EE 2720, Spring 05

~~Solutions of Homework #7~~

Solutions of Test #2

EE 2720, Spring 05, Test 2 Solutions (1)

Problem 1: $X \cdot Y + X' \cdot Z + Y \cdot Z =$

$X \cdot Y + X' \cdot Z + 1 \cdot YZ = X \cdot Y + X' \cdot Z + (X + X') \cdot Y \cdot Z =$

$= X \cdot Y + X' \cdot Z + X \cdot Y \cdot Z + X' \cdot Y \cdot Z =$

$= \underbrace{X \cdot Y + X \cdot Y \cdot Z} + \underbrace{X' \cdot Z + X' \cdot Z \cdot Y} =$

$= X \cdot Y \cdot (1 + Z) + X' \cdot Z (1 + Y) =$

$= X \cdot Y \cdot 1 + X' \cdot Z \cdot 1 = X \cdot Y + X' \cdot Z \Rightarrow$ proven

Problem 2: Apply theorem of eq. (2) first to get:

$(A + B + C') \cdot (A' + B' + D) \cdot (A' + C + D') \cdot (A + C' + D) =$

$= (A + C' + B) \cdot (A + C' + D) \cdot (A' + B' + D) \cdot (A' + C + D') =$

$= (A + C' + B \cdot D) \cdot [A' + (B' + D) \cdot (C + D')] =$

$= (A + C' + B \cdot D) \cdot [A' + (D + B') \cdot (D' + C)]$

Now apply theorem of eq. (3) on $(D + B') \cdot (D' + C)$ to get:

$(A + C' + B \cdot D) \cdot (A' + D \cdot C + D' \cdot B')$; (apply theorem of eq (3) again).

$= A \cdot (D \cdot C + D' \cdot B') + A' (C' + B \cdot D)$; (now apply theorem of eq (1))

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Problem 2 cont:

$$= A\cdot D\cdot C + A\cdot D'\cdot B' + A'\cdot C' + A'\cdot B\cdot D.$$

If we were to multiply out using only theorem of eq. (1), we would generate $3\times3\times3\times3 = 81$ product terms and would have to eliminate 77 of them!! (too much work and not easy). Here I only got 4 terms

Problem 3:

$$F = X + X'\cdot Y + Y\cdot Z' =$$

$$= X\cdot\underbrace{(Y+Y')}_{1}\cdot\underbrace{(Z+Z')}_{1} + X'\cdot Y\cdot\underbrace{(Z+Z')}_{1} + Y\cdot Z'\underbrace{(X+X')}_{1}$$

$$= X\cdot(Y\cdot Z + Y\cdot Z' + Y'\cdot Z + Y'\cdot Z') + X'\cdot Y\cdot Z +$$

$$+ X'\cdot Y\cdot Z' + X\cdot Y\cdot Z' + X'\cdot Y\cdot Z' =$$

$$= X\cdot Y\cdot Z + X\cdot Y\cdot Z' + X\cdot Y'\cdot Z + X\cdot Y'\cdot Z'$$

$$+ X'\cdot Y\cdot Z + X'\cdot Y\cdot Z' + \cancel{X\cdot Y\cdot Z'} + \cancel{X'\cdot Y\cdot Z}$$

$$= \underset{1\,1\,1}{X\cdot Y\cdot Z} + \underset{1\,1\,0}{X\cdot Y\cdot Z'} + \underset{1\,0\,1}{X\cdot Y'\cdot Z} + \underset{1\,0\,0}{X\cdot Y'\cdot Z'} + \underset{0\,1\,1}{X'\cdot Y Z}$$

$$+ \underset{0\,1\,0}{X'\cdot Y\cdot Z'} = \Sigma_{X,Y,Z}(2,3,4,5,6,7)$$

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Problem 4: $F = (X'+Y)\cdot(X+Z')\cdot(Y'+Z) =$

