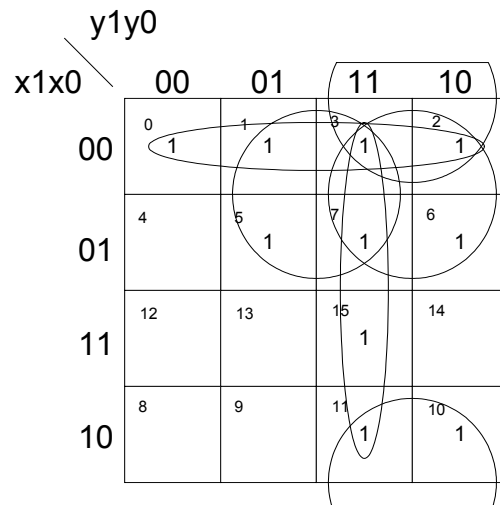


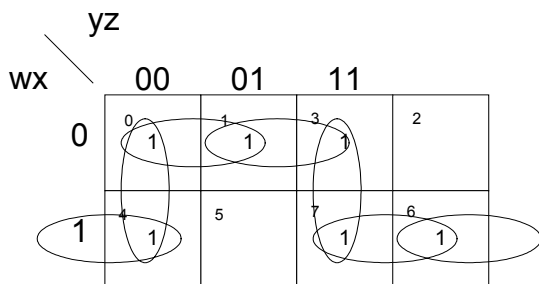
4.4a.)

N	x1	x0	y1	y0	F
0	0	0	0	0	1
1	0	0	0	1	1
2	0	0	1	0	1
3	0	0	1	1	1
4	0	1	0	0	0
5	0	1	0	1	1
6	0	1	1	0	1
7	0	1	1	1	1
8	1	0	0	0	0
9	1	0	0	1	0
10	1	0	1	0	1
11	1	0	1	1	1
12	1	1	0	0	0
13	1	1	0	1	0
14	1	1	1	0	0
15	1	1	1	1	1



$$PI = x1'x0', y1y0, x1'y0, x1'y1, x0'y1$$

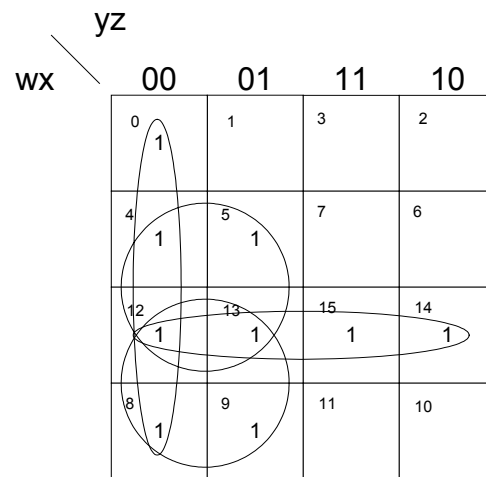
4.4b.)



$$PI: w'x', w'y, wx, wy', x'y', xy$$

4.4c.)

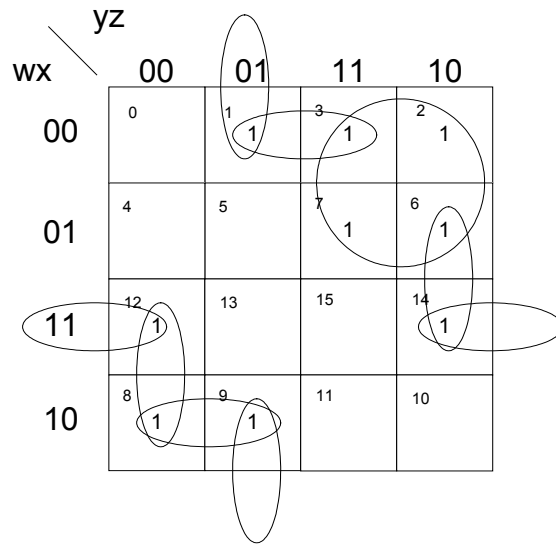
N	w	x	y	z	F
0	0	0	0	0	1
1	0	0	0	1	0
2	0	0	1	0	0
3	0	0	1	1	0
4	0	1	0	0	1
5	0	1	0	1	1
6	0	1	1	0	0
7	0	1	1	1	0
8	1	0	0	0	1
9	1	0	0	1	1
10	1	0	1	0	0
11	1	0	1	1	0
12	1	1	0	0	1
13	1	1	0	1	1
14	1	1	1	0	1
15	1	1	1	1	1



PI: $y'z'$, wx , xy' , wy'

4.4d.)

