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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Machine Structures 1 exam solution

Exercise 1 : (4 points)

1. Definition of Computer Science: It is the study of the theoretical foundations of information and computation, and the practical techniques for using, designing, and building computer systems to process, store, and communicate information. **(1 point)**

2. Bases: **(1 point)**

Decimal: **Base-10**
Binary: **Base-2**
Octal: **Base-8**
Hexadecimal: **Base-16**

3. Logical OR symbol: It is symbolized by the **plus sign (+)**. **(1 point)**

4. Range for Unsigned Integers (N bits): The range is **$[0, 2^N - 1]$**. **(1 point)**

Exercise 2 : (5 points)

1. Convert **$(371)_8$** to hexadecimal going through binary: **(1 point)**

$$(3\ 7\ 1)_8 = (011 \mid 111 \mid 001)_2 = (0 \mid 1111 \mid 1001)_2 = \mathbf{(0\ F\ 9)_{16}}$$

$(371)_8 = (F9)_{16}$

2. Convert **$(0.8125)_{10}$** to binary fraction using Successive Multiplication by 2: **(1 point)**

Multiplication	Integer part
0.8125 x 2 = 1.625	1
0.625 x 2 = 1.250	1
0.25 x 2 = 0.500	0
0.5 x 2 = 1.000	1

$(0.8125)_{10} = (0.1101)_2$

3. Determining the unknown base *x* solving the following equation $(101)_x = (37)_{10}$ **(1 point)**

To solve this, we need to convert $(101)_x$ to base-10.

$$(101)_x = 1 \cdot x^2 + 0 \cdot x^1 + 1 \cdot x^0$$
$$(101)_x = x^2 + 0 + 1$$
$$(101)_x = x^2 + 1$$

Now we set this equal to $(37)_{10}$:

$x^2 + 1 = 37$
$x^2 = 37 - 1$
$x^2 = 36$
$x = \sqrt{36}$
$x = 6$ (Since bases are positive)

So, the unknown base **x = 6**.

4. Binary Subtraction: **(1 point)**

$(1010)_2$ - $(0111)_2$ = $(0011)_2$

```
   1 10 1 1 10
 -  0  1 1  1
    1  1 1
 -------------
 = 0  0 1  1
```

5. Convert **$(2047)_{10}$** to hexadecimal using Successive Euclidean Division by 16: **(1 point)**

Division	Remainder
2047 ÷ 16 = 256	15(F)
127 ÷ 16 = 7	15(F)
7 ÷ 16 = 0	7

$(2047)_{10}$ = $(7FF)_{16}$

Exercise 3 : (5 points)

1. Encoding on 6-bits the decimal: $(-15)_{10}$

- Convert **$(-15)_{10}$** to binary using SED by 2: **(1 point)**

Division	Remainder
15 ÷ 2 = 7	1
7 ÷ 2 = 3	1
3 ÷ 2 = 1	1
1 ÷ 2 = 0	1

$(-15)_{10}$ = $(-1111)_2$

- Convert **$(-1111)_2$** to UI, SM, 1C, 2C: **(1 point)**

Fixed-Width	Decimal values	Binary value	Unsigned Integer	Sign-Magnitude (MSB Sign bit)	One's Complement (Invert all bits)	Two's Complement (1C +1)
6-bits	-15	-1111	N.A.	$[101111]_{SM-6}$	$[110000]_{1C-6}$	$[110001]_{2C-6}$

2. Decoding the 32-bit binary number to decimal: **$[C1200000]_{FP\text{-}32}$**

- Convert the Single Precision from Hexadecimal to Binary:

  $[C1200000]_{FP\text{-}32}$ = $[1|100,0001,0|010,0000,0000,0000,0000,0000]_{FP\text{-}32}$

- Extract Fields: **(0.5 point)**
  S (Sign bit) = 0 → Negative number **(-)**
  E_{biased} = 10000010 → $E_b = 2^7 + 2^1$ = **$(130)_{10}$**
  M = 010,0000,0000,0000,0000,0000 → **M = 01**

- Calculating the Real Exponent: **(0.5 point)**
  Bias = $(127)_{10}$ (constant value)
  $E_{real} = E_{biased}$ - Bias = 130 - 127 = 3 → **E_r = 3**

- Determine Significand: **(0.5 point)**
  - Since the number is normalized, the significand is 1.M
  - Significand = **$(1.01)_2$**

- Calculating the final value: **(0.5 point)**
  The formula: FP = $(-1)^S \times 1.M \times 2^{Er}$
  FP = $-1.01 \times 2^3 = (-1010)_2$
  Using FP: $(1010)_2 = (1x2^3) + (0x2^2) + (1x2^1) + (1x2^0)$ = **$(-10)_{10}$**

3. Encoding the word "Binary" into its 8-bit ASCII hexadecimal representation: **(1 point)**

$[42\ 69\ 6E\ 61\ 72\ 79]_{ASCII}$

Exercise 4 : (6 points)

1. The Truth Table of the function: $F(A,B,C) = (A \oplus B) + \overline{C}$ **(2 point)**

A	B	C	$(A \oplus B) + \overline{C}$
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

2. The Truth Table of the function $\Sigma(2,3,5,7,11,13)$: **(1 point)**

A	B	C	D	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	0

The SoP form of the Truth Table is: **(1 point)**

$$F(A,B,C,D) = \overline{A}\overline{B}C\overline{D} + \overline{A}\overline{B}CD + \overline{A}B\overline{C}D + \overline{A}BCD + A\overline{B}CD + AB\overline{C}D$$

3. Karnaugh map method using SoP: **(1 point)**

CD \ AB	00	01	11	10
00	0	0	0	0
01	0	1	1	0
11	1	1	0	1
10	1	0	0	0

The SoP reduction is: $F(A,B,C,D) = B\overline{C}D + \overline{B}CD + \overline{A}BD + \overline{A}\overline{B}C$ **(1 point)**