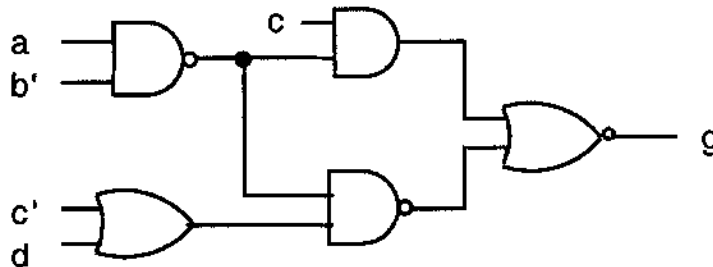


Do any 10 of the 12 problems. Make sure it is clear which one you do not want graded (or I will grade the first 10 problems). All problems are worth 20 points.

1. The following function is already in minimum sum of products form. Show the equation and a block diagram for an implementation using only 2-input NAND gates. No gate may be used as a NOT. All variables are available both uncomplemented and complemented. For full credit, find a solution using 14 gates; partial credit for more gates or one or two 3-input gates. Bonus of up to 5 points for less.

$$F = A'B'C'D' + B'CD'E + BD + BC'E' + CDE' + C'DE$$

2. Show an algebraic expression for the following circuit. Reduce it to a minimum sum of products expression (2 terms, 4 literals.)



3. Convert the following to a sum of minterms. Remove any duplicates from the list.

$$f = (a + b' + c)(a + c + d)(b + c')(b' + d')$$

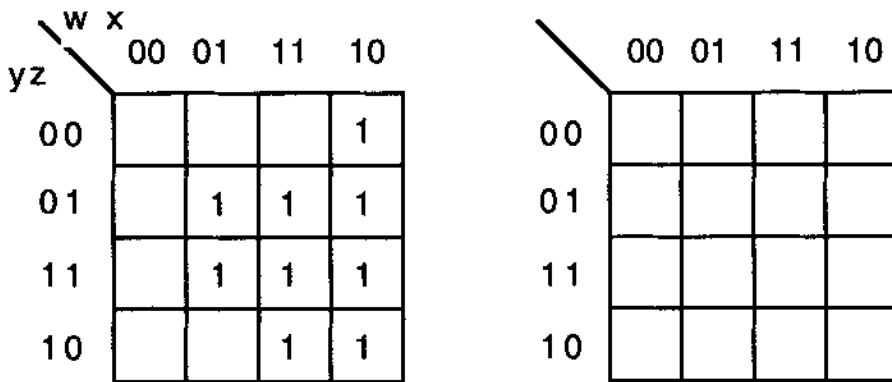
4. For the following function, find THE minimum sum of products solution.

		a b			
		00	01	11	10
c d	00	1			
	01		1	1	1
	11		1		1
	10	1	1		

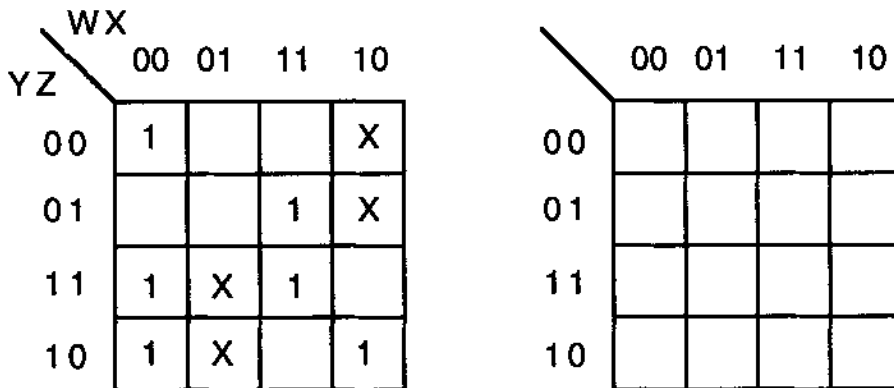
5. For the following function, list all of the prime implicants and find BOTH minimum sum of product expressions. (extra maps shown for your convenience)

$$h(w, x, y, z) = \sum m(2, 3, 5, 6, 7, 9, 10, 11, 13, 14)$$

6. For the function, g, shown, show the equations and a block diagram for a minimum cost two-level NAND implementation a minimum two-level NOR implementation (spare map shown). All variables are available both uncomplemented and complemented.



7. For the function, f, shown find a minimum sum of products expression and a minimum product of sums expression (spare map shown).



8. For the following function (3 copies of the map shown), find all 4 minimum sum of products expressions.

		a b			
	c d	00	01	11	10
00			X	1	X
01		X	1	X	X
11			X	1	
10				1	X

		a b			
	c d	00	01	11	10
00			X	1	X
01		X	1	X	X
11			X	1	
10				1	X

		a b			
	c d	00	01	11	10
00			X	1	X
01		X	1	X	X
11			X	1	
10				1	X

9. For the following 5-variable function, F, find BOTH minimum sum of product solutions. (Two copies of the map are shown.)

		BC				0
	DE	00	01	11	10	
00		1			1	
01		1	1	1	1	
11					1	
10					1	

		BC				1
	DE	00	01	11	10	
00						
01			1	1		
11				1	1	
10				1	1	

10. For the following 5-variable function, F, find the minimum sum of product solution. (Two copies of the map are shown.) (6 terms, 20 literals)

		BC				0
	DE	00	01	11	10	
00		1		1		
01			1	1		
11			1	1	1	
10			1	1	1	

		BC				1
	DE	00	01	11	10	
00				1		
01		1	1	1	1	
11		1			1	
10					1	

11. For the two functions shown, find a minimum two-level solution (map and equations) corresponding to 5 AND gates and 2 OR gates with a total of 19 inputs. All inputs are available both uncomplemented and complemented. (Show only the maps and equations.)

		w	x		
	y z	00	01	11	10
00		1			
01		1	1	1	
11		1	1	1	
10		1		1	

f

		w	x		
	y z	00	01	11	10
00		1			1
01		1	1	1	
11		1	1	1	
10				1	

g

12. For the three functions shown, find a minimum two-level solution (map and equations) corresponding to 7 AND gates and 3 OR gates with a total of 30 inputs. All inputs are available both uncomplemented and complemented. (Show the maps and equations.)

		a	b		
	c d	00	01	11	10
00				1	1
01		1	1		
11		1	1		1
10			1	1	

f

		a	b		
	c d	00	01	11	10
00		1			1
01			1	1	
11					
10			1	1	

g

		a	b		
	c d	00	01	11	10
00					1
01		1	1	1	
11		1	1		
10					1

h