

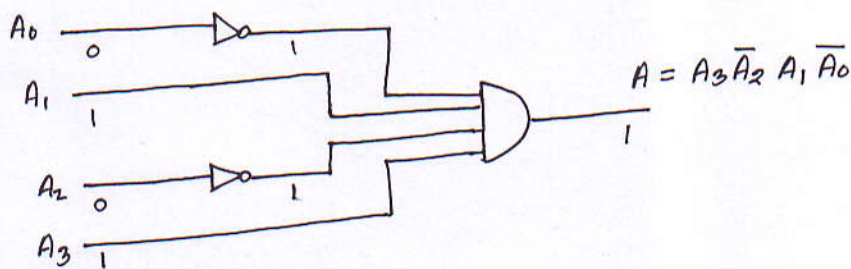
# Digital Logic Design :

## Lecture 12

**Decoders :** The basic function of a decoder is to detect the presence of a specified combination of bits (code) on its input and to indicate the presence of that code by a specified output level.

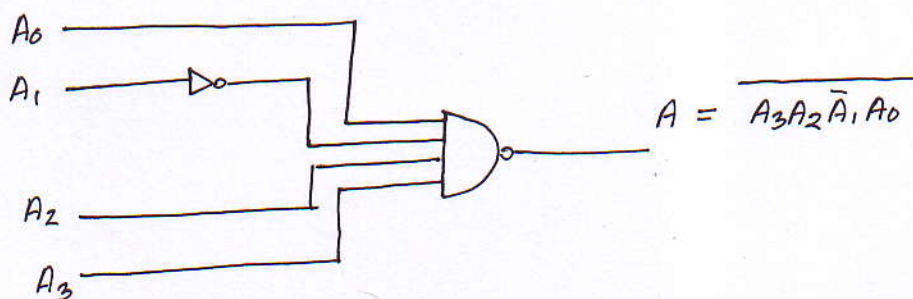
1) Determine the logic required to decode the binary number 1010 by producing a HIGH level on the output.

ans. : Decoding function :  $A = A_3 \bar{A}_2 A_1 \bar{A}_0$



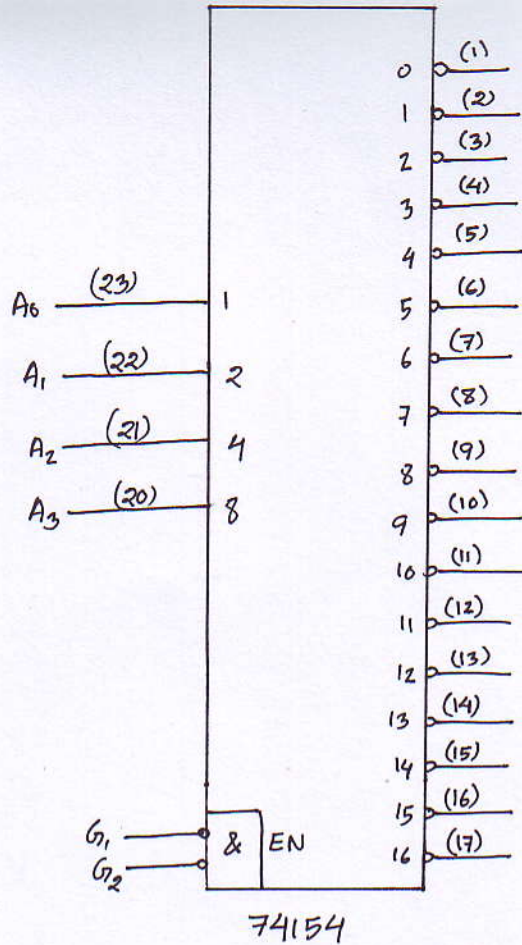
2) Determine the logic required to decode the binary number 1101 by producing an active-LOW output.

