Practice:

You started this quiz near when it was due, so you won't have the full amount of time to take the quiz.

This is a preview of the published version of the quiz

Started: Aug 24 at 9:11am

Quiz Instructions

Instructions

- This exam is an individual effort.
- You are not permitted to help others, in any way, with this exam.
- You are not permitted to release or to discuss this exam with anyone, except the course staff, until given permission to do so by the instructors (which will not occur until all students have completed the exam. There may be exceptional cases that take it late).
- You are permitted to use only the official course textbook, the official course slides, and your own personal notes.
- A simple calculator is permitted, but won’t prove to be helpful (we don’t think).
- You have 90 minutes, from first exposure through submission to take this exam. Do not attempt to “peek”, “check”, or “test” the exam. This will start your clock.
- We only expect the exam to take 70-90 minutes.
- The exam counts for the 25% “exam portion” of the midterm grade, but is reduced to counting as a “double homework” for the final grade.
- In order to make the exam an “invested but low stakes” experience, half of this exam’s weight toward the final grade may be dropped as one of the two “homework drops”, but the full weight can’t be dropped.

Question	Topic	Points
1	Integers	10
2	Floats	15
3	Array Sizes	5

4	Array	
5	Structs and Alignment	12
6	Assembly: Basic	8
7	Assembly: Switch	15
8	Assembly: Loops and Conditionals	12
9	Memory Hierarchy	5
10	Locality	3
11	Caching	10
Total:		100

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Question 1 10 pts

1. Integers (10 points, 2 points per blank)

This question is based upon the following declaration on a **machine using 8-bit two's complement arithmetic for signed integers.**

Fill in the empty boxes in the table below.

- **Show all digits for the "Binary" column, including any leading 0s. Do not add spaces, letters, annotations, groupings, units, etc.**
- You need not fill in entries marked with "--".
- TMax denotes the largest positive two's complement number
- TMin denotes the most negative two's complement number.

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Expression		tation
0xFF		-
0x80		-
-28 - 5		-
--		10000001
100 + 70		--

2. Floats (15 points)

The floating point questions below are based upon an IEEE-like floating point format with the following specification:

- 8-bit width
- There is s = 1 sign bit
- There are k = 3 fraction bits
- Wherever rounding is necessary, round-to-even should be used. In addition, you should give the rounded value of the encoded floating point number.
- This question asks about the undecoded bits within the IEEE-like representation, answer in binary without spaces, groupings, annotations, letters, units, etc.

Question 2 1 pts

Question 2: Floats (15 points, 1 point for this part)

2(A) (1 points) What is the bias? (Answer in decimal)

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Question 3 1 pts

Question 2: Floats (15 points, 1 point for this part)

2(B) (1 points) What is the exponent for denormalized numbers? (Answer in decimal)

Hint: This question asks about the actual, decoded exponent, not the bit pattern or value of the bit pattern in isolation.

Question 4 1 pts

Question 2: Floats (15 points, 1 point for this part)

2(C) (1 points) What is the maximum exponent for normalized numbers? (Answer in decimal)

Hint: This question asks about the actual, decoded exponent, not the bit pattern or value of the bit pattern in isolation.

Question 5 1 pts

Question 2: Floats (15 points, 1 point for this part)

2(D) (1 points) What exponent bit pattern is used for special values (infinity, NaN, etc)?

Hint: This question asks about the undecoded bits within the IEEE-like representation, answer in binary without spaces, groupings, annotations, letters, units, etc.

Question 6 11 pts

Question 2: Floats (11 points, 1 point for each blank in this part)

This question is based upon an IEEE-like floating point format with the following specification:

- 8-bit width
- There is s = 1 sign bit
- There are k = 4 fraction bits
- **Wherever rounding is necessary, round-to-even** should be used. In addition, you should give the rounded value of the encoded floating point number.
- If the question asks about the undecoded bits within the IEEE-like representation, answer in binary without spaces, groupings, annotations, letters, units, etc.
- **For the 3rd column: Answer as a fully reduced decimal fraction**, i.e. use the smallest denominator possible without a fractional numerator. The fraction need not be proper: In other words, **the numerator can be larger than the denominator.**

2(E-I) (1 point per blank) Fill in the following:

Value	**Binary Representation**	**Rounded Value as a reduced decimal fraction**	**Rounding *ERROR* as a reduced decimal fraction**
-13		--	--
13/16		--	--
-Infinity -Inf		--	--
3-3/8		**Fully reduced:** /	**Fully reduced:** (neglect sign) /

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-5/32		/	--

Question 7 5 pts

3. Arrays Sizes (5 points, 2.5pts per part)

Consider the following definitions in an x86-64 system with 8-byte pointers and 2-byte shorts, 4-byte ints, and 8-byte longs. Answer with only a decimal number

Definition A	**Definition B**
int numbersA[5][3][2];	char *numbersB = numbersA;

3(A) (2.5 points): If the address of numbersB is 10000, what it the address of numbersA[3][2][1]?