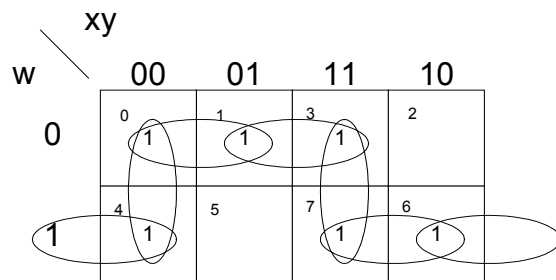
N	w	x	y	z	F
0	0	0	0	0	
1	0	0	0	1	1
2	0	0	1	0	1
3	0	0	1	1	1
4	0	1	0	0	
5	0	1	0	1	
6	0	1	1	0	1
7	0	1	1	1	1
8	1	0	0	0	1
9	1	0	0	1	1
10	1	0	1	0	
11	1	0	1	1	
12	1	1	0	0	1
13	1	1	0	1	
14	1	1	1	0	1
15	1	1	1	1	



PI: $w'y$, $w'x'z$, wxz' , $wx'y'$, $wy'z'$, $x'y'z$, xyz'

4.6a.)

N	w	x	y	F
0	0	0	0	1
1	0	0	1	1
2	0	1	0	0
3	0	1	1	1
4	1	0	0	1
5	1	0	1	0
6	1	1	0	1
7	1	1	1	1



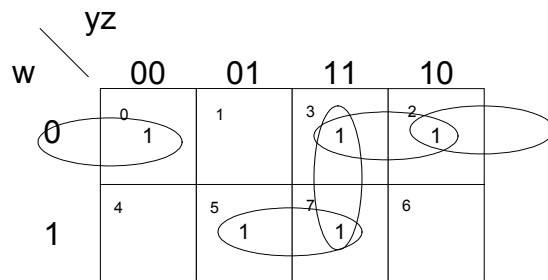
PI: $w'x'$, $w'y$, xy , wx , wy' , $x'y'$

EPI: None

Minimum covers: 1.) $w'x' + xy + wy'$ OR 2.) $w'y + wx + x'y'$

4.6b.)

N	w	y	z	F
0	0	0	0	1
1	0	0	1	
2	0	1	0	1
3	0	1	1	1
4	1	0	0	
5	1	0	1	1
6	1	1	0	
7	1	1	1	1



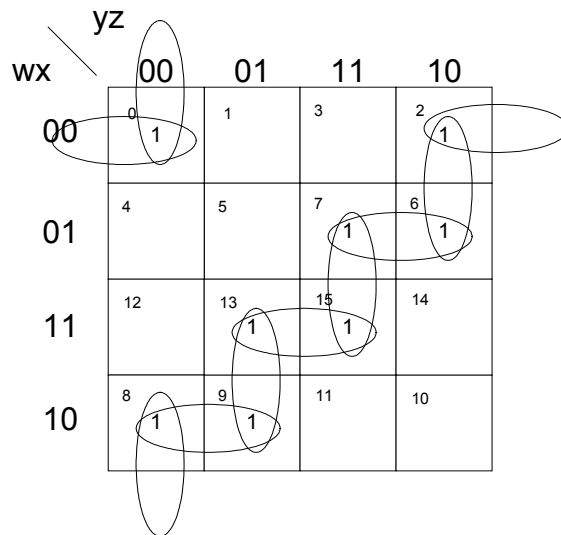
PI: $w'z'$, $w'y$, wz , yz

EPI: $w'z'$, wz

Minimum covers: 1.) $w'z' + wz + w'y$ OR 2.) $w'z' + wz + yz$

4.6c.)

