**Number Systems**

* Readings: 1.1 – 1.7
* **Unsigned binary** – value = 0 → 2n – 1
* **Signed binary**
  + Sign & magnitude – leftmost bit is sign bit
    - E.g. -5 → -(101) → 1101
  + One’s complement – flip each bit
    - E.g. -5 → -(0101) → 1010
  + Two’s complement – flip each bit then + 1
    - E.g. -5 → -(0101) → 1010 → 1011
* Most significant bit (MSB) always determines sign
* For 2’s complement:
  + x + y = x + y (mod 2n)
  + !x = 2n – x (2’s complement of x)
  + thus x – y = x + !y = x + 2n – y (mod 2n) ≡ x – y
* **Signed addition** – add as normal, disregard carry-out
* **Signed subtraction** – add the 2’s complement of subtrahend, disregard carry-out
  + E.g. M – N = M + !N
* **Overflow** – when adding/subtracting 2 numbers of the same sign and result is a different sign
  + E.g. 0100 (4) – 1010 (-6) = 0100 + 0110 = 1010 (-6) ← overflow
* Sign extension
  + 4 → 0100 → 0000 0100
  + -6 → 1010 → 1111 1010