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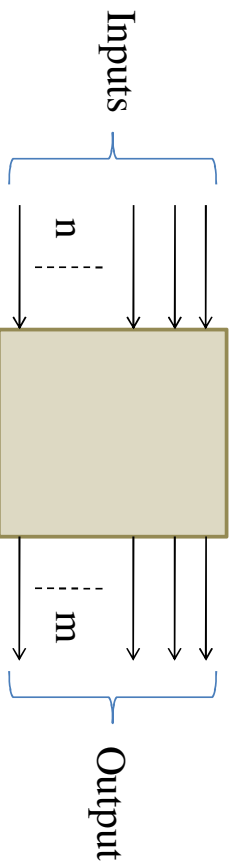
EL114

Digital Logic Design

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Introduction

Combinational Logic Circuit



1. **Design** a **combinational logic circuit** with **three input variables** that will produce a **logic output** when more than one input variables are logic 1.

First Step:

Truth Table Formation

3 inputs



$$2^3 = 8$$

combinations

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

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3

Numericals

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Second Step:

Determining Boolean Expression

(For this K-map can be used)

A	BC			
	00	01	11	10
0	m0	m1	1 m3	1 m2
1	1 m4	1 m5	1 m7	1 m6

$$Y = AC + BC + AB$$

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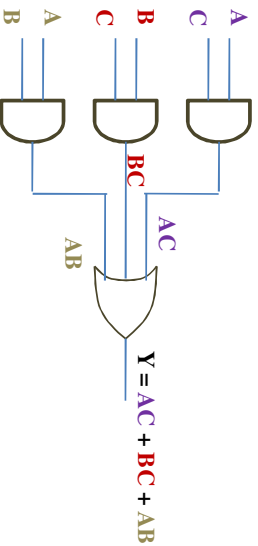
4

Numericals

Third Step:

Realization of Boolean Expression by Logic Gates

$$Y = AC + BC + AB$$



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5

Numericals

2. **Design** a **combinational logic circuit** that converts **Binary to BCD** form. The given range of binary inputs is from 0_{10} to 15_{10} .

First Step:

Truth Table Formation

Determining number of Inputs

0_{10} to $15_{10} = 16$ Combinations



$$2^4 = 16$$

Corresponds
to 4 inputs

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6

Numericals

Determining number of Outputs

In BCD form, each decimal digit is represented by four bits.

Ex: $(1)_{10} = (0001)_{BCD}$

$(15)_{10} = (0001\ 0101)_{BCD}$

So for representing $(15)_{10}$, 8 bits will be required in BCD form

$(00)_{10} = (0000\ 0000)_{BCD}$
 $(01)_{10} = (0000\ 0001)_{BCD}$
 $(02)_{10} = (0000\ 0010)_{BCD}$
 $(03)_{10} = (0000\ 0011)_{BCD}$
 $(04)_{10} = (0001\ 0000)_{BCD}$
 $(05)_{10} = (0001\ 0001)_{BCD}$
 $(06)_{10} = (0001\ 0010)_{BCD}$
 $(07)_{10} = (0001\ 0011)_{BCD}$
 $(08)_{10} = (0010\ 0000)_{BCD}$
 $(09)_{10} = (0010\ 0001)_{BCD}$
 $(10)_{10} = (0010\ 0010)_{BCD}$
 $(11)_{10} = (0010\ 0011)_{BCD}$
 $(12)_{10} = (0011\ 0000)_{BCD}$
 $(13)_{10} = (0011\ 0001)_{BCD}$
 $(14)_{10} = (0011\ 0010)_{BCD}$
 $(15)_{10} = (0011\ 0011)_{BCD}$

It can be observed the most significant three bits are always zero and never used. So last three bits can be discarded.



So total number of output bits can be considered as 5 instead of 8

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7

4-bit Binary Input

5-bit BCD Output

D	C	B	A	B4	B3	B2	B1	B0
0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	1
0	0	1	0	0	0	0	1	0
0	0	1	1	0	0	0	1	1
0	1	0	0	0	0	1	0	0
0	1	0	1	0	0	1	0	1
0	1	1	0	0	0	1	1	0
0	1	1	1	0	0	1	1	1
1	0	0	0	0	1	0	0	0
1	0	0	1	0	1	0	0	1
1	0	1	0	0	1	0	1	0
1	0	1	1	0	1	0	1	1
1	1	0	0	0	1	1	0	0
1	1	0	1	0	1	1	0	1
1	1	1	0	0	1	1	1	0
1	1	1	1	0	1	1	1	1

Second Step:
Determining Boolean Expression
 (For this K-map can be used)

For each column of the output
 i.e. B4, B3, B2, B1, B0



K-map will be formed.
 So in total 5 K-maps will be formed.