ans. : Decoding function :  $A = \overline{A_3 A_2 \bar{A}_1 A_0}$



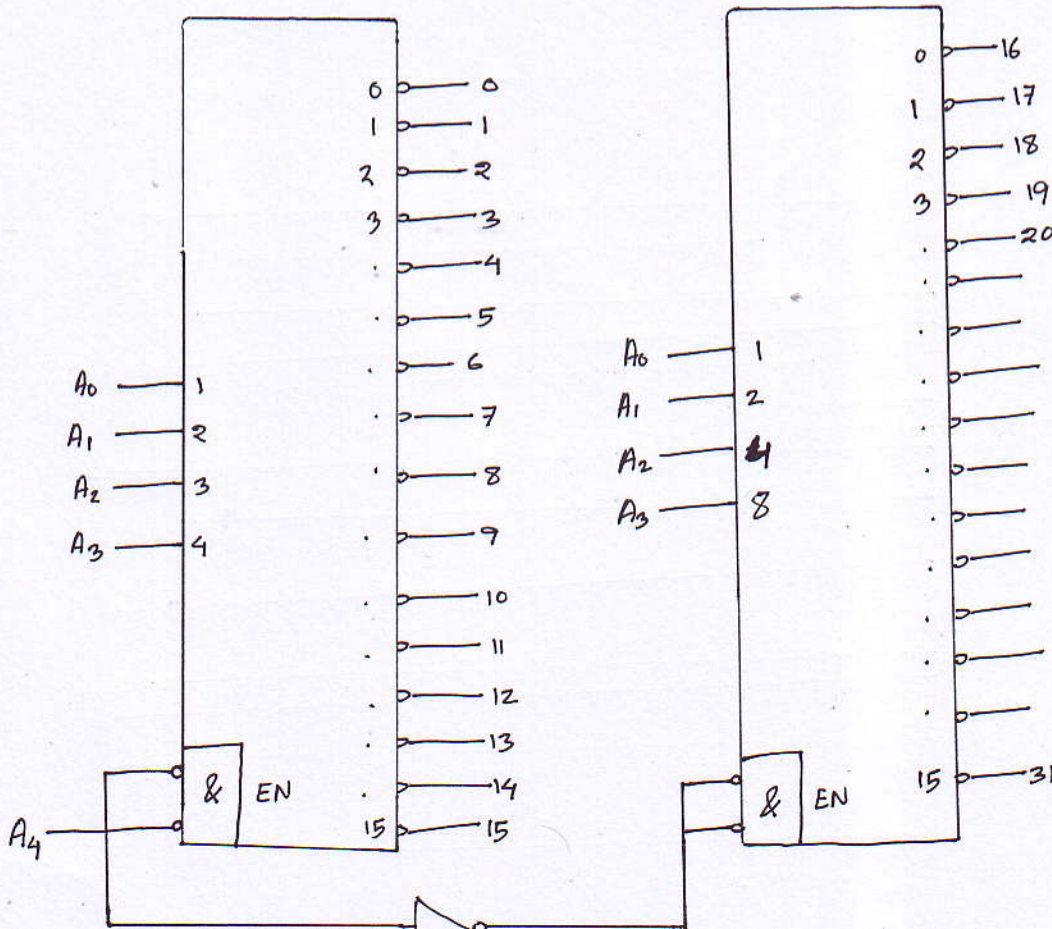






Logic symbol for the 74154 4-line to 16-line decoder

\* Design a 5-bit decoder using 74154.



Encoders : An encoder accepts an active level on one of its inputs and converts it to a coded output, such as decimal to BCD .

