DATE 10/11/2025

Digital Logic Design

Assignment # 1

NAME : SHAYAN RIZWAN

REG# : 2024585

Q1. State of a 16-bit register :

1000 0101 0011 1001

The two interpretations are :

1- BCD (Binary-Coded Decimal) : A code where each group of 4 bits represents a single decimal digit (0-9).

2- Gray code : A code where the sequence represents hexadecimal digits, but encoded in a special way where consecutive values differ by only one bit.

a) $\boxed{1000}$ $\boxed{0101}$ $\boxed{0011}$ $\boxed{1001}$

8421 8421 8421 8421

8 (4+1) (2+1) (8+1)

⇒ 8 5 3 9

∴ The BCD content is the four decimal digits : 8, 5, 3, 9.

e.g. 15 ⟶

BINARY	BINARY-CODED DECIMAL
$\boxed{1111}$	$\boxed{0001}$ $\boxed{0101}$
15	1 5

b) $\boxed{1000}$ $\boxed{0101}$ $\boxed{0011}$ $\boxed{1001}$

Four hexadecimal digits, encoded in gray code.

Binary → Gray code (Apply XOR operation betwe[en] successive bits and the ans is the gray code value)

e.g. 1 ⊕ 1 ⊕ 0 ⊕ 1 ⊕ 1

↳ 10110

DATE: __/__/____

$\oplus$ XOR

⇒ $0 \oplus 0 = 0$

$0 \oplus 1 = 1$

$1 \oplus 0 = 1$

$1 \oplus 1 = 0$

In order to convert :

Gray code → binary

⇒ e.g. 1 0 1 1 0

1 1 0 1 1

∴ 1000 → 1111 | 0101 → 0110 | 0011 → 0010 | 1001 → 1110

⇒ Gray code → binary

⇒	1111	0110	0010	1110
⇒	(8+4+2+1)	(4+2)	(2)	(8+4+2)
⇒	15	6	2	14
⇒	F	6	2	E

∴ As Gray code for hexadecimal : F 6 2E (four hex digits)

Q2. In signed 2's complement representation for an 8-bit number :

⇒ The MSB is the sign bit.

↳ If MSB = 1 → number is negative (-ve)

↳ If MSB = 0 → number is positive (+ve).

e.g., 111 00010

⇒ 000 11101

+ 1

000 11110

128 64 32 16 8 4 2 1 ⇒ 16 + 8 + 4 + 2 = 30

∴ Since the original number's MSB was 1 (negative) the decimal value is : -30.

DATE: ___/___/___

(b) $(5C7B.6)_{16} = (?)_2 = (?)_{10}$

5	C	7	B	6
0101	1100	0111	1011	0110

$\therefore (0101110001111011.0110)_2$

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	1	1	1	0	0	0	1	1	1	1	0	1	1

$\Rightarrow (2^{14}) + (2^{12}) + 2^{11} + 2^{10} + 2^{6} + 2^{5} + 2^{4} + 2^{3} + 2^{1} + 2^{0}$

$\Rightarrow 23679$

For the fractional part .0110, positions are negative powers of 2 (from left to right : $2^{-1}, 2^{-2}, 2^{-3}, \ldots$)

$\Rightarrow$. 0 1 1 0

2^{-1} 2^{-2} 2^{-3} 2^{-4}

$\Rightarrow (2^{-2} \times 1) + (2^{-3} \times 1) = 0.25 + 0.125$

$\Rightarrow 0.25 + 0.125 = 0.375$

$\therefore (23679.375)_{10}$

Q3.

A	B	C	D	$\bar{A}$	$\bar{B}$	$\bar{C}$	$\bar{A}BCD$	$\bar{A}CD$	$ABCD$	$\bar{B}\bar{C}D$	$\bar{A}B$	F
0	0	0	0	1	1	1	0	0	0	0	0	0
0	0	0	1	1	1	1	0	0	0	1	0	1
0	0	1	0	1	1	0	0	0	0	0	0	0
0	0	1	1	1	1	0	0	1	0	0	0	1
0	1	0	0	1	0	1	0	0	0	0	1	1
0	1	0	1	1	0	1	0	0	0	0	1	1
0	1	1	0	1	0	0	0	0	0	0	1	1
0	1	1	1	1	0	0	1	1	0	0	1	1
1	0	0	0	0	1	1	0	0	0	0	0	0
1	0	0	1	0	1	1	0	0	0	1	0	1
1	0	1	0	0	1	0	0	0	0	0	0	0
1	0	1	1	0	1	0	0	0	0	0	0	0
1	1	0	0	0	0	1	0	0	0	0	0	0
1	1	0	1	0	0	1	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	1	0	0	1

Date:

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

AB \ CD	00	01	11	10
00	0	1	1	0
01	1	1	1	1
11	0	0	1	0
10	0	1	0	0

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

Simplified SOP form of the Boolean equation :

$\Rightarrow \bar{A}BCD + \bar{A}CD + ABCD + \bar{B}\bar{C}D + \bar{A}B$

$\Rightarrow \bar{A}BCD + ABCD + \bar{A}CD + \bar{B}\bar{C}D + \bar{A}B$

$\Rightarrow BCD(\bar{A}+A) + \cancel{\bar{A}(CD)}\ \bar{A}CD + \bar{B}\bar{C}D + \bar{A}B$

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

$\Rightarrow F = \bar{A}CD + \bar{A}B + BCD + \bar{B}\bar{C}D$

∴ Yes, both methods yield the same result.

