ECEn/CS 224
Chapter 6 Homework Solutions

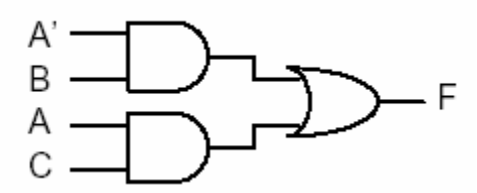
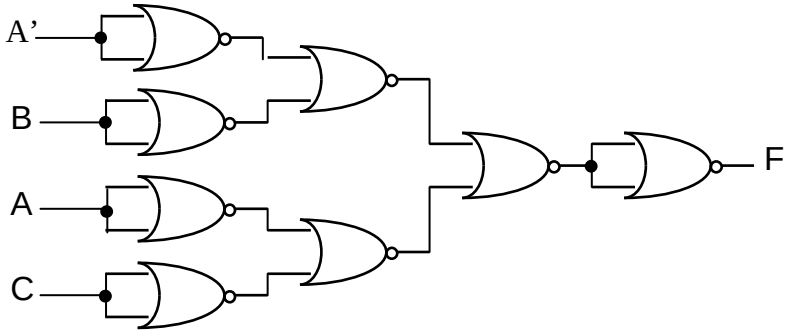
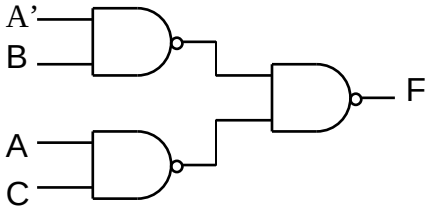


Figure 5.2(a)

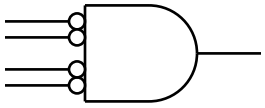
6.1. Implement the schematic for Figure 5.2(a) using only NOR gates.



6.2. Implement the schematic for Figure 5.2(a) using only NAND gates.



6.5. Assume you have been given the assignment to design a function to determine whether the value of a 4-bit Boolean value is equal to zero. A 4-bit value is zero if all of its individual bits are zero. The output of this function should be TRUE when the value of the 4-bit value is zero. Draw a single-gate schematic which implements this function. Use the correct symbol and justify your answer.



The output of this function is "1" if and only if all of the inputs are "0". This is the correct symbol because it clearly suggests that the output is "1" when the first, second, third, **and** fourth inputs are all **zero**.

6.7. Bubble match the schematic of Figure 6.14 to have a non-inverted output. Then, write the logic function the circuit implements by inspection.

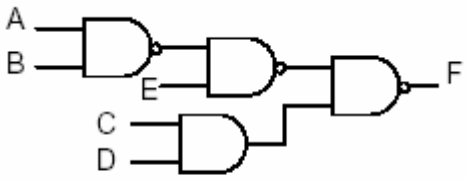
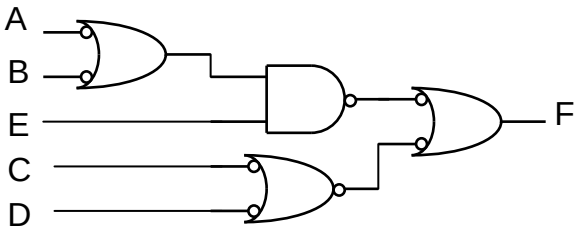


Figure 6.14: Problem Circuit

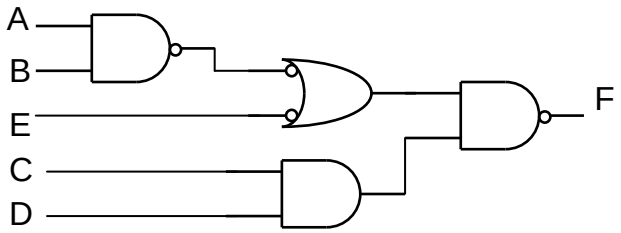
The bubble matched circuit with non-inverted output is:



The logic function for this circuit is:

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

6.8. Bubble match the schematic of Figure 6.14 to have an inverted output. Then, write the logic function the circuit implements by inspection.



F = [(AB + E')(CD)]' = [(AB + E')CD]'

6.9. Use DeMorgan's to verify that your answers to the previous two problems are equivalent.

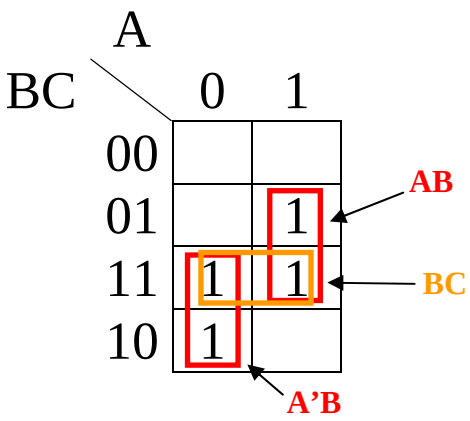
F = [(AB + E')CD]'
= (AB+E)' + (CD)'
= (AB)'E' + (C' + D')
= (A' + B')E' + C' + D'

The final line is the expression we obtained in problem 6.7. Thus the two answers are equivalent.