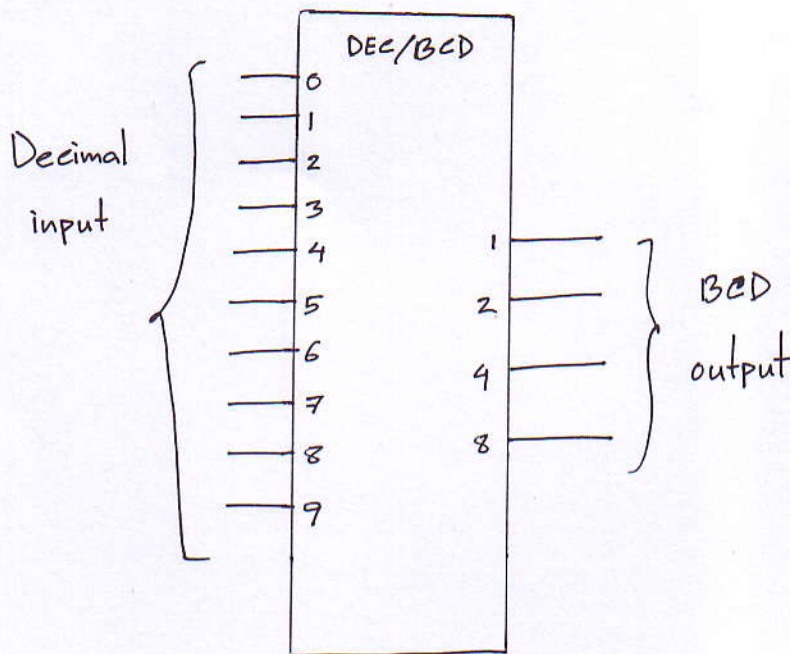


Fig : Logic symbol for a decimal to BCD encoder .

Decimal Digits	BCD code			
	$A_3$	$A_2$	$A_1$	$A_0$
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

$$A_0 = 1 + 3 + 5 + 7 + 9$$

$$A_1 = 2 + 3 + 6 + 7$$

$$A_2 = 4 + 5 + 6 + 7$$

$$A_3 = 8 + 9$$



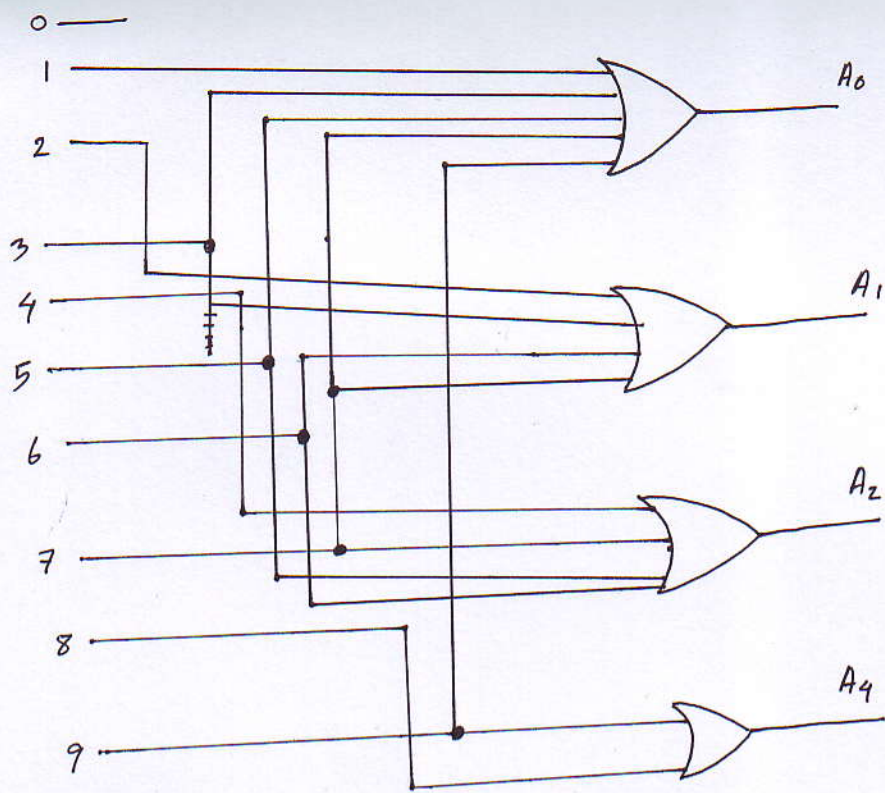


Fig : Logic diagram for a decimal to BCD encoder.

The Decimal to BCD priority encoder :

Let priority is given to the higher order digits .

Requirements to activate  $A_0$

- 1)  $A_0$  is HIGH if 1 is HIGH and 2,4,6,8 LOW,  
 $A_0$  " " " 3 " " " 4,6,8 " ,  
 $A_0$  " " " 5 " " " 6,8 " ,  
 $A_0$  " " " 7 " " " 8 " ,  
 $A_0$  " " " 9 " " .

$$\therefore A_0 = 1 \cdot \bar{2} \cdot \bar{4} \cdot \bar{6} \cdot \bar{8} + 3 \cdot \bar{4} \cdot \bar{6} \cdot \bar{8} + 5 \cdot \bar{6} \cdot \bar{8} + 7 \cdot \bar{8} + 9$$

