

Introduction to Operating Systems, Fall 2020
Question Sheet

- I. [Ch1+Ch13]19pts] Regarding 10 operations
- What is the difference between synchronous IOs and asynchronous IOs?
 - Is `read()` synchronous or asynchronous by default?
 - Is `write()` synchronous or asynchronous by default?
2. [Ch1r-Ch13][6pts) Describe the procedure of handing a timer interrupt, from that the timer generates an interrupt signal to the resumption of the interrupted program. Your answer must at least involve the following items: interrupt vector table, program counter, stack, and interrupt service routine.
- [Ch2][10pts) Consider a user program that prompts the user for an input string, saves the string in a disk file, and terminates itself. List five different system calls that the program uses. You must also explain why the program uses these calls.
4. [Ch2][4pts) Regarding microkernel operating systems:
- They are considered more secure than monolithic kernels. Why?
 - They suffer from poor performance for IO intensive applications. Why?
5. [Ch3][8pts) There are three possible states of a process: *running*, *ready*, and *waiting*. Now, consider a process that is currently running on the CPU. What is the next state of the process if
- the process is preempted by another high-priority process.
 - the process initiates a synchronous IO operation and is then blocked.
6. (Ch3)[5pts) Why context switch is implemented as an interrupt rather than a standard procedure call?
7. ICh4][8pts) Threads in a process share almost everything, including the text, heap, and opened files, except the stack. Explain why it is necessary for concurrent threads to have their own stacks.
- [Ch.:I]/Gots) You are writing a CPU-bound program, which can be perfectly parallelized. The thread library that you use is based on the many-to-many thread model. Let the number of kernel-level threads allocated to the program be K and the number of physical CPU cores be C . Let the process contain U user-level threads. Discuss possible performance implications in terms of the utilization of CPU cores) for the following cases:
- $LI = K > C$
 - $U < K \cdot C$
9. [Ch5][24pts) CPU scheduling algorithms
- Shortest-Job-First (SJF) is the best in terms of the reduction of average process waiting time. However, SJF is not a good choice for CPU scheduling in

real systems. Give two reasons for that.

- Is) what is the problem when the time slice for Round-Robin (RR) is too small? ci
With multilevel feedback queue scheduling, 10-bound processes will be gradually promoted to upper-level queues, i.e., higher-priority queues. Explain the rationale of this design.
- d) Many real-time operating systems implement Rate-Monotonic scheduling algorithm only but not Earliest-Deadline First scheduling. Explain why.
- e) Process migration is necessary for load balancing among CPUs. However, it is always desirable to reduce the frequency of process migration. Explain why.
- f) Why the virtual runtime approach in Linux CPU scheduling is free from starvation?
10. [Ch6][13pts] Why do modern operating systems use spin locks as a synchronization mechanism only on multiprocessor systems and not on single-processor systems?
11. ICh6)[6pts] What is the potential problem of the following "solution" to the bounded-buffer problem? How it can be corrected?

```
semaphore empty=N,full=0,mutex=1;// N is the buffer size
do
    // produce an item
    wait (muter-);
    wait (empty);
    // add the item to the buffer
    signal (full);
    signal
(muter-); } while
(true),
// -----
do {
    wait (muter-);
    wait (full);
    // remove an item from buffer
    signal (empty);
    signal (muter-);
    // consume the removed
    item }while (true);
// consumer process
```

12. [Ch6][6pts] There is only one restroom on the first floor of our building. The restroom is shared by all students, but it is made uni-sex with the following rules:
- Females and males cannot appear in the restroom at the same time, and
 - there cannot be more than 3 people using the restroom
- Write programs for males and females to solve this problem. Use as many semaphores as you wish. You don't have to worry about starvation.

" Your answer must be specific and include necessary details. Gluing a short answer without sufficient explanation will result in a score penalty.