N	w	x	y	z	F
0	0	0	0	0	1
1	0	0	0	1	0
2	0	0	1	0	1
3	0	0	1	1	0
4	0	1	0	0	0
5	0	1	0	1	0
6	0	1	1	0	1
7	0	1	1	1	1
8	1	0	0	0	1
9	1	0	0	1	1
10	1	0	1	0	0
11	1	0	1	1	0
12	1	1	0	0	0
13	1	1	0	1	1
14	1	1	1	0	0
15	1	1	1	1	1



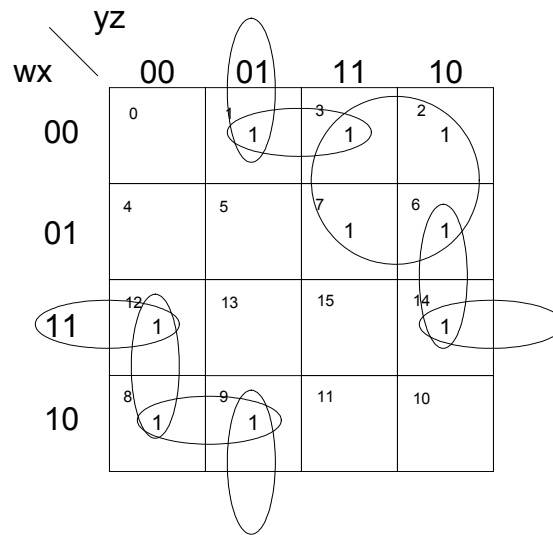
PI: $w'x'z'$, $w'xy$, wxz , $wx'y'$, $x'y'z'$, $wy'z$, xyz , $w'yz'$

EPI: None

Minimum covers: 1.) $w'x'z' + w'xy + wxz + wx'y'$ OR 2.) $x'y'z' + wy'z + xyz + w'yz'$

4.6d.)

N	w	x	y	z	F
0	0	0	0	0	0
1	0	0	0	1	1
2	0	0	1	0	1
3	0	0	1	1	1
4	0	1	0	0	0
5	0	1	0	1	0
6	0	1	1	0	1
7	0	1	1	1	1
8	1	0	0	0	1
9	1	0	0	1	1
10	1	0	1	0	0
11	1	0	1	1	0
12	1	1	0	0	1
13	1	1	0	1	0
14	1	1	1	0	1
15	1	1	1	1	0



PI: $w'y, w'x'z, wxz', wx'y', wy'z', x'y'z, xyz'$

EPI: $w'y$

Minimum covers: 1.) $w'y + w'x'z + wxz' + wx'y'$ OR 2.) $w'y + wy'z' + x'y'z + xyz'$

4.7a.)

w	x	y	z	F	Group	Set	w	x	y	z	C?	E?
0	0	0	0	0	0	0	0	0	0	0	Y	
1	0	0	0	1	1	4	0	1	0	0	Y	
2	0	0	1	0	1	8	1	0	0	0	Y	
3	0	0	1	1	2	5	0	1	0	1	Y	
4	0	1	0	0	2	9	1	0	0	1	Y	
5	0	1	0	1	2	10	1	0	1	0	Y	
6	0	1	1	0	2	12	1	1	0	0	Y	
7	0	1	1	1	3	13	1	1	0	1	Y	
8	1	0	0	0	3	14	1	1	1	0	Y	
9	1	0	0	1	4	15	1	1	1	1	Y	

w	x	y	z	C?	Group	Set	w	x	y	z	C?
10	1	0	1	0	1	1	0	-	0	0	Y
11	1	0	1	1	0	0,4	-	0	0	0	Y
12	1	1	0	0	0	0,8	0	1	0	-	Y
13	1	1	0	1	1	4,5	-	1	0	0	Y
14	1	1	1	0	1	4,12	1	0	0	-	Y
15	1	1	1	1	1	8,9	1	0	-	0	Y
					1	8,10	1	-	0	0	Y
					1	8,12	1	-	0	0	Y
					2	5,13	-	1	0	1	Y
					2	9,13	1	-	0	1	Y
					2	10,14	1	-	1	0	Y
					2	12,13	1	1	0	-	Y
					2	12,14	1	1	-	0	Y
					3	13,15	1	1	-	1	Y
					3	14,15	1	1	1	-	Y

