CSci 402 - Operating Systems

Final Exam (PM Section)

Summer 2020

(10:00:00am - 10:40:00am, Tuesday, August 4)

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Teaching Assistant: Ben Yan

(This exam is open book and open notes.
Remember what you have promised when you signed your
Academic Integrity Honor Code Pledge.)

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. Since this is a take-home exam, no need to sign above since you won't submit this file.
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 in the **answers text file**.
5. For non-multiple-choice and non-fill-in-the blank questions, please show all work (if applicable and appropriate). If you cannot finish a problem, your written work may 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. It's very difficult to draw pictures in a text file and you are not permitted to submit additional files other than the answers text file.
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 **vfork()**?

(1) **vfork()** is equivalent to **fork()**
(2) **vfork()** is best used by experienced system programmers because it can be tricky to use it correctly
(3) **vfork()** is faster than **fork()** if used properly
(4) if **vfork()** is used, the parent process and the child process cannot run "concurrently"
(5) none of the above is correct

2，3，4对，461页

Answer (just give numbers): 2, 3, 4

(Q2) (2 points) Let's say that you have four threads A, B, C, and D and you are using **stride scheduling**. You have decided to give thread A 4 tickets, thread B 3 tickets, thread C 2 tickets, and thread D 1 ticket. The initial pass values that **you must used** for the four 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 "A:4" for iteration 1 since A is the "winner" and the winning pass value is 4.) 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.

3 4 6 12

itr	A	B	C	D
1	(4)	6	9	8
2	7	(6)	9	8
3	(7)	10	9	8
4	10	10	9	(8)
5	10	10	(9)	20

A B C D
4 3 2 1
3 4 6 12

(Q3) (2 points) Which of the following statements are correct about virtual machine monitor (VMM)?

(1) in the virtual machine approach, the OS of the "real machine" is the VMM
(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 a terminal device that's attached to a virtual machine
(5) VMM is sometimes referred to as the "hypervisor"

Answer (just give numbers): 1, 5

1，5是对的，772页

(Q4) (2 points) Considering only **clustered hash page table** schemes and **(non-clustered) hashed page table** schemes, which of the following statements are correct?

(1) the performance of clustered hash page tables is independent of how address space is allocated
(2) non-clustered hash page tables would perform better if contiguous virtual pages are used (such as in weenix)
(3) clustered hash page tables would perform better if address space is truly sparsely allocated
(4) the performance of non-clustered hash page tables depends on the lengths of the hash conflict/collision resolution chains
(5) none of the above is correct

1, 4吧

Answer (just give numbers): _____

(Q5) (2 points) Which of the following statements are correct about the basic (two-level) virtual memory scheme where a virtual address is divided into a virtual page number (say 20 bits) and an offset (say 12 bits) on a 32-bit machine?

(1) virtual page number is just an array index into a page table which has 2^{20} entries
(2) an entry in a page table contains a 20-bit physical page number no matter how much physical memory is present
(3) a physical address is obtained by adding a physical page number with the 12-bit offset
(4) when performing a virtual to physical address translation, the least-significant 12-bits of the virtual address (i.e., the offset) must equal to the least-significant 12-bits of the translated address
(5) during the lifetime of a user process, the mapping of virtual pages to physical pages stays the same

1, 4

Answer (just give numbers): _____

(Q6) (2 points) Which of the following statements are correct about **undo journaling** and **redo journaling**?

(1) in undo journaling, you record "before images" in the log
(2) in redo journaling, you record "after images" in the log
(3) you record the same information into the log no matter if you are using undo journaling or redo journaling
(4) in undo journaling, you record "after images" in the log
(5) in redo journaling, you record "before images" in the log

1, 2

Answer (just give numbers): _____

(Q7) (2 points) Which of the following statements are correct about the **FIFO** scheduler?

(1) it's inherently unfair to long jobs
(2) it can have a large average wait time
(3) it can "starve" some jobs
(4) it has the largest variance in wait time among all scheduling disciplines
(5) it appears to have high throughput

2，对819页

Answer (just give numbers): 2,

(Q8) (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));
}
```

run current thread

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

5对，看码很明显

Answer (just give numbers): 5

(Q9) (2 points) What are the **OS design approaches** to fix the **reliability** problem of a **monolithic kernel** to reduce kernel crashes?

(1) use dynamic kernel modules so that unreliable kernel module can be unloaded while the rest of the kernel is running
(2) run the entire system (kernel+applications) inside a virtual machine
(3) shrink the code that must run in the privileged mode
(4) never release a kernel unless it's completely bug-free
(5) none of the above is correct

2，3应该对
731页

Answer (just give numbers):

(Q10) (2 points) Which of the following statements are correct about **shadow objects** if we want **copy-on-write** and **fork()** to work together?

(1) in **weenix**, a chain of shadow objects is maintained in a double-linked circular list
(2) if a virtual memory area/segment is shared-mapped, you must use a shadow object for its mmobj
(3) a shadow object holds pages that were copy-on-write but have never been modified
(4) if a virtual memory area/segment is privately mapped and writable, you must use a shadow object for its mmobj
(5) if a virtual memory area/segment is read-only, its mmobj must be a shadow object

Answer (just give numbers): _____

4对，476页

(Q11) (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)	9	7	8	-
wt (hrs)	24	21	23	22.67

全对

(Q12) (2 points) Which of the following statements are correct about **futex**?

(1) futex is not fast at all because it uses **CAS()** operations
(2) the best place to use a futex is inside the kernel
(3) if a futex is **not locked** by any thread, `futex_lock()` must enter the kernel to obtain the lock
(4) if a futex is **locked** by another thread, a system call is often required for the calling thread to obtain the lock
(5) futex is designed to work in both single-processor and multi-processor environments

Answer (just give numbers): _____

2，4，53页

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

(1) the paravirtualized guest OS most likely cannot run on the real hardware
(2) the main disadvantage of paravirtualization is performance
(3) you can only make limited amount of modifications to the guest OS
(4) paravirtualization can deal with "sensitive instructions" quite easily
(5) the guest OS cannot tell if it's running on the real machine or a virtual machine

1对，737页

Answer (just give numbers): _____

(Q14) (2 points) Which of the following statements are correct about the **popf machine instruction** in a regular **Intel x86 processor**?

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

3对，771页 2，3

Answer (just give numbers): _____

(Q15) (2 points) Which of the following statements are correct about **backing store**?

(1) read-only mapping of a file sometimes need a backing store in swap space
(2) pages in a shadow object always need a backing store in swap space
(3) read-write shared mapping of a file sometimes need a backing store in swap space
(4) read-write private mapping of a file sometimes need a backing store in swap space
(5) none of the above is correct

选5吧
感觉都不对阿

Answer (just give numbers): _____

(Q16) (2 points) Which of the following are useful approaches to **reduce page fault latency**?

(1) use a FIFO replacement policy
(2) prefetching
(3) lazy evaluation
(4) use a larger translation lookaside buffer
(5) use a pageout daemon

2，5 410页

Answer (just give numbers): _____