Ahsanullah University of Science and Technology

Department of Computer Science and Engineering

DIGITAL LOGIC DESIGN LAB
CSE 2106

Experiment No : 07

Experiment Name : (a) Design a combinational logic circuit to convert 84-2-1 code to 2421 code.

(b) Design a combinational logic circuit to convert the 5 bit BCD to Binary equivalent.

Submitted by

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Experiment Name :

a) Design a combinational logic circuit to convert the 8 4 -2 -1 code to 2421 code.

Objective :

8 4 -2 -1 and 2421 codes are weighted code. They are also self complementing code because the sum of all of its weight is equal to 9. i.e. (8+4-2-1 = 9) and (2+4+2+1 = 9). So conducting binary equivalent of decimal of number, the numbers code and it's 9's complement code should have complementary relationship. For example, in 84-2-1 system, Decimal 0 = 0000 (in 84-2-1) system and 9's complement of (0 = 9) then 9 (in 84-2-1) should have 1111. Hence, 0 and its 9's complement i.e. 9 maintain their self - complement relationship which is similar to 2421 system. The objective of this experiment is to design a circuit which can convert from 84-2-1 to 2421 code.

Truth Table :

Minterm Designation	Decimal Values	Input (84-2-1)				Output (2421)			
		A	B	C	D	W	X	Y	Z
0	0	0	0	0	0	0	0	0	0
7	1	0	1	1	1	0	0	0	1
6	2	0	1	1	0	0	0	1	0
5	3	0	1	0	1	0	0	1	1
4	4	0	1	0	0	0	1	0	0
11	5	1	0	1	1	0	1	0	1
10	6	1	0	1	0	0	1	1	0
9	7	1	0	0	1	0	1	1	1
8	8	1	0	0	0	1	1	1	0
15	9	1	1	1	1	1	1	1	1

$W = \Sigma(8, 15)$

$X = \Sigma(4, 11, 10, 9, 8, 15)$

$Y = \Sigma(6, 5, 10, 9, 8, 15)$

$Z = \Sigma(7, 5, 11, 9, 15)$

$d = \Sigma(1, 2, 3, 12, 13, 14)$

Function Simplification :

$W = \Sigma(8, 15)$

$d = \Sigma(1, 2, 3, 12, 13, 14)$

CD / AB	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$		X	X	X
$\bar{A}B$				
AB	X	X	1	X
$A\bar{B}$	1			

$W = AB + A\bar{C}\bar{D}$

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

$X = \Sigma(4, 11, 10, 9, 8, 15)$

$d = \Sigma(1, 2, 3, 12, 13, 14)$

CD / AB	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$		X	X	X
$\bar{A}B$	1			
AB	X	X	1	X
$A\bar{B}$	1	1	1	1

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

$Y = \Sigma(6, 5, 10, 9, 8, 15)$

$d = \Sigma(1, 2, 3, 12, 13, 14)$

$AB \backslash CD$	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$		X	X	X
$\bar{A}B$		1		1
AB	X	X	1	X
$A\bar{B}$	1	1		1

