Coen/Elen 21c
Homework 5 Solution

Problem 1. Text Problem 3.12b (b only)

Min term	List 1 ABCD	Flags		Min-terms	List 2 ABCD	Flags		Min-terms	List 3 ABCD	Flags	
2	0010	α	$\surd$	2,3	001-	α	PI_5	4,5,6,7	01	β	PI_1
4	0100	β	$\surd$	4,5	010-	β	$\surd$	4,6,12,14	-1-0	β	PI_2
3	0011	α	$\surd$	5,6	01-0	β	$\surd$	5,7,13,15	-1-1	α	PI_3
5	0101	$\alpha\beta$	$\surd$	4,12	-100	β	$\surd$	12,13,14,15	11	α	PI_4
6	0110	β	$\surd$	3,7	0-11	α	PI_6				
12	1100	$\alpha\beta$	$\surd$	5,7	01-1	$\alpha\beta$	PI_7				
7	0111	$\alpha\beta$	$\surd$	5,13	-101	α	$\surd$				
13	1101	α	$\surd$	6,7	011-	β	$\surd$				
14	1110	$\alpha\beta$	$\surd$	6,14	-110	β	$\surd$				
15	1111	α	$\surd$	12,13	110-	α	$\surd$				
				12,14	11-0	$\alpha\beta$	PI_8				
				7,15	-111	α	$\surd$				
				13,15	11-1	α	$\surd$				
				14,15	111-	α	$\surd$				

$$PI_{\alpha\beta} = \{PI_7 = \bar{A}BD, PI_8 = AB\bar{D}\}$$
$$PI_{\alpha} = \{PI_3 = \bar{B}D, PI_4 = AB, PI_5 = A\bar{B}C, PI_6 = \bar{A}CD\}$$
$$PI_{\beta} = \{PI_1 = \bar{A}B, PI_2 = B\bar{D}\}$$

Problem 2. Text Problem 3.14

3.14 Use the Quine-McCluskey method to minimize the following functions with don't cares:

(a) $f(A,B,C,D) = \sum m(0,6,9,10,13) + d(1,3,8)$

List 1 Minterm	$ABCD$		List 2 Minterms	$ABCD$		List 3 Minterms	$ABCD$	
0	0000	$\surd$	0,1	000-	$\surd$	0,1,8,9	-00-	PI_1
1	0001	$\surd$	0,8	-000	$\surd$			
8	1000	$\surd$	1,3	00-1	PI_2			
3	0011	$\surd$	1,9	-001	$\surd$			
6	0110	PI_5	8,9	100-	$\surd$			
9	1001	$\surd$	8,10	10-0	PI_3			
10	1010	$\surd$	9,13	1-01	PI_4			
13	1101	$\surd$						

	$\surd$ 0	$\surd$ 6	$\surd$ 9	$\surd$ 10	$\surd$ 13
$*PI_1$	$\otimes$		$\times$		
PI_2					
$*PI_3$				$\otimes$	
$*PI_4$			$\times$		$\otimes$
$*PI_5$		$\otimes$			

$$PI_{\alpha\beta} = PI_1 + PI_3 + PI_4 + PI_5$$
$$= \bar{B}\bar{C} + A\bar{B}\bar{D} + A\bar{C}D + \bar{A}BC\bar{D}$$

(b) $f(A,B,C,D) = \sum m(1,4,7,10,13) + d(5,14,15)$

List 1			List 2			List 3		
Minterm	$ABCD$		Minterms	$ABCD$		Minterms	$ABCD$	
1	0001	√	1,5	0-01	PI_2	5,7,13,15	-1-1	PI_1
4	0100	√	4,5	010-	PI_3			
5	0101	√	5,7	01-1	√			
10	1010	√	5,13	-101	√			
7	0111	√	10,14	1-10	PI_4			
13	1101	√	7,15	-111	√			
14	1110	√	13,15	11-1	√			
15	1111	√	14,15	111-	PI_5			

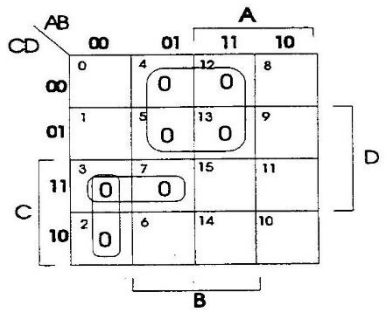
	√ 1	√ 4	√ 7	√ 10	√ 13
$*PI_1$			⊗		⊗
$*PI_2$	⊗				
$*PI_3$		⊗			
$*PI_4$				⊗	
PI_5					

$$PI_{\alpha\beta} = PI_1 + PI_2 + PI_3 + PI_4$$
$$= BD + \bar{A}\bar{C}D + \bar{A}B\bar{C} + AC\bar{D}$$

