0907231 Digital Logic	**First Exam**	**Spring 2017**
6 Problems, 4 Pages	**60 Minutes**	**March16th, 12:00 PM**

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Problem 1: Solve the following short questions. **(11 points)** 11

a) ~~(350.4)~~$_4$ is equal to (56.25)$_{10}$

$(320.1)_4$

$3*16 + 2*4 + 0 + \frac{1}{4}$

$= 48 + 8 + .25$

$= \cancel{56.25}$

b) $(36.125)_{10}$ is equal to (24.2)$_{16}$

$2*16 + 4 + \frac{2}{16} =$

$32 + 4 + .125$

36.125

c) $(8ABC.FE8)_{16}$ is equal to (105274.7750)$_8$

(1000101010111100.111111101000)

d) $(0110\ 1001\ 1000\ 0001)_{BCD}$ is equal to (6981)$_{10}$

e) Given that the total number of countries in the world is 196.

- What is the ***minimum*** number of digits needed to encode the countries of the world using a numbering system with ***base 7 (i.e. r =7)***? $\lceil \log_7 196 \rceil = ?$

  ....3digits.

- If we want to encode the countries of the world using ***4 digits*** of a numbering system with ***base 5 (i.e. r = 5)***, the number of unused codes will be ....429.. Codes

$(5)^4 = 625$

$625 - 196 = 429$

f) Using ***Boolean algebra*** prove the following relational statement. ***Show your steps clearly***.

distributive law

simplification theorem

$$A B\bar{C} + BC + \bar{C}D + B\bar{C} + \bar{D} = B + \bar{C} + \bar{D}$$

2

$AB\bar{C} + BC + \bar{C}D + \bar{D} + B\bar{C} \Rightarrow$

simplification

$B(A\bar{C} + C) + \bar{D} + \bar{C} + B\bar{C}$

$= B(C + A) + \bar{D} + \bar{C} + B\bar{C}$

Commutitive law

$= BC + BA + \bar{D} + \bar{C} + B\bar{C}$

minimization theorem

$BC + B\bar{C} + BA + \bar{D} + \bar{C}$

$B + BA + \bar{D} + \bar{C}$

$B(1 + A) + \bar{D} + \bar{C}$

$B \cdot 1 + \bar{D} + \bar{C}$

$= B + \bar{D} + \bar{C}$ #

g) If $F(A,B,C,D) = \sum_m(0,1,2,4,8,9)$ then $F = \prod_M($ 3, 5, 6, 7, 10, 11, 12, 13, 14, 15 $)$

h) The ***dual*** of the Boolean expression $\bar{A} + \bar{B}C + 0$ is:

$\bar{A} \cdot (\bar{B} + C) \cdot 1 = \bar{A} \cdot (\bar{B} + C)$.

i) The ***complement*** of the function $F(A,B,C,D) = \overline{\overline{AB} + C} + CD$ is:

~~AA~~ ....

~~$(A + B ...)$~~

$((\bar{A} + \bar{B}) + C) \cdot (\bar{C} + \bar{D})$

$\overline{AB} + C \cdot \overline{CD}$

$(\overline{AB} + C) \cdot (\bar{C} + \bar{D})$

Problem 2: Given the following function: **(2 points)**

1

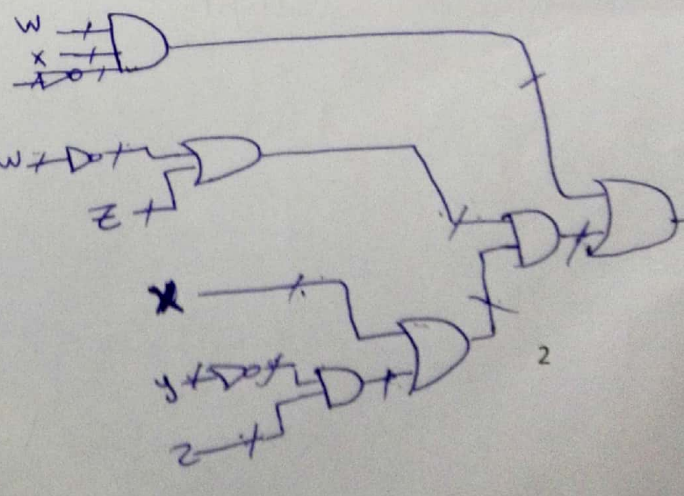
$$F(W,X,Y,Z) = WX\bar{Y} + (\bar{W} + Z) \cdot (X + \bar{Y}Z)$$

What is the literal cost (L), the gate-input cost (G) and the gate-input cost with inverters counted (GN), of F?

