NAME: SOLUTIONS **UNumber:** _____ **Computer Logic Design**

Duration: 75 Minutes **CDA 3201** **September 29, 2016**

Closed Book, Notes, HW **Exam 1** **R. Kasturi**

One sheet of Letter size paper written on front and back is allowed.

SHOW ALL WORK TO GET PARTIAL CREDIT. MAKE REASONABLLE ASSUMPTIONS.

I (One point each) Answer True or False. Unless otherwise noted, all numbers are in decimal.

_T_ a. If a Boolean expression is false its dual must also be false.

_T_ b. Quine-McCluskey method is guaranteed to find the most minimized Sum of Products expression.

_T_ c. For a function of three binary variables, $\sum m(1,3,6,7) + \sum d(0,2)$ and $\prod M(4,5).\prod D(0,2)$ have identical truth tables.

_F_ d. Every *Don't Care* term must be covered by at least one of the terms of the resulting Boolean expression.

_F_ f. A truth table implemented by its Ca*nonical Product of Sums* form must have the same number of literals as its *Canonical Sum of Products* implementation.

_F_ e. An N-Channel MOS transistor forms a conducting channel when its gate is negative with respect to its source.

_F_ g. The minimized Boolean expression for any function obtained from Quine McCluskey method must include every variable in its true or complement form.

_F_ h. $(011)_2$ x $(011)_2$ x $(011)_2$ = $(0111111)_2$ where x denotes multiplication operation.

_T_ i. When representing positive values, $(4077)_8 = (83F)_{16}$

_T_ j. $\overline{[A(\overline{AB})]}.\overline{[B(\overline{AB})]} = \overline{A\overline{B} + \overline{A}B}$

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II (10 points) Use the Quine-McCluskey Method to find the minimum sum of products form for the Boolean expression $F(W,X,Y,Z) = \Sigma m(0,4,5,8,9,13) + \Sigma d(2,7,15)$. Identify Essential Prime Imlicants, if any.

QUINE-McCLUSKEY IMPLICATION TABLE

Minterm	Column 1	Column 2	Column 3
0	0 0 0 0 ✓	0 0 _ 0 *	
2	0 0 1 0 ✓	0 _ 0 0 *	
4	0 1 0 0 ✓	_ 0 0 0 *	
8	1 0 0 0 ✓	0 1 0 _ *	
5	0 1 0 1 ✓	1 0 0 _ *	
9	1 0 0 1 ✓	0 1 _ 1 ✓	_ 1 _ 1 *
7	0 1 1 1 ✓	_ 1 0 1 ✓	
13	1 1 0 1 ✓	1 _ 0 1 *	
15	1 1 1 1 ✓	_ 1 1 1 ✓	
		1 1 _ 1 ✓	

WX / YZ	00	01	11	10
00	0: 1	4: 1	12: 0	8: 1
01	1: 0	5: 1	13: 1	9: 1
11	3: 0	7: X	15: X	11: 0
10	2: X	6: 0	14: 0	10: 0

CROSSCHECK WITH K-MAP

$XZ + \bar{W}\bar{Y}\bar{Z} + W\bar{X}\bar{Y}$

Prime Implicant Chart

MINTERMS	0	4	5	8	9	13	
5,7,13,15 _ 1 _ 1	- - -	- - -	- * -	- - -	- - -	- * -	✓
0,2 00_0	*						THERE ARE
0,4 0_00	- * -	- * -	- - -	- - -	- - -	- - -	✓ NO
0,8 _000	*			*			EPIs
4,5 010_		*	*				
8,9 100_	- - -	- - -	- - -	* -	- * -	- - -	✓
9,13 1_01					*	*	
COVERED ? →	✓	✓	✓	✓	✓	✓	

Final Boolean Expression, F(WXYZ) = $XZ + \bar{W}\bar{Y}\bar{Z} + W\bar{X}\bar{Y}$