Group	Set	w	x	y	z	C?	E?	0	4	5	8	9	10	12	13	14	15
0	0,4,8,12	-	-	0	0	N	Y	X	X		X			X			
1	4,5,12,13	-	1	0	-	N	Y		X	X				X	X		
1	8,9,12,13	1	-	0	-	N	Y				X	X		X	X		
1	8,10,12,14	1	-	-	0	N	Y				X		X	X		X	
2	12,13,14,15	1	1	-	-	N	Y						X	X	X	X	

PI: $y'z'$, xy' , wy' , wz' , wx

EPI: $y'z'$, xy' , wy' , wz' , wx

Minimal cover: $y'z' + xy' + wy' + wz' + wx$

4.7b.)

	w	x	y	z	F	Group	Set	w	x	y	z	C?
0	0	0	0	0	1	0	0	0	0	0	0	Y
1	0	0	0	1	1	1	1	0	0	0	1	Y
2	0	0	1	0	1	2	1	0	0	1	0	Y
3	0	0	1	1	0	4	1	0	1	0	0	Y
4	0	1	0	0	1	5	2	0	1	0	1	Y
5	0	1	0	1	1	6	2	0	1	1	0	Y
6	0	1	1	0	1	9	2	1	0	0	1	Y
7	0	1	1	1	0	11	3	1	0	1	1	Y
8	1	0	0	0	0	13	3	1	1	0	1	Y
9	1	0	0	1	1	15	4	1	1	1	1	Y

	w	x	y	z	F	Group	Set	w	x	y	z	C?
10	1	0	1	0	0							
11	1	0	1	1	1							
12	1	1	0	0	0	0	0,1	0	0	0	-	Y
13	1	1	0	1	1	0	0,2	0	0	-	0	Y
14	1	1	1	0	0	0	0,4	0	-	0	0	Y
15	1	1	1	1	1	1	1,5	0	-	0	1	Y
						1	1,9	-	0	0	1	Y
						1	2,6	0	-	1	0	Y
						1	4,5	0	1	0	-	Y
						1	4,6	0	1	-	0	Y
						2	5,13	-	1	0	1	Y
						2	9,11	1	0	-	1	Y
						2	9,13	1	-	0	1	Y
						3	11,15	1	-	1	1	Y
						3	13,15	1	1	-	1	Y

Group	Set	w	x	y	z	C?	E?	0	1	2	4	5	6	9	11	13	15
	0,1,4,5	0	-	0	-	N	N	X	X		X	X					
	0,2,4,6	0	-	-	0	N	Y	X		X	X		X				
	1,5,9,13	-	-	0	1	N	N		X			X		X		X	
	9,11,13,15	1	-	-	1	N	Y							X	X	X	X

PI: w'y', w'z', y'z, wz

EPI: None

4.7c.)

