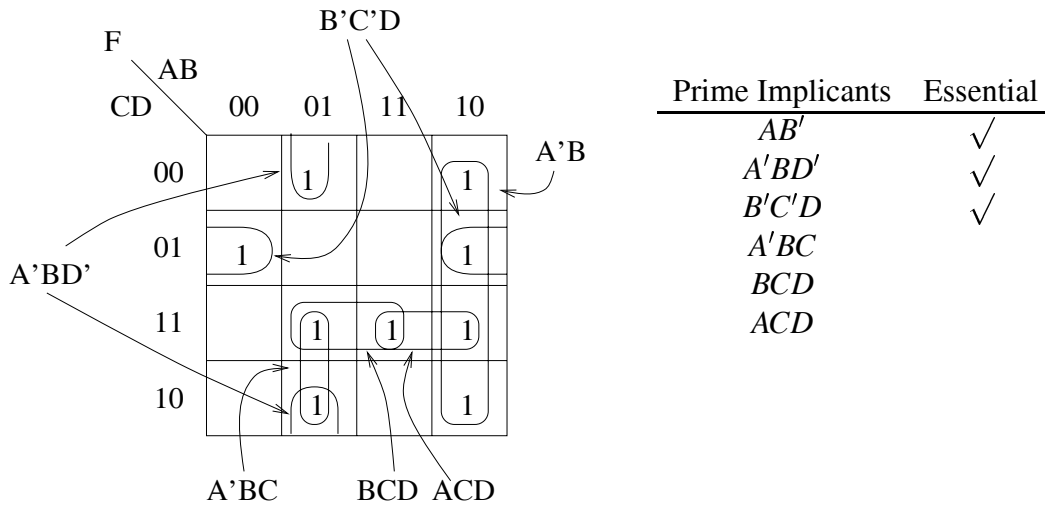


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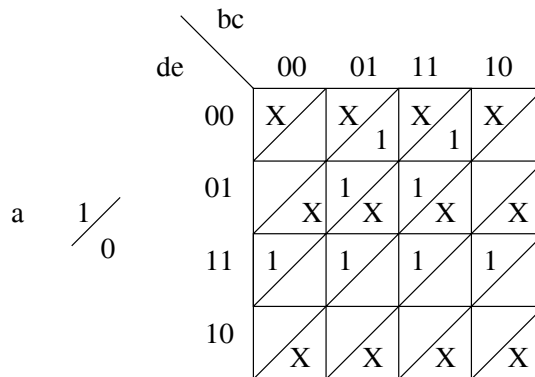
Sample Exam #2

From Fall 1998

1. (6 pts) For the function $f(A,B,C,D) = \sum m(1,4,6,7,8,9,10,11,15)$, list **all** of the prime implicants and indicate which of these are essential prime implicants.



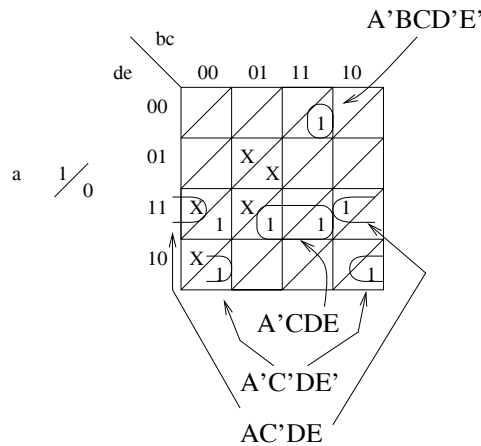
2. (4 pts) Fill in Karnaugh Map for the function
 $f(a,b,c,d,e) = ace + a'cd'e' + ac'de$
 with a function of don't care conditions given by:
 $d(a,b,c,d,e) = a'de' + a'd'e + ad'e'$



3. (6 pts) Use the Quine-McCluskey procedure to find all of the prime implicants for $f(a,b,c,d) = \sum m(3,7,9,14) + \sum d(1,4,6,11)$.

1	0001	✓	1,3	00-1	✓	(1,9),(3,11)	-0-1	PI-1
4	0100	✓	1,9	-001	✓	(1,3),(9,11)	-0-1	
			4,6	01-0	PI-2			
3	0011	✓						Prime Implicants
6	0110	✓	3,7	0-11	PI-3			PI-1 = $B'D$
9	1001	✓	3,11	-011	✓			PI-2 = $A'BD'$
			6,14	-110	PI-4			Don't Care
7	0111	✓	9,11	10-1	✓			PI-3 = $A'CD$
11	1011	✓	6,7	011-	PI-5			PI-4 = BCD'
14	1110	✓						PI-5 = $A'BC$

4. (6 pts) Loop all of the *essential prime implicants* on a Karnaugh map for $F(a,b,c,d,e) = \sum m(2,3,7,10,12,15,27) + \sum d(5,18,19,21,23)$.

