Experiment No. 4

Batch:A2 **Roll No.: 16010421063** **Experiment No.: 4**

Aim: Design a 4 bit binary to BCD convertor using the Circuitverse simulator.

Resources needed: Circuitverse online simulator

Theory:

- Although the CPU uses binary arithmetic for computation, the result has to be converted into decimal for display purpose. The token counter displays, railway platform displays, even calculator displays are all decimal displays. Conversion from binary to decimal is a non-trivial process. To reduce the processing overhead, BCD format offers a nice alternative.

- In BCD (Binary Coded Decimal) format the decimal digits are stored as separate binary numbers. When these numbers are incremented, decremented or reset, only part of the remaining number needs to be changed. Also, the conversion from binary to decimal and unpacking of the digits is avoided.

- Because the BCD numbers are essentially decimal numbers, only 0-9 digits are used. Therefore when we do binary to BCD mapping, we either wrap around the numbers from 10 to 15 or we treat them as don't cares.

Binary Code A B C D	Decimal Number	BCD Code B_5	B_4	B_3	B_2	B_1
0 0 0 0	0	0	0	0	0	0
0 0 0 1	1	0	0	0	0	1
0 0 1 0	2	0	0	0	1	0
0 0 1 1	3	0	0	0	1	1
0 1 0 0	4	0	0	1	0	0
0 1 0 1	5	0	0	1	0	1
0 1 1 0	6	0	0	1	1	0
0 1 1 1	7	0	0	1	1	1
1 0 0 0	8	0	1	0	0	0
1 0 0 1	9	0	1	0	0	1
1 0 1 0	10	1	0	0	0	0
1 0 1 1	11	1	0	0	0	1
1 1 0 0	12	1	0	0	1	0
1 1 0 1	13	1	0	0	1	1
1 1 1 0	14	1	0	1	0	0
1 1 1 1	15	1	0	1	0	1

Procedure:

a) Design logic circuit for the binary to BCD convertor using the following steps:-
   i. Draw the truth table for the 4 bit convertor (already given above)
   ii. Draw the K map for each of the (four) outputs
   iii. Calculate the logic equation for each output
   iv. Draw the circuit on paper
   v. Verify the circuit using the Circuitverse simulator. (Lab instructor will guide you on how to create an account use the simulator).

b) Upload the write-up with the solved design problems given in write-up.

Observations and Results: Simulate as per instructions in Lab session. Take snapshots of the results and paste them in the write-ups.

Outcomes:

	Inputs				Outputs				
	A	B	C	D	B_4	B_3	B_2	B_1	B_0
0	0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	0	1
2	0	0	1	0	0	0	0	1	0
3	0	0	1	1	0	0	0	1	1
4	0	1	0	0	0	0	1	0	0
5	0	1	0	1	0	0	1	0	1
6	0	1	1	0	0	0	1	1	0
7	0	1	1	1	0	0	1	1	ϕ
8	1	0	0	0	0	1	0	0	0
9	1	0	0	1	0	1	0	0	1
10	1	0	1	0	1	0	0	0	0
11	1	0	1	1	1	0	0	0	1
12	1	1	0	0	1	0	0	1	0
13	1	1	0	1	1	0	0	1	1
14	1	1	1	0	1	0	ϕ	0	0
15	1	1	1	1	1	0	1	0	1

K Map for B_0

AB \ CD	00	01	11	10
00	0 (0)	1 (1)	1 (3)	0 (2)
01	0 (4)	1 (5)	1 (7)	0 (6)
11	0 (12)	1 (13)	1 (15)	(14)
10	0 (8)	1 (9)	1 (11)	0 (10)

$B_0 = D$

K Map for B_1

AB \ CD	00	01	ϕϕ	10
00	0 (0)	0 (1)	1 (3)	1 (2)
01	0 (4)	0 (5)	1 (7)	1 (6)
1ϕ	1 (12)	1 (13)	0 (15)	0 (14)
10	0 (8)	0 (9)	0 (11)	0 (10)

$B_1 = \bar{A}C + AB\bar{C}$

K Map for B_2

AB \ CD	00	01	1ϕ	10
00	0 (0)	0 (1)	0 (3)	0 (2)
01	1 (4)	1 (5)	1 (7)	1 (6)
1ϕ	0 (12)	0 (13)	1 (13)	1 (14)
10	0 (8)	0 (9)	0 (11)	0 (10)

