CSci 402 - Operating Systems
Final Exam (DEN Section)
Spring 2020

(9:00am - 9:40am, Friday, May 8)

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Teaching Assistant: Ben Yan

(This exam is closed book, closed notes, closed everything.
No "cheat sheet" allowed.
No calculators, cell phones, or any electronic gadgets.)

Time: 40 minutes

_____-
Name (please print)

Total: 32 points

_____-
Signature

Instructions

1. This is the first page of your exam. The previous page is a title page and does not have a page number. Please write and sign your name on this sheet *now*.
2. Read problem descriptions carefully. You may not receive any credit if you answer the wrong question. Furthermore, if a problem says *"in N words or less"*, use that as a hint that N words or less are expected in the answer (your answer can be longer if you want). Please note that points may get *deducted* if you put in wrong stuff in your answer.
3. If a question doesn't say `weenix`, please do not give `weenix`-specific answers.
4. Write answers to all problems on the exam itself. If you are taking the exam *remotely* and if you need additional space, please ask for additional sheets and only write on one side since they need to be fax'ed.
5. Show all work (if applicable). If you cannot finish a problem, your written work will help us to give you partial credit. We may not give full credit for answers only (i.e., for answers that do not show any work). Grading can only be based on what you wrote and cannot be based on what's on your mind when you wrote your answers.
6. Please do *not* just draw pictures to answer questions (unless you are specifically asked to draw pictures). Pictures will not be considered for grading unless they are clearly explained with words, equations, and/or formulas.
7. For problems that have multiple parts, please clearly *label* which part you are providing answers for.
8. Please ignore minor spelling and grammatical errors. They do not make an answer invalid or incorrect.
9. During the exam, please only ask questions to *clarify* problems. Questions such as "would it be okay if I answer it this way" will not be answered (unless it can be answered to the whole class). Also, you are suppose to know the definitions and abbreviations/acronyms of *all technical terms*. We cannot "clarify" them for you. We also will **not** answer any clarification-type question for multiple choice problems since that would often give answers away.
10. Unless otherwise specified and stated explicitly, multiple choice questions have one or more correct answers. You will get points for selecting correct ones and you will lose points for selecting wrong ones.
11. When we grade your exam, we must assume that you wrote what you meant and you meant what you wrote. So, please write your answers accordingly.

(Q1) (2 points) Which of the following statements are correct about a **terminal driver** and a **pseudo-terminal driver**?

(1) for a pseudo-terminal, the input and output (on the device end) comes from and goes to a device
(2) pseudo-terminal does not behave like a terminal at all
(3) both pseudo-terminal driver and terminal driver are kernel drivers
(4) for a pseudo-terminal, the input and output (on the device end) comes from and goes to an application
(5) a pseudo-terminal driver runs in user space while a terminal driver runs in the kernel

Answer (just give numbers): _____

(Q2) (2 points) Let's say that you have three threads A, B, and C and you are using **stride scheduling**. You have decided to give thread A 2 tickets, thread B 4 tickets, and thread C 5 ticket. The initial pass values that **you must used** for the three threads are shown below along with the "winner" of the iteration 1. Please fill out all the entries (pass values) in the table. For **iterations 2 through 5**, please write on your answer sheet the "winner" and the winning pass value of that iteration. (For example, you would write "B:2" for iteration 1 since B is the "winner" and the winning pass value is 2.) You must use the **smallest possible integer stride values** when calculating the pass values. Please note that if you get the stride values wrong, you will not get any partial credit for this problem.

itr	A	B	C
1	5	(2)	4
2			4
3	5		
4		7	
5			8

(Q3) (2 points) Which of the following statements are correct about **network device drivers** and **terminal device drivers**?

(1) their abstractions to user applications are completely different
(2) in network communication, data needs to be passed from one layer to another without copying
(3) network drivers deal with binary data while terminal drivers deal with non-binary data
(4) one major difference between the two is the data rate they must deal with
(5) most of the work performed by a network device driver is done as "deferred processing"

Answer (just give numbers): _____

(Q4) (2 points) A correct implementation of **straight-threads** (i.e., no interrupt) **synchronization** on a single processor is shown here:

```
void mutex_lock(mutex_t *m)
{
  if (m->locked) {
    enqueue(m->queue,
        CurrentThread);
    thread_switch();
  } else
    m->locked = 1;
}
```

```
void mutex_unlock(mutex_t *m)
{
  if (queue_empty(m->queue))
    m->locked = 0;
  else
    enqueue(runqueue,
        dequeue(m->queue));
}
```

Let's say that thread X owns mutex **m**. Which of the following statements are correct about what would happen if another thread (thread Y) calls **mutex_lock(m)**?

(1) thread Y will enter the run queue and will try to lock the mutex again next time when it runs
(2) thread X will enter **mutex_unlock()** immediately and thread Y will return from mutex_lock() immediately with the mutex locked
(3) thread Y will enter **m**'s mutex queue and thread X will not be affected
(4) thread X will enter **thread_switch()** and thread Y will return from thread_switch() immediately
(5) thread Y will enter **thread_switch()** and thread X will return from thread_switch() immediately

Answer (just give numbers): _____

(Q5) (2 points) Which of the following statements are correct about having a **monolithic kernel**?

(1) its main advantage is performance
(2) its main disadvantage is reliability
(3) it's more robust (i.e., crashes less) because it's not broken into little pieces
(4) it encourages system programmers to write more elegant code
(5) none of the above is correct

Answer (just give numbers): _____

(Q6) (2 points) Which of the following statements are correct about virtual machine monitor (VMM)?

