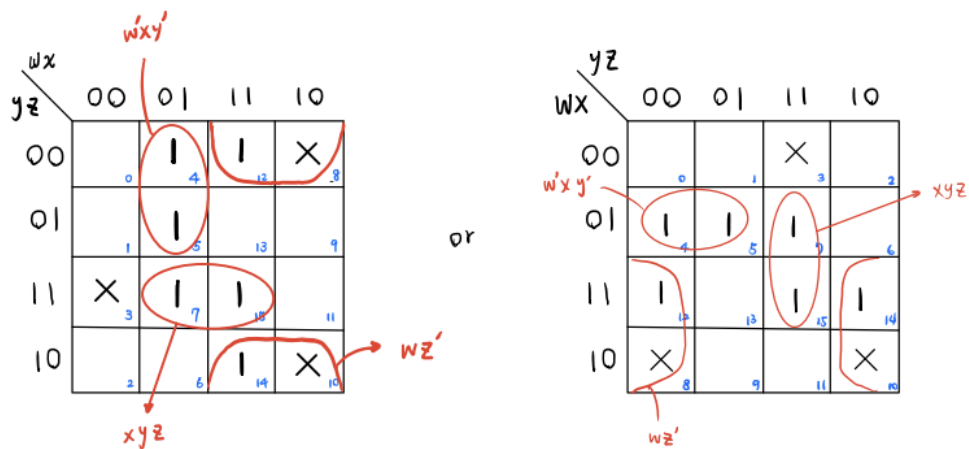
Sop form  $f = ac + bc + ab$ ,  $g = a'b'c + a'bc' + ab'c' + abc$

Logic diagrams



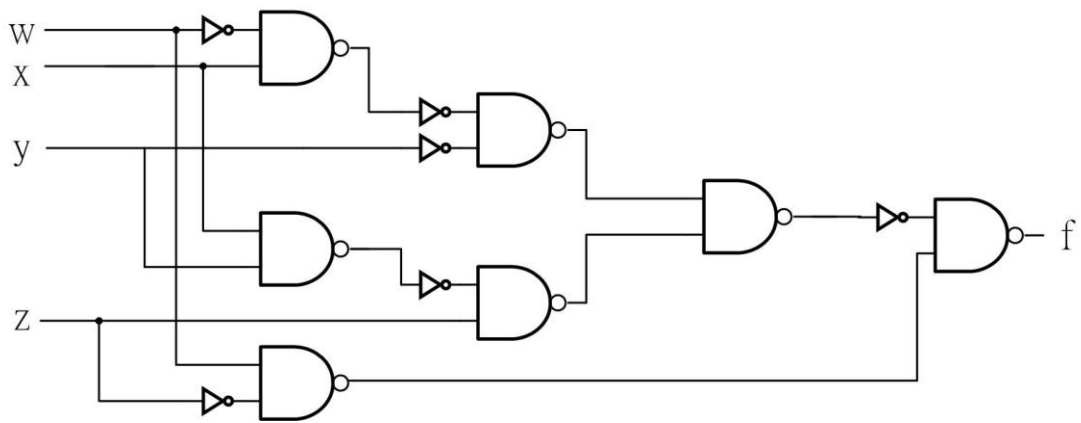
4.  $f(w, x, y, z) = \Sigma(4, 5, 7, 12, 14, 15) + \Sigma_d(3, 8, 10)$

K map:



