Sétif 1 University
Faculty of Sciences
Common Core Mathematics and Computer Science

1st semester (year 2025/26)
Machine Structures 1 course
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Problem set 3
(Binary Encoding)

Exercise 1:

1). Perform the following encoding/decoding operations, showing all steps involved in the transformation:

1. Decimal: $(+6)_{10}$
- Encode in Unsigned Integer 4-bits.
- Encode in Sign-Magnitude 4-bits.
- Encode in One's Complement 4-bits.
- Encode in Two's Complement 4-bits.

2. Decimal: $(-12)_{10}$:
- Encode in Unsigned Integer 6-bits.
- Encode in Sign-Magnitude 6-bits.
- Encode in One's Complement 6-bits.
- Encode in Two's Complement 6-bits.

3. Decimal: $(+63)_{10}$
- Encode in Unsigned Integer 8-bits.
- Encode in Sign-Magnitude 8-bits.
- Encode in One's Complement 8-bits.
- Encode in Two's Complement 8-bits.

4. Decimal: $(-1)_{10}$
- Encode in Unsigned Integer 10-bits.
- Encode in Sign-Magnitude 10-bits.
- Encode in One's Complement 10-bits.
- Encode in Two's Complement 10-bits.

5. Binary: $[0110]_{4\text{-bits}}$
- As Unsigned Integer to decimal.
- As Sign-Magnitude to decimal.
- As One's Complement to decimal.
- As Two's Complement to decimal.

6. Binary: $[110101]_{6\text{-bits}}$
- As Unsigned Integer to decimal.
- As Sign-Magnitude to decimal.
- As One's Complement to decimal.
- As Two's Complement to decimal.

7. Binary: $[10000000]_{8\text{-bits}}$
- As Unsigned Integer to decimal.
- As Sign-Magnitude to decimal.
- As One's Complement to decimal.
- As Two's Complement to decimal.

8. Binary: $[1111111111]_{10\text{-bits}}$
- As Unsigned Integer to decimal.
- As Sign-Magnitude to decimal.
- As One's Complement to decimal.
- As Two's Complement to decimal.

2). For each Fixed-Width: N=4-bits, N=6-bits, N=8-bits, N=10-bits. What is the number of the representable values, and what are the ranges of representable values for each of the four encoding schemes (UI, SM, 1C, 2C)?

Exercise 2:

1). For each of the two decimal numbers +45 and +128, determine the minimum number of bits (N) required to represent both numbers correctly in binary?

2). Determine the minimum number of bits (N) required to represent both numbers +45 and -128 correctly in all four encoding schemes (UI, SM, 1C, 2C)?

Exercise 3:

1). Perform the following additions and subtractions of 8-bits Two's Complement numbers, showing all the steps involved in the work. Then analyze the validity of the results.

1. Two's Complement addition:

$(75)_{10}$
$+ (37)_{10}$

2. Two's Complement addition:

$(91)_{10}$
$+ (53)_{10}$

3. Two's Complement subtraction:

$(112)_{10}$
$- (65)_{10}$

4. Two's Complement subtraction:

$(-46)_{10}$
$- (101)_{10}$

2). Perform the following binary additions on 8-bits, then interpret the binary numbers as encoded on 2C and UI, showing all the steps used in the conversion. And checking the validity.

1. 8-bits addition:

$[00010100]_{8\text{-bits}}$
$+ [00100111]_{8\text{-bits}}$

2. 8-bits addition:

$[00010101]_{8\text{-bits}}$
$+ [11100111]_{8\text{-bits}}$

3. 8-bits addition:

$[10000001]_{8\text{-bits}}$
$+ [00010110]_{8\text{-bits}}$

4. 8-bits addition:

$[11111111]_{8\text{-bits}}$
$+ [10000000]_{8\text{-bits}}$

Exercise 4:

Perform the following Floating-Point decoding and encoding numbers to decimals. Show your steps clearly.

1. Binary Single Precision to Decimal:

$[41300000]_{FP32}$
$[BE500000]_{FP32}$

2. Decimal to Binary Single Precision:

$(+15.25)_{10}$
$(-0.0625)_{10}$

3. Binary Double Precision to Decimal:

$[4035000000000000]_{FP64}$

4. Decimal to Binary Double Precision:

$(-4.75)_{10}$

5. Binary Single Precision to Decimal:

$[00700000]_{FP32}$

6. Binary Single Precision to Decimal:

$(2.938736 \times 10^{-39})_{10}$

Exercise 5:

1). Encode the sentence "Salamou Alaykoum" into its 8-bit ASCII hexadecimal representation.

2). You are given the following sequence of 8-bit ASCII hexadecimal values. Decode this sequence to reveal the original sentence:

$[59\ 65\ 61\ 72\ 20\ 32\ 30\ 32\ 35]_{ascii}$