(1) VMM is a terminal device that's attached to a virtual machine
(2) VMM is an application that runs inside a virtual machine
(3) in the virtual machine approach, the VMM runs in the user mode of the real machine
(4) VMM is sometimes referred to as the "hypervisor"
(5) in the virtual machine approach, the OS of the "real machine" is the VMM

Answer (just give numbers): _____

(Q7) (2 points) What are the reasons the **line-disciplining code** is made into a separate **module**? (Please note that the word "locale" below refers to "language-specific issues" in the line-discipline module.)

(1) modularity: separate the device dependent part from the device independent part in handling the terminal device
(2) make the code for dealing with different locales easier to write since system programmers won't have to worry about hardware specific characteristics
(3) make terminal device drivers easier to write because device manufacturers won't have to write code to deal with different locales
(4) performance: make the terminal device seem more responsive
(5) none of the above is correct

Answer (just give numbers): _____

(Q8) (2 points) Let's say that you have three threads A, B, and C and you are using the basic **round-robin (RR) / time-slicing** scheduler with a very small time slice. At time zero, all three threads are in the run queue and their processing times are shown in the table below. Assuming that there are no future arrivals into the run queue, please complete the table below with the "waiting time" of all three threads and the "average waiting time" (AWT) of these three threads and write the results on your answer sheet. Please make it very clear which waiting time is for which thread and which one is the AWT. For non-integer answers, you can use fractions or decimals with two digits after the decimal point. Your answer must not contain plus or multiplication symbols. You must use the definition of "waiting time" given in lectures.

	A	B	C	AWT
T (hrs)	5	4	6	-
wt (hrs)	14	12	15	41/3

(Q9) (2 points) Which of the following statements are correct about **I/O virtualization**?

(1) I/O virtualization is not a big problem in building virtual machines on servers because only a small number of devices need to be supported
(2) in VMware's solution to I/O virtualization, most device drivers in the guest OS must be rewritten so that they can be supported
(3) I/O virtualization in building virtual machines on popular end-user machines is challenging because it's virtually impossible for virtual machine vendors to support all devices
(4) in Xen's solution to I/O virtualization, only a few device drivers in the guest OS has to be rewritten in order for Xen to use them
(5) VMware's I/O virtualization solution performs faster than Xen's solution

Answer (just give numbers): _____

(Q10) (2 points) For a terminal, input characters may need to be processed/edited in some way before they reach the application. What **data structures** are used to **solve this problem**? Please select the best answer below (i.e., **only one** answer).

(1) a pair of input/output buffers
(2) an address translator
(3) a hash table and a B+ tree
(4) a partial-line queue and a completed-line queue
(5) none of the above is correct

Answer (just give numbers): _____

(Q11) (2 points) Which of the following statements are correct about the **popf machine instruction** in a regular **Intel x86 processor**?

(1) executing it in the user mode causes a trap while executing it in the privileged mode does not
(2) it behaves differently when it is executed in kernel and user modes
(3) executing it even in the privileged mode would cause a trap
(4) executing it in either the user mode or the privileged mode won't cause a trap
(5) none of the above is correct

Answer (just give numbers): _____

(Q12) (2 points) Which of the following statements are correct about what happens when a user process that runs in a virtual machine makes a system call?

(1) the system call is converted into another system call for the VMM
(2) the system call is ~~emulated~~ by the guest OS
(3) the system call would first trap into the ~~guest OS~~ VMM
(4) the system call is intercepted by the dynamic linker in the VMM
(5) none of the above is correct

Answer (just give numbers): _____

(Q13) (2 points) Which of the following statements are correct about **paravirtualization**?

(1) it means to fix the hardware so that an OS/kernel can run in a virtual machine without modification
(2) it means that the virtualized OS/kernel is a modified version of the real OS/kernel
(3) VMware is well-known for ~~its paravirtualization~~ patent
(4) a Xen system uses paravirtualization
(5) none of the above is correct

Answer (just give numbers): _____

(Q14) (2 points) Which of the following statements are correct about **executing a sensitive instruction** in an IBM 360 **virtual machine**?

(1) when a sensitive instruction is executed in the **VMM**, it should causes an additional trap into the VMM itself
(2) when a sensitive instruction is executed in the **virtual privileged mode** of the **virtual machine**, it should cause a trap into the VMM
(3) when a sensitive instruction is executed in the **virtual user mode** of the **virtual machine**, it should cause a trap into the VMM
(4) when a sensitive instruction is executed in the **privileged mode** of the **real machine**, it should cause a trap into the VMM
(5) none of the above is correct

Answer (just give numbers): _____

(Q15) (2 points) What are the **OS approaches** to fix the **reliability** problem of a **monolithic kernel** to reduce kernel crashes?

(1) never release a kernel unless it's completely bug-free
(2) run the entire system (kernel+applications) inside a virtual machine
(3) shrink the code that must run in the privileged mode
(4) make the kernel code "open-source" so that anyone can look for bugs in the kernel
(5) none of the above is correct

Answer (just give numbers): _____

(Q16) (2 points) For a terminal, it is possible that characters can arrive from the keyboard even though there isn't a waiting read request from an application. It is also possible that characters generation are too fast for the terminal to display characters. What **data structures** are used to **solve these two problems**? Please select the best answer below (i.e., **only one** answer).

(1) an address translator
(2) a partial-line queue and a completed-line queue
(3) a pair of input/output buffers
(4) a hash table and a B+ tree
(5) none of the above is correct

Answer (just give numbers): _____