Logic equation for  $A_1$

- 2)  $A_1$  is HIGH if 2 is HIGH and 4,5,8,9 LOW,  
 $A_1$  is HIGH if 3 is HIGH and 4,5,8,9 LOW,  
 $A_1$  is HIGH if 6 is HIGH and 8,9 LOW,  
 $A_1$  is HIGH if 7 is HIGH and 8,9 LOW.

$$\therefore A_1 = (2+3) \bar{4} \bar{5} \bar{8} \bar{9} + (6+7) \bar{8} \bar{9}$$

Logic equation for  $A_2$

- 3)  $A_2$  is HIGH if 4 is HIGH and 8,9 LOW,  
 $A_2$  " " " 5 " " " 8,9 " ,  
 $A_2$  " " " 6 " " " 8,9 " ,  
 $A_2$  " " " 7 " " " 8,9 " .

$$\therefore A_2 = (4+5+6+7) \bar{8} \bar{9}$$

- 4)  $A_3$  is HIGH if 8 or 9 is HIGH,

$$\therefore A_3 = 8+9$$

Fig: Logic for  $A_3$

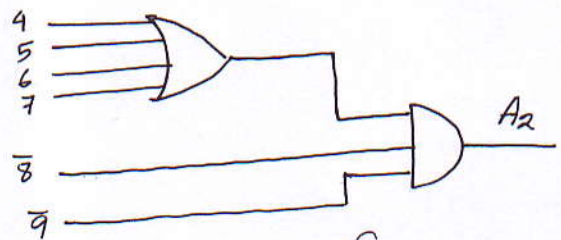
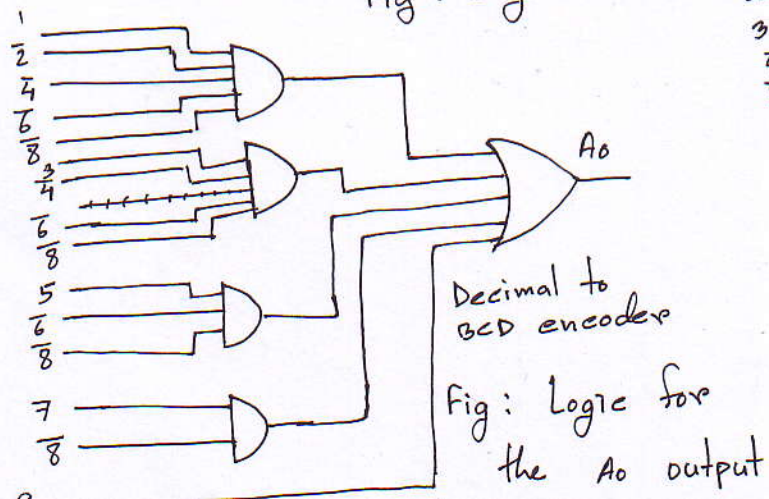