$$Y = AB + A\bar{D} + \bar{C}D + C\bar{D}$$

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

$Z = \Sigma(7, 5, 11, 9, 15)$

$d = \Sigma(1, 2, 3, 12, 13, 14)$

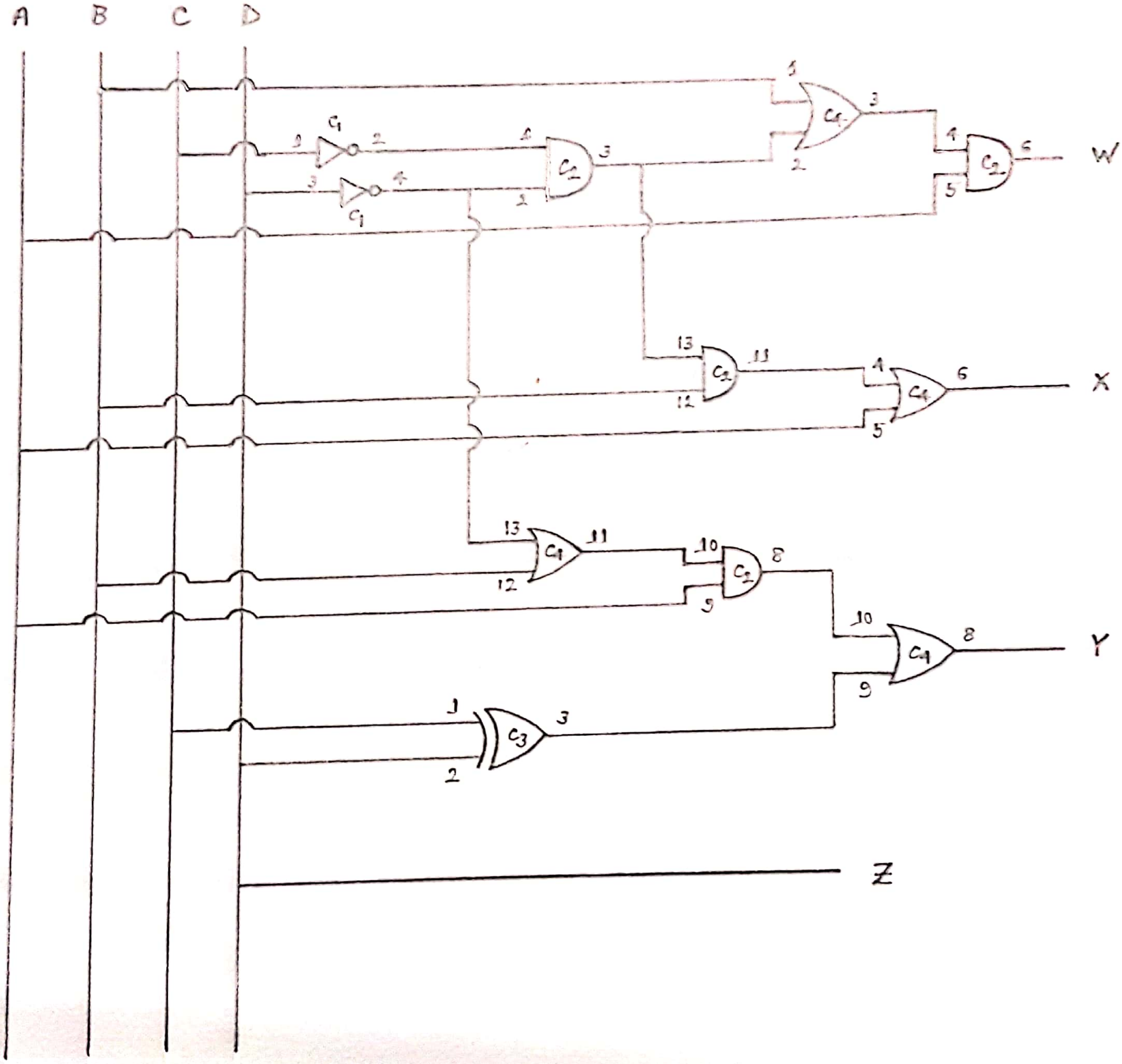
$AB \backslash CD$	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$		X	X	X
$\bar{A}B$		1	1	
AB	X	X	1	X
$A\bar{B}$		1	1	

$$Z = D$$

Circuit Diagram :

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

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



IC Requirements :

1. $C_1 \Rightarrow$ 7404 (NOT Gate) — 1 piece
2. $C_2 \Rightarrow$ 7408 (AND Gate) — 1 piece
3. $C_3 \Rightarrow$ 7486 (XOR Gate) — 1 piece
4. $C_4 \Rightarrow$ 7432 (OR Gate) — 1 piece

Conclusion :

In this experiment, we designed a combinational logic circuit which will convert 84-2-1 code to 2421 code and implement it. For simplification of the equation we have used K-map and reducing the actual formula. If we get the correct output according to input, then our experiments was successfully completed.

b) Design a combinational logic circuit to convert the 5 bit BCD to binary equivalent.

