0907231 Digital Logic	First Exam	Summer 2019
9 Problems, 6 Pages	75 Minutes	July 11th, 9:00 AM

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6

Problem 1: Solve the following short questions. **(9 points)**

a) $(42.3)_6$ is equal to (26.5 $)_{10}$

$2\times6^0+4\times6^1+3\times6^{-1}$

$2\times1+24+\frac{3}{6}\ \frac{1}{2}$

(26.5)

b) $(368)_{10}$ is equal to (101110000 $)_2$

368/2	184	0	23/2	11	1
184/2	92	0	11/2	5	1
92/2	46	0	5/2	2	1
46/2	23	0	2/2	1	0
			1/2	0	1

c) $(375.47)_8$ is equal to (FD.9C $)_{16}$

421
8421

$(011111101.100111)_2$

A 10, B 11, C 12, D 13 = FD.9C

d) $(00111001)_{Excess3}$ is equal to (012 $)_4$

39

= (06)$_{10}$

6/4	1	2
1/4	0	1
0/4	0	0

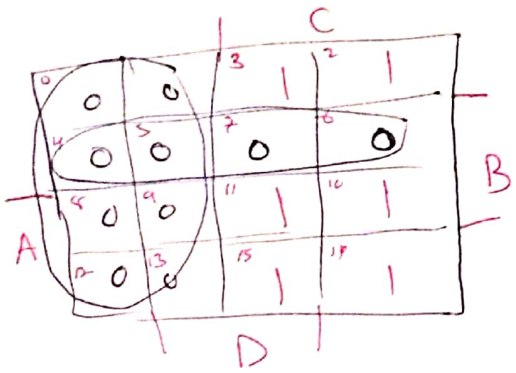
e) Assume *N* is a 4-digit number represented in numbering system of base 5(i.e. radix=5). The ***minimum*** number of digits needed when representing *N* in decimal is 3

f) The ***Even parity*** bit for the following $(010111011110111)_2$ code word is: ……… 1 ………

g) Given $F(A,B,C,D) = (ABC + \bar{B}C)(C + A\bar{D})$,

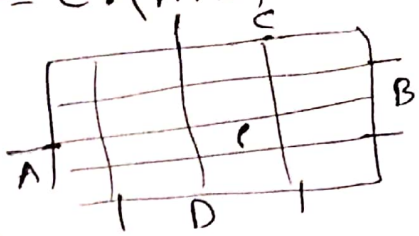
Determine $F(A,B,C,D) = \prod_M($ 0, 1, 4, 5, 6, 7, 8, 9, 12, 13)

$F = ABC + \bar{B}C + ABC\bar{D} + A\bar{B}C\bar{D}$



$\bar{F} = \bar{C} + \bar{A}B$

$F = C.(A + \bar{B}) = AC + \bar{B}C$



h) Given $\bar{F}(A,B,C,D) = \sum_m(1,2,3,5,7,10,13,15)$,

Determine $F(A,B,C,D) = \sum_m($ 0, 4, 6, 8, 9, 11, 12, 14)

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

i) The ***Dual*** for the function $F = (ABC + \overline{CD}).B + C$ is:

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

Problem 2. ***Using Boolean algebra***, prove that: $A \oplus B = \bar{A}B + A\bar{B}$ **(3 points)**

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

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

$= AA + AC + A\bar{B} + \bar{B}C + AC + CC + \bar{A}B + A\bar{B}$

$A + AC + A\bar{B} + \bar{B}C + AC + C + \bar{A}B$

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

$1 \qquad 1$

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

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

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

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

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

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

$= A + B + C$ #

Problem 3: Given the following function: **(2 points)**

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

2

Without any simplification, 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 = 13

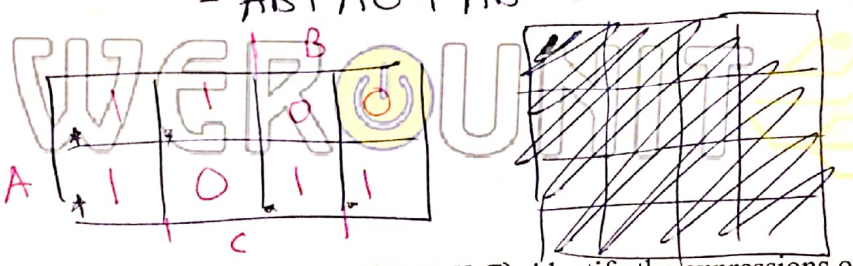
GN = 16

Problem 4: ***Fill*** the K-map of function F given by the following Boolean expression. ***You must label the K-map with the input variables***. **(2 points)**