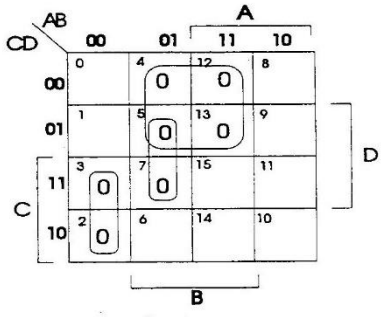
Problem 3. Text Problem 3.45 (a & b)

3.45 Find the minimum POS form for the following functions.

(a) $f(A,B,C,D) = \prod M(2,3,4,5,7,12,13)$
$= (\bar{B}+C)(A+B+\bar{C})(A+\bar{C}+\bar{D})$ - Option 1
$= (\bar{B}+C)(A+B+\bar{C})(A+\bar{B}+\bar{D})$ - Option 2

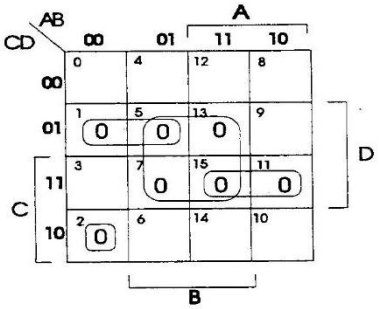


Option 1



Option 2

(b) $f(A,B,C,D) = \prod M(1,2,5,7,11,13,15)$
$= (\bar{B}+\bar{D})(A+C+\bar{D})(\bar{A}+\bar{C}+\bar{D})(A+B+\bar{C}+D)$



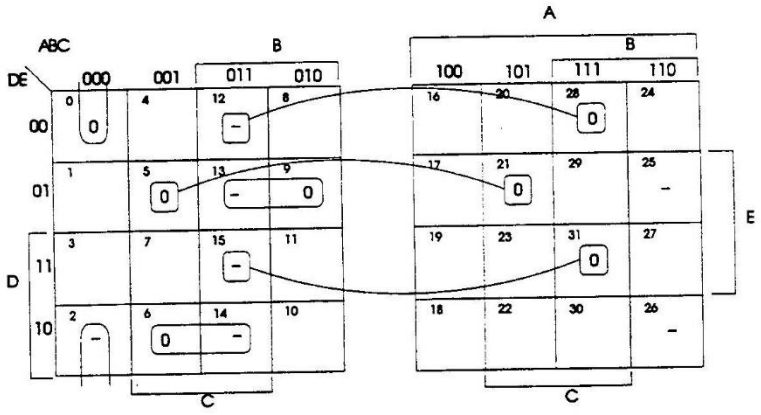
Problem 4. Text Problem 3.55

3.55 Find the minimum POS form for the following function.

$$f(A,B,C,D,E) = \prod M(0,5,6,9,21,28,31) \cdot D(2,12,13,14,15,25,26)$$

$$= (A+B+C+E)(B+\bar{C}+D+\bar{E})(A+\bar{C}+\bar{D}+E)(\bar{B}+\bar{C}+D+E)$$
$$\cdot(\bar{B}+\bar{C}+\bar{D}+\bar{E})(A+\bar{B}+D+\bar{E}) \quad \text{- Opt 1}$$

$$= (A+B+C+E)(B+\bar{C}+D+\bar{E})(A+\bar{C}+\bar{D}+E)(\bar{B}+\bar{C}+D+E)$$
$$\cdot(\bar{B}+\bar{C}+\bar{D}+\bar{E})(\bar{B}+C+D+\bar{E}) \quad \text{- Opt 2}$$



Option 1

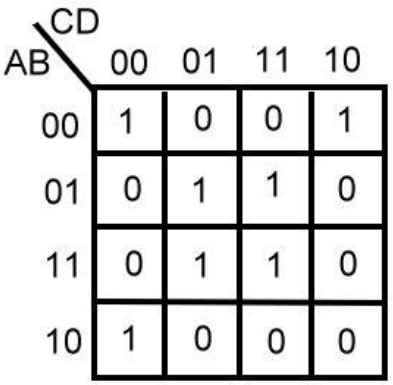
Problem 5

. Please indicate which of the following are or are not XOR or XNOR functions.
For those functions that are XOR or XNOR , write their the algebraic expression for that function.

a. f(A,B,C) = ∑m (1,3,4,6)

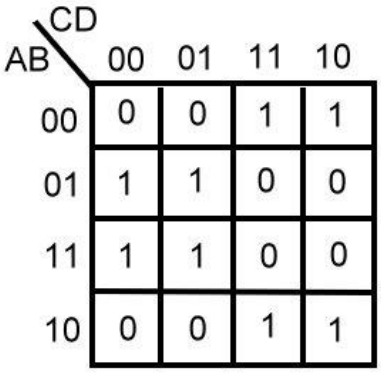
A \ BC	00	01	11	10
0	0	1	1	0
1	1	0	0	1

b. f(A,B,C,D) = ∑m (0,2,5,7,8,13,15)



