EX.1 Number Conversions

Calculations were made on paper

a. 1100101110_2 **to decimal**

$$1100101110_2 = 814_{10}$$

b. 11001000011101_2 **to hexadecimal**

$$11001000011101_2 = 321D_{16}$$

c. 11001000011101_2 **to octal**

$$11001000011101_2 = 31075_8$$

d. 458_{10} **to binary**

$$458_{10} = 111001010_2$$

e. 6197_{10} **to octal**

$$6197_{10} = 14605_8$$

f. 15816_{10} **to hexadecimal**

$$15816_{10} = 3DC8_{16}$$

g. 245_8 **to binary**

$$245_8 = 010100101_2$$

h. 5026_8 **to decimal**

$$5026_8 = 2582_{10}$$

i. 437_8 **to hexadecimal**

$$437_8 = 23F_{16}$$

j. $9FEA_{16}$ **to binary**

$$9FEA_{16} = 1001111111101010_2$$

k. $9FEA_{16}$ **to octal**

$$9FEA_{16} = 117752_8$$

l. $1D4C_{16}$ **to decimal**

$$1D4C_{16} = 7500_{10}$$

m. $3G8_{19}$ **to 13-base notation**

$$3G8_{19} = 836_{13}$$

EX.2 Signed Binary to Decimal Conversion

a. 0000 1000 0001 1010 0110 0101 0111 0011

Since the binary number starts with a 0, it is positive. We convert it directly to decimal:

$$(0\times2^{31})+(0\times2^{30})+(0\times2^{29})+(0\times2^{28})+$$
$$(1\times2^{27})+(0\times2^{26})+(0\times2^{25})+(0\times2^{24})+(0\times2^{23})+(0\times2^{22})+(0\times2^{21})+(1\times2^{20})+$$
$$(1\times2^{19})+(0\times2^{18})+(1\times2^{17})+(0\times2^{16})+(0\times2^{15})+(1\times2^{14})+(1\times2^{13})+(0\times2^{12})+$$
$$(0\times2^{11})+(1\times2^{10})+(0\times2^{9})+(1\times2^{8})+(0\times2^{7})+(1\times2^{6})+(1\times2^{5})+(1\times2^{4})+$$
$$(0\times2^{3})+(0\times2^{2})+(1\times2^{1})+(1\times2^{0})=(135947635)_{10}$$

b. 1000 1000 0001 1010 0110 0101 0111 0011

Since the binary number starts with a 1, it is negative in two's complement format. To find the decimal value, we follow these steps:

1. Find the two's complement (invert the bits and add 1).
2. Convert the resulting binary number to decimal.
3. Negate the result.

The binary number:

$$1000\ 1000\ 0001\ 1010\ 0110\ 0101\ 0111\ 0011_2$$

Step 1: Invert the bits:

$$0111\ 0111\ 1110\ 0101\ 1001\ 1010\ 1000\ 1100_2$$

Add 1:

$$0111\ 0111\ 1110\ 0101\ 1001\ 1010\ 1000\ 1100_2+1=0111\ 0111\ 1110\ 0101\ 1001\ 1010\ 1000\ 1101_2$$

Step 2: Convert to decimal:

$$0111\ 0111\ 1110\ 0101\ 1001\ 1010\ 1000\ 1101_2$$

$(0\times2^{31})+(1\times2^{30})+(1\times2^{29})+(1\times2^{28})+(0\times2^{27})+(1\times2^{26})+(1\times2^{25})+(1\times2^{24})+(1\times2^{23})+$
$(1\times2^{22})+(1\times2^{21})+(0\times2^{20})+(0\times2^{19})+(1\times2^{18})+(0\times2^{17})+(1\times2^{16})+(1\times2^{15})+$
$(0 \times 2^{14}) + (0 \times 2^{13}) + (1 \times 2^{12}) + (1 \times 2^{11}) + (0 \times 2^{10}) + (1 \times 2^{9}) + (0 \times 2^{8})+$
$(1\times2^{7})+(0\times2^{6})+(0\times2^{5})+(0\times2^{4})+(1\times2^{3})+(1\times2^{2})+(0\times2^{1})+(1\times2^{0}) = (2011536013)_{10}$

