CS2100 Computer Organization
AY2024/25 Semester 2
Assignment 1
Total Marks: 40

Q1. Conversion Between Number Systems (2 x 6 = 12 marks)
(a) Convert the binary number 1101011.011 to decimal, hexadecimal, and base-6.

(b) Convert the decimal number 255.3705 to binary, ternary, and hexadecimal. Your answer should be most accurate to 3 digits in the fraction part.

Q2. Understanding Encodings in Different Systems (2 x 3 = 6 marks)
(a) Represent the decimal number -128 using 8-bit signed-magnitude, 8-bit 2's complement and 8-bit excess-128 encoding. If you can't represent any of them, state the reason.

(b) A system uses 4-bit base 4 digits (quaternary). What is the range of unsigned integers (in decimals) that can be represented in this system? Also, convert the base-4 number 3210.1 to binary.

Q3. IEEE 754 Floating Point Numbers (2 x 3 = 6 marks)
(a) Calculate the IEEE 754 single-precision floating-point representation of decimal number -0.15625 and explain the steps involved in converting it from decimal to IEEE 754 format.

(b) Calculate the decimal equivalent of the IEEE 754 single-precision floating point number 0x42480000 and explain the steps involved in converting it from IEEE 754 format to decimal.

Q4. Analyse the following MIPS code and answer the below questions. (16 marks)
Note: bge is a pseudo-instruction that branch-on-greater-than-or-equal. You will treat this as single instruction while answering the following questions.

```
#t0 - element to be found
#t2 - base address of array
#t3 - size of the int array

        addi $t4, $zero, 0      #instruction 1
l1:
        bge $t4, $t3, f2        #instruction 2
        sll $t5, $t4, 2         #instruction 3
        add $t6, $t2, $t5       #instruction 4
        lw $t7, 0($t6)          #instruction 5
```

```
        beq $t7, $t0, f1        #instruction 6
        addi $t4, $t4, 1        #instruction 7
        j l1                    #instruction 8
f1:
        addi $t1, $zero, 1      #instruction 9
        j exit                  #instruction 10
f2:
        addi $t1, $zero, 0      #instruction 11
exit:
```

(a) [2 Marks] Explain the purpose of the given MIPS code when $t0 = 5, $t2 = 0x1000, and $t3 = 100. Assume the address 0x1000 contains the base address of an integer array. The element of the array takes values from 1 to 100. What operation does the code perform on the integer array stored at base address 0x1000?

(b) [3 Marks] For the given MIPS code and initial values, calculate the total number of instructions executed in the worst-case scenario.

(c) [4 Marks] In the same scenario, determine how many times the branch instructions "bge $t4, $t3, f2" and "beq $t7, $t0, f1" are taken in both best-case and worst-case situations. You need to calculate how many times each branch instructions are calculated for best case and worst case separately.

(d) [3 Marks] If you want to modify the given MIPS code to count the number of times $t0 appears in the array, what are the minimal changes required? Identify the specific instructions that need to be modified or added while keeping the structure of the original code intact.

(e) [4 Marks] From the original MIPS code, provide the hexadecimal encoding of the following instructions. You can assume the address of the first instruction is 0x00400020:

(i) sll $t5, $t4, 2

(ii) j l1