Chapter #9
Number Systems

Radix Conversion

- Decimal→Binary
- Binary→Decimal
- Decimal→Hexadecimal
- Hexadecimal->Decimal

Decimal→Binary (Integer)

- Method #1:
  - Subtract powers of 2 until number is 0
  - Example: $(83)_{10}$

    83>64:83-64=19 (1)

    19<32: (0)

    19>16:19-16=3 (1)

    3<8: (0)

    3<4: (0)

    3>2:3-2=1 (1)

    1=1:1-1=0 (1)
  - Result: $(83)_{10}=(1010011)_2$

Decimal→Binary (Integer)

- Method #2:
  - Divide by 2 until number is 0 (extract remainder)
  - Example: $(83)_{10}$

    83/2 = 41rem 1 (1)
    41/2 = 20 rem 1 (1)
    20/2 = 10 rem 0 (0)
    10/2 = 5 rem 0 (0)
    5/2 = 2 rem 1 (1)
    2/2 = 1 rem 0 (0)
    1/2 = 0 rem 1 (1)
  - Result: $(83)_{10}=(1010011)_2$

Decimal→Binary (Fraction)

- Method #1:
  - Subtract powers of 2 until number is 0
  - Example: $(0.3125)_{10}$

    0.3125 <(1/2) (0)

    0.3125>(1/4):0.3125-(1/4)=0.0625 (1)

    0.0625<(1/8) (0)

    0.0625=(1/16):0.0625-(1/16)=0 (1)
  - Result: $(0.3125)_{10}=(.0101)_2$

Decimal→Binary (Fraction)

- Method #2:
  - Multiply by 2 until number is 0 (extract integer)
  - Example: $(0.3125)_{10}$

    0.3125 * 2 = 0.625 (0)

    0.625 * 2 = 1.25 (1)

    0.25 * 2 = 0.5 (0)

    0.5 * 2 = 1.0 (1)
  - Result: $(0.3125)_{10}=(0.101)_2$

Decimal→Binary (Fraction)

- Method #3:
  - Only works if can be converted exactly
  - Count # of fractional positions: *m*
  - Multiply fraction by 2^m to produce binary integer *x*
  - Result: 0.x
  - Eg: 0.3125 (4 positions)

    $0.3125*2^4=5=(101)_2$

    $0.3125=(0.0101)_2$

Binary→Decimal (Integer)

- Method #1:
  - Add powers of 2
  - Example: $(1010011)_2$

    $(2^6 + 2^4 + 2^1 + 2^0) = 64+16+2+1=83$

  - Result:$(1010011)_2=(83)_{10}$

Binary→Decimal (Integer)

- Method #2:
  - Multiply by 2 & add digit
  - Eg: $(1010011)_2$

    0*2+1=1

    1*2+0=2

    2*2+1=5

    5*2+0=10

    10*2+0=20

    20*2+1=41

    41*2+1=83

  - Result:$(1010011)_2=(83)_{10}$

Binary→Decimal (Fraction)

- Method #1:
  - Add powers of 2
  - Eg: 0.1011

    $(2^{-1} + 2^{-3} + 2^{-4}) = 0.6875$

Binary→Decimal (Fraction)

- Method #2:
  - Multiply by 2 step by step & divide by $2^{\#digits}$
  - Eg: 0.1010011

    0*2+1=1

    1*2+0=2

    2*2+1=5

    5*2+0=10

    10*2+0=20

    20*2+1=41

    41*2+1=83

  - Result:$83/2^7=0.6484375$

Decimal→Hexadecimal (Integer)

- Methods:
  - Divide by 16 until # is 0
  - Convert from Decimal→Binary→Hexadecimal

Decimal→Hexadecimal (Fraction)

- Methods:
  - Multiply by 16 until # is 0 (extract integer)
  - Convert from Decimal→Binary→Hexadecimal

Hexadecimal→Decimal (Integer)

- Methods:
  - Add digits weighted by powers of 16
  - Multiply by 16 and add digit
  - Convert from HEX→Binary→Decimal

Hexadecimal→Decimal (Fraction)

- Methods:
  - Add digits weighted by negative powers of 16
  - Multiply by 16 step by step & divide by $16^{\#digits}$
  - Convert from HEX→Binary→Decimal