HANOI UNI. OF SCI. AND TECH. FACULTY OF MATHEMATICS AND INFORMATICS

WRITING TEST, FALL 2024 Course: Intro. to Comp. Org. and Arch. Course Id: CS365, Duration: 60 minutes	Student name: [redacted] ..... Student Id: [redacted] ..No. ..... Class Id: ....

Assessors' name and signature	Examiners' name and signature	Total score

Test Id: 2 (This test consists of 10 questions)

Note: *This is an open-book exam and students are allowed to use books, smartphones, etc.*

Questions with one correct answers

Question 1. What is the decimal value of this 8-bit two's complement number 1110 0101 after shifting the number left two bits?

☐ −148 ☐ 108 ☐ 148 ☐ −108

Question 2. Suppose that register $t2 contains 0000 0000 0000 0000 0000 1101 0000 0000 and register $t1 contains 0000 0000 0000 0000 0011 1100 0000 0000. Which of the following MIPS instructions places the value 0000 0000 0000 0000 0011 1111 0000 0000 in register $t0?

☐ `and $t1, $t2, $t0`
☐ `or $t0, $t1, $t2`
☐ `add $t1, $t2, $t0`
☐ `add $t0, $t1, $t2`

Question 3. Which of the following MIPS codes loads the 32-bit constant 0000 0000 0010 0000 0000 0001 0000 0000 into register $s0?

☐
```
lui $s0, 256
addi $s0, $s0, 32
```
☐
```
lui $s0, 46
addi $s0, $s0, 256
```
☐
```
lui $s0, 32
addi $s0, $s0, 25
```
☐
```
lw $s0, 256
add $s0, $s0, 32
```

Question 4. Suppose that the computer A, which has a 500MHz clock, runs a program P in 10 seconds. The computer B, which has twice the clock rate of A, runs P in 6 seconds. What is the number of clock cycles required for P on B?

☐ 3600×10^6 cycles
☐ ..... cycles
☐ 4600×10^6 cycles
☐ 4800×10^6 cycles

Question 5. What is the machine instruction corresponding to the MIPS instruction: `add $s0,$a0,$t7`?

☐ 0x00BF8020
☐ 0x00AE8020
☐ 0x008F80..
☐ 0x00AD8020

Question 6. Given a program P. Suppose that we have two computers A and B implementing the same instruction set architecture. Computer A has a clock cycle time of 1 ns and a CPI of 2.0 for P, and computer B has a clock cycle time of 2.5 ns and a CPI of 1.2 for P. How much faster is computer A than computer B for this program?

☐ 1.5 t..es
☐ 1.3 times
☐ ..... times
☐ 0.9 times

Constructed-response questions

Question 7. Add comments to the following MIPS code and describe in one sentence what it computes. Assume that $a0 is initially contains 5 and $v0 is used for the output.

```
begin:  addi $t0,  $zero, 0
        addi $t1,  $zero, 1
loop:   slt  $t2,  $a0,   $t1
        bne  $t2,  $zero, fin
        add  $t0,  $t0,   $t1
        addi $t1   $t1,   2
        j    loop
fin:    add  $v0,  $t0,   $zero
```

Initialize $t0 = 0, $t0 will be used to store the running total
Initialize $t1 = 1, $t1 will be used as the loop counter
Compare $a0 (5) with $t1. If $a0 < $t1, $t2 = 1, otherwise $t2 = 0
If $t2 != 0 ($a0 < $t1), Jump to the label fin
Add $t1 to $t0. $t0 accumulates the sum of odd numbers up to $a0
Increment $t1 by 2 to move to the next odd number
Jump back to the label loop to repeat the process
Store the final result from $t0 into $v0

a) The code calculates the sum of odd numbers from 1 to the value in $a0
b) For $a0 = 5, the odd numbers are 1, 3 and 5 => The sum is 1+3+5 = 9
c) For $a0 = 5, the result stored in $v0 is 9

Question 8. What are the MIPS instructions corresponding to the following machine instructions?

```
1000 1101 0010 1000 0000 0100 1011 0000
0000 0010 0100 1000 0100 0000 0010 0000
1010 1101 0010 1000 0000 0100 1011 0000
```

lw $t0, 1200 ($t1)
add $v0, $t1, $t0
sw $t0, 1200 ($t1)

Question 9. Compile the following C program into MIPS assembly code.

```
int func (int n)
  {
    int i=0;
    while (i<n)
      i=i+1;
    return i;
  }
```

```
func:
    addi $t0, $zero, 0
loop:
    slt  $t1, $t0, $a0
    beq  $t1, $zero, end
    addi $t0, $t0, 1
    J loop
end:
    add  $v0, $t0, $zero
    Jr $ra
```

Question 10. Construct the full trust table described by the following Verilog module.

```
module func (A, B, C, S, D);
  input A, B, C;
  output S, D;
  assign S=A&B&C;
  assign D=(A^B)|(B^C)|(C^A);
endmodule
```

A	B	C	S = A ∧ B ∧ C	D = (A ⊕ B) ∨ (B ⊕ C) ∨ (C ⊕ A)
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	0	1
1	0	0	0	1
1	0	1	0	1
1	1	0	0	1
1	1	1	1	0

Constructed-response questions

Question 7. Add comments to the following MIPS code and describe in one sentence what it computes. Assume that $a0 is initially contains 8 and $v0 is used for the output.

```
begin:  addi $t0,  $zero, 0
        addi $t1,  $zero, 1
loop:   slt  $t2,  $a0,   $t1
        bne  $t2,  $zero, fin
        add  $t0,  $t0,   $t1
        addi $t1   $t1,   2
        j    loop
fin:    add  $v0,  $t0,   $zero
```

Initialize $t0 to 0, $t0 will store the sum
Initialize $t1 to 1, $t1 keeps track of current number
if $a0 < $t1 → $t2 = 1 else $t2 = 0
if $t2 is 0 exit the loop and jump to fin
add $t1 to sum in $t0
Increment $t1 by 2 to move to next odd number
Repeat loop
store the final sum ($t0) in $v0 for output

Question 8. What are the MIPS instructions corresponding to the following machine instructions?

```
1000 1101 0010 1000 0000 0100 1011 0000   → lw   $t0, 1200($t1)
0000 0010 0100 1000 0100 0000 0010 0000   → add  $t0, $s2, $t0
1010 1101 0010 1000 0000 0100 1011 0000   → sw   $t0, 1200($t1)
```

Question 9. Compile the following C program into MIPS assembly code.

```
int func (int n)
  {
    int i;
    for (i=0;i<n;i=i+1)
      if (i=n) return i;
  }
```

```
func:
    addi $sp, $sp, -8
    sw   $ra, 4($sp)
    sw   $a0, 0($sp)

    li   $t0, 0
    bge  $t0, $a0, loop_end
    bne  $t0, $a0, increment

    move $v0, $t0
    lw   $ra, 4($sp)
    addi $sp, $sp, 8
    jr   $ra

increment:
    addi $t0, $t0, 2
    j    loop_start

loop_end:
    li   $v0, 0
```

lw $ra, 4($sp) addi $sp, $sp, 8
jr $ra

Question 10. Construct the full trust table described by the following Verilog module.

```
module func (A, B, C, S, D);
   input A, B, C;
   output S, D;
   assign S=A^B^C;
   assign D=(A&B)|(B&C)|(C&A);
endmodule
```