Department of Computer Science
National Chiao Tung University

Digital System Design

First Midterm Exam 11/1/2012

1. (10%) Convert decimal +47, +26 to binary using the *signed 2's complement* representation and enough bits to accommodate the numbers. Then perform the binary equivalent of (+26)+(−47), and (−26)+(−47). What is the minimum number of bits which is needed for correct results of these computations?

2. (10%) Represent the *unsigned* decimal numbers 53 and 69 in BCD, and then show the steps necessary to form their sum.

3. (6%) Find the *complement* of $g(x,y,z) = w(x'+y'z)$.

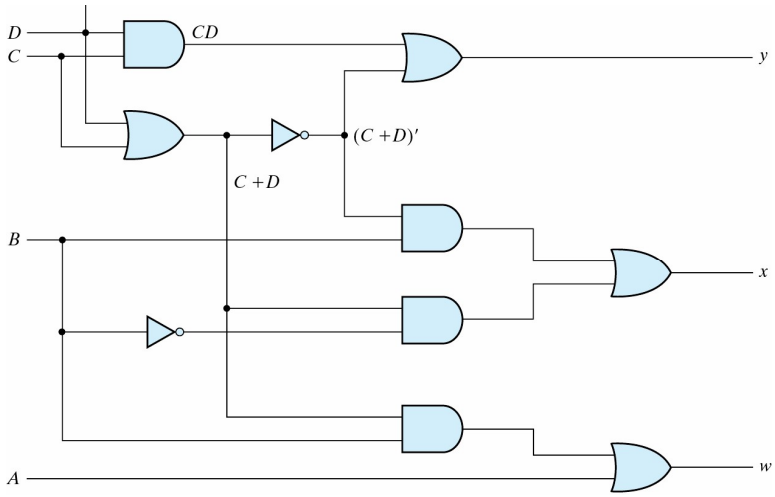
4. (10%) Show that $(y+x)\,(y+z') = y+(xz')$ by using (i) truth table and (ii) algebraic manipulation (without using distributive laws).

5. (8%) Express the complement of function $F(A,B,C,D)=A'(B'C+D')+B'CD$ in *product-of-maxterm* form.

6. (10%) Obtain the optimal *sum-of- product* (SOP) implementation of $F(w,x,y,z) = \sum(3,4,6,10,12,14)$ with *don't care* conditions $d(w,x,y,z) = \sum(1,8,9,13)$.

7. (10%) Find all *prime implicants* for $F(A,B,C,D) = \sum(0,2,4,5,7,8,10,13)$ and determine which are *essential.*

8. (18%) For the following circuit, obtain multiple-level NAND gate circuit for w, the optimal POS implementation of x, and the truth table of y.



9. (8%) Obtain the two-level NAND implementation of $f(x,y,z) = y+(xy+z')(y'+z)$.

10. (10%) Implement $F = AB' + B'C + AC'D$ with OR and inverter gates.

1. $(+47)_{10} = (0101111)_2 \rightarrow 1010000 + 1 = 1010001 \, (2's)$

$(+26)_{10} = (0011010)_2 \rightarrow 1100101 + 1 = 1100110 \, (2's)$

①

sign

0011010

0100001

+) (0101111) + 1 : 1 1010001   2's complement

1110101 ↘ −1

1110100 ↙ 取補

0001011 ↘

$-(0001011) = -21$ #

② 1110011 0

1101001

$\cancel{1}$ 1011011 1 → 1011011 0 → 0100100 1

8 bits → −(64 8 1   )

→ −73 #

2. $(53)_{10} = (0101 \; 0011)_{BCD}$

$(69)_{10} = (0110 \; 1001)_{BCD}$

+)

