Department of Physical Measurements

Instrumentation Computer Science 1 Exam

June, 15 2025

Exercise 1: Numeration (4 points)

1. Convert the following numbers:

   - 110010_2 to base 10
   - $3A_{16}$ to base 10
   - 63_{10} to base 2 and base 16

> **Solution:**
>
> - $110010_2 = 1 \cdot 2^5 + 1 \cdot 2^4 + 0 \cdot 2^3 + 0 \cdot 2^2 + 1 \cdot 2^1 + 0 \cdot 2^0 = 32 + 16 + 2 = \boxed{50_{10}}$
> - $3A_{16} = 3 \cdot 16 + 10 = \boxed{58_{10}}$
> - Base 2: ($63_{10} = \boxed{111111_2}$)
>   Base 16: ($63_{10} = \boxed{3F_{16}}$)

2. Represent the number -42 using 8 bits in:

   - One's complement
   - Two's complement

> **Solution:**
>
> - $-42_{10} = (11010101)_{1C8}$
> - $-42_{10} = (11010110)_{2C8}$

Number Encoding (4 points)

1. Represent -3.5 in IEEE 754 single precision floating-point format

> **Solution:** Sign bit: 1 (negative number)
> $3.5_{10} = 11.1_2$
> Normalized form: 1.11×2^1
> Biased exponent: $1 + 127 = 128 = 10000000_2$
> Fraction: 11000000000000000000000
> $3.5_{10} =$ 1 0000000 11000000000000000000000

2. Encode the character 'Z' in ASCII (8-bit binary), Given that the character 'A' is encoded in ASCII: 65

Solution: Given: 'A' = 65 in ASCII ; 'Z' = 65 + 25 = 90 ; $90_{10} = \boxed{01011010_2}$

Exercice 3 :Boolean Algebra (4 points)

1. Simplify the expression: $F(A,B,C) = A\bar{B}\bar{C} + A\bar{B}C + ABC$

Solution: $F = A\bar{B}(\bar{C} + C) + ABC = A\bar{B} + ABC$
$\boxed{F = A(\bar{B} + BC)}$

2. Build the truth table for F(A,B,C)

Solution:

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

3. Provide the corresponding logic diagram

Exercice 4 : Combinational Circuits (8 points)

We want to design a combinational circuit that compares two 2-bit binary numbers $A = A_1A_0$ and $B = B_1B_0$. The circuit produces three outputs:

- $S_1 = 1$ if A > B
- $S_2 = 1$ if A = B
- $S_3 = 1$ if A < B

1. Complete the truth table (16 combinations)

Solution:

A_1	A_0	B_1	B_0	S_1	S_2	S_3
0	0	0	0	0	1	0
0	0	0	1	0	0	1
0	0	1	0	0	0	1
0	0	1	1	0	0	1
0	1	0	0	1	0	0
0	1	0	1	0	1	0
0	1	1	0	0	0	1
0	1	1	1	0	0	1
1	0	0	0	1	0	0
1	0	0	1	1	0	0
1	0	1	0	0	1	0
1	0	1	1	0	0	1
1	1	0	0	1	0	0
1	1	0	1	1	0	0
1	1	1	0	1	0	0
1	1	1	1	0	1	0

2. Provide simplified logic equations

Solution: $S2 = (A_1 \text{ XNOR } B_1)(A_0 \text{ XNOR } B_0)$
$S1 = A_1\bar{B}_1 + (A_1 \text{ XNOR } B_1)A_0\bar{B}_0$
$S3 = \bar{A}_1 B_1 + (A_1 \text{ XNOR } B_1)\bar{A}_0 B_0$

3. Draw a logic diagram for output S_1