Objective :

BCD (Binary Coded Decimal) is a system of representing numbers in which each decimal digit is represented by 4 bits. On the other hand, binary number is a 2 based number system. For 0 to 9, Binary values for BCD inputs are some. But then from 10 to 15 (decimal Value) there is no output of binary. Then from 16 to 25 (BCD value) the binary value is 6 less than the equivalent Decimal of the BCD input. Thus this process is repeated. The objective of this experiment is to design a 5 bit BCD to binary code converter circuit.

Truth Table :

Decimal Values	Input (BCD)					Output (Binary)				
	A	B	C	D	E	F_5	F_4	F_3	F_2	F_1
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	1	0	0	0	0	1
2	0	0	0	1	0	0	0	0	1	0
3	0	0	0	1	1	0	0	0	1	1
4	0	0	1	0	0	0	0	1	0	0
5	0	0	1	0	1	0	0	1	0	1
6	0	0	1	1	0	0	0	1	1	0
7	0	0	1	1	1	0	0	1	1	1
8	0	1	0	0	0	0	1	0	0	0
9	0	1	0	0	1	0	1	0	0	1
10	0	1	0	1	0	X	X	X	X	X
11	0	1	0	1	1	X	X	X	X	X
12	0	1	1	0	0	X	X	X	X	X
13	0	1	1	0	1	X	X	X	X	X
14	0	1	1	1	0	X	X	X	X	X
15	0	1	1	1	1	X	X	X	X	X
16	1	0	0	0	0	0	1	0	1	0
17	1	0	0	0	1	0	1	0	1	1
18	1	0	0	1	0	0	1	1	0	0
19	1	0	0	1	1	0	1	1	0	1
20	1	0	1	0	0	0	1	1	1	0
21	1	0	1	0	1	0	1	1	1	1
22	1	0	1	1	0	1	0	0	0	0
23	1	0	1	1	1	1	0	0	0	1
24	1	1	0	0	0	1	0	0	1	0
25	1	1	0	0	1	1	0	0	1	1
26	1	1	0	1	0	X	X	X	X	X
27	1	1	0	1	1	X	X	X	X	X
28	1	1	1	0	0	X	X	X	X	X
29	1	1	1	0	1	X	X	X	X	X
30	1	1	1	1	0	X	X	X	X	X
31	1	1	1	1	1	X	X	X	X	X

Function simplification :

$F_5 = \Sigma(22, 23, 24, 25)$

$d = \Sigma(10, 11, 12, 13, 14, 15, 26, 27, 28, 29, 30, 31)$

AB \ CDE	$\bar{C}\bar{D}\bar{E}$	$\bar{C}\bar{D}E$	$\bar{C}DE$	$\bar{C}D\bar{E}$	$CD\bar{E}$	CDE	$C\bar{D}E$	$C\bar{D}\bar{E}$
$\bar{A}\bar{B}$								
$\bar{A}B$			x	x	x	x	x	x
AB	1	1	x	x	x	x	x	x
$A\bar{B}$					1	1		

$\therefore$ simplified function, $F_5 = AB + ACD$

$= A(B + CD)$

$F_4 = \Sigma(8, 9, 16, 17, 18, 19, 20, 21)$

$d = \Sigma(10, 11, 12, 13, 14, 15, 26, 27, 28, 29, 30, 31)$

AB \ CDE	$\bar{C}\bar{D}\bar{E}$	$\bar{C}\bar{D}E$	$\bar{C}DE$	$\bar{C}D\bar{E}$	$CD\bar{E}$	CDE	$C\bar{D}E$	$C\bar{D}\bar{E}$
$\bar{A}\bar{B}$								
$\bar{A}B$	1	1	x	x	x	x	x	x
AB			x	x	x	x	x	x
$A\bar{B}$	1	1	1	1			1	1

