

# 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 9:15am

## Quiz Instructions

### Instructions

- **THIS IS A CLOSED BOOK, CLOSED NOTES EXAM**
- 
- 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).
- A simple calculator is permitted, but won't prove to be helpful (we don't think).
- You have 180 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 1 15 pts

### Integers (5 points, 1 point per blank)

Fill in the five empty boxes in the table below when possible and indicate "UNABLE" when impossible.

	<b>6-bit 2s complement signed</b>	<b>6-bit unsigned</b>
--	-----------------------------------	-----------------------

Binary representation of 36 decimal	<input type="text"/>	<input type="text"/>
Binary representation of T <sub>min</sub> (negative)	<input type="text"/>	-----
Integer (Decimal) value of (16 + 18)	<input type="text"/>	-----



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Question 2 1 pts

### Question 2: Floats

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  $k = 3$  exponent 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.

2(A) (1 points) What is the bias?



Question 3 1 pts

### Question 2: Floats

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  $k = 3$  exponent 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.

2(B) (1 points) V

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Question 4 1 pts

**Question 2: Floats**

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  $k = 3$  exponent bits
- Wherever rounding is necessary, round-to-even should be In addition, you should give the rounded value of the encoded floating point number.

2(C) (1 points) What is the minimum exponent for normalized numbers (*Hint: Most negative*)?



Question 5 1 pts

**Question 2: Floats**

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  $k = 3$  exponent bits
- Wherever rounding is necessary, round-to-even should be In addition, you should give the rounded value of the encoded floating point number.

2(D) (1 points) What is the maximum exponent for normalized numbers (*Hint: Most positive*)?



Question 6 6 pts

**Question 2: Flo**

2(E-H) (6 points)

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Value	Binary Representation	Rounded Value a reduced decimal fraction
-5/32	<input type="text"/>	--
-13/32	<input type="text"/>	--
19/128	<input type="text"/>	+ <input type="text"/> / <input type="text"/>

**3. (20 points) Assembly**

Please consider the following assembly code segment:

```

movl    %edi, -4(%rbp)
movl    %esi, -8(%rbp)
movl    %edx, -12(%rbp)
movl    %ecx, -16(%rbp)
movl    -4(%rbp), %eax
cmpl    -8(%rbp), %eax
jle     .L2
jmp     .L3
.L4:
movl    -8(%rbp), %eax
movl    %eax, %esi
movl    $.LC0, %edi
movl    $0, %eax
call    printf
addl    $1, -8(%rbp)

```

```

.L3:
    movl    %eax, %eax
    cmpl   %eax, %eax
    jle    .L1

.L2:
    movl    -8(%rbp), %eax
    cmpl   -4(%rbp), %eax
    jle    .L1
    jmp    .L6

.L7:
    movl    -4(%rbp), %eax
    movl    %eax, %esi
    movl    $.LC0, %edi
    movl    $0, %eax
    call   printf
    addl   $1, -4(%rbp)

.L6:
    movl    -4(%rbp), %eax
    cmpl   -8(%rbp), %eax
    jle    .L7

.L1:

```



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### Question 7 4 pts

3(A) (4 points): How many loops are within this question?



### Question 8 4 pts

3(B) (4 points): How many if statements are within this question (that can't be considered part of the pre-test for an if or while loop)?



### Question 9 4 pts

3(C) (4 points): Do two or more loops share the same loop control variable (a variable which is updated by the body of the loop and used as part of the test for the loop)?

Yes

No



### Question 10 4 pts

3(D) (4 points): Do two or more loops share the same end point? In other words, do they stop when the loop control variable reaches the same value or condition?

Yes



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No



Question 11 4 pts

3(E) (4 points): Are the loop(s) most likely pre-test loops, e.g. while or for, or post-test loops, e.g. do-while?

Pre-test

Post-test



4. (20 points) **Structs and Alignment**

Consider the following struct:

```
struct {
    short s; // 2-byte type
    int i;   // 4-byte type
    short sa[4];
    char c; // 1-byte type
} exam;
```

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



Question 12 3 pts

4(A) (3 points): How many bytes of padding would the compiler place immediately before s?



Question 13 4 pts

4(B) (4 points): How many bytes of padding would the compiler place immediately before i?



Question 14 4 pts

4(C) (4 points): How many bytes of padding would the compiler place immediately before sa?



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Question 15 3 pts

4(D) (3 points): (3 points) How many bytes of padding would the compiler place immediately before c?



Question 16 3 pts

4(E) (3 points): How many bytes of padding would the compiler place immediately after c?



Question 17 3 pts

4(F) (3 points): At most, how many bytes could be saved by reordering the fields of the struct?



Question 18 3 pts

### Arrays Sizes (4 points)

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

Definition A	Definition B
<code>int numbersA[ 2 ][ 4 ][ 6 ];</code>	<code>int *numbersB = numbersA;</code>

**5(a)(1.5 point):** How many bytes are allocated to numbersA? (Write "UNKNOWN" if not knowable):

 Bytes

*Hint:* Think sizeof()

5(b) (1.5 point): How many bytes are allocated to numbers? (Write "UNKNOWN" if not knowable):

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Hint: Think sizeof()



Question 19 2 pts

Array Arithmetic

5(c) (2 points): Consider the following definitions as implemented on a shark machine, i.e. x86-64. What is the difference, i.e. number of bytes, between numbers[ 0 ][ 2 ] and numbers[ 2 ][ 2 ]? [distance] bytes

<b>Definition A</b>
<code>int numbers[ 3 ][ 5 ];</code>



Question 20 1 pts

Part 6(A): Caching

Given a model described as follows:

- Number of sets: 8
- Total size: 64 bytes (not counting meta data)
- Block offset bits: 2
- Replacement policy: Set-wise LRU
- 8-bit addresses

6(A)(1) (1 point) How many bits for the tag?





Question 21 1 pts

**Part 6(A): Caching**

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Given a model described as follows:

- Number of sets: 8
- Total size: 64 bytes (not counting meta data)
- Block offset bits: 2
- Replacement policy: Set-wise LRU
- 8-bit addresses

**6(A)(2) (1 point)** How many lines per set?



Question 22 1 pts

**Part 6(A): Caching**

Given a model described as follows:

- Number of sets: 8
- Total size: 64 bytes (not counting meta data)
- Block offset bits: 2
- Replacement policy: Set-wise LRU
- 8-bit addresses

**6(A)(3) (1 point)** How many bytes per block?



Question 23 12 pts

**6(A)(4-9) Caching (12 points, 1 point each):** 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)
	0xA2		

<b>6(A)(4)</b>				<input type="checkbox"/> You started this quiz near when it was due, so you won't have the full amount of time to take the quiz. <input type="checkbox"/>
<b>6(A)(5)</b>	0XD7	<input type="text" value="[ Select ]"/>	<input type="text" value="[ Select ]"/>	<input type="checkbox"/>
<b>6(A)(6)</b>	0X92	<input type="text" value="[ Select ]"/>	<input type="text" value="[ Select ]"/>	<input type="checkbox"/>
<b>6(A)(7)</b>	0XD3	<input type="text" value="[ Select ]"/>	<input type="text" value="[ Select ]"/>	<input type="checkbox"/>
	0XB2			
<b>6(A)(8)</b>	0XA1	<input type="text" value="[ Select ]"/>	<input type="text" value="[ Select ]"/>	<input type="checkbox"/>
<b>6(A)(9)</b>	0X92	<input type="text" value="[ Select ]"/>	<input type="text" value="[ Select ]"/>	<input type="checkbox"/>



Question 24 3 pts

### 6(B) (3 points): Locality

Consider a cache with 8 sets, 2 lines/set, and a block size of 16 bytes on a system with 4-byte ints.