The most simplified SOP form derived through Boolean algebra and the equation obtained from the K-map method are functionally identical. In the K-map method, grouping adjacent 1's (and don't ca corresponds to the Boolean algebra law of distributivity and adjacency ($XY + X\bar{Y} = X$). Any discrepancy in the number of literals per term confirms, rather than contradicts, their equivalence, as it demonst the successful application of minimization principles.

DATE __/__/____ Implementation of POS using NOR gates

24. $f(A,B,C,D) = \Sigma m(0,1,6,7,14,15) + d(2)$

$\Rightarrow \quad \Pi m(3,4,5,8,9,10,11,12,13) + d(2)$

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

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

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

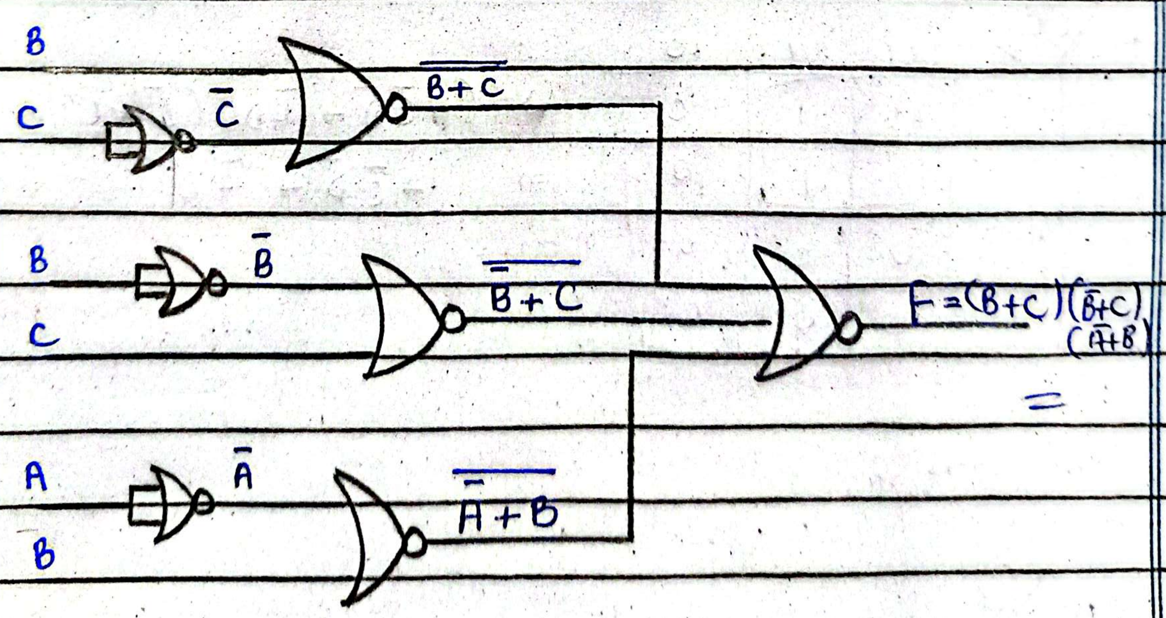
$F = \overline{(B+\bar{C})} + \overline{(\bar{B}+C)} + \overline{(\bar{A}+B)}$

$F = \overline{\quad NOR \quad NOR \quad NOR \quad}$

Two level implementation of NOR.

Demorgan's Theorem

- $\overline{A \cdot B \cdot C} = \bar{A} + \bar{B} + \bar{C}$
- $\overline{A+B+C} = \bar{A} \cdot \bar{B} \cdot \bar{C}$
- $\bar{\bar{A}} = A$



DATE : __ /__ /_____

QS.

Month				31	30	29	28
A	B	C	D	m_0	m_1	m_2	m_3
0	0	0	1	1			
0	0	1	0			1	1
0	0	1	1	1			
0	1	0	0		1		
0	1	0	1	1			
0	1	1	0		1		
0	1	1	1	1			
1	0	0	0	1			
1	0	0	1		1		
1	0	1	0	1			
1	0	1	1		1		
1	1	0	0	1			

$$m_0 = (A\bar{C}\bar{D} + \bar{A}D)\bar{E} + (A\bar{C}\bar{D} + \bar{A}D)L$$

AB \ CD	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	1	0	0	0
10	1	0	d	0

$\Rightarrow (A\bar{C}\bar{D} + \bar{A}D)(\cancel{\bar{L}+L})'$

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

for m_1 ;

AB \ CD	00	01	11	10
00	0	0	0	0
01	1	0	0	1
11	0	0	0	0
10	0	1	1	0

$\Rightarrow \bar{L}(\bar{A}B\bar{D} + A\bar{B}D) +$

$\Rightarrow L(\bar{A}B\bar{D} + A\bar{B}D)$

$\Rightarrow \bar{A}B\bar{D} + \bar{\bar{A}}\bar{B}D$

DATE: __/__/____

For m_2 ;

AB \ CD	00	01	11	10
00	0	0	0	1
01	0	0	0	0
11	0	0	0	0
10	0	0	0	0

$\Rightarrow L\,\bar{A}\bar{B}C\bar{D}$

for $m_1 \rightarrow \bar{L}\bar{A}\bar{B}C\bar{D}$

SCHEMATIC(S) :-