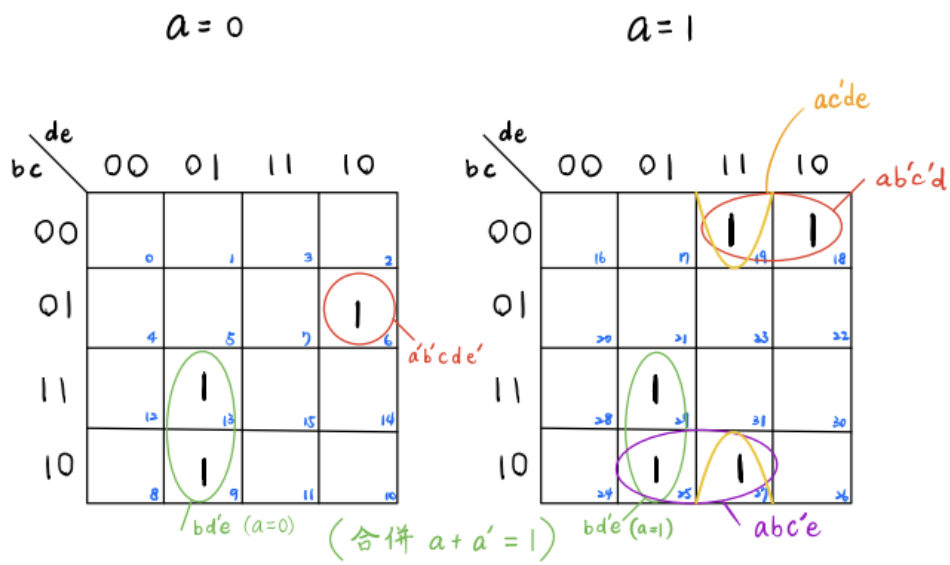
$$f(w,x,y,z) = wz' + w'xy' + xyz$$

Logic diagram:



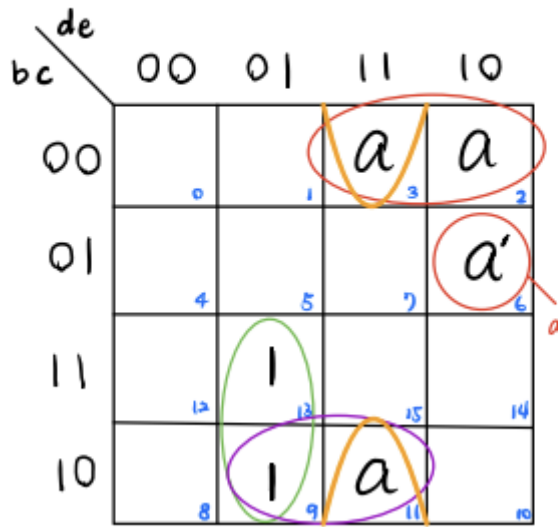
5.

Method1:



Method2:

$$a=0 \rightarrow a' \quad a=1 \rightarrow a$$



**PIs**

There are 5 PIs:  $a'b'cde'$ ,  $bd'e$ ,  $ab'c'd$ ,  $abc'e$ ,  $ac'de$

**EPIs**

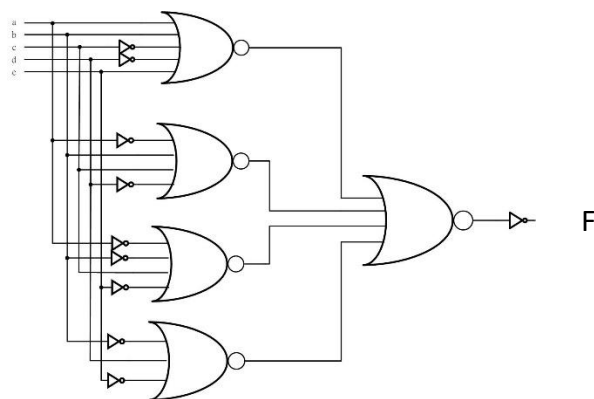
There are 3 EPIs:  $bd'e$ ,  $a'b'cde'$ ,  $ab'c'd$

**minimal covers:**

- $bd'e + a'b'cde' + ab'c'd + abc'e$  or
- $bd'e + a'b'cde' + ab'c'd + ac'de$

**two-level NOR-NOR circuit:**

- $F = bd'e + a'b'cde' + ab'c'd + abc'e$   
 $= [(b'+d+e')(a+b+c'+d'+e)(a'+b+c+d')(a'+b'+c+e) ]'$



or

- $F = bd'e + a'b'cde' + ab'c'd + ac'de$   
 $= (b'+d+e') + (a+b+c'+d'+e) + (a'+b+c+d') + (a'+c+d'+e')$