$$= (X'+Y+\underbrace{Z\cdot Z'}_{0})\cdot(X+Z'+\underbrace{Y\cdot Y'}_{0})\cdot(Y'+Z+\underbrace{X\cdot X'}_{0})$$

$$= (X'+Y+Z)\cdot(X'+Y+Z')\cdot(X+Z'+Y)\cdot(X+Z'+Y')\cdot$$

$$(Y'+Z+X)\cdot(Y'+Z+X') =$$

$$= (\underset{1}{X'}+\underset{0}{Y}+\underset{0}{Z})\cdot(\underset{1}{X'}+\underset{0}{Y}+\underset{1}{Z'})\cdot(\underset{0}{X}+\underset{0}{Y}+\underset{1}{Z'})\cdot(\underset{0}{X}+\underset{1}{Y'}+\underset{1}{Z'})$$

$$\cdot(\underset{0}{X}+\underset{1}{Y'}+\underset{0}{Z})\cdot(\underset{1}{X'}+\underset{1}{Y'}+\underset{0}{Z}) = \prod_{X,Y,Z}(1,2,3,4,5,6)$$

Problem 5: (a) Using the graphical approach:

I will first provide a figure showing an OR-AND realization of F from where I will get the figure that shows the realization using only NOR gates

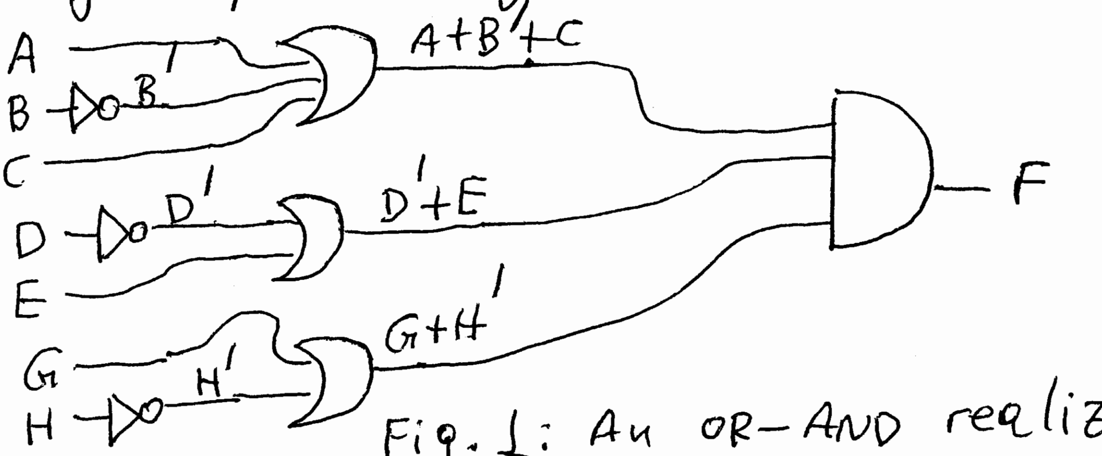

Fig. 1: An OR-AND realization of F

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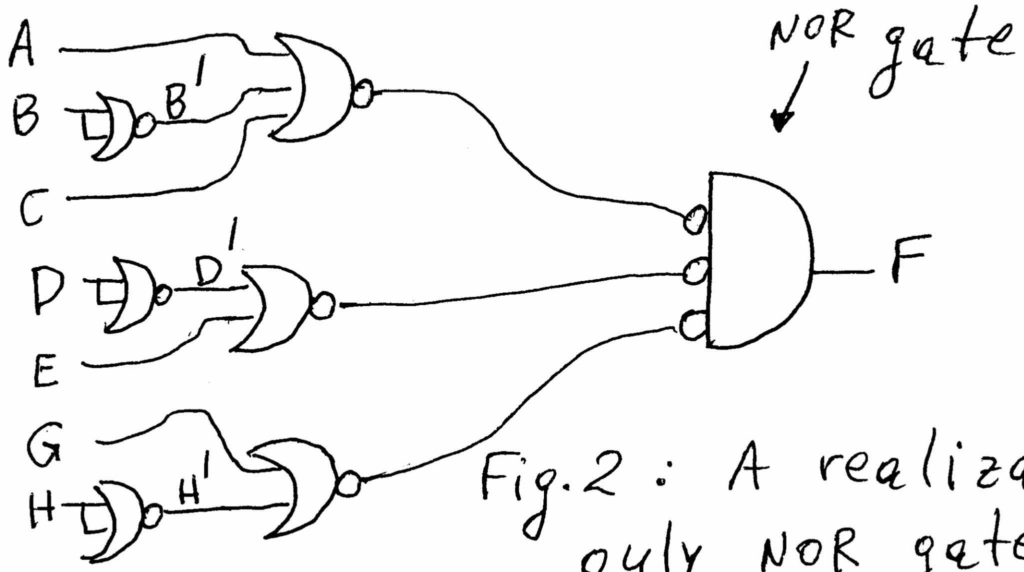

