INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI
DEPARTMENT OF MATHEMATICS AND STATISTICS

MA635P-Scientific Programming Laboratory

Lab Exercise-3 (30 Marks) Deadline: 20 January 2026, 4:00 PM

Binary - Decimal

1. Write a Python program to convert the given Decimal number to Binary number [5]
2. Write a Python program to convert the converted Binary number from the previous problem to a decimal number and validate your exercise [5]
3. Write a Python code to build an integer register (8-bits) from scratch [5]
   - Step 1: Create an 8-bit unsigned integer register
   - Step 2: Binary $\rightarrow$ Decimal
   - Step 3: Find the largest and smallest number it can represent

   (a) Write a Python code to generalize the integer register with 16, 32, and 64 bits.

   (b) Suppose you have a register with 16 bits, of which 1 bit is allotted for the sign bit, and the remaining bits are allotted for an unsigned integer. What will be the smallest number, and the largest number? Check it.
4. Write a Python code to list all floating-point numbers that can be represented in the form

$$c = \pm(0.b_1b_2)_2 \times 2^{\pm k}$$

   where $b_1, b_2, k \in \{0, 1\}$ [5]
5. Write a Python code to list all floating-point numbers that can be represented in the form

$$c = \pm(0.b_1b_2b_3)_2 \times 2^{\pm k}$$

   where $b_1, b_2, b_3, k \in \{0, 1\}$. List out all floating point numbers where $b_1 = 1$ [5]
6. Write a Python code to build a float register (8 bits) from scratch [5]

$$(-1)^{b_7} \times (1.b_3b_2b_1b_0)_2 \times 2^{(b_6b_5b_4)_2-3}$$

$$\text{value} = (-1)^{\text{sign}} \times \left(1 + \sum_{i=1}^{4} b_{4-i}2^{-i}\right) \times 2^{(e-3)}$$

$$e \in \{1, 2, \cdots, 2^3 - 2\} = \{1, 2, \cdots, 6\}$$

$$2^{e-3} \in \{2^{-2}, 2^{-1}, \cdots, 2^3\}$$

- Step 1: Create a floating Register Structure using the following dictionary

```
fp={
"sign"     : 0
"exponent" : [1 1 1]
"fraction" : [1 1 1 1 ]}
```

- Step 2: Binary $\rightarrow$ Decimal
- Step 3: Find the smallest floating-point number that this register can represent
- Step 4: Find the largest floating-point number that this register can represent

(a) Write a Python code to generalize the float register with 32, 64, 80, and 128 bits

(b) Suppose you have a register with 16 bits of which 1 bit is allotted for the sign bit, 4 bits are allotted for the exponents, and the remaining bits are allotted for fractions. What will be the machine epsilon, the smallest number, and the largest number?

(c) Suppose you have a register with 24 bits of which 1 bit is allotted for the sign bit, 6 bits are allotted for the exponents, and the remaining bits are allotted for fractions. What will be the machine epsilon, the smallest number, and the largest number?

(d) Suppose you have a register with 32 bits of which 1 bit is allotted for the sign bit, 12 bits are allotted for exponents, and the remaining bits are allotted for fractions. What will be the machine epsilon, the smallest number, and the largest number?

(e) Suppose you have a register with 64 bits of which 1 bit is allotted for the sign bit, 20 bits are allotted for exponents, and the remaining bits are allotted for fractions. What will be the machine epsilon, the smallest number, and the largest number?