Dhirubhai Ambani Institute of Information and Communication Technology

EL114

Digital Logic Design

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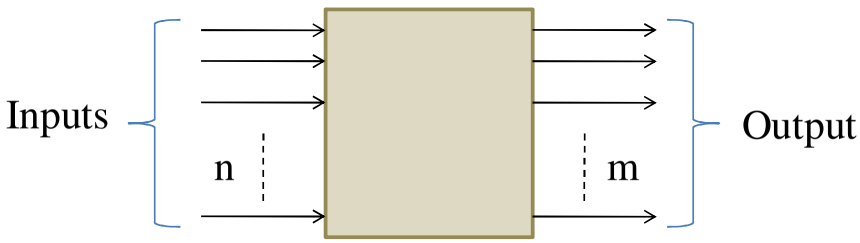
Introduction

Combinational logic Circuit



Numericals

Hardware Implementation

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

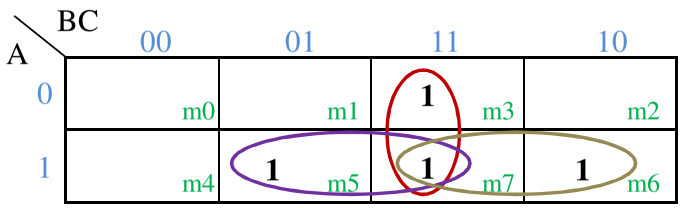
$2^3 = 8$ combinations

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**

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)

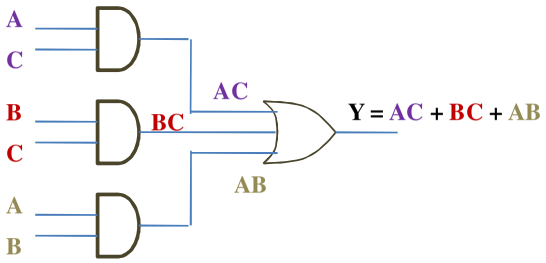


$$Y = AC + BC + AB$$

Numericals

Third Step:
Realization of Boolean Expression by Logic Gates

$$Y = AC + BC + AB$$



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

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

$(00)_{10} = (0000\ 0000)_{BCD}$
$(01)_{10} = (0000\ 0001)_{BCD}$
.
.
$(09)_{10} = (0000\ 1001)_{BCD}$
$(10)_{10} = (0001\ 0000)_{BCD}$
$(11)_{10} = (0001\ \ 0001)_{BCD}$
$(12)_{10} = (0001\ 0010)_{BCD}$
$(13)_{10} = (0001\ 0011)_{BCD}$
$(14)_{10} = (0001\ \ 0100)_{BCD}$
$(15)_{10} = (0001\ \ 0101)_{BCD}$

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

First Step:
Truth Table Formation

Determined number of inputs to be 4

Determined number of outputs to be 5

		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	1	0	0	1	0
1	1	0	1	1	0	0	1	1
1	1	1	0	1	0	1	0	0
1	1	1	1	1	0	1	0	1

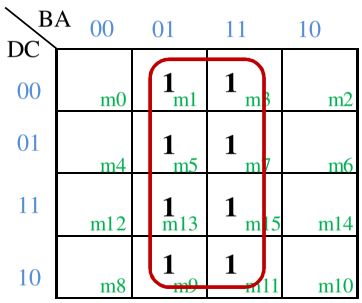
Second Step:
Determining Boolean Expression
(For this K-map can be used)

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



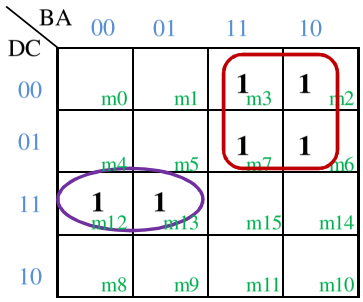
B0= A

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	1	0	0	1	0
1	1	0	1	1	0	0	1	1
1	1	1	0	1	0	1	0	0
1	1	1	1	1	0	1	0	1

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

K-map and Boolean Expression determination for B1



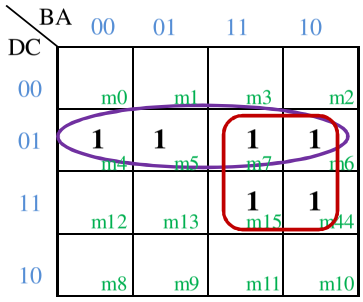
B1 = B' CD + BD'

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	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	1	0	0	1	0
1	1	0	1	1	0	0	1	1
1	1	1	0	1	0	1	0	0
1	1	1	1	1	0	1	0	1

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

K-map and Boolean Expression determination for B2



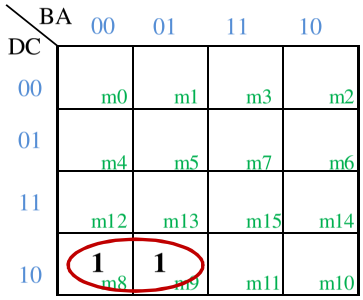
B2 = CD' + BC

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	1	0	0	1	0
1	1	0	1	1	0	0	1	1
1	1	1	0	1	0	1	0	0
1	1	1	1	1	0	1	0	1

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

K-map and Boolean Expression determination for B3



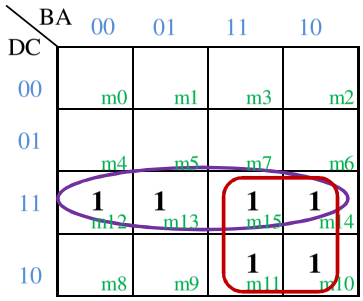
B3 = B'C'D

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	1	0	0	1	0
1	1	0	1	1	0	0	1	1
1	1	1	0	1	0	1	0	0
1	1	1	1	1	0	1	0	1

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

K-map and Boolean Expression determination for B4



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	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	1	0	0	1	0
1	1	0	1	1	0	0	1	1
1	1	1	0	1	0	1	0	0
1	1	1	1	1	0	1	0	1

Third Step:
Realization of Boolean Expression by Logic Gates

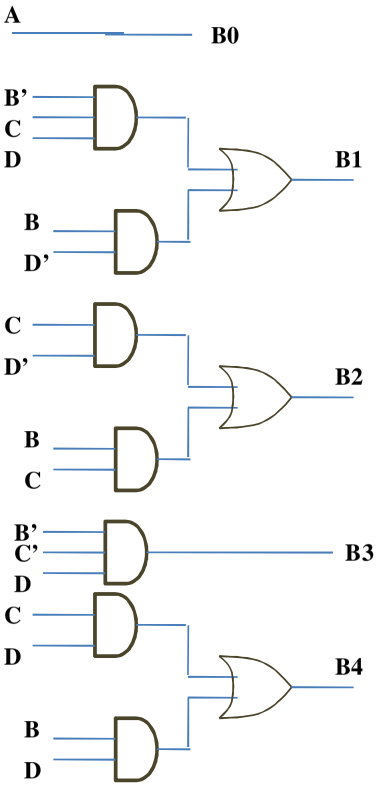
B0= A

B1 = B' CD + BD'

B2 = CD' + BC

B3 = B'C'D

B4 = CD + BD



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.