Hint: **Answer with only a whole decimal number.** Not prefix, no suffix, no units, etc. Just a number

The address of numbersA[3][2][1] is

Hint: **Answer with only a whole decimal number**. No units. no fractions. No weirdness.

3(B) (2.5 points): What would be returned by sizeof(numbersB) after the assignment is completed?

Hint: **Answer with only a whole decimal number**. No units. no fractions. No weirdness.

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5. Structs and Alignment (12 points, 2 points per part)

The struct questions below are based upon the following definition as implemented on a shark machine, i.e. x86-64 with 1-byte chars, 2-byte shorts, 4-byte ints, 8-byte longs, and 8-byte pointers.

```
struct {
  char c1;
  short s;
  long l;
  int i;
} exam;
```

Assume a system which requires “natural alignment” (the alignment presented in lectures), i.e. each type needs to be aligned to a multiple of its data type size.

Question 8 2 pts

5. Structs and Alignment (12 points, 2 points per part)

5(A) (2 points) What is the value of sizeof(struct exam)?

Question 9 2 pts

5. Structs and Alignment (12 points, 2 points per part)

5(B) (2 points) How many bytes of padding does the compiler introduce after *s*?

Question 10 2 pts

5. Structs and Alignment (12 points, 2 points per part)

5(C) (2 points) How many bytes of padding does the compiler introduce after l?

Question 11 2 pt

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5. Structs and Alignment (12 points, 2 points per part)

5(D) (2 points) How many bytes of padding does the compiler introduce after i?

Question 12 2 pts

5. Structs and Alignment (10 points, 2 points per part)

5(E) (2 points) Which of the following field orderings minimize the amount of padding introduced by the compiler?

- c1, s, l, i
- c1, l, s, i
- l, i, s, c1
- l, s, i, c1
- All of the above
- None of the above

Question 13 2 pts

5. Structs and Alignment (12 points, 2 points per part)

5(F) (2 points) Assuming the fields of the struct were organized optimally by the programmer, what would be the value of sizeof (struct exam)?

Question 14 10 pts

6. Assembly-Basic (8 points, 2 points per part)

Please consider the following assembly:

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```
fun:
        movslq  %edx, %rdx
        movslq  %edi, %rdi
        movzwl  (%rsi,%rdx,2), %eax
        movw    %ax, (%rsi,%rdi,2)
        movzwl  4(%rsi,%rdx,2), %eax
        sall    $4, %eax
        movw    %ax, 4(%rsi,%rdi,2)
        movzwl  6(%rsi), %eax
        ret
```

6(A) (2 points) What type are the elements of the array? [Select]

6(B) (2 points) Which of the following arguments to the function contains the base of an array? Answer 0, 1, 2, 3, 4, 5, or 6 [Select]

6(C) (2 points) Which of the following arguments to the function contains an index to the array? Answer 0, 1, 3, 4, or 5 [Select]

6(D) (2 points) This code performs a mathematical operation, which one is performed?

[Select]

6(E) (2 points) Which of the following is one of the operands for the operation above?

[Select]

7. Assembly-Switch (18 points)

Consider the following code, which was compiled from C Programming Language source code containing one s

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```
(gdb) disassemble foo
Dump of assembler code for function foo:
   0x000000000040052d <+0>:     push   %rbp
   0x000000000040052e <+1>:     mov    %rsp,%rbp
   0x0000000000400531 <+4>:     mov    %edi,-0x4(%rbp)
   0x0000000000400534 <+7>:     mov    %esi,-0x8(%rbp)
   0x0000000000400537 <+10>:    cmpl   $0x5,-0x8(%rbp)
   0x000000000040053b <+14>:    ja     0x40055d <foo+48>
   0x000000000040053d <+16>:    mov    -0x8(%rbp),%eax
   0x0000000000400540 <+19>:    mov    0x400640(,%rax,8),%rax
   0x0000000000400548 <+27>:    jmpq   *%rax
   0x000000000040054a <+29>:    addl   $0x1,-0x4(%rbp)
   0x000000000040054e <+33>:    addl   $0x4,-0x4(%rbp)
   0x0000000000400552 <+37>:    shll   -0x4(%rbp)
   0x0000000000400555 <+40>:    jmp    0x400560 <foo+51>
   0x0000000000400557 <+42>:    subl   $0x2,-0x4(%rbp)
   0x000000000040055b <+46>:    jmp    0x400560 <foo+51>
   0x000000000040055d <+48>:    shll   -0x4(%rbp)
   0x0000000000400560 <+51>:    mov    -0x4(%rbp),%eax
   0x0000000000400563 <+54>:    pop    %rbp
   0x0000000000400564 <+55>:    retq
End of assembler dump.
```