1011 1100

+) 0110 0110

1 0010 0010

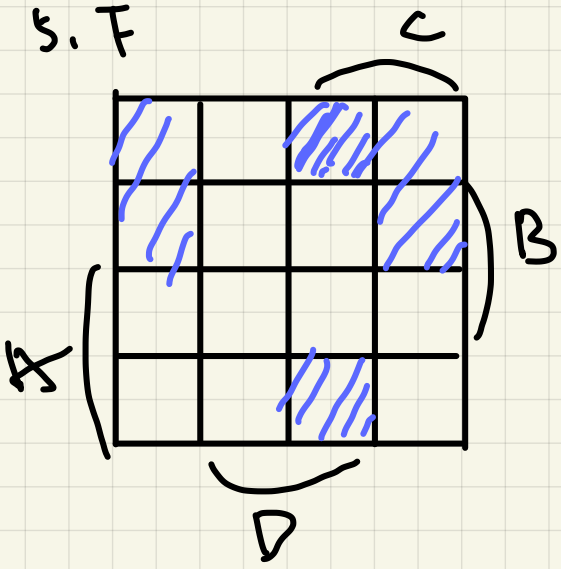
1 2 2 #

3. $w' + (x(y+z'))$

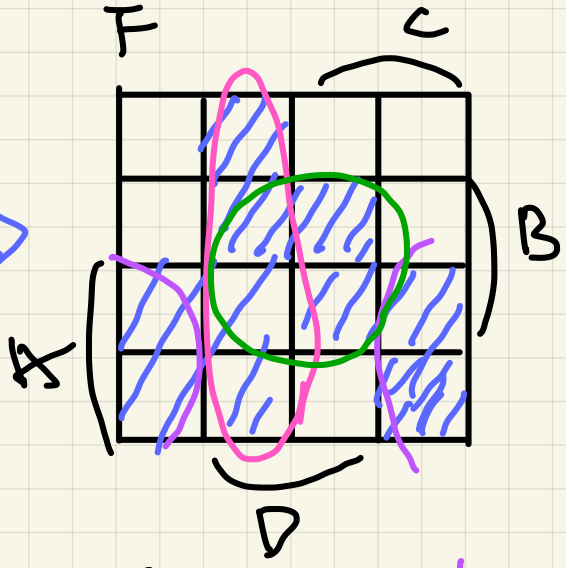
4 (i) x y z $(y+x)$ $(y+z')$ $(y+x)(y+z')$ $y+(xz')$

(ii) $(y+x)(y+z')$

5. F



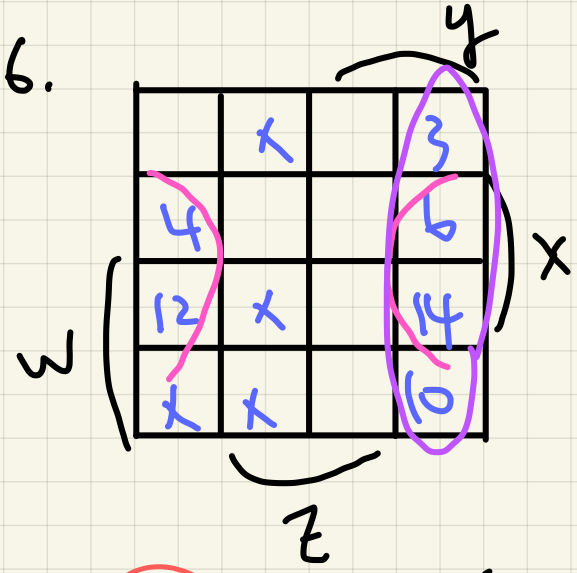
⇒



$F' = CD + AD' + BD$

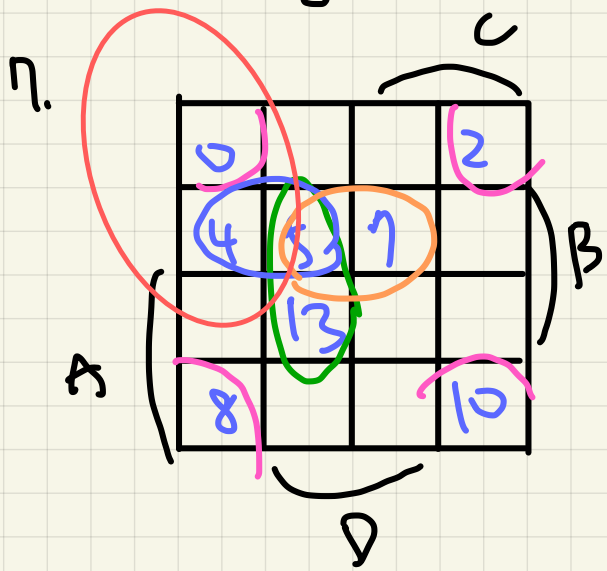
$F = (C+D')(A'+D)(B'+D')$

6.



$F = xz' + yz'$

7.