w	x	y	z	F	Group	Set	w	x	y	z	C?
0	0	0	0	0	1	1	0	0	0	1	Y
1	0	0	0	1	1	2	0	0	1	0	Y
2	0	0	1	0	1	8	1	0	0	0	Y
3	0	0	1	1	2	3	0	0	1	1	Y
4	0	1	0	0	2	6	0	1	1	0	Y
5	0	1	0	1	2	9	1	0	0	1	Y
6	0	1	1	0	2	12	1	1	0	0	Y
7	0	1	1	1	3	7	0	1	1	1	Y
8	1	0	0	0	3	14	1	1	1	0	Y
9	1	0	0	1							
10	1	0	1	0	Group	Set	w	x	y	z	C?
11	1	0	1	1	1	1,3	0	0	-	1	N
12	1	1	0	0	1	1,9	-	0	0	1	N
13	1	1	0	1	1	2,3	0	0	1	-	Y
14	1	1	1	0	1	2,6	0	-	1	0	Y
15	1	1	1	1	1	8,9	1	0	0	-	N
					1	8,12	1	-	0	0	N
					2	3,7	0	-	1	1	Y
					2	6,7	0	1	1	-	Y
					2	6,14	-	1	1	0	N
					2	12,14	1	1	-	0	N
					Group	Set	w	x	y	z	C?
						2,3,6,7	0	-	1	-	N

PI: w'x'z, x'y'z, wx'y', wy'z', xyz', wxz', w'y

4.7d.)

w	x	y	z	F	Group	Set	w	x	y	z	C?
0	0	0	0	0	0	0	0	0	0	0	Y
1	0	0	0	1	1	2	0	0	1	0	Y
2	0	0	1	0	1	4	0	1	0	0	Y
3	0	0	1	1	2	5	0	1	0	1	Y
4	0	1	0	0	2	10	1	0	1	0	Y
5	0	1	0	1	3	11	1	0	1	1	Y
6	0	1	1	0	3	13	1	1	0	1	Y
7	0	1	1	1	4	15	1	1	1	1	Y
8	1	0	0	0							
9	1	0	0	1	Group	Set	w	x	y	z	C?
10	1	0	1	0		0,2	0	0	-	0	N
11	1	0	1	1		0,4	0	-	0	0	N
12	1	1	0	0		2,10	-	0	1	0	N
13	1	1	0	1		4,5	0	1	0	-	N
14	1	1	1	0		5,13	-	1	0	1	N
15	1	1	1	1		10,11	1	0	1	-	N
						11,15	1	-	1	1	N
						13,15	1	1	-	1	N

E?	0	2	4	5	10	11	13	15
N	X	X						
N	X		X					
N		X			X			
N			X	X				
N				X			X	
N					X	X		
N						X		X
N							X	X

PI: w'x'z', w'y'z', x'yz', w'xy',xy'z, wx'y, wyz, wxz

4.8a.)

	w	x	y	z	F	Group	Set	w	x	y	z	C?
0	0	0	0	0	1	0	0	0	0	0	0	Y
1	0	0	0	1	1	1	1	0	0	0	1	Y
2	0	0	1	0	1	1	2	0	0	1	0	Y
3	0	0	1	1	1	2	3	0	0	1	1	Y
4	0	1	0	0	0	2	5	0	1	0	1	Y
5	0	1	0	1	1	2	6	0	1	1	0	Y
6	0	1	1	0	1	2	10	1	0	1	0	Y
7	0	1	1	1	1	3	7	0	1	1	1	Y
8	1	0	0	0	0	3	11	1	0	1	1	Y
9	1	0	0	1	0	4	15	1	1	1	1	Y

	w	x	y	z	F	Group	Set	w	x	y	z	C?
10	1	0	1	0	1							
11	1	0	1	1	1							
12	1	1	0	0	0	0	0,1	0	0	0	-	Y
13	1	1	0	1	0	0	0,2	0	0	-	0	Y
14	1	1	1	0	0	1	1,3	0	0	-	1	Y
15	1	1	1	1	1	1	1,5	0	-	0	1	Y
						1	2,3	0	0	1	-	Y
						1	2,6	0	-	1	0	Y
						1	2,10	-	0	1	0	Y
						2	3,7	0	-	1	1	Y
						2	3,11	-	0	1	1	Y
						2	5,7	0	1	-	1	Y
						2	6,7	0	1	1	-	Y
						2	10,11	1	0	1	-	Y
						3	7,15	-	1	1	1	Y
						3	11,15	1	-	1	1	Y

