

# Final Exam (April 28, 2015)

## Materials:

### Topics A to F:

[http://www.eecs.yorku.ca/course\\_archive/2014-15/W/1520R/Topics.html](http://www.eecs.yorku.ca/course_archive/2014-15/W/1520R/Topics.html)

Textbook: Ch. 1, 2, 3, 4, 5, 10, 11.1, 11.2, 12.3, 15.1, 15.2, 15.3, 16.1, 16.2

Glade Manual: Ch. 1 - 9

# Review on Number Systems

1. To convert from a decimal number (Base 10) to other bases

Step 1: Always divide the decimal number by the new base, write down the quotient and the remainder

Step 2: Divide the quotient by the new base, write down the new quotient and the new remainder

Step 3: Keep repeating step 2 until quotient is 0

2. To convert from Binary to Octal

Step 1: group bits into threes, right to left

Step 2: convert each such group to an octal digit

Ex: what is the Octal representation of 1011010010 ?

**Ans:** 001 011 010 010 ← Base 2  
           1    3    2    2 ← Base 8 (Octal representation)

# Review on Number Systems

## 3. To convert from binary to Hexadecimal

Step 1: group bits into fours, right to left

Step 2: convert each such group to a hexadecimal digit

Ex: what is the Hexadecimal representation of 1011010010 ?

**Ans:**    0010   1101   0010   ← Base 2  
           2        D        2        ← Base 16 (Hexadecimal representation)

# Review on Number Systems

## 4. To convert from Octal to Binary

convert each octal digit to a three-bit binary representation

Ex: what is the Binary representation of 745 (Octal) ?

**Ans:**      7    4    5    ← Base 8 (Octal representation)

          111 100 101    ← Base 2

Hence, 745 in octal is 111100101 in binary

## 5. To convert from Hexadecimal to Binary

convert each Hexadecimal digit to a four-bit binary representation

Ex: what is the Binary representation of 745 (Hexadecimal) ?

**Ans:** 745 in hexadecimal is 011101000101 in binary

# Review on Number Systems

## 6. To convert from Octal to Hexadecimal

Convert Octal to Binary first and then convert from Binary to Hexadecimal

Ex: Convert 53 (Octal) to Hexadecimal

**Ans:**      5    3            ← Base 8 (Octal representation)  
               101 011        ← Base 2

Group the binary digits in groups of 4:

              0010 1011        ← Base 2  
               2    B            ← Base 16 (Hexadecimal representation)

Hence, 53 in octal is equivalent to 2B in hexadecimal

# Review on Number Systems

## 7. To convert from Hexadecimal to Octal

Convert Hexadecimal to Binary first and then convert from Binary to Octal

Ex: Convert 53 (Hexadecimal) to Octal

**Ans:**        5    3            ← Base 16 (Hexadecimal representation)

          0101  0011        ← Base 2

Group the binary digits in groups of 3:

          001  010  011        ← Base 2

          1    2    3            ← Base 8 (Decimal representation)

Hence, 53 in hexadecimal is equivalent to 123 in octal

# Review on Number Systems

8. To convert from any bases to decimal (base 10)

Use the following equation ( $n$  = number of digits,  $B$  = original base,  $d_i$  = digit in the  $i^{\text{th}}$  position in the number) :

$$d_n * B^{n-1} + d_{n-1} * B^{n-2} + \dots + d_2 * B^1 + d_1$$

Ex: Convert 53 (Hexadecimal) to decimal

**Ans:**  $5 * 16^1 + 3 * 16^0 = 80 + 3 = 83$

Ex: Convert 53 (Octal) to decimal

**Ans:**  $5 * 8^1 + 3 * 8^0 = 40 + 3 = 43$

# Review on Number Systems

Show how the pattern 10111000 translates using each of the following interpretations

Two's complement:



8-bit normalized floating point:



# Review on Number Systems

Two's complement: invert all the bits and add 1 to find the original magnitude of the decimal number

$$\begin{array}{r}
 10111000 \\
 \\
 01000111 \\
 + \quad \quad 1 \\
 \hline
 01001000
 \end{array}$$

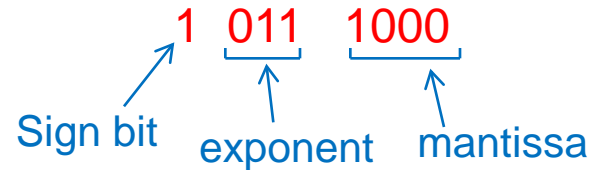
 Inverted bits  
 Add 1

01001000 corresponds to decimal 72

Hence, 10111000 corresponds to decimal -72

# Review on Number Systems

Floating point: 8-bit floating-point format is 1 bit for sign, 3 bits for exponent, 4 bits for mantissa



011 in decimal is 3, have to subtract 4 based on excess-4 notation, so  $3 - 4 = -1$

Hence, the format is:  $-0.1000 \times 2^{-1}$

$-0.01000 \times 2^0$  ← Shift the radix point to the left so that the format is expressed in terms of  $2^0$

$= -0.01$  ← Still in base 2

Hence,  $-0.01$  in base 2 is  $-1/4$  or  $-0.25$  in decimal