ECEn/CS 224
Chapter 7 Homework Solutions

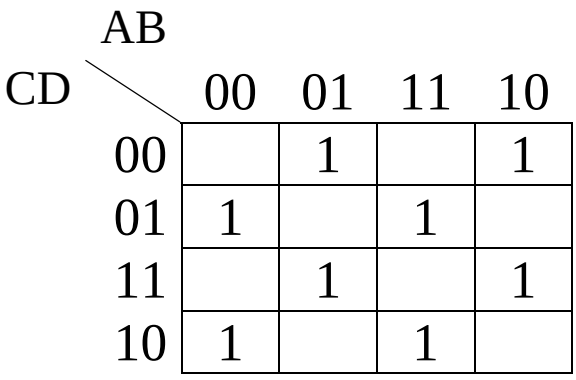
7.1 Using a KMap, prove the SOP form of the consensus theorem (see section 3.5.5). Does the KMap help illustrate why the third term is redundant?

The consensus theorem is: AC + A'B + BC = AC + A'B



From the KMap, we can see that BC is redundant. It is not required to cover all of the "1"s.

7.2. Draw the KMap for a 4-input XOR function. Can you see why it cannot be reduced?



It is clear from its KMap that the XOR function cannot be reduced because no groupings can be made to combine terms.

7.4. Find the minimum SOP solution to the following problem: F(A,B,C,D) = Σm(0,2,5,7,8,10,13,15). If multiple minimum solutions exist, show all of them.

CD \ AB	00	01	11	10
00	1			1
01		1	1	
11		1	1	
10	1			1

F = B'D' + BD = B ≡ D

7.5. Find the minimum POS solution to the following problem: F(A,B,C,D) = ΠM(1,3,4,6,9,11,12,14). If multiple minimum solutions exist, show all of them.

CD \ AB	00	01	11	10
00		0	0	
01	0			0
11	0			0
10		0	0	

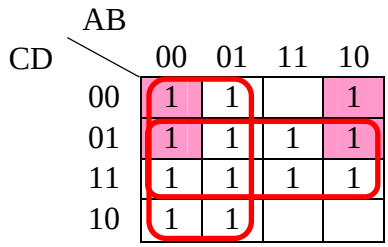
The inverse of F can be written from the groupings of "0"s as follows:

F' = B'D + BD' = B ⊕ D

Taking the inverse of both sides and applying DeMorgan's law we obtain:

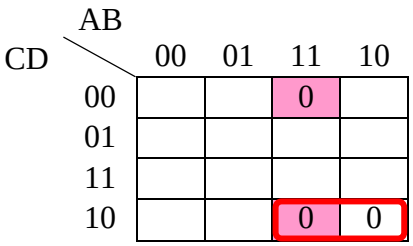
F = (B+D')(B'+D) = B ≡ D

7.6. Find the minimum SOP solution to the following problem: F(A,B,C,D) = Σm(0,1,2,3,4,5,6,7,8,9,11,13,15). If multiple minimum solutions exist, show all of them.



F = A' + D + B'C'

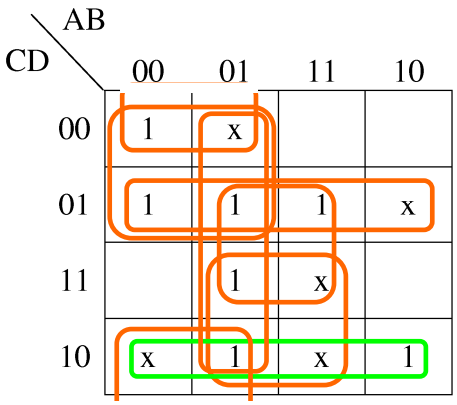
7.7. Find the minimum POS solution to the previous problem. If multiple minimum solutions exist, show all of them.



F' = ACD' + ABD'

F = (A'+C'+D)(A'+B'+D)

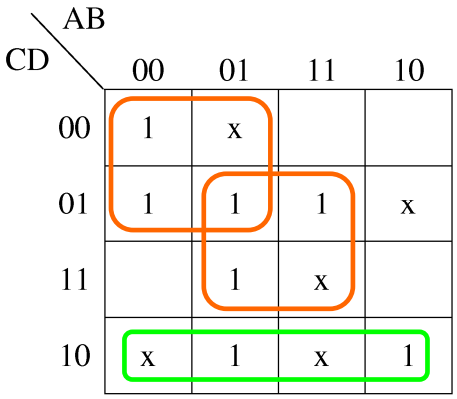
7.8. Consider the following problem: F(A,B,C,D) = Σm(0,1,5,6,7,10,13) + Σd(2,4,9,14,15). Identify all the prime implicants in its KMap. Then clearly mark (using color) the essential prime implicants.



Prime Implicants: C'D, CD', A'B, A'D', BD, BC, A'C'
Essential Prime Implicants: CD'

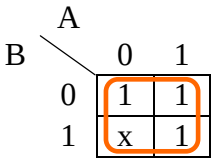
7.9 Write the minimum SOP solution to the KMap above. If multiple minimum solutions exist, show all of them.

Since CD' is an essential prime implicant, it must be in the solution. Given this, we must find the minimum number of prime implicants to cover the remaining "1"s.



F = CD' + BD + A'C'

7.11. Consider the following problem: F(A,B) = Σm(0,2,3) + Σd(1). Find the minimum SOP solution to this problem. If multiple minimum solutions exist, show all of them.



F = 1