$B_2 = BC + \bar{A}B$

KMap for B_3

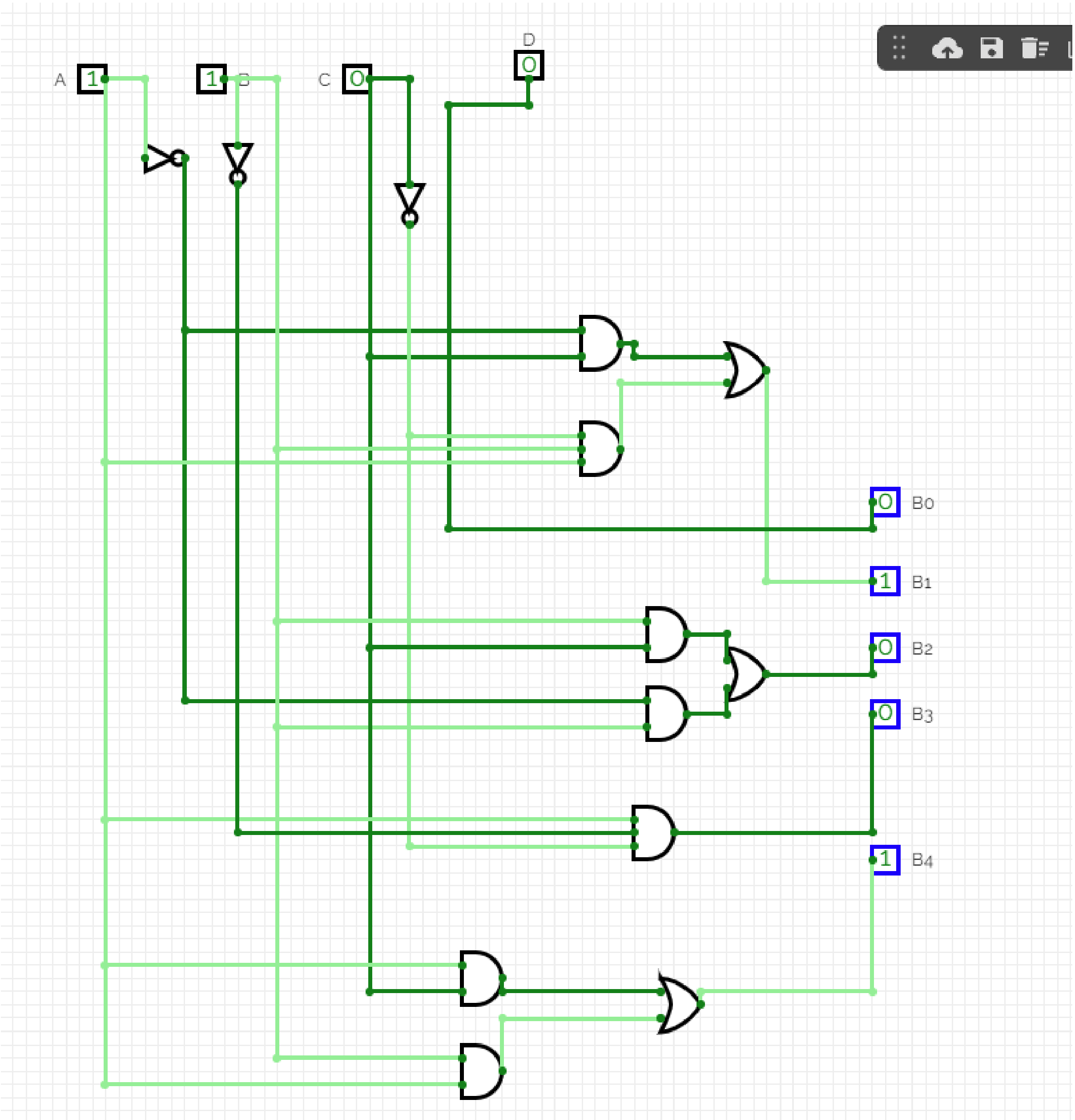
AB \ CD	00	01	11	10
00	0 (0)	0 (1)	0 (3)	0 (2)
01	0 (4)	0 (5)	0 (7)	0 (6)
11	(12)	(13)	(15)	0 (14)
ϕ0	1 (8)	1 (9)	0 (11)	0 (10)

$B_3 = \bar{A}\ A\bar{B}\bar{C}$

KMap for B_4

AB \ CD	00	01	11	10
00	(0)	(1)	(3)	(2)
01	(4)	(5)	(7)	(6)
11	1 (12)	1 (13)	1 (15)	1 (14)
10	(8)	(9)	1 (11)	1 (10)

$B_4 = AC + AB$



Conclusion: We constructed a binary to BCD convertor using basic logic gates such as AND OR NOT. We got the equation required using kmap method

Grade: AA / AB / BB / BC / CC / CD /DD

Signature of faculty in-charge with date

References:
Books/ Journals/ Websites:

1. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill.