Digital Logic Design

Lecture No 08 : BCD Addition, Other Codes, Gary Code

BEE-12CD

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BCD Arithmetic

- BCD arithmetic involving negative numbers uses the 10's complement for representing the negative numbers including the sign digit.
  - 0 (0000) represents a positive sign and 9 (1001) represents a negative sign
- As an example, imagine we want to add

  (+257) + (-160) = +97

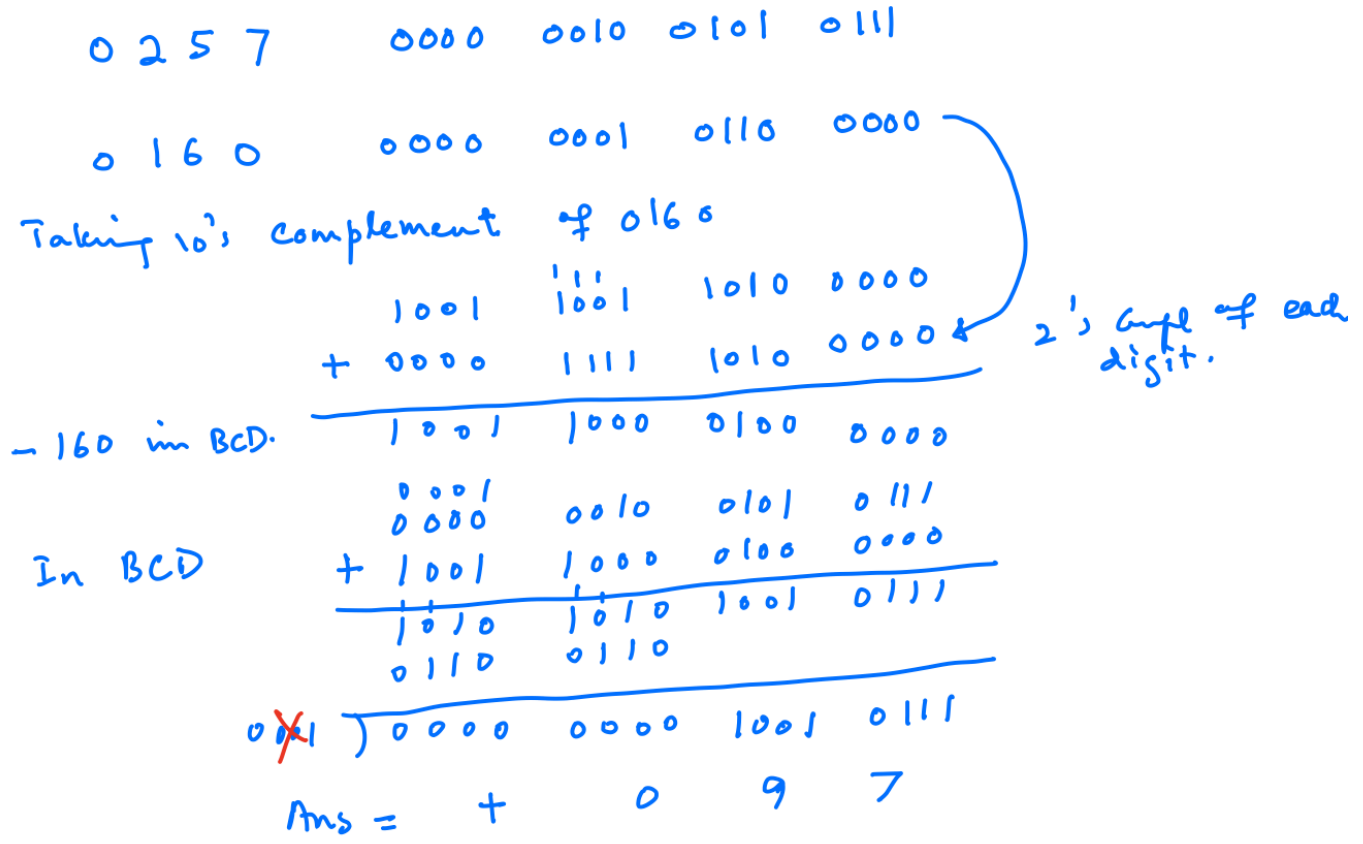
	1
0 257	0000 0010 0101 0111
9 840	1001 1000 0100 0000
	1010 1010 1001 0111
	0110 0110
0 097	0000 0000 1001 0111

- Note: To obtain 10's complement of a BCD number, we first take the 9's complement (by subtraction of each digit from 9) and then add one to least significant digit

BCD Arithmetic using 2's Complement method

- As an example, imagine we want to add

  (+257) + (-160) = +097



Other Decimal Codes

- There are various other decimal codes that can be used:
  - BCD (8 4 2 1)
  - 2 4 2 1
  - Excess-3 code. (adds binary 0011 to the BCD code)
  - 8 4 -2 -1
  - Gray Code
  - ASCII Character Code
  - Error-Detecting Code
- Each bit has a "weight" associated with it and you can compute the decimal value by adding the weights where a 1 exists in the code-word.

Four Different Binary Codes

Decimal digit	BCD 8421	2421	Excess-3	8 4 -2 -1
0	0000	0000	0011	0000
1	0001	0001	0100	0111
2	0010	0010	0101	0110
3	0011	0011	0110	0101
4	0100	0100	0111	0100
5	0101	1011	1000	1011
6	0110	1100	1001	1010
7	0111	1101	1010	1001
8	1000	1110	1011	1000
9	1001	1111	1100	1111

Summary Binary Codes

- Binary Codes?
  - To represent discrete information, n bits can represent 2^n quantities
  - Decimal digits codes, representing each digit separately
    - BCD, 2421, Excess-3, 84-2-1, 4321etc
- BCD Addition?
  - If the sum of two BCD number is more than 9 then add 6 to it.
- BCD Arithmetic?
  - Signed BCD : 0000 for positive, 1001 for negative number
  - Take 10's complement of negative number and add it to the other number, discard carry, if sum is more than nine add binary 6 to get BCD digits
  - Take 2's complement of each digit, leaving least significant zeros, add binary 10 to first non zero digit and add binary nine to all other digits

The End