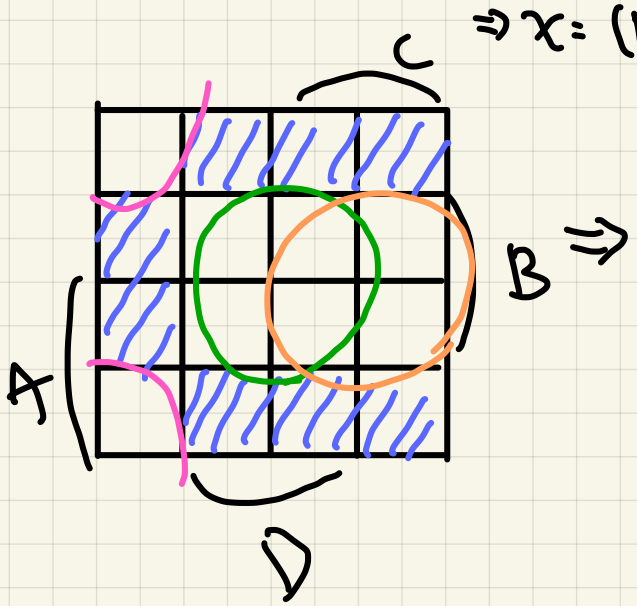
$F = \underline{B'D'} + \underline{BC'D} + A'BC' + \underline{A'BD}$

essential

8. y: trivial

$x = BC'D' + (C+D)B' \Rightarrow x' = B'C'D' + BD + BC$

$\Rightarrow x = (B+C+D)(B'+D')(B'+C')$

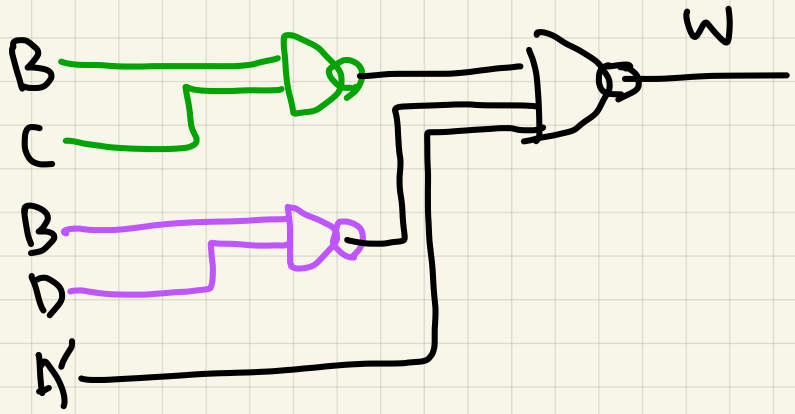


$\Rightarrow$

$W = A + B(C+D)$

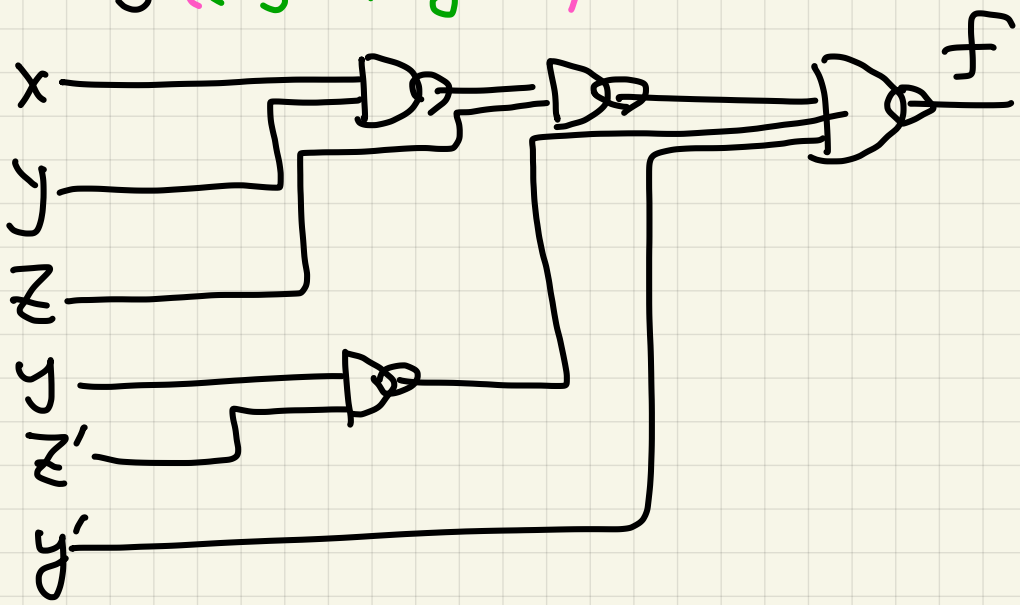
$= (A'(BC+BD)')'$

$= (A'(BC)'(BD)')'$



9. $f = (y'((xy+z')(y'+z))')'$

$= (y'(((xy)'z)'(yz')'))'$



10. $F = (A'+B)' + (B+C')' + (A'+(+D)'$