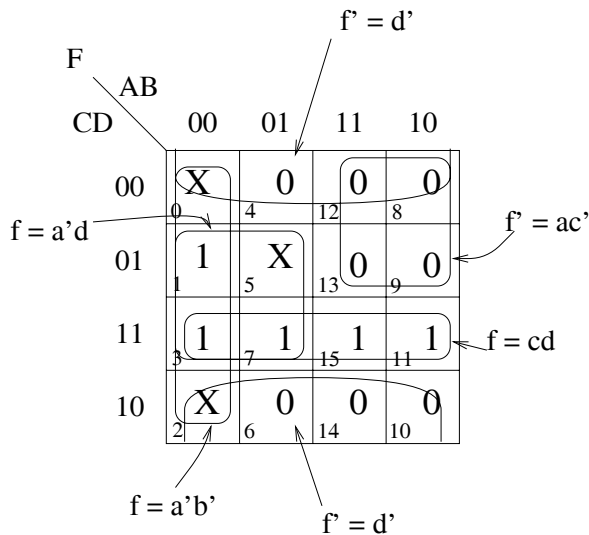


5. (4 pts) The prime implicants for the function $f(a,b,c,d,e) = \sum m(5,7,11,12,27,29) + \sum d(14,20,21,22,23)$ are $b'ce$, $ab'c$, $a'bce'$, $bc'de$, and $acd'e$. Set up a prime implicant chart to use to determine all of the minimal sum-of-product expressions for the function but do **not** actually find the minimal expression. Label the essential prime implicants (if any).

Prime Implicant	Binary Value	Covering	Minterms	Don't Care
$b'ce =$	-01-1	10111		23
		10101		21
		00111	7	
		00101	5	
$ab'c =$	101-	10111		23
		10110		22
		10101		21
		10100		20
$a'bce' =$	011-0	01110		13
		01100	12	
$bc'de =$	-1011	11011	27	
		01011	11	
$acd'e =$	1-101	11101	29	
		10101		21

	5	7	11	12	27	29
$b'ce$	X	X				
$ab'c$						
$a'bce'$				X		
$bc'de$			X		X	
$acd'e$						X

6. (8 pts) For the function $f(a,b,c,d) = \sum m(1,3,7,11,15) + \sum d(0,2,5)$,
 (a) find a minimum sum-of-products expression,
 (b) find a minimum product-of-sums expression.



(a) $f(a,b,c,d) = cd + a'b'$
 or
 $f(a,b,c,d) = cd + a'd$

(b) $f'(a,b,c,d) = d' + ac'$
 applying DeMorgan's Law results in:
 $f(a,b,c,d) = d(a'+c)$

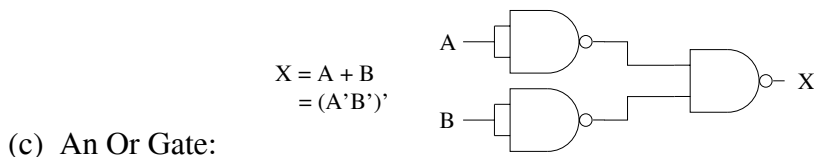
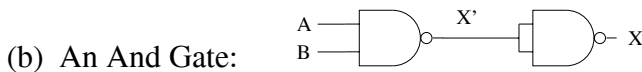
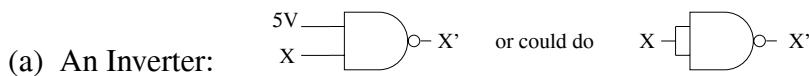
7. (8 pts) Use a prime implicant chart to minimize the function $f(a, b, c, d) = \sum m(4, 5, 6, 8, 11, 13, 15)$ which has the following prime implicants: $a'bc'$, $a'bd'$, $bc'd$, acd , abd , and $ab'c'd'$

	4	5	6	8	11	13	15						
	$a'bc'$	X	X										
Essential	$a'bd'$	X		(X)									
	$bc'd$		X			X							
Essential	acd				(X)		X						
	abd					X	X						
Essential	$ab'c'd'$			(X)									

Essential prime implicants cover minterms 4,6,8,11 and 15. Need prime implicants to cover minterms 5 and 13. Both are covered by $bc'd$, so we have:

$$f = a'bd' + acd + ab'c'd' + bc'd$$

8. (4 pts) Indicate how a NAND gate can be used to implement:



- (d) Because a NAND gate can be used to implement all three basic Boolean functions, how would we describe it? **Functionally Complete**

9. (4 pts) Fill in Karnaugh Map for the function

$$f(a,b,c,d,e) = \prod M(1, 3, 6, 11, 15, 19, 20, 25, 27) \cdot \prod D(4, 9, 13, 16, 29, 31).$$

		bc			
		00	01	11	10
a	de	00	01	11	10
	00	X 1	0 X	1 1	1 1
	01	1 0	1 1	X X	0 X
	11	0 0	1 1	X 0	0 0
10	1 1	1 0	1 1	1 1	