

Design of a Combinational Circuit (BCD to 7-Segment Decoder) – Reference Solution

Instructor:-

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Pre-Lab Tasks:

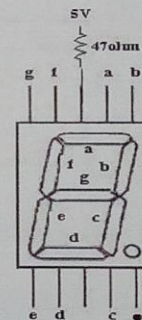
1. What do you mean by BCD numbers? Explain with Examples.

In computing and electronics, Binary Coded Decimal (BCD) is a class of binary encoding of decimal numbers, where each decimal digit is represented by a fixed number of bits.

Decimal	BCD
0	0000
1	0001
2	0010
3	0011

2. 7-Segment LED Displays are commonly used for displaying decimal Numbers (0 to 9). It can also be used for displaying alphabets. A 7-Segment LED Displays essentially consist of 7 LEDs configured as shown below to display numbers. It comes in two configurations. Common Cathode and Common Anode. Draw the diagram showing connections to drivers and power source and ground for both configurations and highlight differences between the two. Also give signal logic level required to light up the LEDs in the segment in each configuration:

Draw diagram of common cathode and common anode.



In common cathode, all the cathodes of LEDs are connected together to common ground (GND). while in common anode, all the anodes of LEDs are connected together to common positive supply (+Vcc).

Common cathode => Logic High required to light up segments
Common anode => Logic Low required to light up segments



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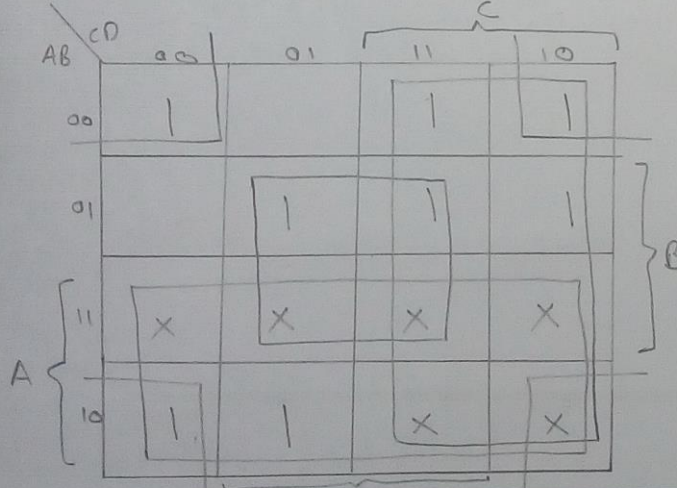
3. Design a BCD-to-Seven Segment Decoder with minimum number of gates that converts BCD Numbers 0 through 9 in such a way that the display shows 0-9 on the Seven-Segment-Display. The unused input combinations should be taken as don't care conditions. For what configuration are you making truth table?

a) Give Truth Table

Inputs (BCD)				Outputs (7 LEDs on 7-Segment Display)						
A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	1	0	1	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	1	0	1	1
1	0	1	0	x	x	x	x	x	x	x
1	0	1	1	x	x	x	x	x	x	x
1	1	0	0	x	x	x	x	x	x	x
1	1	0	1	x	x	x	x	x	x	x
1	1	1	0	x	x	x	x	x	x	x
1	1	1	1	x	x	x	x	x	x	x

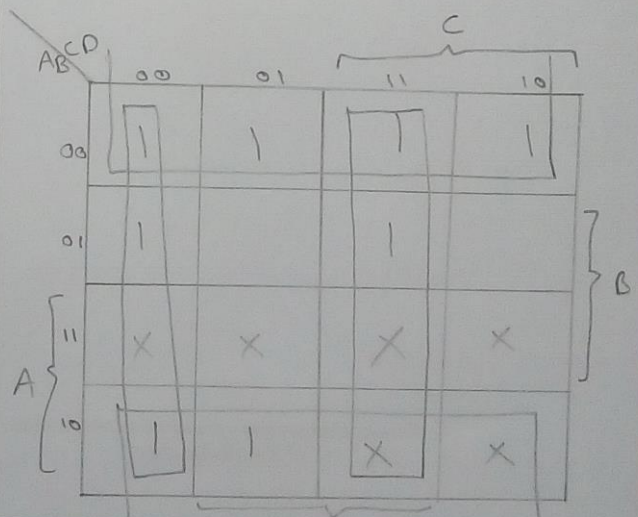
b) K-Map Simplification

$$a(A, B, C, D) = \sum(0, 2, 3, 5, 6, 7, 8, 9)$$



$$a(A, B, C, D) = A + C + BD + B'D'$$

$$b(A, B, C, D) = \sum(0, 1, 2, 3, 4, 7, 8, 9)$$



$$b(A, B, C, D) = B' + C'D' + CD$$



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$$c(A, B, C, D) = \sum(0, 1, 3, 4, 5, 6, 7, 8, 9)$$

AB \ CD	00		01		11		10	
	C	D	C	D	C	D	C	D
00	1	1	1	1	1	1	1	1
01	1	1	1	1	1	1	1	1
11	X	X	X	X	X	X	X	X
10	1	1	X	X	X	X	X	X

$$c(A, B, C, D) = A + B + C' + D$$

$$d(A, B, C, D) = \sum(0, 2, 3, 5, 6, 8, 9)$$

AB \ CD	00		01		11		10	
	C	D	C	D	C	D	C	D
00	1	1	1	1	1	1	1	1
01	1	1	1	1	1	1	1	1
11	X	X	X	X	X	X	X	X
10	1	1	X	X	X	X	X	X

$$d(A, B, C, D) = A + CD' + B'D' + B'C + BC'D$$

$$e(A, B, C, D) = \sum(0, 2, 6, 8)$$

AB \ CD	00		01		11		10	
	C	D	C	D	C	D	C	D
00	1	1	1	1	1	1	1	1
01	1	1	1	1	1	1	1	1
11	X	X	X	X	X	X	X	X
10	1	1	X	X	X	X	X	X

$$e(A, B, C, D) = CD' + B'D'$$

$$f(A, B, C, D) = \sum(0, 4, 5, 6, 8, 9)$$

AB \ CD	00		01		11		10	
	C	D	C	D	C	D	C	D
00	1	1	1	1	1	1	1	1
01	1	1	1	1	1	1	1	1
11	X	X	X	X	X	X	X	X
10	1	1	X	X	X	X	X	X

$$f(A, B, C, D) = A + BC' + C'D + BD'$$

$$g(A, B, C, D) = \sum(2, 3, 4, 5, 6, 8, 9)$$

AB \ CD	00		01		11		10	
	C	D	C	D	C	D	C	D
00	1	1	1	1	1	1	1	1
01	1	1	1	1	1	1	1	1
11	X	X	X	X	X	X	X	X
10	1	1	X	X	X	X	X	X

$$g(A, B, C, D) = A + CD' + BC' + B'C$$



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c) Draw Hardware Schematic diagram showing pin numbering and connections of each IC.

Draw a hardware schematic diagram as you draw for lab 5.

Lab Tasks:

4. Implement the above circuit in hardware using minimum number of NAND gates.
5. Mention which configuration of 7-Segment Display did you use in Lab? If you were to use the other configuration what change would you need in your circuit?

Common Cathode configuration was used.

If common Anode configuration was used, the ground (GND) will be replaced by positive supply (+Vcc). Also all the reduced expressions of a-g would change because the decoder table will be changed.