2

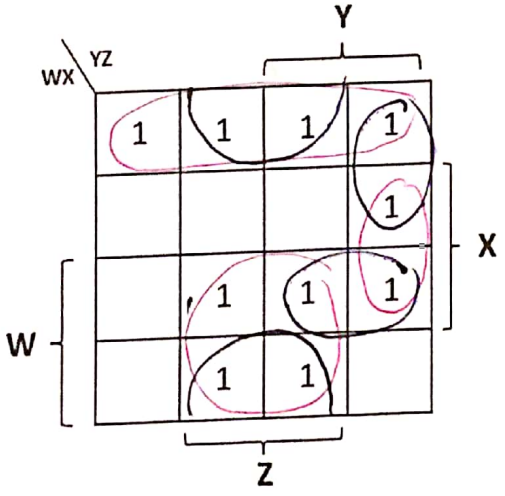
$$F(A,B,C) = (A + \bar{B}).(\bar{A} + B + \bar{C})$$
$$= \cancel{A\bar{A}} + AB + A\bar{C} + \bar{A}\bar{B} + \cancel{B\bar{B}} + \bar{C}\bar{B}$$
$$= AB + A\bar{C} + \bar{A}\bar{B} + \bar{C}\bar{B}$$

$F = \sum_m(0,1,4,6,7)$



Problem 5: Consider the following K-map for function $F(W,X,Y,Z)$, identify the expressions of the ***six*** prime implicants and determine which are essential. **(3 points)**

3

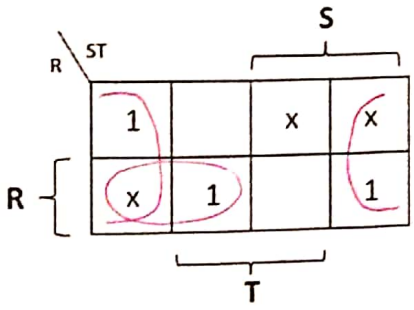


Prime Implicant Expression	Is it Essential?
$\bar{W}\bar{X}$	✓
$\bar{X}Z$	X
WZ	✓
$\bar{W}y\bar{Z}$	X
$xy\bar{Z}$	X
wXy	X

Problem 6: Given the K-map of function $F(R,S,T)$, write the ***optimized*** Boolean expression of F as ***Sum of Products (SoP)***. **(2 points)**

SoP

2

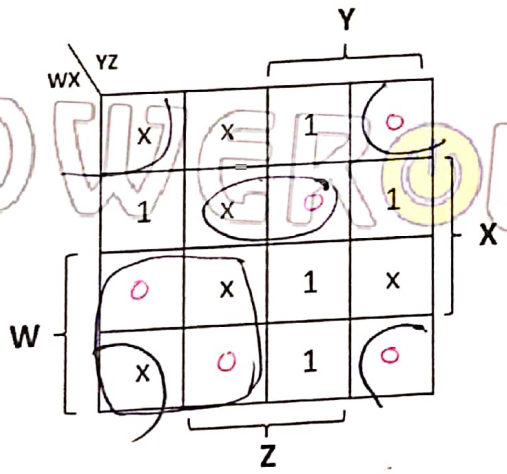


$$F(R,S,T) = \overline{T} + R\overline{S}$$

Problem 7: Given the K-map of function $F(W,X,Y,Z)$, write the ***optimized*** Boolean expression of F as ***Product of Sums (PoS)***. **(3 points)**

POS

3



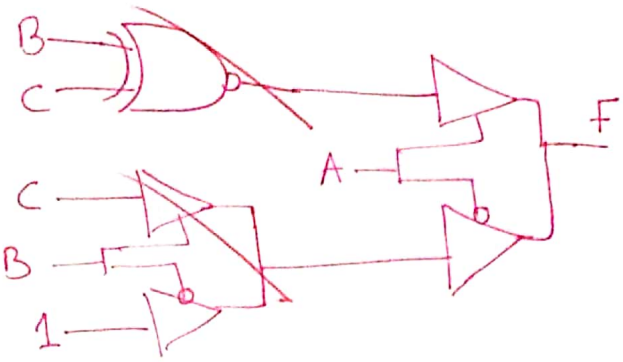
$\overline{F} = \overline{X}\overline{Z} + \overline{W}XZ + WY$