$\therefore$ simplified function, $F_4 = \bar{A}B + A\bar{B}\bar{C} + A\bar{B}\bar{D}$

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

$F_3 = \Sigma(4, 5, 6, 7, 18, 19, 20, 21)$

$d = \Sigma(10, 11, 12, 13, 14, 15, 26, 27, 28, 29, 30, 31)$

AB \ CDE	$\bar{C}\bar{D}\bar{E}$	$\bar{C}\bar{D}E$	$\bar{C}DE$	$\bar{C}D\bar{E}$	$CD\bar{E}$	CDE	$C\bar{D}E$	$C\bar{D}\bar{E}$
$\bar{A}\bar{B}$					1	1	1	1
$\bar{A}B$			X	X	X	X	X	X
AB			X	X	X	X	X	X
$A\bar{B}$			1	1			1	1

$\therefore$ simplified function, $F_3 = A\bar{C}D + \bar{A}C + C\bar{D}$

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

$F_2 = \Sigma(2, 3, 6, 7, 16, 17, 20, 21, 24, 25)$

$d = \Sigma(10, 11, 12, 13, 14, 15, 26, 27, 28, 29, 30, 31)$

AB \ CDE	$\bar{C}\bar{D}\bar{E}$	$\bar{C}\bar{D}E$	$\bar{C}DE$	$\bar{C}D\bar{E}$	$CD\bar{E}$	CDE	$C\bar{D}E$	$C\bar{D}\bar{E}$
$\bar{A}\bar{B}$			1	1	1	1		
$\bar{A}B$			X	X	X	X	X	X
AB	1	1	X	X	X	X	X	X
$A\bar{B}$	1	1					1	1

$\therefore$ simplified function, $F_2 = \bar{A}D + A\bar{D}$

$= A \oplus D$

$F_1 = \Sigma(1, 3, 5, 7, 9, 17, 19, 21, 23, 25)$

$d = \Sigma(10, 11, 12, 13, 14, 15, 26, 27, 28, 29, 30, 31)$

AB \ CDE	$\bar C\bar D\bar E$	$\bar C\bar D E$	$\bar C D E$	$\bar C D\bar E$	$C D\bar E$	$C D E$	$C\bar D E$	$C\bar D\bar E$
$\bar A\bar B$		1	1			1	1	
$\bar A B$		1	X	X	X	X	X	X
AB		1	X	X	X	X	X	X
$A\bar B$		1	1			1	1	

