

Final Exam

12 December 2017, 120 minutes, 26 questions, 100 points

The exam is closed book and notes.
Please keep all electronic devices turned off and out of reach.
Note that a question may require *multiple* checked boxes for a correct answer. Checking *some* but not *all* of the required boxes will result in a *partial* answer worth only 2 of the 4 points. Checking any box that shouldn't be checked results in an *incorrect* answer, worth zero.

1. Return my exam to my Kingsbury mailbox. [0 pts]
 Hold my exam in your office. I will pick it up prior to February 15.
 Shred my exam. I never want to see it again.
2. Interpret 0xCAFEDADA (shown in hexadecimal) as an IEEE single-precision floating-point value. Which of the following statements about this value are true? [4 pts]
 It is negative.
 Its stored exponent is 0x95.
 Its actual exponent is -22 (in decimal).
 It is a denormalized value.
3. Concerning the concurrent buffer assignment, which of the following statements are true: [4 pts]
 Each buffer required only one mutex.
 Each buffer required only one condition variable.
 A consumer, pulling a value from the buffer, never blocks.
 A producer, putting a value in the buffer, never blocks.
4. Encode the following Unicode character (shown in hex) as UTF-8: 0x3333. The sequence of bytes (shown in hex) would be: [4 pts]
 33 33.
 D3 93.
 E3 8C B3.
 F3 93 83 93.
 none of the above.
5. Which of the following statements about the Intel 64 are true? [4 pts]
 All parameters are passed on the stack.
 The **rbp** register points to the top frame on the stack.
 The runtime stack grows from lower address towards higher address.
 The **ret** instruction pops the return address from the top of the runtime stack.

6. Consider the following C function:

[4 pts]

```
unsigned int f(void)
{
    int x = 1;
    return *((unsigned char *) &x);
}
```

On a 2's complement machine with a byte-addressable memory, the function will:

- return 0 if the machine is little-endian and 1 otherwise.
- return 1 if the machine is little-endian and 0 otherwise.
- always return 1.
- always return 0.
- none of the above.

7. Consider the following RISC-V program:

[4 pts]

```
top :
    sbreak
    sbreak
    sbreak
    sbreak
    blt x7, x9, top
```

What is the encoding of the `blt` instruction?

- `0xFE93C1E3`.
- `0xFE93C7E3`.
- `0xFE93C8E3`.
- `0x0093C0E3`.
- none of the above.

8. Consider how -19 (base 10) would be represented in the memory of a Little Endian machine as a 16-bit 2's complement integer. The two bytes, shown left to right in increasing memory address order, would be: [4 pts]

- `0xFF 0xED`.
- `0xED 0xFF`.
- `0x13 0x80`.
- `0x80 0x13`.
- none of the above.

9. The UTF-16 sequence (shown in hexadecimal) `0x0800 0x0C10` is represented in UTF-32 (in hexadecimal) [4 pts] as:

- two Unicode characters, `0x00000800` and `0x00000C10`.
- two Unicode characters, `0x00000000` and `0x00000010`.
- a single Unicode character, `0x00010010`.
- a single Unicode character, `0x00000010`.
- none of the above.

10. Which of the following statements about using a POSIX condition variable are true? [4 pts]
- The caller of `pthread_cond_wait` must hold the lock of an associated mutex.
 - The caller of `pthread_cond_signal` will block if there are no threads waiting on the condition variable.
 - If `pthread_cond_wait` is called when there are already threads waiting on the condition variable, then an error code is returned.
 - A maximum of two threads are allowed to wait on a condition variable.
11. Which of the following statements about a POSIX mutex are true? [4 pts]
- Only one thread at a time can hold the lock of a mutex.
 - A thread will block if the thread tries to unlock a mutex for which it does not own the lock.
 - A critical section is protected by first unlocking a mutex, then executing the critical section, then locking the mutex.
 - A thread cannot own the lock on two different mutexes at the same time..
12. Which of the following are examples of a program exhibiting temporal locality: [4 pts]
- iterating through all members of an array in order.
 - repeatedly incrementing a loop counter variable inside a loop.
 - a sequence of instructions being executed in order without any branch or call instructions.
 - adding two registers together.
13. Add together the following two 8-bit 2's complement integers (shown in hexadecimal): `0xFF` and `0x01`. Which [4 pts] of the following are true statements about the result?
- The result (in hexadecimal) is `0x100`.
 - The result is negative.
 - The result overflows.
 - The result in decimal is `-2`.
 - The result in decimal is `0`.
14. Which of the following statements about virtual memory are true? [4 pts]
- The translation lookaside buffer (TLB) is a cache that stores recent virtual-to-physical page translations.
 - The page table resides in physical memory.
 - A page table entry includes a valid flag that is used to indicate whether a virtual page is currently in physical memory.
 - A write of a word in virtual memory always causes the virtual memory to perform a disk read.
15. Which of the following statements about the Java Virtual Machine are true? [4 pts]
- All instructions are 32 bits.
 - Operands are loaded into registers before operating on them.
 - The PC contains the address of the instruction currently being executed.
 - It uses PC-relative addresses for its branch instructions.
16. Which of the following statements about assemblers are true? [4 pts]
- They have two passes because the definition for a label may come before its use.
 - They place in the `outsymbol` section of the output object file all labels that are defined in the input file.
 - They place in the `insymbol` section of the object file all labels that are referenced in the input file but not defined.
 - They use a symbol table to store the address associated with each defined label.

17. Which of the following statements about the Intel 64 **CMPXCHG** instruction are true? [4 pts]
- It is used with the **LOCK** prefix to ensure that its memory actions are atomic.
 - It is a convenient way to swap the values of two memory locations in a single instruction.
 - It is used when implementing mutexes in order to protect the contents of the struct implementing the state of the mutex from concurrent updates by two threads.
 - Its functionality can be utilized in C via the *atomic_flag_test_and_set* library function.
18. Which of the following statements about thread control blocks (TCBs) are true? [4 pts]
- The TCBs for all ready-to-run threads are linked together to form the ready list.
 - A TCB is used to store the current state of a thread when the thread yields to another thread.
 - The main thread does not have a TCB.
 - The TCBs for all threads waiting to lock a mutex are linked together to form the wait queue for the mutex.
19. Add the following two IEEE single-precision floating-point values shown in hexadecimal: 0x40A00001 and 0x40A00002. The result in hexadecimal is: [4 pts]
- 0x40A00003.
 - 0x40B00003.
 - 0x00000000.
 - 0x41200002.
 - 0x41200001.
 - none of the above.
20. In an implementation of an exception mechanism for C programs on the Intel 64, the **throwException** function: [4 pts]
- pushes the current **rbp**, the saved **rbp** and the saved **rip** onto the “snapshot” stack.
 - puts the exception number into the **rax** register.
 - pops the “snapshot” stack.
 - none of the above.
21. Which of the following statements about a mark-and-sweep garbage collector are true? [4 pts]
- The mark phase is responsible to marking all allocated blocks that are still in use.
 - The sweep phase considers all marked blocks to be garbage that can be reclaimed as free (no longer allocated).
 - The mark phase traverses the run-time stack in order to mark blocks pointed to by local variables.
 - The sweep phase will combine adjacent free blocks.
22. A memory cache with only one line per set is known as a: [4 pts]
- direct-mapped cache.
 - set-associative cache.
 - fully-associative cache.
 - translation lookaside buffer.
 - none of the above.

23. Consider how the following two C loops would be accessed by a memory system with 32 words and a direct-mapped cache with 4 sets and a block size of 4 words. [4 pts]

```
for (i = 0; i < 32; i++)
    a[i] = i;
sum = 0;
for (i = 0; i < 32; i++)
    sum += a[i];
```

Assume the array is an array of words, only the array is in the cache, and the first word of the array is at address zero. If the cache is initially empty, how many cache hits would there be for writes and how many cache hits would there be for reads?

- 32 read hits and 24 write hits.
 - 0 read hits and 0 write hits.
 - 24 read hits and 24 write hits.
 - 0 read hits and 24 write hits.
 - none of the above.
24. Which of the following statements about the IAS computer are true? [4 pts]
- It was not a stored-program computer.
 - Its memory consisted of 40-bit words.
 - It utilized the IEEE floating-point standard.
 - It utilized the ASCII character encoding standard.
25. Which of the following statements about the Control Data Corporation (CDC) 6600 are true? [4 pts]
- It contained a hardware run-time stack to support recursive functions.
 - It used 1's complement to implement signed integer values.
 - It was designed to do character processing applications.
 - It was a stored-program computer.
26. Consider this C declaration: [4 pts]

```
long (*f)(long *);
```

This declares a:

- pointer to a function that takes a pointer to a long, and returns a long.
- function that takes a pointer to a long, and returns a pointer to a long.
- pointer to a function that takes a long, and returns a pointer to a long.
- none of the above.