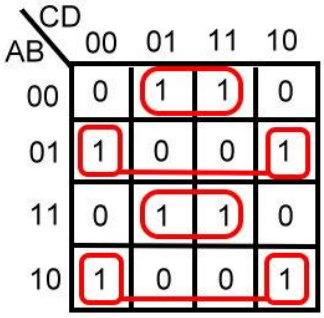
NO, it is not XOR or XNOR. If minterm m10 were = 1, it would be an **XNOR .= (B ^ D)'**

c. f(A,B,C,D) = ∑m (2,3,4,5,10,11,12,13)



YES, it is an XOR function: **f(A,B,C,D) = B ^ C**

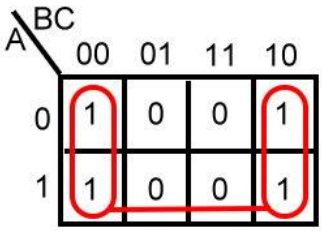
d. f(A,B,C,D) = ∑m(1,3,4,6,8,10,13,15)



Signature checkerboard pattern in groups of two 1's gives an XOR pattern (since 0000 cell = 0)

F(A,B,C,D) = A ^ B ^ D

e. f(A,B,C) = ∑m(0,2,4,6)

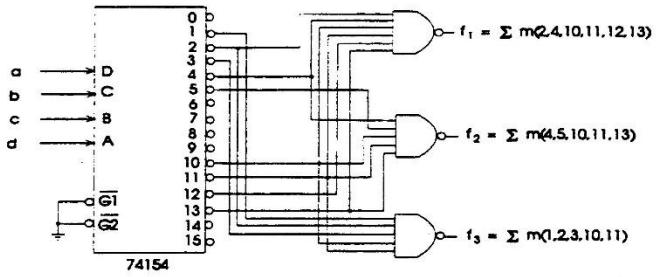


NO. This function is not an XOR or XNOR pattern.

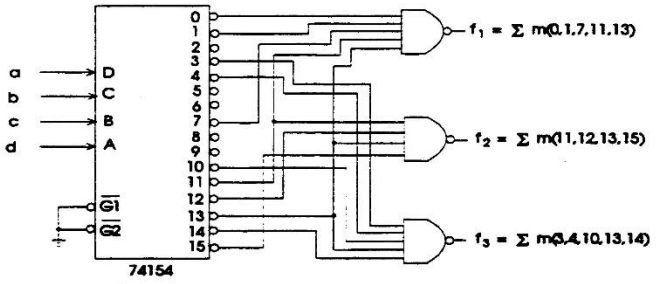
F(A,B,C) = C

4.4 Realize each of the following sets of functions using only a single 74154 decoder module and output logic gates (choose NAND or AND gates to minimize the fan-in of the output gates).

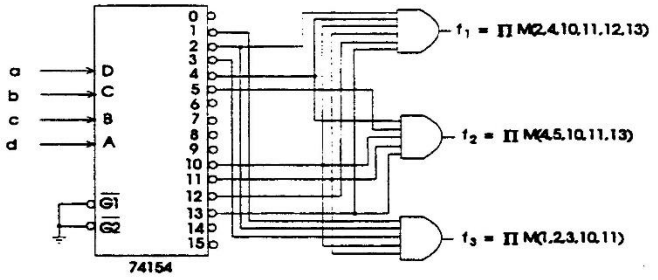
(a) $f_1(a,b,c,d) = \sum m(2,4,10,11,12,13)$
$f_2(a,b,c,d) = \prod M(0-3,6-9,12,14,15) = \sum m(4,5,10,11,13)$
$f_3(a,b,c,d) = \bar{b}c + \bar{a}\bar{b}d = \sum m(1,2,3,10,11)$



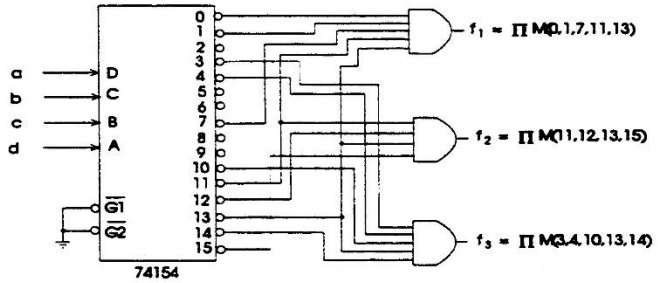
(b) $f_1(a,b,c,d) = \sum m(0,1,7,13)$
$f_2(a,b,c,d) = ab\bar{c} + acd = \sum m(11,12,13,15)$
$f_3(a,b,c,d) = \prod M(0-2,5-9,11,12,15) = \sum m(3,4,10,13,14)$



c. Repeat part (a) for the complements of the three functions.



d. Repeat part (b) for the complements of the three functions.



4.15 Design an 8-to-1 multiplexer, using only 4-to-1 multiplexer modules without enable lines. (Do not use any additional gates.)