Second Step:
Determining Boolean Expression
 (For this K-map can be used)

K-map and Boolean Expression
 determination for B0

DC \ BA	00	01	11	10
00	m0 1	m1 1	m3 1	m2 1
01	m4 1	m5 1	m7 1	m6 1
11	m12 1	m13 1	m15 1	m14 1
10	m8 1	m9 1	m11 1	m10 1

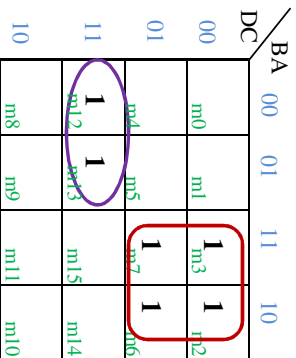
$$B0=A$$

4-bit Binary Input				5-bit BCD Output				
D	C	B	A	B4	B3	B2	B1	B0
0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	1
0	0	1	0	0	0	0	1	0
0	0	1	1	0	0	0	1	1
0	1	0	0	0	0	1	0	0
0	1	0	1	0	0	1	0	1
0	1	1	0	0	0	1	1	0
0	1	1	1	0	0	1	1	1
1	0	0	0	0	1	0	0	0
1	0	0	1	0	1	0	0	1
1	0	1	0	1	0	0	0	0
1	0	1	1	1	0	0	0	1
1	1	0	0	0	1	0	0	1
1	1	0	1	1	0	0	1	0
1	1	1	0	1	1	0	1	1
1	1	1	1	0	1	0	1	0
1	1	1	1	1	1	0	1	1

Numericals

Second Step:
Determining Boolean Expression
 (For this K-map can be used)

K-map and Boolean Expression determination for B1



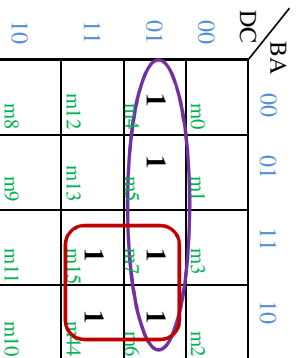
$$B1 = B'CD + BD'$$

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Numericals

Second Step:
Determining Boolean Expression
 (For this K-map can be used)

K-map and Boolean Expression determination for B2



$$B2 = CD' + BC$$

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Numericals

Second Step:
Determining Boolean Expression
 (For this K-map can be used)

K-map and Boolean Expression
 determination for B3

	BA			
DC	00	01	11	10
00	m0	m1	m3	m2
01	m4	m5	m7	m6
11	m12	m13	m15	m14
10	m8	m9	m11	m10

$$B3 = B'C'D$$

Numericals

Second Step:
Determining Boolean Expression
 (For this K-map can be used)

K-map and Boolean Expression
 determination for B4

	BA			
DC	00	01	11	10
00	m0	m1	m3	m2
01	m4	m5	m7	m6
11	m12	m13	m15	m14
10	m8	m9	m11	m10

$$B4 = CD + BD$$

4-bit Binary Input					5-bit BCD Output				
D	C	B	A	B4	B3	B2	B1	B0	
0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	1	1
0	0	1	0	0	0	0	1	0	2
0	0	1	1	0	0	0	1	1	3
0	1	0	0	0	0	1	0	0	4
0	1	0	1	0	0	1	0	1	5
0	1	1	0	0	0	1	1	0	6
0	1	1	1	0	0	1	1	1	7
1	0	0	0	0	1	0	0	0	8
1	0	0	1	0	1	0	0	1	9
1	0	1	0	1	0	0	1	0	10
1	0	1	1	1	0	0	1	1	11
1	1	0	0	1	1	0	0	0	12
1	1	0	1	1	1	0	0	1	13
1	1	1	0	1	1	1	0	0	14
1	1	1	1	1	1	1	0	1	15

4-bit Binary Input					5-bit BCD Output				
D	C	B	A	B4	B3	B2	B1	B0	
0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	1	1
0	0	1	0	0	0	0	1	0	2
0	0	1	1	0	0	0	1	1	3
0	1	0	0	0	0	1	0	0	4
0	1	0	1	0	0	1	0	1	5
0	1	1	0	0	0	1	1	0	6
0	1	1	1	0	0	1	1	1	7
1	0	0	0	0	1	0	0	0	8
1	0	0	1	0	1	0	0	1	9
1	0	1	0	1	0	0	0	0	10
1	0	1	1	1	0	0	0	1	11
1	1	0	0	1	1	0	0	0	12
1	1	0	1	1	1	0	0	1	13
1	1	1	0	1	1	1	0	0	14
1	1	1	1	1	1	1	0	1	15

Third Step: Realization of Boolean Expression by Logic Gates

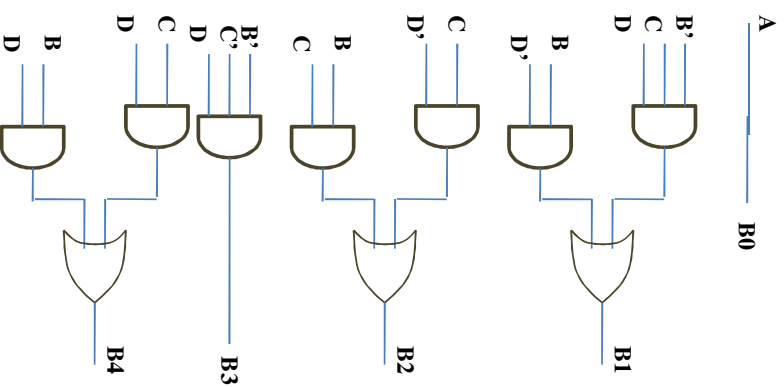
$$B_0 = A$$

$$B_1 = B'CD + BD'$$

$$B_2 = CD' + BC$$

$$B_3 = B'C'D$$

$$B_4 = CD + BD$$



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15

Assignment-2

1. Design a combinational logic circuit for Excess-3 to BCD converter.
2. Design a combinational logic circuit for Gray to Binary code converter.

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16