THIS PROVIDES MINIMAL COVER

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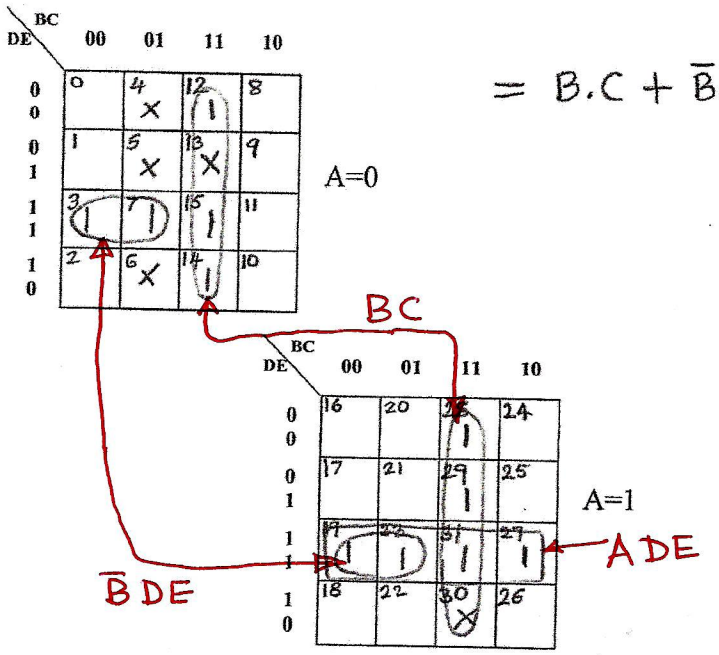
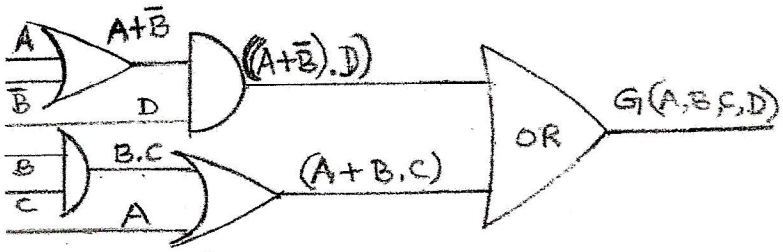
III (a) (5 points) Using K-map find the simplified Boolean expression for the function
$F(A,B,C,D,E) = \sum m(3,7,12,14,15,19,23,27,28,29,31) + \sum d(4,5,6,13,30)$

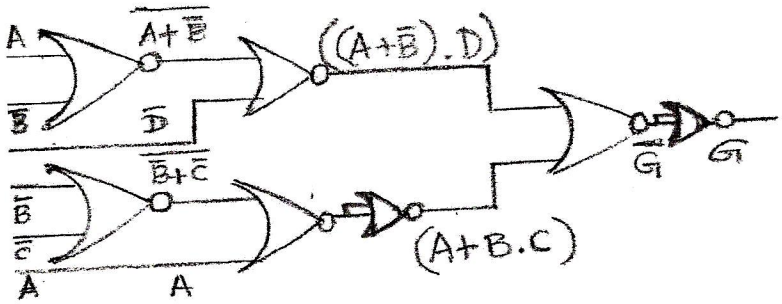


$= B.C + \bar{B}.D.E + A.D.E$

(b) (i) (2 points) Draw the gate level diagram for the multi-level function exactly as expressed here (i.e., do not expand or simplify): $G(A,B,C,D) = \left((A+\bar{B}).D\right) + (A+B.C)$



(ii) (3 points) Redraw the function (do not expand or simplify) using only NORs:



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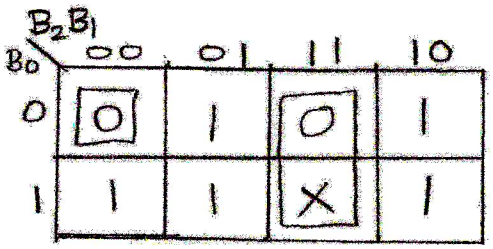
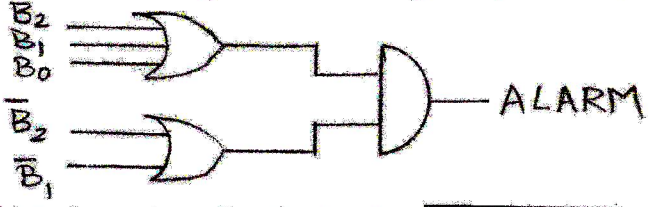
IV (a) (6 points) Days of the week are represented using three bits as shown in the table. An alarm circuit is enabled and rings a bell each day of the week at 7 AM but you want to disable it on the weekend. Complete the Truth Table representing disabled alarm on Saturday and Sunday by 0; derive the minimized **product of sums** (POS) binary expression for the alarm. Draw the corresponding gate level diagram. Assume that the variables are available in both True and Complement form.

B_2	B_1	B_0	DAY	ALARM
0	0	0	SUN	0
0	0	1	MON	1
0	1	0	TUE	1
0	1	1	WED	1
1	0	0	THU	1
1	0	1	FRI	1
1	1	0	SAT	0
1	1	1	---	X



$$ALARM = (B_2 + B_1 + B_0).(\overline{B}_2 + \overline{B}_1)$$



(b) (4 points) Show the arrangement of CMOS transistors to realize the function $\overline{((A.B + C).D)}$