$F = (X+\overline{Z})(W+\overline{X}+\overline{Z})(\overline{W}+Y)$

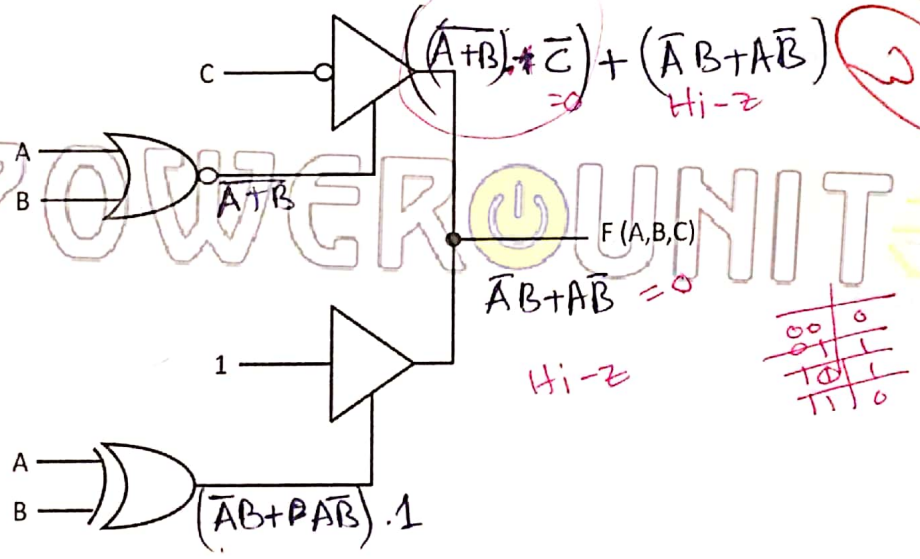
$$F(W,X,Y,Z) = (X+\overline{Z})(W+\overline{X}+\overline{Z})(\overline{W}+Y)$$

Problem 8. The following table is the truth table for $F(A, B, C)$. Draw the implementation of the function using ***only four*** Tri-state buffers and ***one*** XNOR gate. **(3 points)**

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



Problem 9. Considering the following combinational logic circuit, answer the questions below: **(3 points)**



a) Write the equation of output F ***without simplification***:

$$F(A,B,C) = \left(\overline{A+B}\right).\overline{C} + \left(\overline{A}B + A\overline{B}\right) = \left(\overline{A+B}\right).\overline{C} + A \oplus B$$

b) If output F is at ***high-impedance state***, what are the values of A and B:

A = 1

B = 1

Digital Logic , First Exam, Summer 2019.

problem (1) Solve the following short questions. [9 points]

A) $(42.3)_6$ is equal to (26.5)$_{10}$

$42.3 \Rightarrow 4*6^1 + 2*6^0 + 3*6^{-1} = 24 + 2 + 0.5 = 26.5$

B) $(368)_{10}$ is equal to (101110000)$_2$

368/2	184	0	LSD
184/2	92	0	
92/2	46	0	
46/2	23	0	
23/2	11	1	$=(101110000)_2$
11/2	5	1	
5/2	2	1	
2/2	1	0	
1/2	0	1	MSD

C) $(375.47)_8$ is equal to (FD.9C)$_{16}$

$(375.47)_8 = (\underbrace{011}_{3}\underbrace{111}_{7}\underbrace{101}_{5}.\underbrace{100}_{4}\underbrace{111}_{7}\underbrace{00}_{0})_2 = (\underbrace{1111}_{15}\underbrace{1101}_{13}.\underbrace{1001}_{9}\underbrace{1100}_{12})_2 = (FD.9C)_{16}$

D) $(\underbrace{00}_{0}\underbrace{111}_{7}\underbrace{001}_{1})_{Excess3}$ is equal to (12)$_4$

* أول اشي بنحول من Excess3 لـ BCD
* وبعدين من BCD لـ decimal وبعدين من عشري لـ 4

$=(00000110)_2$

$=(06)_{10}$

$\frac{6}{4}$	1	2	LSD
$\frac{1}{4}$	0	1	MSD

$\Rightarrow (012)_4$

problem [2] : Using Boolean algebra, prove that: [3 points]

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

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

$$= A + AC + A\bar{B} + \bar{B}C + \cancel{AC} + C + \cancel{A\bar{B}} + \bar{A}B$$

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

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

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

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

$$= A + B + C \quad \#$$

* هاد مش داخل هاد إمتحان .

problem [3] : Given the following function: [2 points]

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

without simplification, what is (L), (G) and (GN)?

L = 8

G = 13

GN = 16

problem [4] : Fill the K-map of function F given by the following Boolean expression. You must label the K-map with the input Variables. [2 points]

$$F(A,B,C) = (A+\bar{B}).(\bar{A}+B+\bar{C}) = \cancel{A\bar{A}} + AB + A\bar{C} + \bar{A}\bar{B} + \cancel{\bar{B}B} + \bar{C}\bar{B}$$

$$= AB + A\bar{C} + \bar{A}\bar{B} + \bar{C}\bar{B}$$

		C	B, C	B
	1	1	0	0
A	1	0	1	1

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E) Assume N is a 4-digit number represented in numbering system of base 5 (i.e radix = 5). The minimum number of digits needed when representing N in decimal is **3**

حسب قانون $n = \lceil \log_2 M \rceil$ وممكن إذا ما عرفتي كم الجواب تحطي الوغاريتم بدون ما تكتبي انه 3 .

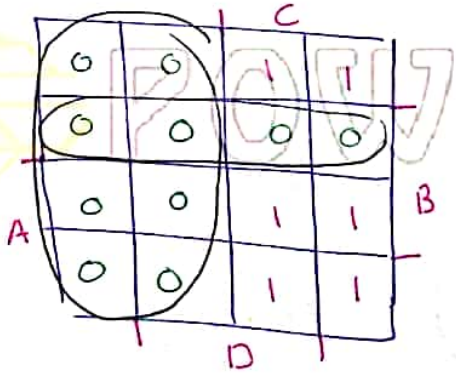
F) The Even parity bit for the following $(0\,1\,0\,1\,1\,1\,0\,1\,1\,1\,1\,0\,1\,1\,1)_2$ is **1**

G) Given $F(A,B,C,D) = (ABC + \bar{B}C)(C + A\bar{D})$

determine $F(A,B,C,D) = \Pi_M(0,1,4,5,6,7,8,9,12,13)$

$F = ABC + \bar{B}C + ABC\bar{D} + A\bar{B}C\bar{D}$

k-map



H) Given $\bar{F}(A,B,C,D) = \sum_m(1,2,3,5,7,10,13,15)$.

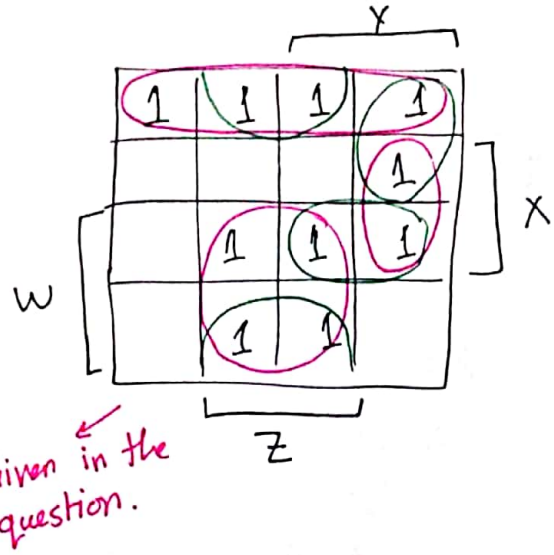
determine $F(A,B,C,D) = \sum_m(0,4,6,8,9,11,12,14)$

