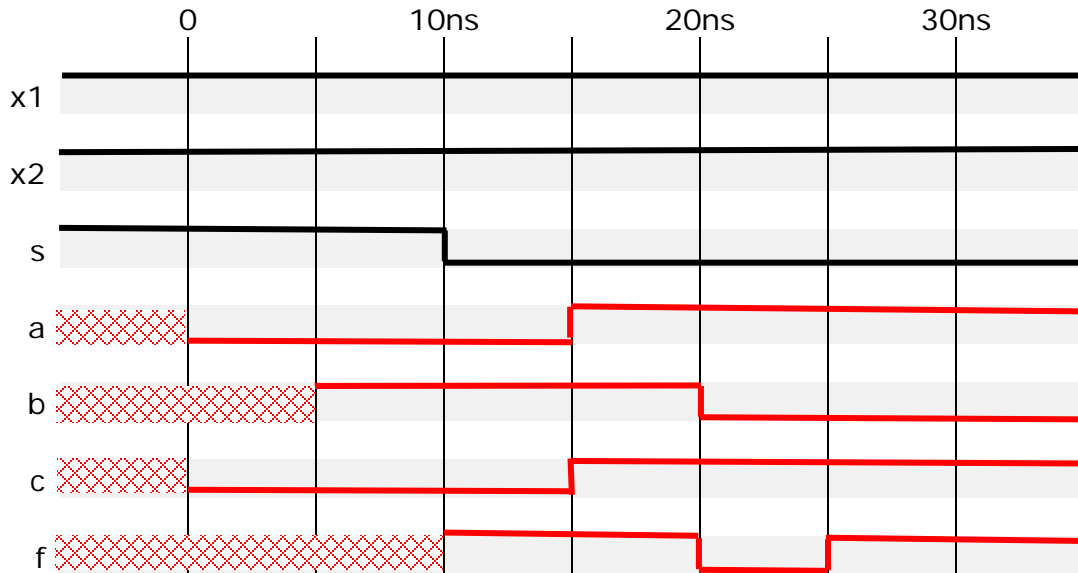
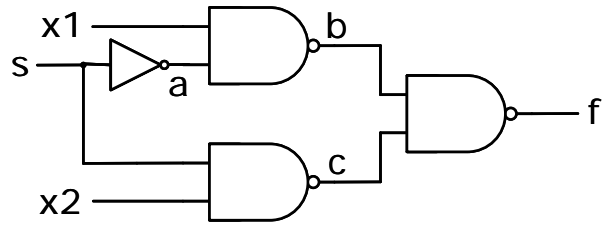


BEE 271 Spring 2017
Homework 2 answers

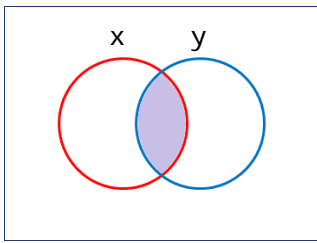
Please answer the following questions. Each is worth 10 points.

- Referring to this circuit, fill in the timing diagram below, showing what happens to signals a, b, c and f. Assume all gate delays are 5 ns. You may not assume anything about the input signals prior to what's shown, so please indicate by crosshatching any signals that are unknown.

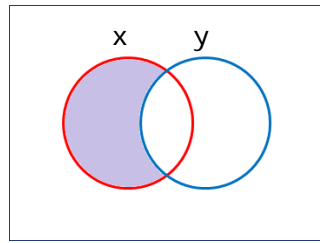


2. Prove the combining theorem using a Venn diagram.

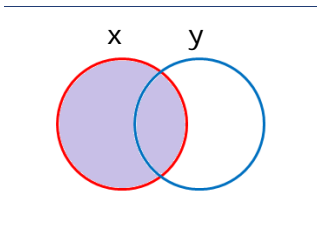
14a. $x \cdot y + x \cdot y' = x$



$x \cdot y$



$x \cdot y'$

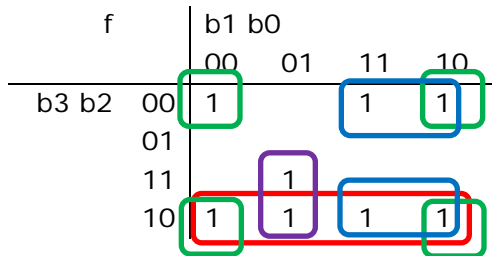


$x \cdot y + x \cdot y' = x$

3. What is an implicant? What is the difference between an implicant, a prime implicant and an essential prime implicant?