Consider also the following dump:

```
0x400630:       0x0000000000020001      0x0000000000000000
0x400640:       0x000000000040054a      0x000000000040054e
0x400650:       0x000000000040054e      0x0000000000400552
0x400660:       0x000000000040055d      0x0000000000400557
0x400670:       0x0000003c3b031b01      0xfffffd9000000006
0x400680:       0xfffffdd000000088      0xfffffebd00000058
0x400690:       0xfffffef5000000b0      0xffffff40000000d0
0x4006a0:       0xffffffb0000000f0      Cannot access memory at address 0x4006a8
```

Question 15 3 pts

7(A)(3 points) What is the address of case=3's entry in the switch table (not what the switch table points to)? Please do **not** include the leading 0s or a leading 0x

Question 16 3 pts

7. Assembly-Switch (18 points)

7(B) (3 points) Which of the following executes for case 3?

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- addl $0x1,-0x4(%rbp)
- addl $0x4,-0x4(%rbp)
- subl $0x2,-0x4(%rbp)
- shll -0x4(%rbp)
- mov -0x8(%rbp),%eax
- None of the above

Question 17 3 pts

7. Assembly-Switch (18 points)

7(C) (3 points) Which integer input values are managed by non-default cases of the switch statement? Check all that apply.

- [ ] 0
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] Other value(s) in addition to those above
- [ ] None of the above

Question 18 3 pt

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7. Assembly-Switch (18 points)

7(D) (3 points) If there is a default case, at what address, in hex, does the begin?

- If there isn't a default case, write NONE.
- When writing an address, please do not include any leading 0s, prefixes or suffixes, or any spaces, and please write any letters in either all upper or all lower case, not mixed case. Please do not include the 0x prefix.

Your answer: [blank]

Question 19 3 pts

7. Assembly-Switch (18 points)

7(E) (3 points) Which of the following case(s), if any, consist of exactly the same code as least one other, **but not default**, case (no extra code, no code missing)? Check all that apply. [exact_same]

- [ ] 0
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] None of the above

Question 20 3 pts

7. Assembly-Sv

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7(F) (3 points) V *of their own code*?