What is the maximum stride (index step) size while sequentially accessing a 1D int array to maintain a cache miss rate of no more than 42%?



Question 25 2 pts

### 6(C) (2 points): Memory Hierarchy and Effective Access Time

Imagine a system with a main memory layered beneath a cache:

- The cache has a 4ns access time.

- The main memory has an access time of 0ns
- The cache memory has an access time of 0ns
- In the event of a cache miss, the main memory access time is 0ns

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**5(C) (2 points)** What is the effective, overall access time in ns?



### Switch Statement (10 points)

Please consider the following assembly, compiled on a shark machine:

```
(gdb) disassemble foo
Dump of assembler code for function foo:
0x0000000000401136 <+0>:    endbr64
0x000000000040113a <+4>:    push   %rbp
0x000000000040113b <+5>:    mov    %rsp,%rbp
0x000000000040113e <+8>:    mov    %edi,-0x4(%rbp)      # %edi is 0th argument
0x0000000000401141 <+11>:   mov    %esi,-0x8(%rbp)     # %esi is 1st argument
0x0000000000401144 <+14>:   cml    $0x6,-0x8(%rbp)
0x0000000000401148 <+18>:   ja     0x40117a <foo+68>
0x000000000040114a <+20>:   mov    -0x8(%rbp),%eax
0x000000000040114d <+23>:   mov    0x402008(,%rax,8),%rax
0x0000000000401155 <+31>:   notrack jmp  *%rax          # You can ignore the notrack
and focus on the jmp
0x0000000000401158 <+34>:   addl   $0x1,-0x4(%rbp)
0x000000000040115c <+38>:   jmp    0x40117e <foo+72>
0x000000000040115e <+40>:   shll   $0x2,-0x4(%rbp)
0x0000000000401162 <+44>:   shll   -0x4(%rbp)
0x0000000000401165 <+47>:   jmp    0x40117e <foo+72>
0x0000000000401167 <+49>:   mov    -0x4(%rbp),%eax
0x000000000040116a <+52>:   lea   0x3(%rax),%edx
0x000000000040116d <+55>:   test  %eax,%eax
0x000000000040116f <+57>:   cmovs %edx,%eax
0x0000000000401172 <+60>:   sar   $0x2,%eax
0x0000000000401175 <+63>:   mov   %eax,-0x4(%rbp)
0x0000000000401178 <+66>:   jmp   0x40117e <foo+72>
0x000000000040117a <+68>:   addl  $0x2,-0x4(%rbp)
0x000000000040117e <+72>:   mov   -0x4(%rbp),%eax
```

0x0000000000401181	0x0000000000000000	0x0000000000000000
0x000000000000		
End of assemble		

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And the following memory dump:

```
(gdb) x/14xg 0x402000
0x402000      0x00000000000020001      0x000000000040117a
0x402010:    0x000000000040115e      0x0000000000401158
0x402020:    0x0000000000401162      0x000000000040117a
0x402030:    0x000000000040117a      0x0000000000401167
0x402040:    0x00000003c3b031b01     0xffffefe000000006
0x402050:    0xfffff00000000080     0xfffff010000000a8
0x402060:    0xfffff04000000058     0xfffff0f60000006c
```

⋮  
 Question 26 2 pts

At what address does the jump table start? [jmp\_start]

Note: Answer in HEX, prefixing with 0x, and leaving off any leading 0s.

⋮  
 Question 27 2 pts

At what address does the code for the default case begin? [def\_addr]

Note: Answer in HEX, prefixing with 0x, and leaving off any leading 0s.

⋮  
 Question 28 2 pts

How many non-negative cases use the default case?

0

1



3



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A huge number



Question 29 2 pts

Exactly one case fall through to another case. What is the address of the first line of code shared by both cases (falls through case and fallen into case)?

Note: Answer in HEX, prefixing with 0x, and leaving off any leading 0s.



Question 30 2 pts

How many entries are there in the jump table?

Note: Answer in decimal without leading 0s.

Not saved

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