

Computer Science and Engineering

2021 Sample Midterm

Answer all questions in the space provided

Student Last Name: _____

Student Given Name: _____

Student ID. No: _____

Section	Points	Marks
A	40	
B	40	
C	20	
Total	100	

Section A

A1.

Compilers can have a profound impact on the performance of an application. Assume that for a program, compiler A results in a dynamic instruction count of $1.0E9$ and has an execution time of 1.1 s, while compiler B results in a dynamic instruction count of $1.2E9$ and an execution time of 1.5 s.

- Find the average CPI for each program given that the processor has a clock cycle time of 1 ns.
- Assume the compiled programs run on two different processors. If the execution times on the two processors are the same, how much faster is the clock of the processor running compiler A's code versus the clock of the processor running compiler B's code?
- A new compiler is developed that uses only $6.0E8$ instructions and has an average CPI of 1.1 . What is the speedup of using this new compiler versus using compiler A or B on the original processor?

- CPU time = Instruction count \times CPI \times Clock cycle time
CPI = CPU time / (Instruction count \times Clock cycle time)

$$\begin{aligned}\text{Compiler A CPI} &= 1.1 / (1.0E9 \times 1.0E-9) = 1.1 \\ \text{Compiler B CPI} &= 1.5 / (1.2E9 \times 1.0E-9) = 1.25\end{aligned}$$

- $1 / \text{Clock cycle time} = \text{Instruction count} \times \text{CPI} / \text{CPU time}$
Clock rate (Frequency) = Instruction count \times CPI / CPU time

For same CPU or execution time on both processors,
 $f_B/f_A = (\text{Instruction count}(B) \times \text{CPI}(B)) / (\text{Instruction count}(A) \times \text{CPI}(A)) = 1.37$

- For the original processor with a clock cycle time of 1 ns:

$$\begin{aligned}(\text{CPU time})_A / (\text{CPU time})_{\text{NEW}} &= (\text{Instruction count} \times \text{CPI})_A / (\text{Instruction count} \times \text{CPI})_{\text{NEW}} \\ &= (1.0E9 \times 1.1)_A / (6.0E8 \times 1.1)_{\text{NEW}} \\ &= 1.67\end{aligned}$$

$$\begin{aligned}(\text{CPU time})_B / (\text{CPU time})_{\text{NEW}} &= (\text{Instruction count} \times \text{CPI})_B / (\text{Instruction count} \times \text{CPI})_{\text{NEW}} \\ &= (1.2E9 \times 1.25)_B / (6.0E8 \times 1.1)_{\text{NEW}} \\ &= 2.27\end{aligned}$$

A2.

Assume that registers $\$s0$ and $\$s1$ hold the values $0x80000000$ and $0xD0000000$, respectively. What is the value of $\$t0$ for the following assembly code?

```
add $t0, $s0, $s1
add $t0, $t0, $s0
```

$\$t0 = 0xD0000000$

A3.

Provide a minimal set of MIPS instructions that may be used to implement the following pseudoinstruction:

not \$t1, \$t2

nor \$t1, \$t2, \$t2

or

nor \$t1, \$0, \$t2

A4.**A5.**

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Section B

B1.

For the following C/Java statement, what is the corresponding MIPS assembly code? Assume that the variables f, g, and h are given and could be considered 32-bit integers as declared in a C program. Use a minimal number of MIPS assembly instructions.

$f = g + (h - 5);$

addi f, h, -5 (note, no subi)

add f, f, g

B2.

Give the binary representation of -67 in each of the following data representations

(a) 8-bit one's complement

(b) 8-bit two's complement

(c) hex

0100 0011 = +67 Decimal

a. 1011 1100 = -67 8-bit one's complement

+1

b. 1011 1101 = -67 8-bit two's complement

c. 0xbd = -67 hex

B3.**B4.**

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Section C

C1.

For the MIPS assembly instructions below, what is the corresponding C/Java statement? Assume that the variables f, g, h, i, and j are assigned to registers \$s0, \$s1, \$s2, \$s3, and \$s4, respectively. Assume that the base address of the arrays A and B are in registers \$s6 and \$s7, respectively.

```
sll $t0, $s0, 2
add $t0, $s6, $t0
sll $t1, $s1, 2
add $t1, $s7, $t1
lw $s0, 0($t0)
addi $t2, $t0, 4
lw $t0, 0($t2)
add $t0, $t0, $s0
sw $t0, 0($t1)
```

$B[g] = A[f] + A[1+f];$

C2.

Provide the type, assembly language instruction, and binary representation of instruction described by the following MIPS fields:

```
op=0x28,    rs=4,    rt=8,    const=0xc
10 1000    00100    01000    0000 0000 0000 1100
sb        $a4    $t0        0xc
sb $t0, 0xc($a4)
I type
```

C3.

C4.

...