

Name: _____

CSE30321 Midterm Test

Fall, 2007

Test Guidelines:

1. Place your name on EACH page of the test in the space provided.
2. Answer every question in the space provided. If separate sheets are needed, make sure to include your name and clearly identify the problem being solved.
3. Read each question carefully. Raise your hands if you have any questions.
4. This exam is closed textbook and notes. You are allowed to use TWO one-sided crib sheets. No other materials or human interchange is permitted.
5. All other points of the ND Honor Code are in effect!
6. **Upon completion, please turn in both this test and the supplemental material.**

The following questions are based on the MIPS ISA. Detailed information about this ISA is given in the supplemental material. For the following pseudo code,

```
int Comp_Count(int Thd) {
    i = 0; Count = 0;
    while (Array[i] >= 0) {
        if(Array[i] >= Thd) Count++;
        i++; }
    return(Count) }
```

the following MIPS assembly code is given below.

```
... # code at the beginning of the procedure
add $v0, $0, $0 # $v0 holds "Count"
add $t0, $0, $0 # $t0 holds "i"
Loop: lw $t1, Array($t0) # reads an array element
      slt $t2, $t1, $0
      bne $t2, $0, Done
      slt $t2, $t1, $a0 # $a0 holds "Thd"
      bne $t2, $0, Inc
      addi $v0, $v0, 1 # increment "Count"
Inc:  addi $t0, $t0, 4 # go to the next element
      j Loop
Done: ... # more code to end the procedure
```

- (15 pts.) Let the address of the first element in `Array`, i.e., `&Array[0]`, be `0x10010000` (hex). Then the third instruction shown becomes a pseudoinstruction. Rewrite the instruction by using only actual machine supported instructions.
- (20 pts.) Assume that `Array` contains N positive elements followed by an element of `-1`, and p percent of N elements are greater than or equal to `Thd`. Suppose that **all** load type instructions take 5 cycles, branch and jump types of instructions take 3 cycles while the rest takes 4 cycles. Let the total number of instructions executed be M , what is the average CPI of this program? Express your answer in terms of M , N and p . Show your work.

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3. (15 pts.) Assume that one implementation of the original MIPS ISA can run at 1 GHz. We want to modify the MIPS ISA and architecture design. For the same given code and data, our new design increases the instruction count by 10% but reduces the average CPI by 20%. How fast (i.e., at what clock frequency) must our new design run in order to achieve a speedup of 4 compared with the original implementation? Show your work. (**Hint:** You don't need to solve the previous problems in order to solve this one.)

4. (12 pts.) Suppose another procedure `ProcX` calls the `Comp_Count` procedure with the instruction (`jal Comp_Count`) stored at memory location `X1`. Before calling `Comp_Count`, `$ra = X0`. The first instruction of `Comp_Count` is at memory location `Y1`. What is the value in `$ra` at the beginning of `Comp_Count`? at the end of `Comp_Count`? at the end of `ProcX`?

5. (8 pts.) Does `Comp_Count` need to save anything on the stack? If yes, what need to be saved? If not, why?