# Basic of Informatics – Lab 1.

**Base n:**

- Each position to the left is equal to n times the position to the right
- Each position to the right is equal to the position to the left divided by n

**Octal: Base 8**

- 8 symbols: 0,1,2,3,4,5,6,7
  - 4096 – 512 – 64 – 8 – 1
  - 402 in octal = 258 in decimal

**Hexadecimal: Base 16**

- 16 symbols: 0,1,2,3,4,5,6,7,8,9, A, B, C, D, E, F
  - 65536 – 4096 – 256 – 16 – 1
  - 402 in octal = 258 in decimal = 102 in Hexadecimal
  - 7473 in octal = 3899 in decimal = F3B in Hexadecimal

**Binary: Base 2**

- 2 symbols: 0, 1
  - 256 - 128 - 64 -32 - 16 - 8 - 4 - 2 – 1
  - 100000010 in binary = 382 in octal = 258 in decimal = 102 in Hexadecimal

**Counting with the Binary System**

- Positional number system
  - the value of each digit is determined by its position
  - 101 is different from 110
  - The lowest place value is the rightmost position, and each successive position to the left has a higher place value

**Base 2**

- The value of each position corresponds to powers of 2
  - $d_4d_3d_2d_1d_0 = \ldots + d_4\times2^4 + d_3\times2^3 + d_2\times2^2 + d_1\times2^1 + d_0\times2^0$
- Each digit to the left is 2 times the previous digit.

$111100011\ (483) = 1\times2^8 + 1\times2^7 + 1\times2^6 + 1\times2^5 + 0\times2^4 + 0\times2^3 + 0\times2^2 + 1\times2^1 + 1\times2^0$

- To multiply a number by 2 you can simply shift it to the left by one digit, and fill in the rightmost digit with a 0
  - 101×2=1010 (5*2 = 10)
- To divide a number by 2, simply shift the number to the right by one digit (moving the decimal place one to the left).
  - 101÷2=10.1 (5÷2=2.5)
- With n digits, 2n unique numbers can be represented
  - If n=8, 256 ($=2^8$) numbers can be represented 0-11111111

**Converting Binary to Decimal**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $2^6$ | 64 | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
| $2^5$ | 32 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| $2^4$ | 16 | | | | | | | |
| $2^3$ | 8 | *64* | *32* | *16* | *8* | *4* | *2* | *1* |
| $2^2$ | 4 | | | | | | | |
| $2^1$ | 2 | 32+4+2=38 | | | | | | |
| $2^0$ | 1 | | | | | | | |

**Converting Decimal to Binary**

| Decimal | Quotient | Remain | Binary |
|---|---|---|---|
| 47 | 23 | 1 | 1 |
| 23 | 11 | 1 | 11 |
| 11 | 5 | 1 | 111 |
| 5 | 2 | 1 | 1111 |
| 2 | 1 | 0 | 01111 |
| 1 | 0 | 1 | 101111 |

**Decimal to Binary**

- Repeated Division by 2
  - Divide the decimal number by 2
  - If the remainder is 0, on the side write down a 0
  - If the remainder is 1, write down a 1
  - Continue until the quotient is 0
  - Remainders are written beginning at the least significant digit (right) and each new digit is written to left (the most significant digit ) of the previous digit.

| Decimal | Quotient | Remain | Binary |
|---|---|---|---|
| 54 | 27 | 0 | 0 |
| 27 | 13 | 1 | 10 |
| 13 | 6 | 1 | 110 |
| 6 | 3 | 0 | 0110 |
| 3 | 1 | 1 | 10110 |
| 1 | 0 | 1 | 110110 |

**Binary groupings:**

- Bit – Size 1
  - 0-1 (2 Values)
- Nibble – Size 4
  - 0-15 (16 Values)
  - 1101
- Byte – Size 8
  - 0-255 (256 Values)
  - 11011001
- Word – Size 16
  - 0-65535 (65536 Values)
  - 1101101001001001

Exercises:

1. Convert Binary to Decimal
   a) 11
   b) 10
   c) 1001
   d) 1101
   e) 01101101
   f) 10010111
   g)10110
   h)1101
   i)1101101
2. Convert Decimal to Binary
   a) 5
   b) 7
   c) 13
   d) 14
   e) 27
   f) 39
   g) 121
   h) 997
   i)-75
   j)-6
   k)-24
3. Binary Arithmetic
   a) 1010+1110
   b) 1011+1111
   c) 1000+1101
   d) 1111+0010
   e) 1110 1111+1011 1111
   f) 1011-1000
   g) 1011 0111-1011
   h) 1011*1000
   i) 1010*1111
   j) 1010*1110
   k) 1010*1100
   l) 1011*1110
4. Floating Point (sign, exponent, fraction, S-E-F) – Floating Point to Binary, and Binary to FP (remember about precision)
   a) 0100100101
   b) 1101101011
   c) 1011011101
   d) 0100101111
   e) 50.312
   f) 8.3212
   g) -8.1269
   h) 10.5