JOINT INSTITUTE
交大密西根学院

ECE3700J Introduction to Computer Organization

Homework 1

Assigned: September 19, 2023

Due: 2:00pm on September 26, 2023

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1. (10 points) Find the shortest sequence of RISC-V instructions that extracts bits 18 down to 9 from register x15 and uses the value of this field to replace bits 30 down to 21 in register x16 without changing the other bits of registers x15 or x16. (Be sure to test your code using x15 = 0 and x16 = `0xffffffff`. Doing so may reveal a common oversight.)

2. (10 points) Translate the following RISC-V code to C. Assume that the variables f, g, h, i, and j are assigned to registers x5, x6, x7, x28, and x29, respectively. Assume that the base address of the arrays A and B are in registers x10 and x11, respectively.

```
addi   x30, x10, 4
addi   x31, x10, 0
sw   x31, 0(x30)
lw   x30, 0(x30)
add   x5, x30, x31
```

3. Consider the following loop in RISC-V assembly:

```
LOOP: beq x6, x0, DONE
      addi x6, x6, -1
      addi x5, x5, 2
      jal x0, LOOP
DONE: ......
```

   (1) (10 points) Assume that the register x6 is initialized to the value 8. What is the final value in register x5 assuming the x5 is initially zero?

   (2) (10 points) For the loop above, write the equivalent C code. Assume that the registers x5 and x6 are integers m and n, respectively.

   (3) (5 points) For the loop written in RISC-V assembly above, assume that the register x6 is initialized to the value N. How many RISC-V instructions are executed?

   (4) (5 points) For the loop written in RISC-V assembly above, replace the instruction "`beq x6, x0, DONE`" with the instruction "`bge x6, x0, DONE`" and write the equivalent C code.

NOTE: the following problems are optional and won't be graded.

4. For the following C statement, write the corresponding RISC-V assembly code. Assume that the C variables z, x, and y, have already been placed in registers x16, x17, and x18 respectively. Use a minimal number of RISC-V assembly instructions.

```
z = x - (y + 6);
```

5. For the following C statement, write the corresponding RISC-V assembly code. Assume that the variables i and j are assigned to registers x5 and x6 respectively. Assume that the base addresses of the arrays A and B are in registers x16 and x17, respectively.

```
B[i] = A[j] + A[j+1];
```

6. Show how the value `0x01234567` would be arranged in memory of a little-endian and a big-endian machine. Assume the data are stored starting at word address 0.

7. Assume x5 holds the value 0x90F3100C. What is the value of x6 after the following instructions?

```
       addi x6, x0, 1
       blt x5, x0, ELSE
       jal x0, DONE
ELSE:  ori x6, x0, 2
       jal x0, EXIT
DONE:  lui x6, 0xFFFFF
EXIT:  ...
```

8. In lecture notes for Topic 3 Function, there is an example for non-leaf function call written in C code, as follows:

```
int fact (int n){
  if (n < 1) return f;
  else return n * fact(n - 1);
}
```

Assume the function argument `n` is in `x11`, result in `x11` too. Assuming `n` = 5, show how the stack changes whenever it changes throughout the function's lifetime. Show contents of the stack.