Simplified Function, $F_1 = \bar C E + C E = E$

<u>Minimized Expressions:</u>

$F_5 = A(B + CD)$

$F_4 = A\bar B(\bar C + \bar D) + \bar A B$

$F_3 = A\bar C D + C(\bar A + \bar D)$

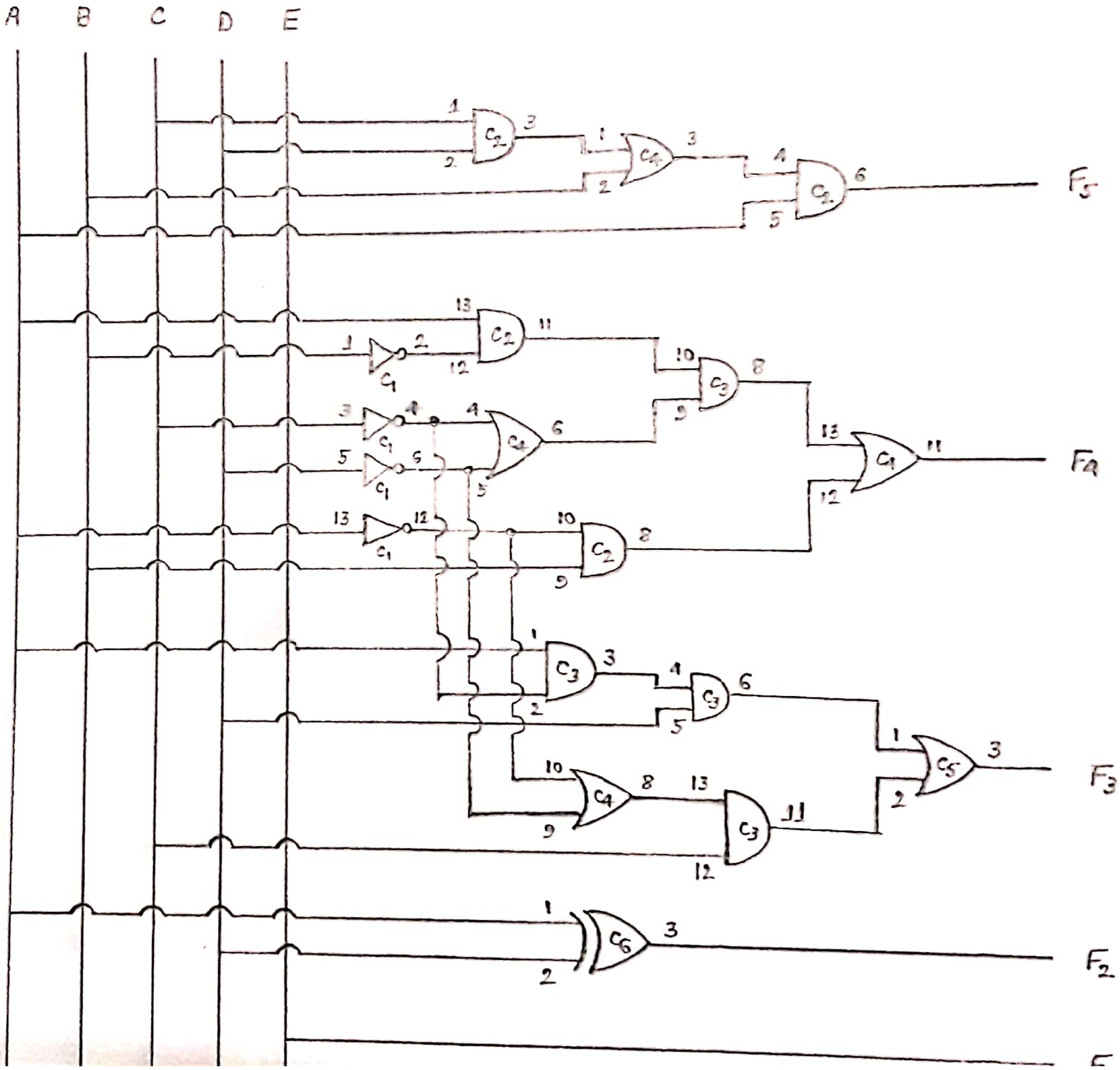
$F_2 = A \oplus D$

$F_1 = E$

Circuit Diagram :

$F_5 = A(B+CD)$ $\qquad$ $F_3 = A\bar{C}D + C(\bar{A}+\bar{D})$ $\qquad$ $F_1 = E$

$F_4 = A\bar{B}(\bar{C}+\bar{D}) + \bar{A}B$ $\qquad$ $F_2 = A \oplus D$



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2. $C_2 = C_3 \Rightarrow$ 7408 (AND Gate) — 2 pieces

3. $C_4 = C_5 \Rightarrow$ 7432 (OR Gate) — 2 pieces

4. $C_6 \Rightarrow$ 7486 (XOR Gate) — 1 piece

Conclusion :

In this experiment, we have constructed a circuit which converts 5 bit BCD to binary equivalent. We have carefully implemented the circuit and used K-Map for simplifying the equations. If we find desired outputs from the experiment according to the truth table, then our experiment was successfully completed.