Fig: Logic for  $A_2$

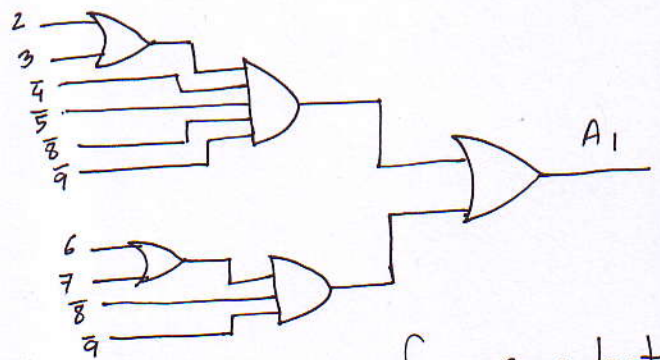


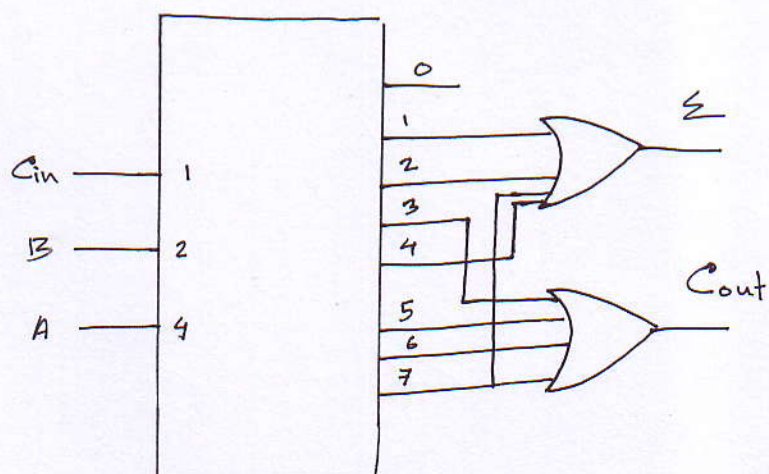
Fig: Logic for  $A_1$  output of a decimal to BCD encoder



Implement a full Adder using a 3bit Decoder and other necessary gates.

Full - Adder Truth table :

A	B	C <sub>in</sub>	Σ	Count
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1



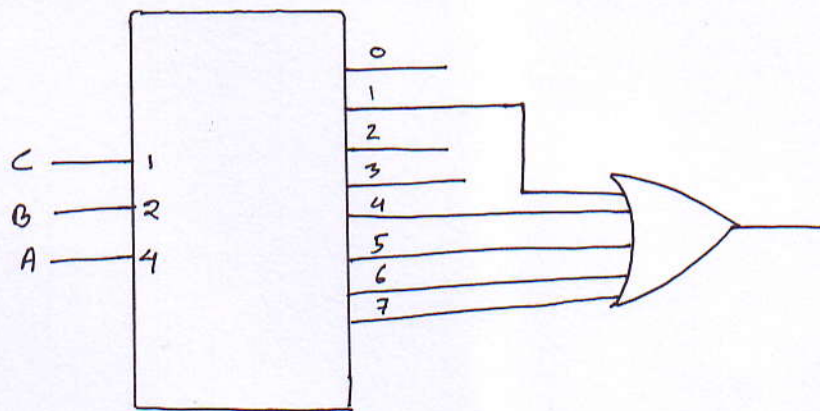
\* Implement the logic function using a 3-bit and other necessary gate,

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

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

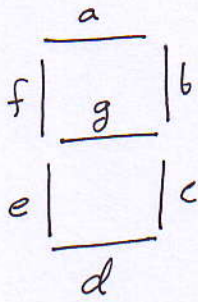
$$= AB\bar{C} + ABC + A\bar{B}C + A\bar{B}\bar{C} + A\bar{B}C + \bar{A}\bar{B}C$$

$$= \underset{110}{AB\bar{C}} + \underset{111}{ABC} + \underset{101}{A\bar{B}C} + \underset{100}{A\bar{B}\bar{C}} + \underset{001}{\bar{A}\bar{B}C}$$

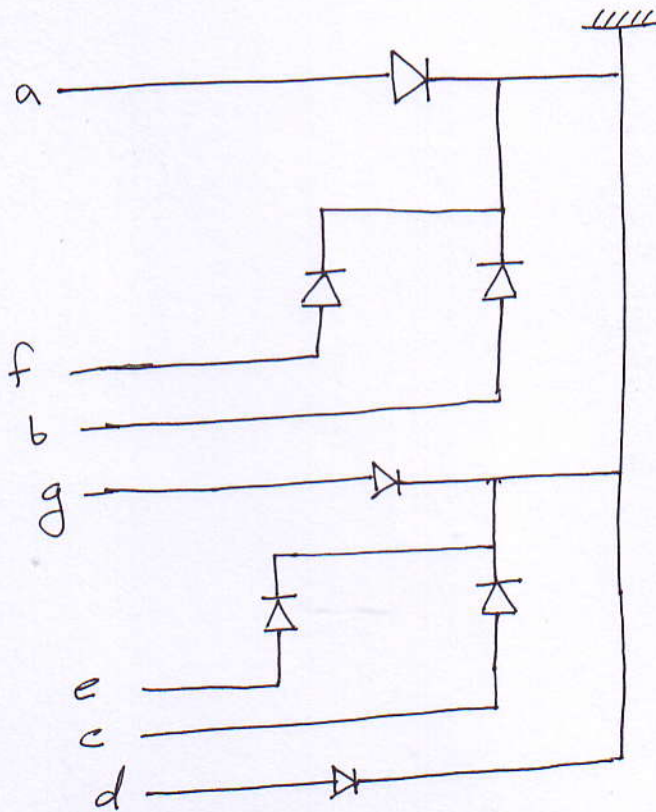




BCD to 7 segment decoder/driver :



