

CS 351 Midterm 1 Review Quiz

Your name: _____

Notes:

- You must explain your answers to receive partial credit.
- You will lose points for incorrect extraneous information, even if the answer is otherwise correct.

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Question 1 [10 points].

- a. Name one advantage and one disadvantage of using fixed-length vs. variable-length instructions in an instruction set.

Advantage of fixed-length instructions:

Disadvantage of fixed-length instructions:

- b. Name one advantage and one disadvantage of the multicycle datapath vs. the pipelined datapath.

Advantage of the multicycle datapath:

Disadvantage of the multicycle datapath:

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Question 2 [10 points].

A proposed hardware optimization for a given processor would decrease the CPI of a certain class of instructions by 40%. This class of instructions currently accounts for 20% of the execution time of this processor on a workload of interest. Unfortunately, this optimization would also result in decreasing the clock rate by 10%.

- a) Is this optimization worth implementing? Show your calculations.

- b) What is the speedup of the optimized machine over the original machine?

Question 3 [10 points].

Consider the following segment of code:

```
add $t0, $t1, $t2
lw $t3, 0($t1)
add $t4, $t5, $t6
beq $t5, $t6, L
```

- a) How many cycles does it take to execute on the multicycle datapath?

- b) How many cycles does it take to execute on the pipelined datapath?

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c) Which of the two datapaths has better latency per instruction? (Show the calculation).

d) Which of the two datapaths has better instruction throughput, as measured in the average number of instructions completed per cycle? Show your work.

Question 4 [10 points].

Translate the following snippet of C code to MIPS. Assume that the address of `A[0]` is in `$s0`, and the variable `i` is in `$s1`. Your code should not modify these two registers. Also assume that `A` is an array of integers.

```
// C code to translate  
A[i]++;
```

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Question 5 [15 points].

Translate the following snippet of C code to MIPS. Assume that the variable `total` is in `$s0`, `N` is in `$s1`, and `i` is in `$s2`.

```
// C code to translate
int total = 0;
for (int i=0; i<N; i++) total += i;
```

Question 6 [15 points].

Translate the following snippet of C code to MIPS. Use the traditional MIPS conventions for argument passing, return values, and adjusting the stack pointer. Assume that `s` and `t` are null-terminated ASCII strings, where each character is a byte.

```
void strcpy(char* s, char* t) {
    int i = 0;
    while (!at_end(s[i])) {
        t[i] = s[i];
        i++;
    }
    t[i] = 0;
}

int at_end(char c) {
    if (c == 0) return 1;
    else return 0;
}
```

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Question 7 [10 points].

For each instruction type on the single-cycle MIPS datapath, state whether or not the instruction writes to the PC. For each instruction that writes to the PC, state what data it writes to the PC and what this data conceptually represents. Also state the value and name of any MUX select signals that allow this data to be written to the PC.

	Writes PC?	Which data gets written	Name of MUX select input	Value of MUX select input
R-format				
LW				
SW				
BEQ				
J				

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Question 8 [10 points].

For each of the following state elements on the multicycle datapath, fill out the chart below **for the instruction fetch cycle only**.

	Written?	Which data gets written	Name of MUX select input	Value of MUX select input
PC				
Memory				
Inst reg.				
Reg. file				
ALUOut				

Question 9 [10 points].

Draw a pipeline diagram tracing the execution of the following instructions. Show any forwarding paths or stalls.

ADD \$t0, \$t1, \$t2
SUBI \$t0, \$t0, 8
LW \$t3, 0(\$t0)
ADD \$t4, t3, \$t3