CS-150 Worksheet 1
Number Systems

This lab is about getting familiar with base conversions and binary arithmetic. Complete each of the follow tasks, remembering to provide your working.

☐ Task 1.1 – Decimal (base 10) to base x

i. Convert the following to binary:

- 12
  12/2 = 6r**0**
  6/2 = 3r**0**
  3/2 = 1r**1**
  1/2 = 0r**1**
  = 1100 in base 2

- 9002
  9002/2 = 4501r**0**
  4501/2 = 2250r**1**
  2250/2 = 1125r**0**
  1125/2 = 562r**1**
  562/2 = 281r**0**
  281/2 = 140r**1**
  140/2 = 70r**0**
  70/2 = 35r**0**
  35/2 = 17r**1**
  17/2 = 8r**1**
  8/2 = 4r**0**
  4/2 = 2r**0**
  2/2 = 1r**0**
  1/2 = 0r**1**
  = 10001100101010 in base 2

ii. Convert the following to octal:

- 341
  341/8 = 42r**5**
  42/8 = 5r**2**
  5/8 = 0r**5**
  = 525 in base 8

- 55
  55/8 = 6r**7**
  6/8 = 0r**6**
  = 67 in base 8

iii. Convert the following to hexadecimal:

- 150
  150/16 = 9r**6**
  9/16 = 0r**9**
  = 96 in base 16

- 2019
  $2019/16 = 126\text{r}\mathbf{3}$
  $126/16 = 7\text{r}14 = 7\text{r}\mathbf{E}$
  $7/16 = 0\text{r}\mathbf{7}$
  $= 7\text{E}3$ in base 16

☐ Task 1.2 – Base x into decimal

i. Convert the following from binary:

- 1101110110
  1×2^9
  $+1 \times 2^8$
  $+0 \times 2^7$
  $+1 \times 2^6$
  $+1 \times 2^5$
  $+1 \times 2^4$
  $+0 \times 2^3$
  $+1 \times 2^2$
  $+1 \times 2^1$
  $+0 \times 2^0$
  $= 512 + 256 + 0 + 64 + 32 + 16 + 0 + 4 + 2 + 0 = 886$ in base 10
- 100101
  1×2^5
  $+0 \times 2^4$
  $+0 \times 2^3$
  $+1 \times 2^2$
  $+0 \times 2^1$
  $+1 \times 2^0$
  $= 32 + 0 + 0 + 4 + 0 + 1 = 37$ in base 10

ii. Convert the following from hexadecimal:

- AB23
  $A \times 16^3$
  $+B \times 16^2$
  $+2 \times 16^1$
  $+3 \times 16^0 = 40960 + 2816 + 32 + 3 = 43811$ in base 10
- 39F
  3×16^2
  $+9 \times 16^1$
  $+F \times 16^0$
  $= 768 + 144 + 15 = 927$ in base 10

☐ Task 1.3 – Addition in binary

i. Calculate the following additions (no limit of word size):

- 101010 + 11010

  101010
  \+ 11010
  111 1 (carry in)
  = 1000100

- 11101101 + 1111011

  11101101
  \+ 1111011
  11111111 (carry in)
  = 101101000

☐ Challenge Task

Write a program, in either Java or Python, which implements the base conversion algorithm for integers via the repeated division method given in the lectures. Try extending this to allow for the conversion of a real number. You might want to make use of the **division** and **modulo** operators.