Computer Architecture Theory + Lab (CS 305/341)

Assignment 4: MIPS ISA Due Date: 22/09/20

(Theory Assignment 2)

Name: Niraj Mahajan

Roll No. 180050069

1. What are the MIPS instructions or instruction sequences corresponding to each of the following pseudoinstructions?

   subi, li, mov, la, beqz, , ble, bleu, seq

   seq stands for "set if equal to"

   Figure these out yourself, then use the SPIM simulator to verify your answer. Note that there may be multiple answers to each of the above.

   Answers:

   1. subi $t1 $t2 V
      - addi $at $0 V
      - sub $t1 $t2 $at
   2. li $t1 IMM
      - lui $t1 IMM_hi
      - ori $t1 $t1 IMM_lo
   3. mov $t1 $t2
      - add $t1 $t2 $0
   4. la $t1 label
      - lui $at 0x1001
      - ori $t1 $at DISP
        i. Here, DISP is the difference in number of bytes between first byte byte in the string and the first data location.
   5. beqz $s1 BRANCH
      - beq $s1 $0 BRANCH
   6. ble $s1 $t1 BRANCH
      - slt $at $t1 $s1
      - beq $at $0 BRANCH
   7. bleu $t1 $t2 BRANCH
      - sltu $at $t2 $t1
      - beq $at $0 BRANCH
   8. seq $t1 $t2 $t3
      - xor $at $t2 $t3
      - addi $t1 $0 1
      - movn $t1 $0 $at

2. What is the machine code corresponding to each of the following instructions/pseudoinstructions?
   (Answer should be in hex).

   sub $t0, $t7, $s5 --> 0x01F54022

andi $5, $s5, 89 --> 0x32A50059
sll $s4, $s4, 3 --> 0x0014A0C0
bge $s4, $t1, 300 --> slt $at, $s4, $t1 --> 0x0289082A
beq $at, $0, 300 --> 0x1020004B
lb $s0, 100($t1) --> 0x81300064

Figure these out yourself, then use the SPIM simulator to verify your answer.

3. Study the following program carefully, then answer the questions below.

```
        .data
arr:    .space 100

        .text
        .globl main
        main:   li      $t0, 0
        li      $t1, 0
        li      $t4, 0
        li      $t5, 4
        li      $s0, 1
        li      $s1, 1
        li      $s3, 6
        sw      $s1, arr($t1)
go:     addi    $t1, 4
        sw      $s1, arr($t1)
        addi    $t1, 4
        sw      $s1, arr($t1)
here:   addi    $t1, 4
        lw      $t6, arr($t4)
        lw      $t7, arr($t5)
L1:     add     $t6, $t6, $t7
        sw      $t6, arr($t1)
        addi    $t4, 4
        addi    $t5, 4
        addi    $t0, 1
        bne     $t0, $s0, here
L2:     addi    $s0, $s0, 1
        addi    $t4, 4
        addi    $t5, 4
        li      $t0, 0
        bne     $s0, $s3, go
        j       $ra
```

- The machine code corresponding to the instruction at label L1 is

  0x01CF7020
- The number of times the instruction at label L1 is executed is ____15____ .
- The number of times the instruction at label L2 is executed is ____5____ .
- Upon program termination, the content of array, arr is
  1, 1, 1, 2, 1, 1, 3, 3, 1, 1, 4, 6, 4, 1, 1, 5, 10, 10, 5, 1,1, 6, 15, 20, 15, {6}
  NOTE: 6 is there considering the data segment in QTSPIM. It is actually the 26th element and hence not officially considered among the "content of array,arr" (since it is size 100, that is 25 words).
- The content of register t4 is ____80____ .
- The content of register t6 is ____6____ .

Figure these out yourself, then use the SPIM simulator to verify your answer