I) The Dual for the function $F = (ABC + C\bar{D}).13 + C$ is

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

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

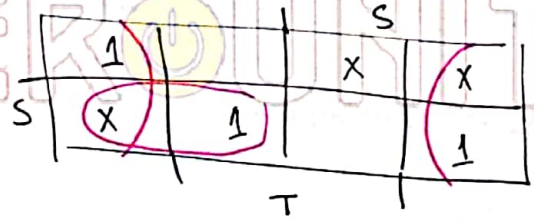
problem [5] : Consider the following K-map for function $F(w,x,y,z)$, identify the expressions of the <u>six</u> prime implicants and determine which are essential. [3 points]



prime implicant Expression	Is it Essential
$\bar{w}\,\bar{x}$	✓
$\bar{x}\,z$	X
$w\,z$	✓
$\bar{w}\,y\,\bar{z}$	X
$x\,y\,\bar{z}$	X
$w\,x\,y$	X

problem [6] : Given the K-map of function $F(R,S,T)$, write the optimized boolean expression of F as sum of product: [3 points]

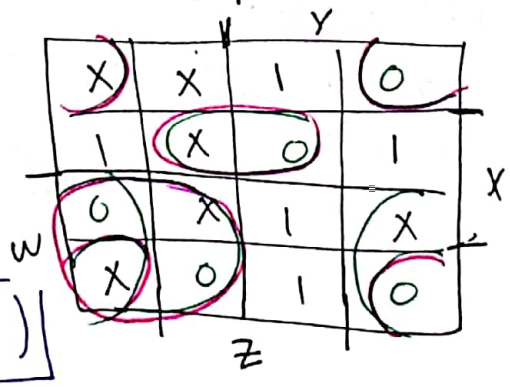
SOP



$F(R,S,T) = \bar{T} + R\bar{S}$

problem [7] : Given the K-map of function $F(w,x,y,z)$, write the optimized Boolean expression of F as product of sum: [3 points]

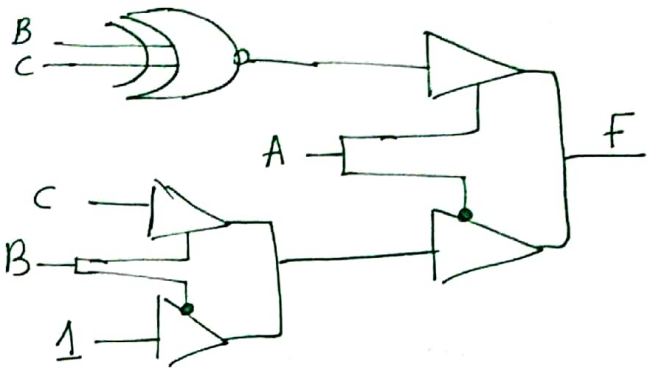
POS



$\bar{F} = \bar{x}\bar{z} + \bar{w}xz + w\bar{y}$

$F = (x+z)(w+\bar{x}+\bar{z})(\bar{w}+y)$

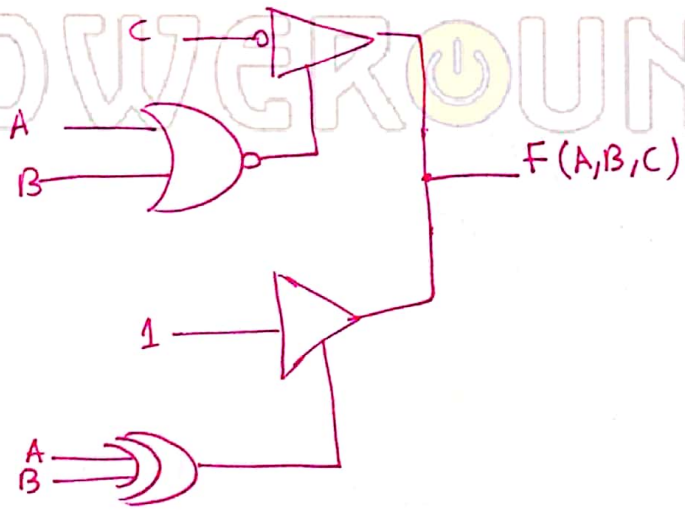
problem [8] : The following table is the truth table for F(A,B,C)
Draw the implementation of the function using only four Tri-state buffers and one XNOR Gate. [3 points]



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

1
C
B XNOR

problem [9] : Considering the following Combinational logic Circuit, answer the questions below: [3 points]



A) write the equation of the out put F:

$$F(A,B,C) = \left(\left(\overline{A+B}\right)\cdot\overline{C}\right) + A \oplus B$$

B) IF the output F is at high-impedance state what is the values of A and B:

A = 1

B = 1