Group	Set	w	x	y	z	C?	E?	0	1	2	3	5	6	7	10	11	15
	0,1,2,3	0	0	-	-	N	Y	X	X	X	X						
	1,3,5,7	0	-	-	1	N	Y		X		X	X		X			
	2,3,6,7	0	-	1	-	N	Y			X	X		X	X			
	2,3,10,11	-	0	1	-	N	Y			X	X				X	X	
	3,7,11,15	-	-	1	1	N	Y				X		X		X	X	

PI: $w'x', w'z, w'y, x'y, yz$

EPI: $w'x, w'z, w'y, x'y, yz$

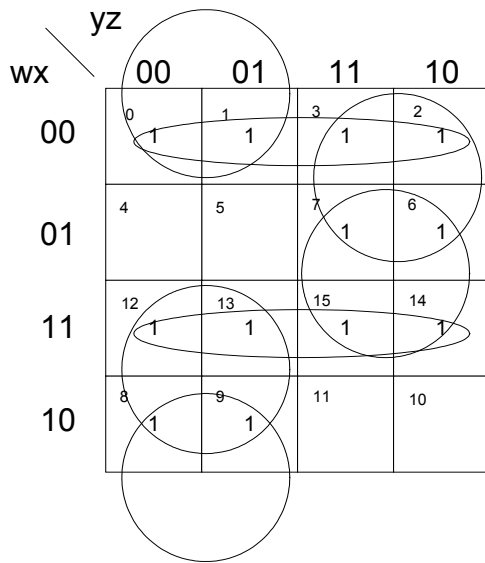
Minimal cover: $w'z + w'z + w'y + x'y + yz$

4.8b.)

w	x	y	z	F	Group	Set	w	x	y	z	C?
0	0	0	0	0	1	0	0	0	0	0	Y
1	0	0	0	1	1	1	0	0	0	1	Y
2	0	0	1	0	1	2	0	0	1	0	Y
3	0	0	1	1	1	8	1	0	0	0	Y
4	0	1	0	0	2	3	0	0	1	1	Y
5	0	1	0	1	2	6	0	1	1	0	Y
6	0	1	1	0	2	9	1	0	0	1	Y
7	0	1	1	1	2	12	1	1	0	0	Y
8	1	0	0	0	3	7	0	1	1	1	Y
9	1	0	0	1	3	13	1	1	0	1	Y
10	1	0	1	0	3	14	1	1	1	0	Y
11	1	0	1	1	4	15	1	1	1	1	Y

w	x	y	z	C?	Group	Set	w	x	y	z	C?
0	0	0	0	-	0	0,1	0	0	0	-	Y
0	0	0	1	-	0	0,2	0	0	-	0	Y
0	0	1	0	-	0	0,8	-	0	0	0	Y
0	1	0	0	-	1	1,3	0	0	-	1	Y
0	1	0	1	-	1	1,9	-	0	0	1	Y
0	1	1	0	-	1	2,3	0	0	1	-	Y
0	1	1	1	-	1	2,6	0	-	1	0	Y
1	0	0	0	-	1	8,9	1	0	0	-	Y
1	0	0	1	-	1	8,12	1	-	0	0	Y
1	0	1	0	-	2	3,7	0	-	1	1	Y
1	0	1	1	-	2	6,7	0	1	1	-	Y
1	1	0	0	-	2	6,14	-	1	1	0	Y
1	1	0	1	-	2	9,13	1	-	0	1	Y
1	1	1	0	-	2	12,13	1	1	0	-	Y
1	1	1	1	-	2	12,14	1	1	-	0	Y
1	1	1	1	-	3	7,15	-	1	1	1	Y
1	1	1	1	-	3	13,15	1	1	-	1	Y
1	1	1	1	-	4	14,15	1	1	1	-	Y

Group	Set	w	x	y	z	C?	E?	0	1	2	3	6	7	8	9	12	13	14	15
0,1,2,3	0 0 - -	N	N	X	X	X	X												
0,1,8,9	- 0 0 -	N	N	X	X									X	X				
2,3,6,7	0 - 1 -	N	N			X	X	X	X										
8,9,12,13	1 - 0 -	N	N										X	X	X	X			
6,7,14,15	- 1 1 -	N	N					X	X								X	X	
12,13,14,15	1 1 - -	N	N												X	X	X	X	



