

CS 3330 Exam 1 – Fall 2016

Name: _____

Computing ID: _____

Letters go in the boxes unless otherwise specified (e.g., for C 8 write “C” not “8”).

Write Letters clearly: if we are unsure of what you wrote you will get a zero on that problem.

Bubble and Pledge the exam or you will lose points.

Assume unless otherwise specified:

- little-endian 64-bit architecture
- %rsp points to the most recently pushed value, not to the next unused stack address.
- questions are single-selection unless identified as select-all

Variable Weight: point values per question are marked in square brackets.

Mark clarifications: If you need to clarify an answer, do so, and also add a * to the top right corner of your answer box.

Information for questions 1–2

x86-64 has 12 icodes: halt, nop, rrmovq, irmovq, rmmovq, mrmovq, OPq, jXX, pushq, popq, call, and ret. The following questions should be answered with the number of those 12 that have the listed property. Valid answers range from 0 to 12.

Question 1 [2 pt]: (see above) How many set the condition codes?

Answer:

Question 2 [2 pt]: (see above) How many perform math in the execute stage? (The textbook said some instructions always add 0 to something (e.g., valE = 0 + valC); don't include that 0+ addition as "math" for this question.)

Answer:

Question 3 [2 pt]: The following are true of memory layout in x86-64 Linux. Which one is due to the x86-64 ISA?

- A the stack grows towards smaller addresses
- B the top of the address space is used by the OS
- C the bottom of the address space is unused
- D the heap grows toward larger addresses
- E executable code begins at address 0x40000000

Answer:

Information for questions 4–5

Consider the following Y86-64 assembly program and its corresponding encoding. (On the left-most column is the memory address of each instruction, followed by its encoding, listed as a sequence of bytes in hexadecimal.)

Assume the program register r8 contains the value 0xA before the given assembly is run.

```
0x000: 30 f0 0a 00 00 00 00 00 00 00 |      irmovq label, %rax
0x00a: 50 08 00 00 00 00 00 00 00 00 | label:  mrmovq 0(%r8), %rax
```

Question 4 [2 pt]: (see above) What is the value of %rax after the first instruction (the `irmovq`) executes?

- A the machine will stop with the invalid address (STAT_ADR) status
- B 0xC
- C 0x5008000000000000 (ends with 12 zeroes)
- D 0x0
- E 0xA
- F 0x850
- G 0x5

Answer:

Question 5 [2 pt]: (see above) What is the value of %rax after the second instruction (the `mrmovq`) executes?

- A the machine will stop with the invalid address (STAT_ADR) status
- B 0x8
- C 0x30f00a0000000000 (ends with 10 zeroes)
- D 0x850
- E 0x30
- F 0xA
- G 0x0
- H 0xaf030
- I 0x5008000000000000 (ends with 12 zeroes)

Answer:

Question 6 [2 pt]: Suppose that `x` is the signed `char` containing the value `-33` (`0b11011111`) and unsigned `char y = (unsigned char)x;`. Which of the following are true?

Select all that apply

- A `x == (int)x`
- B `x == y`
- C `(x >> 1) < x`
- D `(y >> 1) < y`

Answer:

Information for questions 7–8

The following ask about wiring of the SEQ processor.

Question 7 [2 pt]: (see above) The **instruction memory** has one input and one output. During a cycle in which we execute call instruction, the value of the input should be set to:

- A the address of the call instruction
- B the output of the data memory
- C the immediate value (target address) contained within the call instruction
- D the address of the instruction following the call instruction in memory
- E the output of the ALU
- F none of the above

Answer:

Question 8 [2 pt]: (see above) The **program counter register** has one input and one output. During a cycle in which we execute call instruction, the value of the input should be set to:

- A the address of the call instruction
- B the output of the data memory
- C the immediate value (target address) contained within the call instruction
- D the output of the ALU
- E the address of the instruction following the call instruction in memory
- F none of the above

Answer:

Question 9 [2 pt]: Choose the correct compilation of `rax = (rbx ? rcx : rdx)`

- A


```

andq %rbx, %rbx;
jne p2;
rrmovq %rdx, %rax;
p2: rrmovq %rcx, %rax
      
```
- B


```

andq %rbx, %rbx;
rrmovq %rdx, %rax;
je p2;
rrmovq %rcx, %rax
p2:
      
```
- C


```

andq %rbx, %rbx;
je p2;
rrmovq %rdx, %rax;
p2: rrmovq %rcx, %rax
      
```
- D


```

andq %rbx, %rbx;
rrmovq %rdx, %rax;
jne p2;
rrmovq %rcx, %rax
p2:
      
```

Answer:

Question 10 [2 pt]: If we extend Y86-64 to include a new instruction `mrOPq` which is like `OPq` except that it allows for a memory source (e.g., `mxorq 33(%r11), %r12`), how long would its encoding be?