Common Cathode Display  $\rightarrow$  Active high



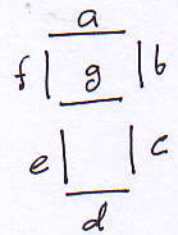
To display 4 the input code is

a	b	c	d	e	f	g
0	1	1	0	0	1	1

# Truth table for BCD to 7-segment decoder :

12-10

Decimal	BCD inputs				Outputs						
	A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	0	1	1	1	1	1	1	0
1	0	0	0	1	0	1	1	0	0	0	0
2	0	0	1	0	1	1	0	1	1	0	1
3	0	0	1	1	1	1	1	1	0	0	1
4	0	1	0	0	0	1	1	0	0	1	1
5	0	1	0	1	1	0	1	1	0	1	1
6	0	1	1	0	1	0	1	1	1	1	1
7	0	1	1	1	1	1	1	0	0	0	0
8	1	0	0	0	1	1	1	1	1	1	1
9	1	0	0	1	1	1	1	1	0	1	1

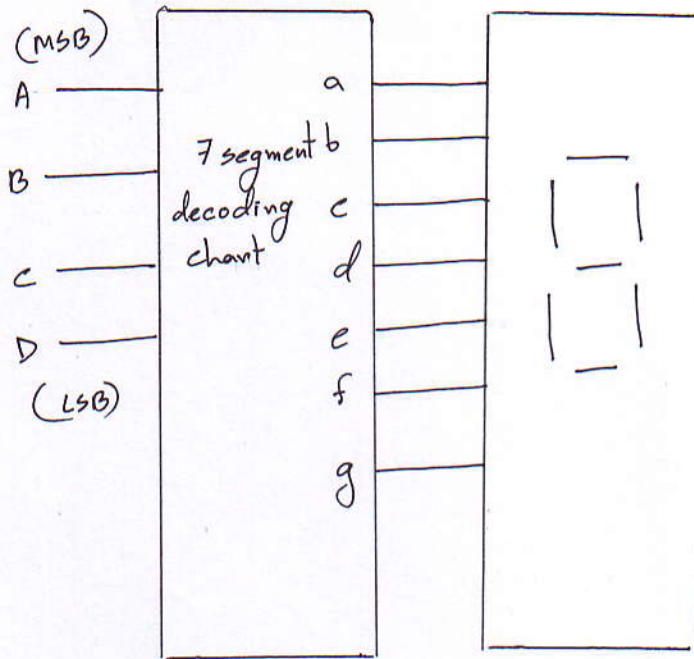
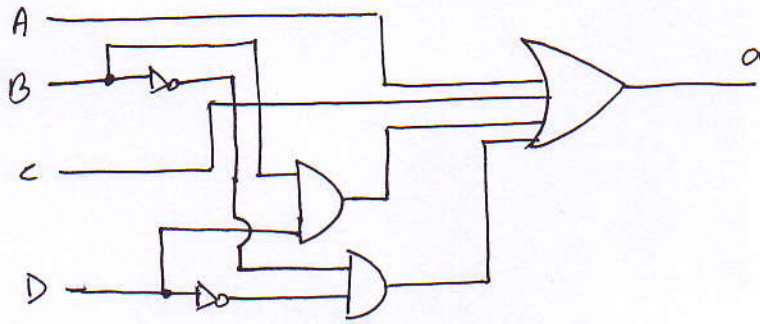


K-map for segment a,

AB \ CD	CD			
	00	01	11	10
00	1 <sup>0</sup>	0 <sup>1</sup>	1 <sup>3</sup>	1 <sup>2</sup>
01	0 <sup>4</sup>	1 <sup>5</sup>	1 <sup>7</sup>	1 <sup>6</sup>
11	X <sup>12</sup>	X <sup>13</sup>	X <sup>15</sup>	X <sup>14</sup>
10	1 <sup>8</sup>	1 <sup>9</sup>	X <sup>11</sup>	X <sup>10</sup>

$\therefore$  Logic for segment 'a' =  $A + C + BD + \bar{B}\bar{D}$





7 segment display cc arrangement.