PI: $w'x'$, $x'y'$, $w'y$, wy' , xy , wx

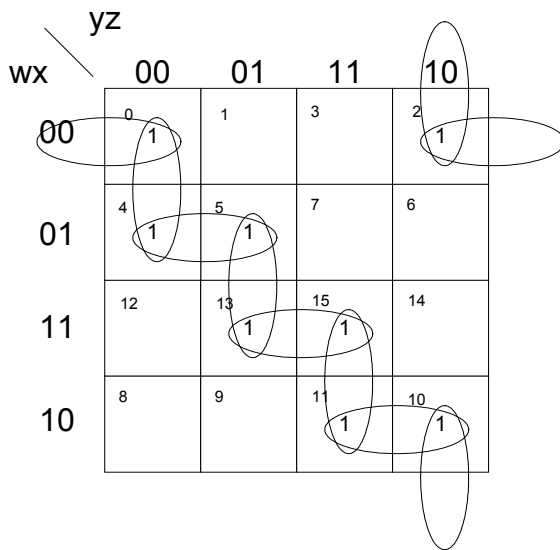
EPI: None

Minimal covers: 1.) $x'y' + w'y + wx$ OR 2.) $w'x' + xy + wy'$

4.8c.)

w	x	y	z	F	Group	Set	w	x	y	z	C?
0	0	0	0	1	0	0	0	0	0	0	Y
1	0	0	1	0	1	2	0	0	1	0	Y
2	0	0	1	1	1	4	0	1	0	0	Y
3	0	0	1	1	2	5	0	1	0	1	Y
4	0	1	0	1	2	10	1	0	1	0	Y
5	0	1	0	1	3	11	1	0	1	1	Y
6	0	1	1	0	3	13	1	1	0	1	Y
7	0	1	1	1	4	15	1	1	1	1	Y
8	1	0	0	0							
9	1	0	0	1							
10	1	0	1	0							
11	1	0	1	1							
12	1	1	0	0							
13	1	1	0	1							
14	1	1	1	0							
15	1	1	1	1							

Group	Set	w	x	y	z	C?	E?	0	2	4	5	10	11	13	15
0	0,2	0	0	-	0	N		X	X						
0	0,4	0	-	0	0	N		X		X					
1	2,10	-	0	1	0	N			X			X			
1	4,5	0	1	0	-	N				X	X				
2	5,13	-	1	0	1	N				X				X	
2	10,11	1	0	1	-	N					X	X			
3	11,15	1	-	1	1	N						X		X	
3	13,15	1	1	-	1	N							X	X	



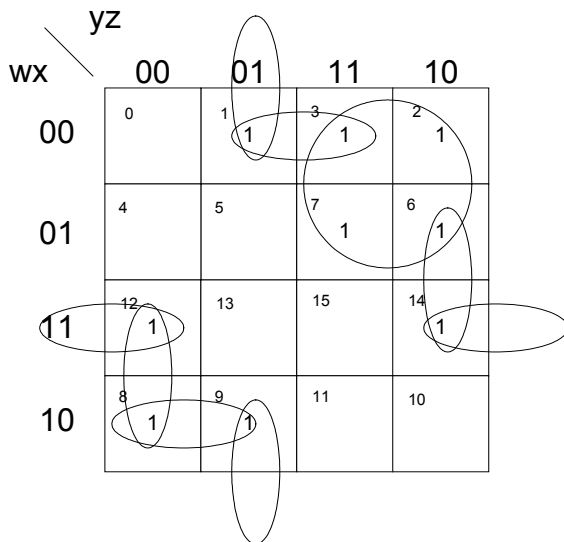
PI: $w'x'z'$, $w'y'z'$, $x'yz'$, $w'xy'$, $xy'z$, $wy'z$, wyz , wxz