In SOP implementation, an implicant is a product term for which the output is a 1. In a POS implementation, an implicant is a sum term for which the output is a 0. A prime implicant is one that cannot be combined with another that has fewer literals. An essential prime implicant is one that must be included in any cover.

4. For the function f defined by this Karnaugh map, write the minterm equation $f = \Sigma m(\dots)$, identify the prime implicants and any essential prime implicants and then write the simplified SOP equation.



$f = \Sigma m(0, 2, 3, 8, 9, 10, 11, 13)$

All but the red implicant ($b_3 b_2'$) are essential prime implicants.

$f = b_2' b_1 + b_2' b_0' + b_3 b_1' b_0$

5. For the function g defined by this Karnaugh map, write the minterm equation $g = \Sigma m(\dots)$, identify the prime implicants and any essential prime implicants and then write the simplified SOP equation.

g		$b_1 b_0$			
		00	01	11	10
$b_3 b_2$	00	1	d		
	01	d	1		
	11			d	d
	10	1	1		

$g = \Sigma m(1, 7, 8, 9) + D(3, 5, 14, 15)$

The red and blue implicants are essential.
Green is not.

$g = b_3 b_2' b_1' + b_3' b_0$

6. For the function h defined by this Karnaugh map, write the Maxterm equation $h = \Pi M(\dots)$, identify the prime implicants and any essential prime implicants and then write the simplified POS equation.

h		$b_1 b_0$			
		00	01	11	10
$b_3 b_2$	00	0			0
	01				
	11	d			
	10	0	0	d	d

$h = \Pi M(0, 2, 8, 9) + D(10, 11, 12)$

Both implicants are essential prime.

$h = (b_3' + b_2) (b_2 + b_0)$

7. For the function j defined by this Karnaugh map, write the Maxterm equation $j = \Pi M(\dots)$, identify the prime implicants and any essential prime implicants and then write the simplified POS equation.

j		$b_1 b_0$			
		00	01	11	10
$b_3 b_2$	00	0		0	0
	01		0		
	11		0		
	10	0	d	0	0

$j = \Pi M(0, 2, 3, 8, 10, 11, 13) + D(9)$

All but the red implicant $(b_3' + b_2)$ are essential prime.

$j = (b_2 + b_1') (b_2 + b_0) (b_3' + b_1 + b_0')$

8. Use a Karnaugh map to find the simplest SOP equation for $f(a, b, c) = \Sigma m(1, 3, 5)$.

f		bc	00	01	11	10
a	0			1	1	
	1			1		

$$f = a'c + b'c$$

9. Use algebraic manipulation to derive the simplest SOP equation for $f(a, b, c) = \Sigma m(1, 3, 5)$, starting from the canonical SOP equation. (Hint: Does your Karnaugh map help you?)

$$\begin{aligned} f &= \Sigma m(1, 3, 5) \\ &= a'b'c + a'bc + ab'c \end{aligned}$$

Duplicating the first term (shared in the Karnaugh map) and grouping:

$$\begin{aligned} f &= (a'b'c + a'bc) + (a'b'c + ab'c) \\ &= a'(b' + b)c + (a' + a)b'c \\ &= a'c + b'c \end{aligned}$$

10. Use a Karnaugh map to find the simplest POS equation for $f(a, b, c, d) = \Pi m(5, 15) + D(7, 13)$.

f		cd	00	01	11	10
a b	00					
	01		0	d		
	11		d	0		
	10					

$$\begin{aligned} f &= \Pi m(5, 15) + D(7, 13) \\ &= b' + d' \end{aligned}$$