L = 8

G = 8 + 6 = 14 (13, 10)

GN = 16



Problem 3: Given the K-map of function $F(A,B,C,D)$, write the ***optimized*** Boolean expression of F as a ***Product of Sums (PoS)***.

(2 points)

2

AB \ CD			C (0011)	C
	0	X	0	1
B	1	0	X	X
A, B	0	0	0	1
A	0	1	0	X
		D	D (1011)	

$F(A,B,C,D)= (\bar{B}+\bar{D})\cdot(\bar{C}+\bar{D})\cdot(\bar{A}+C+D)\cdot(A+B+C)$

Problem 4: Consider the following K-map for function $F(A,B,C,D)$, identify the expressions of all its prime implicants and determine which are essential.

(2 points)

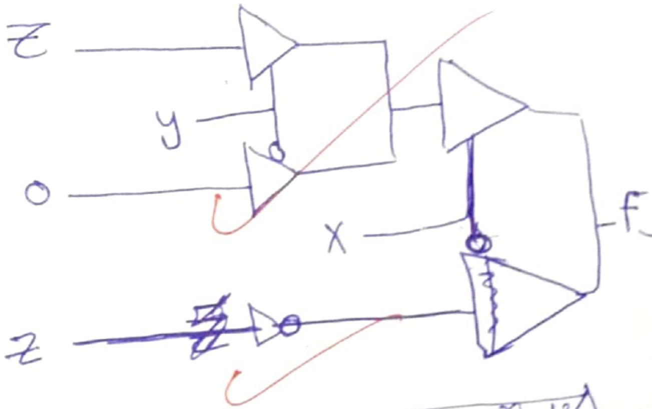
2

AB \ CD			C	C
	1			1
B	1	1	1	
A, B		1	1	
A	1			1
		D	D	

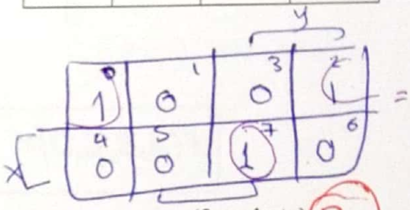
Prime Implicant Expression	Is it Essential?
BD	✓
$\bar{B}\bar{D}$	✓
~~AB~~ $\bar{A}B\bar{C}$	×
$\bar{A}\bar{C}\bar{D}$	×

Problem 5: Given the truth table of function $F(X,Y,Z)$, implement function F using ***tri-state buffers and inverters only***. **(2 points)** 2

X	Y	Z	F
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

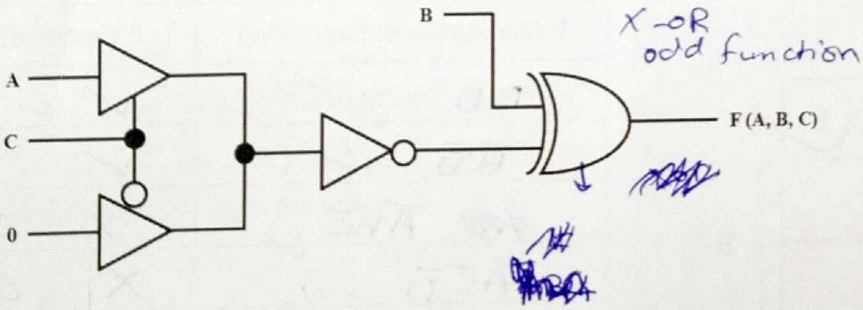


$yzx + \bar{x}\bar{z}$



$\bar{x}\bar{z} + xyz$

Problem 6: Fill-in the truth table for the following circuit. **(2 points)** 2



A	B	C	F
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1