Step 3: Negate the result:

$$-2011536013$$

EX.3

(a) 12345&5013

$$\begin{aligned}
12345_{10} &= 0011000000111001_2 \\
5013_{10} &= 0001001110010101_2 \\
12345\&5013 &= 0011000000111001_2\&0001001110010101_2 \\
&= 0001000000010001_2 \\
&= 4113_{10}
\end{aligned}$$

(b) 432 | − 502

$$\begin{aligned}
432_{10} &= 0000000110110000_2 \\
502_{10} &= 0000000111110110_2 \\
-502_{10} &= 1111111000001010_2 \\
432\,|-502 &= 0000000110110000_2\,|\,1111111000001010_2 \\
&= 1111111110111010_2 \\
&= 1111111110111010_2 \text{ (in two's complement, invert and add 1)} \\
&= 0000000001000101_2 + 1 \\
&= 0000000001000110_2 \\
&= -70_{10}
\end{aligned}$$

(c) $1\hat{9}(\sim 67)$

$$
\begin{aligned}
19_{10} &= 0000000000010011_2 \\
67_{10} &= 0000000001000011_2 \\
\sim 67_{10} &= 1111111110111100_2 \\
19^{\sim 67} &= 0000000000010011_2{}^{1111111110111100_2} \\
&= 1111111110101111_2 \\
&= 1111111110101111_2 \text{ (in two's complement, invert and add 1)} \\
&= 0000000001010000_2 + 1 \\
&= 0000000001010001_2 \\
&= -81_{10}
\end{aligned}
$$

(d) $-178 >> 2$

$$
\begin{aligned}
178_{10} &= 0000000010110010_2 \\
-178_{10} &= 1111111101001110_2 \\
-178 >> 2 &= 1111111101001110_2 >> 2 \\
&= 1111111111010011_2 \\
&= 1111111111010011_2 \text{ (in two's complement, invert and add 1)} \\
&= 0000000000101100_2 + 1 \\
&= 0000000000101101_2 \\
&= -45_{10}
\end{aligned}
$$

(e) $(\sim 178 + 1) >>> 4$

$$
\begin{aligned}
178_{10} &= 0000000010110010_2 \\
\sim 178_{10} &= 1111111101001101_2 \\
(\sim 178 + 1) &= 1111111101001101_2 + 1 \\
&= 1111111101001110_2 \\
(\sim 178 + 1) >>> 4 &= 1111111101001110_2 >>> 4 \\
&= 111111110100_2 \\
&= 268435444_{10}
\end{aligned}
$$

EX.4Arithmetic Operations in 8-bit Two's Complement Notation

(a) $88 - 50$

1. Convert 88 and 50 to their 8-bit binary representations:

$$88_{10} = 01011000_2$$

$$50_{10} = 00110010_2$$

2. Convert 50 to its two's complement (invert and add 1):

$$50_{10} = 00110010_2 \quad \rightarrow \quad \text{invert} \rightarrow 11001101_2 \quad \rightarrow \quad \text{add 1} \rightarrow 11001110_2$$

3. Perform the addition:

$$01011000_2 + 11001110_2 = 100100110_2$$

4. Consider only the least significant 8 bits:

$$100100110_2 \rightarrow 00100110_2$$

5. Convert the result back to decimal:

$$00100110_2 = 38_{10}$$

Thus, $88 - 50 = 38$ is mathematically sound and valid.

(b) $88 + 50$

1. Convert 88 and 50 to their 8-bit binary representations:

$$88_{10} = 01011000_2$$

$$50_{10} = 00110010_2$$

2. Perform the addition:

$$01011000_2 + 00110010_2 = 10001010_2$$

3. Consider only the least significant 8 bits:

$$10001010_2$$

4. Convert the result back to decimal (two's complement):

$$10001010_2 \quad \text{(negate the bits)} \rightarrow 01110101_2 \quad \rightarrow \quad \text{add 1} \rightarrow 01110110_2 = 118_{10} \rightarrow -118_{10}$$

Thus, $88 + 50 = -118$ in 8-bit two's complement notation. The result is not mathematically valid in standard arithmetic due to overflow.

EX.5 Java Hello World

```java
public class HelloWorld {
    public static void main(String[] args) {
    String UserName = "Vahagn";
        String UserId = "MU6613477";

        System.out.println("Hello user. My name is "
                            + UserName + ". My ID is " + UserId);
    }
}
```