►Solution◄

Array Access and Logic Instructions

Question 1: (5 points)

(V03, V04) Assume that register `a0` contains the binary representation of an `lbu` instruction. Write the minimum sequence of RISC-V instructions that produces a value in `a0` such that only the bit corresponding to the number of the register `rd` of the `lbu` instruction is 1. All other bits of `a0` must be zero. An instruction `lbu rd, offset(rs1)` uses the I-format:

```
15  # lumiptr:
16  # parameters:
17  #       a0: screen address
18  #       a1: R (number of rows)
19  #       a2: C (number of columns)
20  lumiptr:
21      mul   t1, a1, a2      # t1 <- R*C
22      add   t1, a0, t1      # t1 <- screen + R*C
23      add   t6, x0, x0      # t6(luminosity) <- 0
24  next_p:
25      lbu   t2, 0(a0)       # t2 <- pixel
26      add   t6, t6, t2      # lumens <- lumens + pixel
27      addi  a0, a0, 1       # p++
28      bne   a0, t1, next_p
29      addi  a0, t6, 0       # a0 <- lumens
30      jalr  zero, ra, 0
```

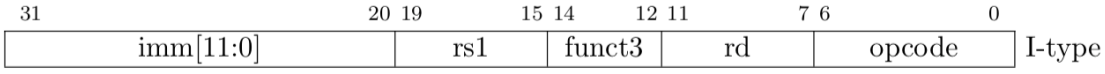
Figure 1: The code for `lumiptr`.

Question 2: (5 points)

Assume that the register `s1` contains the memory address of the first instruction of the function `lumiptr` shown above (RISC-V programs are stored in memory in their binary representation). Write the shortest sequence of RISC-V instructions that loads the binary representation of the instruction `bne` that appears in line 28 into `a0`.

Solution:

```
lw a0, 24(s1)
```



For instance, if the the `rd` register in the instruction whose binary code is in `a0` is register `x3`, then your program has to write the value `0000 0000 0000 0000 0000 0000 0000`

`1000` in `a0`.
In another example, if the `rd` register is register `x27`, then your program has to write the value `0000 1000 0000 0000 0000 0000 0000 0000` in `a0`.

Solution:

```
slli  a0, a0, 20
srli  a0, a0, 27     # a0 <-- rd
addi  t0, zero, 1    # t0 <-- 1
sll   a0, t0, a0     # a0 <-- bit for rd is 1
```