CODE CONVERTERS

Lecture 7 & 8

Code converters

- A code converter circuit will convert coded information in one form to a different coding form.
- Coded representation for 10 decimal symbols is known as binary coded decimal (or BCD) or decimal codes.
- Minimum 4-bits are required to represent decimal symbol.
- Out of 16 , 4-bit combinations, only 10 combinations are used to represent 10 decimal symbols and remaining 6 will not be used (don’t cares)

Difference between binary and BCD representation

- $(28)_{10}$

  Binary representation : $(11100)_{2}$

  8421 BCD representation : $(0010\ 1000)_{2}$

Introduction to BCD codes

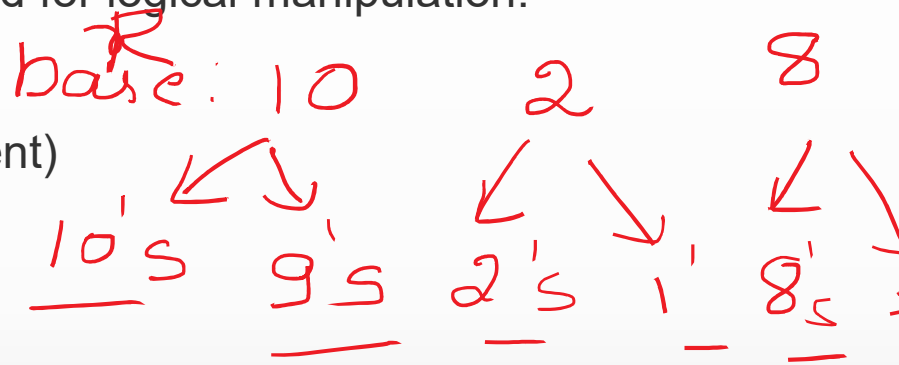
Decimal digit	8421 (BCD)	Excess 3	84-2-1	2421	Gray code
0	0000	0011	0000	0000	0000
1	0001	0100	0111	0001	0001
2	0010	0101	0110	0010	0011
3	0011	0110	0101	0011	0010
4	0100	0111	0100	0100	0110
5	0101	1000	1011	1011	0111
6	0110	1001	1010	1100	0101
7	0111	1010	1001	1101	0100
8	1000	1011	1000	1110	1100
9	1001	1100	1111	1111	1101
Don't cares	1010,1011, 1100,1101, 1110,1111	0000,0001, 0010,1101, 1110,1111	0001,0010, 0011,1100, 1101,1110	0101,0110, 0111,1000, 1001,1010	1000, 1001 1010, 1110

Complements

Are used for simplifying the subtraction operation and for logical manipulation.

There are two complements for each base:

- (R-1)'s complement (Diminished radix complement)
- R's complement (Radix complement)



- (R-1)'s complement:

  (R-1)'s complement of a number is $(R^n - 1) - N$

  Where R → base

  N → number who's complement is to be taken

  n → number of digits/bits in the number N

- R’s complement

  R’s complement of a number is $R^n - N$

  Where R → base

  N → number who's complement is to be taken

  n → number of digits/bits in the number N

Code converter design steps:

- 1. Write the truth table
- 2. Identify the don’t care inputs from input code
- 3. Write the minterms/maxterms for every output variable
- 4. Simplify the expressions for output variables
- 5. Draw the circuit using the specified gates.

Design a 3 bit binary to gray code converter.

3-bit Binary B2 B1 B0	Gray G2 G1 G0
0 0 0	0 0 0
0 0 1	0 0 1
0 1 0	0 1 1
0 1 1	0 1 0
1 0 0	1 1 0
1 0 1	1 1 1
1 1 0	1 0 1
1 1 1	1 0 0

$G_2 = \Sigma m(4,5,6,7)$

$G_1 = \Sigma m(2,3,4,5)$

$G_0 = \Sigma m(1,2,5,6)$

1 1 0 ← binary

1 0 1 ← Gray

$G_2 = B_2$

Ex: +9 1 1 0 0 1 0 ← Binary

1 1 1 0 1 0 1 1 ← Gray

$G_1 = \overline{B}_2 B_1 + \overline{B}_1 B_2 = B_2 \oplus B_1$

$G_0 = B_1 \overline{B}_0 + \overline{B}_1 B_0 = B \oplus B_0$

$G_i = B_{i+1} \oplus B_i$

$i = 0$ to $n-2$

$G_{n-1} = B_{n-1}$

$n \Rightarrow$ no. of bits in binary i/p

Design a code converter to convert a decimal digit represented in 8421 code to a decimal digit represented in Excess 3 code.

Decimal digit	8 4 2 1 A B C D	Excess 3 code E3 E2 E1 E0
0	0000	0011
1	0001	0100
2	0010	0101
3	0011	0110
4	0100	0111
5	0101	1000
6	0110	1001
7	0111	1010
8	1000	1011
9	1001	1100
Don't cares	1010,1011, 1100,1101,1110, 1111	----------

