Name _____

CS 273 Practice Final Exam R. Brown November 11, 2020
SHOW YOUR WORK—No work may mean no credit

Point totals will be adjusted to a 240 point scale later

I pledge my honor that I have neither given nor received assistance during this exam, and that I have seen no dishonest work.

Signed _____
☐ I have intentionally not signed the pledge (*check only if appropriate*)

Answer 7 of the following 8 problems, including the final problem 8. Clearly indicate which problem you are skipping.
Note: Answer problems worth more points for more potential credit.

(*6 pts*) 1. a) Describe the use of UNIX system calls for the following shell input line, using a "process diagram" as discussed in class.

b) `tr a-z A-Z signal.sh > file.out`

c) `emacs & sort file.1 file.2 | diff - file.0`

d) Describe the arguments, return value and behavior of each of the following UNIX system calls.

(i) `fork()`

(ii) `execve()`

(*6 pts*) 2. Write definitions of the following terms.

a) page frame

b) device driver

c) deadlock

d) capability

(*6 pts*) 3. Suppose that the following actions happen in order:

i. Process A acquires exclusive access to a printer just before A's time slice ends.
ii. Process B acquires exclusive access to a tape drive, then blocks trying to get access to that printer.
iii. Process A then blocks trying to get access to that tape drive.

a) Does this situation satisfy the four goals for IPC (mutual exclusion, independence of speed, progress, bounded wait)? Justify your answer by either explaining how all four goals are met, or identifying at least one of those goals that isn't met.

b) Does this situation constitute a deadlock? Justify your answer by either explaining how all four necessary and sufficient conditions (mutual exclusion, hold and wait, no preemption, circular wait) apply, or identifying at least one of those conditions that doesn't apply.

(*6 pts*) 4. Suppose you are advising a programming team that plans to build an application with multiple components that must interact in parallel. **Propose two questions** that would help the team to decide whether to implement those components using threads vs. processes. Be sure to indicate how the answer to each question could help the team choose wisely between using threads and using processes.

Example question: *Will the software run on multiple computers?*
How this could help: *Multiple threads run within a single program, and therefore must run on a single computer. If different parts of the software will run on different computers, those parts will require their own processes.*

(*6 pts*) 5. Suppose you are describing the concept of virtual memory to a person who is unfamiliar with the concept but has had a hardware design course.

a) Write a one-sentence description of the main idea of virtual memory.

b) Explain (for that person) how virtual memory works. Describe and correctly use the terms *page*, *virtual address*, *page table* and *page fault* in your explanation.

(*6 pts*) 6. a) The excerpt below shows the kernel source-code definition of an i-node for a Minix file system (with line numbers).

```
57 struct minix2_inode {
58     __u16 i_mode;        /* protection bits */
59     __u16 i_nlinks;      /* count of hard links to this inode */
60     __u16 i_uid;         /* user id of owner */
61     __u16 i_gid;         /* group id of owner */
62     __u32 i_size;        /* file length in bytes */
63     __u32 i_atime;       /* time this file was last accessed */
64     __u32 i_mtime;       /* time this file was last modified */
65     __u32 i_ctime;       /* time this file originally created */
66     __u32 i_zone[10];    /* disk blocks for this file */
67 };
```

b) For each of the layers of I/O software listed below, indicate one or more lines in the inode data structure above that relate directly to some of the work of that layer. If a layer doesn't relate to any of the lines, enter "None."
One layer is answered as an example (other answers also possible at that layer).

A. User-level software – **66**

B. Device-independent OS software

C. Device driver

D. Interrupt handler

E. Device controller

F. Device

c) Explain two of your answers in b). An example answer is provided.

- **A. Unbuffered I/O operations (e.g., `read()` system call) on a file use disk-block addresses from 66 to access that file's data.**

(*6 pts*) 7. Consider the seven security principles listed below. For **three** of those principles, give examples of security problems that illustrate those principles, and explain how each problem relates to each principle.

a) Be educated about security.

b) Think security throughout design and implementation.

c) Make security design simple and verifyable.

d) Beware of unsafe assumptions.

e) Give the least possible access.

f) Seriously test security.

g) Security/convenience tradeoff.

(*6 pts*) 8. a) **(Required.)** Consider the following Linux command, entered at a shell prompt.

```
cat myfile.txt
```

Identify five different Linux system calls you would expect to be called during execution of that command. Write each system calls in one of the following four aspects of an operating system related to that system call.
One answer is provided as an example (find 5 more).

- Process management
- Memory management
- File system - **open()**
- Input/output

b) Explain your answers for two of your system calls in different aspects of an operating system. *Note:* It is to your advantage to explain system calls that may not obviously relate either to the command or to the system-call aspect you indicated. One answer is provided as an example (find 2 more).

open() - The `cat` program must open the file `myfile.txt` for reading.