* Radix Compliment
  + Given a number n, base r, n digits. Trying to find r's compliment of n
    - N = r^n – N for N != 0
    - If it is 0 then the compliment is 0
  + (note the difference between radix or diminished is that diminish is (r^n-1) vs radix is R^n-N
  + For decimal numbers
    - R = 10
    - 10s compliment of N = 2389; n = 4
    - 10s compl of N = 10^4 – 2389
    - = 7611
    - Note the fast way is use the 9s compliment (subtract each number by 9 then add one)
  + Binary numbers
    - R = 2
    - 2s compliment of N = 1101100
    - 2s compl = 2^7 – 1101100
    - = 00010100
    - 2s compl -> scan binary number from right to left, leave the first 0s unchanged, leave the first 1 unchanged. Then flip everything else.
    - Or 2s compl is the same as 1s compliment and add a 1 to it
* The compliment of a compliment of a number is the function itself.
  + N w/ r base w. n digits
  + Rs compl of N = r^n – N
  + Rs compl of R^n-N= r^n -(r^n-N)
  + = N
* Subtraction w/ compliments
  + M & N } n-digits r.base
  + M-N
  + M-N = M+(rs compl of N)
    - M+(r^n-N)
    - M-N+r^n
  + If M >= N -> sum will produce an edn carry(r^n) which can be discarded
  + -> M-N
  + If M < N -> the sum does not produce an end carry is equal to R^n-(N-M)
    - -> Rs compl of (N-M)
    - -> -(take rs compl of N-M)
  + EX: Using 10s compl find M-N
    - M: 72532; N: 3250
    - Ns 10 compl is 96750 so M -N is 69282
  + Ex:
    - M = 3250
    - N = 72532
    - Ns 10 compl is 27468; M – N(compl) is = 30718
    - 10s compl of 30718 is = -69282
  + EX :
    - X = 1010100
    - Y = 1000011
    - 1) x-y using 2s compl
      * X+y(compl) = 1010100 + 0111101 = 0010001 ( discarding the carry 1 at the front)
    - 2) y – x using 2s compl
      * Y+x(compl) = 1000011 + 0101100 = 1101111
      * -(rs compl of result)
      * -(0010001)
* Sign bit
  + 0 -> +ue #
  + 1 – -ue #
    - Signed binary #; 2s compl of ''r } +ue or –ue
    - If told unsigned then there is no signed bits and +ue #
  + 9 -> unsigned binary -> 1001 = 2^3+2^0 = 8 + 1 = 9
  + 9 -> singed binary -> 01001
    - Signed bit 11001 -> signed binary # find dec equivalent
      * -(2s compl of #)
      * -(0111)
      * -(2^2 + 2^1 + 2^ 0)
      * -7
* Arthimetic Addition
  + 1) 6 +13 = 19
    - 00000110 + 00001101 = 0010011
  + 2) -6 + 13
    - 6 to –6 take the twos compliment : 11111010
    - So now –6 + 13 = 11111010 + 00001101 = 00000111 = 7
  + 3) 6 + -13
    - 00000110 + 11110011 = 11111001
    - -(2s compl)
    - -(0000111)
    - -(2^2 + 2^1 + 2^0)
    - -7
  + 4) -6 + -13
    - 11111010 + 11110011 = 11101101
* Binary Codes
  + 2 distict value 0, 1
  + Circuits(ckts) elements 1 stable states -> 0 or 1
  + N bits binary code
    - Is a group of n bits
    - Up to 2^n combination of 0s and 1s
* A set of 4 elements(2^2) can be represented by 2 bits
  + 00 01 10 11
* A set of 8 elements (2^3) can be represented by 3 bits
  + 000 001 010 011 100 101 110 111
* A Set of 16 elements (2^4) can be represented by 4 binary bits
  + 0000 0001 0010 0011 ….. 1111
* BCD code ( binary – coded decimal)

|  |  |
| --- | --- |
| Decimal Symbol | BCD digits |
| 0 | 0000 |
| 1 | 0001 |
| 2 | 0010 |
| 3 | 0011 |
| 4 | 0100 |
| 5 | 0101 |
| 6 | 0110 |
| 7 | 0111 |
| 8 | 1000 |
| 9 | 1001 |

* + Ex: Dec # 256 find the BCD representation?
    - 2(0010) 5(0101) 6(0110) -> 001001010110
  + Ex 185
    - 000110000101
* More BCD codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Decimal | 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 | 0101 | 1000 | 1011 |
| 6 | 0110 | 1100 | 1001 | 1010 |
| 7 | 0111 | 1101 | 1010 | 1001 |
| 8 | 1000 | 1110 | 1011 | 1000 |
| 9 | 1001 | 1111 | 1100 | 1111 |

* Gray code

|  |  |
| --- | --- |
| Gray Code | Dec Expression |
| 0000 | 0 |
| 0001 | 1 |
| 0011 | 2 |
| 0010 | 3 |
| 0110 | 4 |
| 0111 | 5 |
| 0101 | 6 |
| 0100 | 7 |
| 1100 | 8 |
| 1101 | 9 |
| 1111 | 10 |
| 1110 | 11 |
| 1010 | 12 |
| 1011 | 13 |
| 1001 | 14 |
| 1000 | 15 |