Digital Logic Design

Lecture No 05

Subtraction with Complements

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Subtraction with Complements

- In digital computers the use of borrows to complete subtraction is inefficient. Complements are used to overcome this inefficiency.
- The subtraction of two *n*-digit unsigned numbers *M* – *N* in base *r* can be done as follows:
  - Add the minuend, M, to the r's complement of the subtrahend, N:
    - $M + (r^n - N) = M - N + r^n$
  - If $M \geq N$, the sum will produce an end carry, r^n, which can be discarded; what is left is the result of M – N.
  - If $M < N$, the sum does not produce an end carry and is equal to $r^n - (N - M)$, which is the r's complement of (N – M). To obtain the answer in a familiar form, take the r's complement of the sum and place a negative sign in front.

10’s Complement Subtraction

- Using 10’s complement, subtract 62513 – 2140

M =	62513
10’s complement of N =	97860
Sum	160373
Discard end carry	-100000
Answer	60373

Note that the extra 9 in the 10’s complement of N is to fill the space holder 0

10’ Complement Subtraction

- Using 10’s complement, subtract 2140 - 62513

M =	02140
10’s complement of N =	37487
Sum	39627
There is no end carry.	
10’s complement of 39627	60373
(Add - sign) Answer	-60373

Your Turn

- 10's Complement of 356600
  Answer= 643400

- Do the Subtraction using 10's Complement
  5406 – 77362
  Answer = – 71956
- Do the Subtraction using 10's Complement
  – 2708 – 1984
  Answer = – 4692
- Do the Subtraction using 10's Complement
  – 9708 – 4984
  Answer = – 14692

2’s Complement Subtraction

- Using 2’s complement, subtract 1001001 - 1000110

M =	1001001
2’s complement of N =	0111010
Sum	10000011
Discard end carry 2^7	-10000000
Answer	0000011

2’s Complement Subtraction

- Using 2’s complement, subtract 1000110 - 1001001

M =	1000110
2’s complement of N =	0110111
Sum	1111101
There is no end carry.	
2’s complement of 1111101	0000011
(Add – sign) Answer	-0000011

Using 1's Complement

- You can also use the 1's complement for performing subtraction.
- You can add the minuend M to the (r-1)'s complement of subtrahend N. Then inspect the result
  - If an end carry occurs add 1
  - If there is no end carry take (r-1)'s complement of the result obtained and place a negative sign
  - Note: Remember that 1's complement is 1 less than 2's complement. This means we must compensate by adding 1 when an end carry occurs. Removing an end-carry and adding one is called an end-around carry.

1’s Complement Subtraction

- Using 1’s complement, subtract 1001001 - 1000110

M =	1001001
1’s complement of N =	0111001
Sum	10000010
Discard end carry 2^7	-10000000
	0000010
Add 1 to compensate	+0000001
Answer	0000011

1's Complement Subtraction

- Using 1's complement, subtract 1000110 - 1001001

M =	1000110
1's complement of N =	0110110
Sum	1111100
There is no end carry.	
1's complement of 1111100	0000011
(Add – sign) Answer	-0000011

Summary of Lecture

- Subtraction using r's Complement?
  - If M ≥ N, the sum will produce an end carry, r^n, which can be discarded; what is left is the result of M – N.
  - If M < N, the sum does not produce an end carry and is equal to r^n – (N – M), which is the r's complement of (N – M). To obtain the answer in a familiar form, take the r's complement of the sum and place a negative sign in front
  - If both are negative numbers, then end carry will occur, discard the carry, take complement of sum and place a negative sign
- Subtraction using r-1's Complement?
  - If an end carry occurs add 1
  - If there is no end carry take (r-1)'s complement of the result obtained and place a negative sign
  - If both are negative numbers, then end carry will occur, add the carry, take complement of sum and place a negative sign

The End