- A 1 byte
- B 2 bytes
- C 10 bytes
- D 9 bytes
- E none of the above

Answer:

Question 11 [2 pt]: What is $\log_2(32G)$? Answer as a normal base-10 number.

“Memorizing powers of two became so important later in the semester. (I neglected to memorize them until I needed them later and I regret it.)” —a TA

Answer:

Information for questions 12–13

Recall that we use two condition code flags: SF (the sign flag) is 1 for a negative number and ZF (the zero flag) is 1 for the value zero.

Question 12 [2 pt]: (see above) After executing the Y86-64 assembly instruction `xorq %rax, %rax`, what are possible values for the condition code bits SF and ZF?

Select all that apply.

- A ZF = 1, SF = 0
- B ZF = 0, SF = 1
- C ZF = 1, SF = 1
- D ZF = 0, SF = 0

Answer:

Question 13 [2 pt]: (see above) After executing the Y86-64 assembly instruction `andq %rax, %rax`, what are possible values for the condition code bits SF and ZF?

Select all that apply.

- A ZF = 1, SF = 0
- B ZF = 0, SF = 1
- C ZF = 0, SF = 0
- D ZF = 1, SF = 1

Answer:

Information for questions 14–15

In lab you coded with three kinds of lists: sentinel-terminated arrays; length arrays (also called vectors or ranges); and linked lists.

Question 14 [2 pt]: (see above) Which requires the **least** new memory to be allocated to extend a 64-element list to have a 65th element? Assume we use `malloc` to allocate any new memory needed.

- A sentinel-terminated arrays
- B linked lists
- C length arrays (also called vectors or ranges)

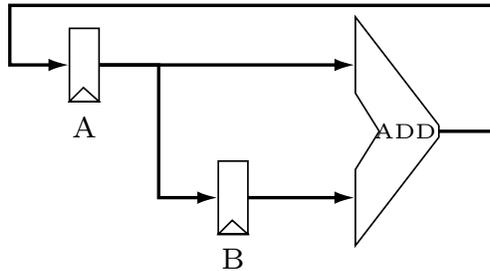
Answer:

Question 15 [2 pt]: (see above) Assume we have 8-byte pointers and list elements are 1-byte values. Which type of list uses the **most** memory?

- A length arrays (also called vectors or ranges)
- B sentinel-terminated arrays
- C linked lists

Answer:

Question 16 [2 pt]:



Answer:

Consider the above circuit, which contains two registers and a ALU that only adds its operands. If register A and register B initially output 1, what value will register A output after 3 rising clock edges happen?

Question 17 [3 pt]: What are the possible return values of the following C function?

```
int foo(int x) {
    int y;
    do {
        y = x;
        x = x >> 1;
    } while (x != y);
    return x;
}
```

Select all that apply.

- A MAX_INT (the most positive possible int)
- B a value not listed above
- C MIN_INT (the most negative possible int)
- D 0
- E -1
- F 1

Answer:

Question 18 [2 pt]: What does the following C code return?

```

int x = 2, y = 2;
if (x) goto qux;
x -= y;
qux:  if (!x) goto plugh;
      y -= 1;
      if (y >= x) goto qux;
plugh: return (10*x + y);

```

Answer:

Answer as either a normal base-10 number or with one of the words “error” (if it contains an error) or “loops” (if it runs forever).

Question 19 [2 pt]: Which of the following is more typical of RISC than CISC?

- A addressing is simplified so that memory operands may appear in any instruction
- B common tasks like pushing onto the stack are reduced to a single instruction
- C all instructions are simplified to have the same encoded length
- D all of the above
- E none of the above

Answer:

Information for questions 20–20

Assume that x and y are 32-bit int-type variables in C. Assume that their initial values are positive (strictly greater than 0).

Question 20 [8 pt]: (see above) Which of the following are guaranteed to be true?

*Note: this will be graded like 8 true/false questions; answer by putting a **check-mark** in the true boxes and leaving the false ones **blank**.*

Select all that apply

- A $(x|y) \geq (x&y)$
- B $(x+y) - ((x&y) \ll 1) \geq (x&y)$
- C $\sim y < -y$
- D $(x > y ? x + \sim y : y + \sim x) \geq 0$
- E $((-x) \gg 2) == -(x \gg 2)$
- F $x | \sim y == -1$
- G $x | \sim x == -1$
- H $x \wedge \sim y < 0$

Question 21 [2 pt]: Which of the following only occur on a rising clock edge?

Select all that apply

- A register file read
- B data memory write
- C data memory read
- D register file write

Answer:

.....
Pledge:

On my honor as a student, I have neither given nor received aid on this exam.

Your signature here