Fig.2 : A realization of F using only NOR gates.

(b) Using the algebraic approach: we have:

$$F = (A+B'+C)\cdot(D'+E)\cdot(G+H') =$$
$$= [[(A+B'+C)\cdot(D'+E)\cdot(G+H')]']'$$
$$= [(A+B'+C)' + (D'+E)' + (G+H')']' \quad (1)$$

From the above eq. (1) we get the following realization shown below.

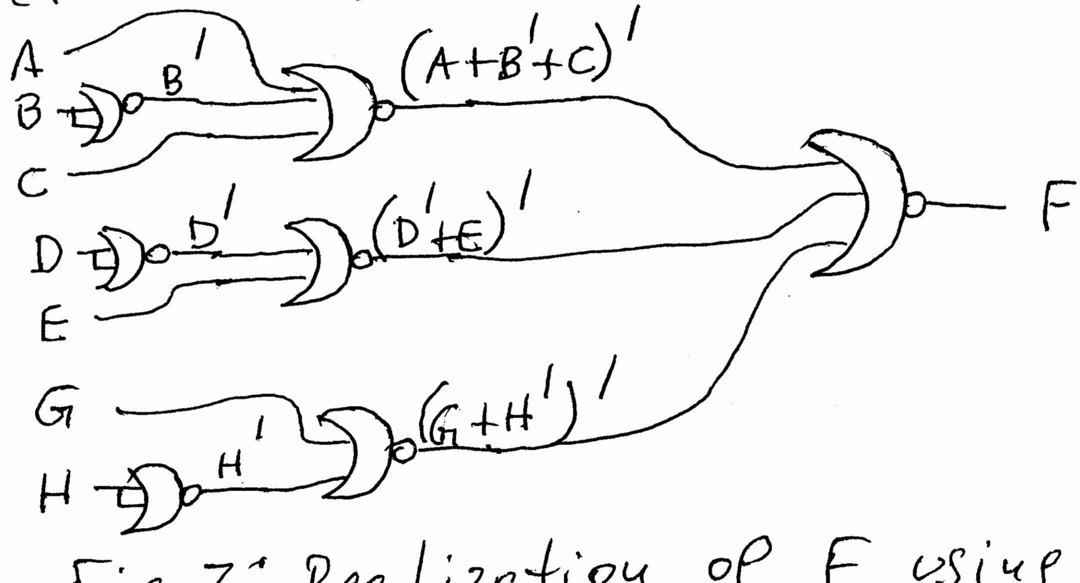

Fig 3: Realization of F using only NOR gates.

Problem 6:

(a)

B

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

$A \cdot C \cdot D'$

From this Karnaugh map we get the following simplified sum-of-products expression for F:

$$\boxed{F = B + A \cdot C \cdot D'}$$

(b)

A+B

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

B+C

B+D'

From this Karnaugh map we get the following simplified product-of-sums expression for F:

$$\boxed{F = (A+B) \cdot (B+C) \cdot (B+D')}$$

Note: Points → (16+20+16+16+16+16) pts = 100 pts