Name: Soham Gandhi

Study Group: Rakesh Pillai, Justin Liang

You must work on this assignment individually. Your submission must be your original work.

Please follow the submission instructions posted on canvas exactly.

**Problem 1** (10 points)**.** There are many different examples of Instruction Set Architectures (ISAs). Give two examples of ISAs other than MIPS. For each example, give the following details:

**ARM & x86\_64**

* What differentiates your ISA from MIPS?

ARM is a newer ISA compared to MIPS and is heavily used in industry, while MIPS at this point is essentially obsolete. ARM also tends towards a lot of registers, while MIPS tends to have fairly few.

x86\_64 uses a little-endian order by default while MIPS is typically big-endian.

* What similarities does the ISA share with MIPS?

Both ARM and MIPS are RISC-based architectures that are commonly used in embedded devices.

x86\_64 and MIPS have very few similarities, but the largest by far is that both are fairly old instruction sets that are somewhat still in use.

* What types of devices or applications most often use your ISA?

Typically, x86\_64 is used by modern-day Windows laptops. This architecture is also heavily used in the data center sector but is slowly dwindling in that sector.

ARM architecture is used in low-power hand-held devices as well as GPUs, and a lot of other mainstream devices. ARM is picking up significantly due to its popularity and functionality with AI/security it offers over x86\_64.

**Problem 2** (20 points)**.** Assume that the base address 0x100800A0 of the array A is stored in $s0. The following table gives the memory addresses of A[0],...,A[3] along with the values stored in the corresponding memory location.

|  |  |  |
| --- | --- | --- |
|  | Stored Value | Memory Address |
| A[0] | 51 | 0x100800A0 |
| A[1] | -66 | 0x100800A4 |
| A[2] | 13 | 0x100800A8 |
| A[3] | 40 | 0x100800AC |

What are the values stored in registers $s0, $s1, $s2, and $s3 after executing the following MIPS instructions?

sw $s0 , 8 ( $ s 0 )

lw $s1 , 4 ( $ s 0 ) lw $s2 , 8 ( $ s 0 )

add $s3, $s1, $ s2

$s0 🡨 0x100800A0

$s1 🡨 -66 🡨 0xFFFFFFBE

$s2 🡨 0x100800A0

$s3 🡨 0x1008005E

**Problem 3** (70 points)**.** Convert each of the following C statements into MIPS instructions. Assume that the variables c, b, and a are stored in $s0, $s1, and $s2, respectively. The base addresses of the arrays A and B are stored in $s3 and $s4, respectively. Assume the arrays A and B contain integers (4 bytes).

1. b = a - B[218] (15 Points)

addiu $t0 $0 2^16

sll $t0 $t0 4

add $t0 $t0 $s4

lw $t0 $t0

sub $s1 $s2 $t0

2) B[5] = b + c – 29 (15 Points)

addi $t0 $s1 -2^9

add $t0 $t0 $s0

sw $t0 20($s4)

3) A[6] = B[a] + b - A[5] (20 Points)

sll $s2 $s2 2

add $s2 $s2 $s4

lw $t0 $s2

add $t0 $t0 $s1

subi $t0 $t0 24($s3)

sw $t0 24($s3)

4) B[10] = A[b+c] + a - b (20 Points)

add $t0 $s0 $s1

sll $t0 $t0 2

add $t0 $t0 $s3

lw $t0 $t0

add $t0 $t0 $s2

sub $t0 $t0 $s1

sw $t0 40($s4)