EPI: None

Minimum covers: 1.) $w'x'y' + w'xy' + wxz + wx'y$ OR 2.) $w'y'z' + xy'z + wyz + x'yz'$

4.8d.)

	w	x	y	z	F	Group	Set	w	x	y	z	C?										
0	0	0	0	0		1	1	0	0	0	1	Y										
1	0	0	0	1	1	1	2	0	0	1	0	Y										
2	0	0	1	0	1	1	8	1	0	0	0	Y										
3	0	0	1	1	1	2	3	0	0	1	1	Y										
4	0	1	0	0		2	6	0	1	1	0	Y										
5	0	1	0	1		2	9	1	0	0	1	Y										
6	0	1	1	0	1	2	12	1	1	0	0	Y										
7	0	1	1	1	1	3	7	0	1	1	1	Y										
8	1	0	0	0	1	3	14	1	1	1	0	Y										
9	1	0	0	1	1																	
10	1	0	1	0		Group	Set	w	x	y	z	C?	E?	1	2	3	6	7	8	9	12	14
11	1	0	1	1		1	1,3	0	0	-	1	N	N	X		X						
12	1	1	0	0	1	1	1,9	-	0	0	1	N	N	X						X		
13	1	1	0	1		1	2,3	0	0	1	-	Y										
14	1	1	1	0	1	1	2,6	0	-	1	0	Y										
15	1	1	1	1		1	8,9	1	0	0	-	N	N						X	X		
						1	8,12	1	-	0	0	N	N						X		X	
						2	3,7	0	-	1	1	Y										
						2	6,7	0	1	1	-	Y										
						2	6,14	-	1	1	0	N	N			X						X
						2	12,14	1	1	-	0	N	N								X	X
						Group	Set	w	x	y	z	C?	E?									
						1	2,3,6,7	0	-	1	-	N	Y		X	X	X	X				



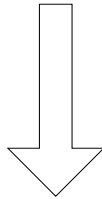
PI: $a'b'd$, $b'c'd$, $ab'c'$, $ac'd'$, bcd' , abd' , $a'c$

EPI: $a'c$

Minimum covers: 1.) $a'c + wxz' + wx'y' + w'x'z$ OR 2.) $a'c + wxz' + wx'y' + x'y'z$ OR
 3.) $a'c + wxz' + x'y'z + wx'y'$ OR 4.) $a'c + wxz + x'y'z + wy'z'$ OR
 5.) $a'c + wy'z' + x'y'z + wxz'$ OR 6.) $a'c + wy'z' + x'y'z + xyz'$

4.19.)

	yz			
wx \	00	01	11	10
00	0 1	1	3	2 1
01	4	5	7 1	6 1
11	12	13 1	15 1	14
10	8 1	9 1	11	10



	yz			
wx \	00	01	11	10
00	0 1	1	3	2 1
01	4	5	7 1	6 1
11	12	13 1	15 1	14
10	8 1	9 1	11	10

Minimum Cover: $w'x'z' + w'xy + wxz + wx'y'$

Hazard Free Cover: $w'x'z' + w'xy + wxz + wx'y' + x'y'z' + wy'z + xyz + w'yz'$

Additional Problem.)

1.) $Z = ABCD + ABDE$

$$Z = ABD(C + E); 5 \text{ literals}$$

2.) $Z = AC + ADE + BC + BDE$

$$Z = C(A + B) + DE(A + B)$$

$$Z = (C + DE)(A + B); 5 \text{ literals}$$

3.) $Z = AD + AE + BD + BE + CD + CE + AF$

$$Z = A(D + E) + B(D + E) + C(D + E)$$

$$Z = (A + B + C)(D + E) + AF; 7 \text{ literals}$$

4.) $Z = ACE + ACF + ADE + ADF + BCE + BCF + BDE + BDF$

$$Z = A(CE + CF + DE + DF) + B(CE + CF + DE + DF)$$

$$Z = (A + B)(C(E + F) + D(E + F))$$

$$Z = (A + B)(C + D)(E + F); 6 \text{ literals}$$