NAND → SOP

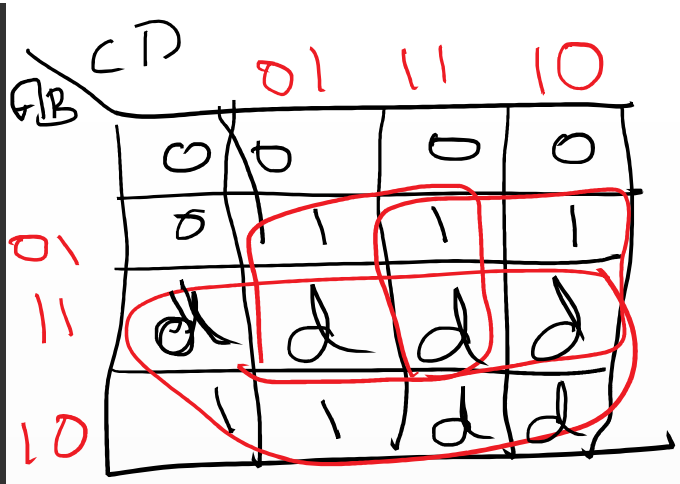
$D(10,11,12,13,14,15)$

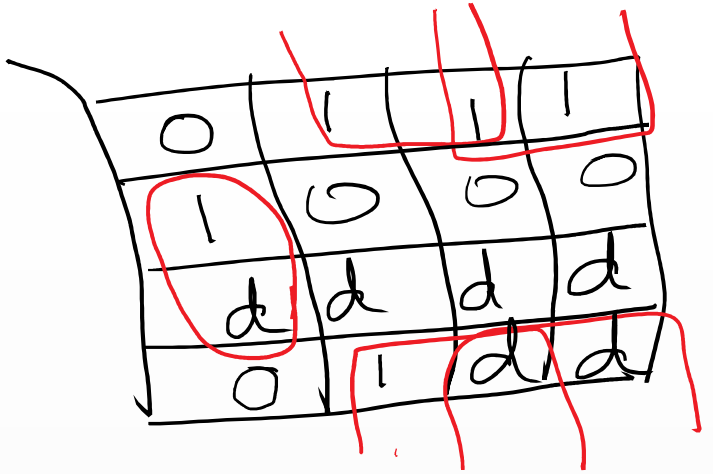
$E_3 = \Sigma m(5,6,7,8,9) + D(10,11,12,13,14,15)$

$E_2 = \Sigma m(1,2,3,4,9) + D(\text{"11"})$

$E_1 = \Sigma m(0,3,4,7,8) + D(\text{"11"})$

$E_0 = \Sigma m(0,2,4,6,8) + D(\text{"11"})$





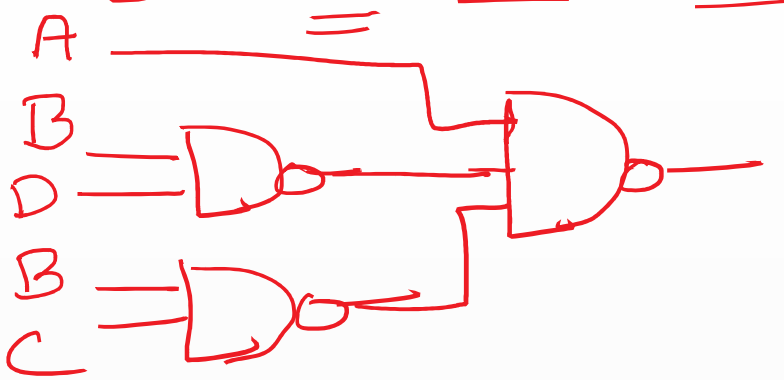
$$E_3 = A + BD + \bar{B}C$$

$$E_2 = \bar{B}C + \bar{B}D + B\bar{C}\bar{D}$$

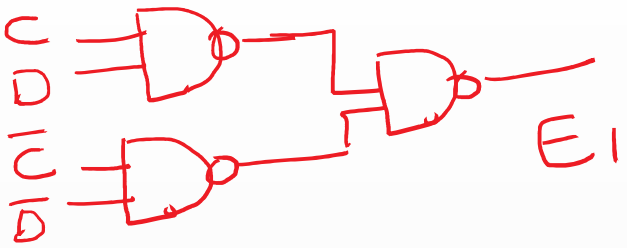
$$E_1 = CD + \bar{C}\bar{D}$$

$$E_0 = \cancel{\bar{C}\bar{D} + B\bar{D}} = \bar{D}$$

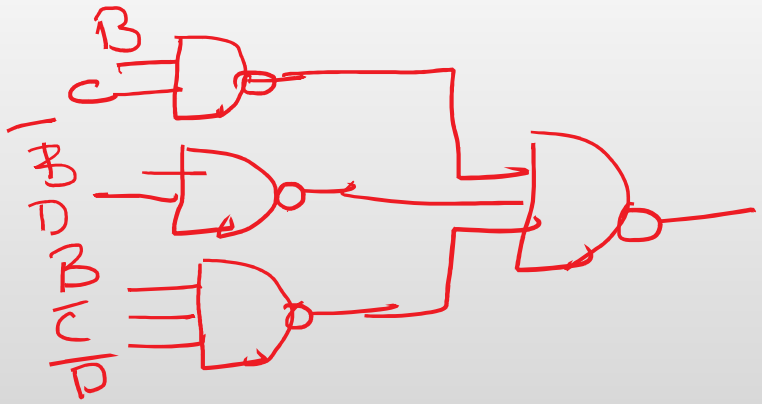
$$E_3 = A + BD + BC$$



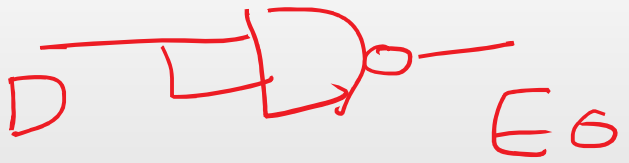
$$E_1 = CD + \overline{C}\,\overline{D}$$



$$E_2 = \overline{B}C + \overline{B}D + B\overline{C}\,\overline{D}$$



$$E_0 = \overline{D}$$



Design a code converter to convert a decimal digit represented in 8 4 2 1 code to a decimal digit represented in 8 4 -2 -1 code.

Decimal digit	**8 4 2 1** **A B C D**	**8 4 -2 -1** **Y3 Y2 Y1 Y0**
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
Don’t cares		

Will be continued……