- [ ] 0
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] None of the above

8. Loops and Conditionals (12 points)

Consider the following code, under the assumption that it was compiled in the same environment using the same "shark machine" toolset you've used all semester:

```
(gdb) disassemble loop
Dump of assembler code for function loop:
   0x000000000040059d <+0>:     push   %rbp
   0x000000000040059e <+1>:     mov    %rsp,%rbp
   0x00000000004005a1 <+4>:     push   %rbx
   0x00000000004005a2 <+5>:     mov    %edi,-0x1c(%rbp)
   0x00000000004005a5 <+8>:     mov    %esi,-0x20(%rbp)
   0x00000000004005a8 <+11>:    mov    %edx,-0x24(%rbp)
   0x00000000004005ab <+14>:    mov    %rcx,-0x30(%rbp)
   0x00000000004005af <+18>:    mov    $0x0,%ebx
   0x00000000004005b4 <+23>:    mov    -0x1c(%rbp),%eax
   0x00000000004005b7 <+26>:    mov    %eax,-0xc(%rbp)
   0x00000000004005ba <+29>:    jmp    0x4005d8 <loop+59>
   0x00000000004005bc <+31>:    mov    -0xc(%rbp),%eax
   0x00000000004005bf <+34>:    cltq
   0x00000000004005c1 <+36>:    lea    0x0(,%rax,4),%rdx
   0x00000000004005c9 <+44>:    mov    -0x30(%rbp),%rax
   0x00000000004005cd <+48>:    add    %rdx,%rax
   0x00000000004005d0 <+51>:    mov    (%rax),%eax
   0x00000000004005d2 <+53>:    add    %eax,%ebx
   0x00000000004005d4 <+55>:    addl   $0x2,-0xc(%rbp)
   0x00000000004005d8 <+59>:    mov    -0xc(%rbp),%eax
   0x00000000004005db <+62>:    cmp    -0x24(%rbp),%eax
```

```
   0x00000000004005de <+65>:    jl     0x4005bc <loop+31>
   0x00000000004
   0x00000000004
   0x00000000004
   0x00000000004
   0x00000000004005eb <+78>:    mov    -0x10(%rbp),%eax
   0x00000000004005ee <+81>:    cltq
   0x00000000004005f0 <+83>:    lea    0x0(,%rax,4),%rdx
   0x00000000004005f8 <+91>:    mov    -0x30(%rbp),%rax
   0x00000000004005fc <+95>:    add    %rdx,%rax
   0x00000000004005ff <+98>:    mov    (%rax),%eax
   0x0000000000400601 <+100>:   add    %eax,%ebx
   0x0000000000400603 <+102>:   addl   $0x2,-0x10(%rbp)
   0x0000000000400607 <+106>:   mov    -0x10(%rbp),%eax
   0x000000000040060a <+109>:   cmp    -0x24(%rbp),%eax
   0x000000000040060d <+112>:   jl     0x4005eb <loop+78>
   0x000000000040060f <+114>:   mov    %ebx,%eax
   0x0000000000400611 <+116>:   pop    %rbx
   0x0000000000400612 <+117>:   pop    %rbp
   0x0000000000400613 <+118>:   retq
End of assembler dump.
```

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Question 21 3 pts

8. Loops and Conditionals (12 points)

8(A) (3 points) How many loops are in the code?

- 0
- 1
- 2
- 3
- 4 or more

Question 22 3 pts

8. Loops and Conditionals (12 points)

8(B) (3 points) What is the relationship between/among the loop(s)?

- There is only one loop, so there is no relationship between or among loops

They are all nested

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One after another

Nested and one after another

Question 23 3 pts

8. Loops and Conditionals (12 points)

8(C) (3 points) Which of the following are true? Check all that apply.

Two or more loops have a starting value in common, e.g. progress with the same number.

Two or more loops have a stopping value in common, e.g. progress up to or down to the same number.

The loops have body code in common

Question 24 3 pts

8. Loops and Conditionals (12 points)

8(D) (3 points) How many times is the ?-operator likely used in the source C Language code?

0

1

2

3

4 or more

Question 25 5 pts

9. Memory Hierarchy (5 points)

You are given the following:

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- L1 cache wit
- L2 cache with an access time of 10ns and a miss rate of 10%
- Main memory with an access time of 100ns

Access to a level of the memory hierarchy is preceded by access to the layers above it. The times given do **not** include this prior time.

What is the effective (average) memory access time for this system in nS? Please include only the number, not the units. Please answer in decimal notation (not fractional notation)

Question 26 3 pts

10. Locality (3 points)

Consider a cache with 4 sets, 2 lines/set, and a block size of 16 bytes on a system with 2-byte shorts.

What is the maximum stride (index step) size while sequentially accessing a 1D short array to maintain a cache miss rate of no more than 28%?

Question 27 1 pts

11. Caching (10 points)

Given a model described as follows:

- 8-bit addresses
- 2-way set associative
- 4 sets
- Total size: 64 bytes (not counting meta data)
- Replacement policy: Set-wise LRU

Question 27 1 pts

11. Caching (10 points)

11(A) (1 point) How many lines per set?

Question 28 1 pts

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11. Caching (10

11(B) (1 point) How many bytes per block?

Question 29 8 pts

11. Caching (10 points)

11(C) (8 points, 0.5 points each blank): Consider the following memory access trace, which is in order and begins at the beginning of time. For each of the following memory accesses, please indicate if it hits or misses, and if it misses, if it suffers from a capacity miss, a conflict miss, or a cold miss:

Question Number	Address	Hit or Miss? Circle one (per row):	Miss Type? Circle one (per row)
11(C)(1)	0x20	[Select]	[Select]
11(C)(2)	0x40	[Select]	[Select]
11(C)(3)	0X42	[Select]	[Select]
11(C)(4)	0X22	[Select]	[Select]
11(C)(5)	0X66	[Select]	[Select]
11(C)(6)	0X80	[Select]	[Select]
11(C)(7)	0XA0	[Select]	[Select]
11(C)(8)	0X42	[Select]	[Select]

Submit Quiz

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