

C1. Operating Systems (25 points)

(a) (7 points) Compare and contrast the implementation of kernel-level multithread system and user-level multithread system.

(b) (7 points) Describe how blocking system calls and page faults will affect user-level multithreads system.

(c) (4 points) Give an example where a single-threaded web server is better than a multithreaded server.

(d) (7 points) What is priority inversion? Can priority inversion problem happen with user-level threads?

C2. Operating Systems (25 points)

(a) (10 points) Consider the following C program:

```
// N:    a predefined constant
// STEP: a predefined constant
int buf[N];
for (int i = 0; i < N; i += STEP)
    buf[i] = buf[i] + 1;
```

When this program is executed on a machine with a 4-KB page size and 64-entry TLB, what values of N and STEP will cause a TLB miss for every execution of the loop? (Note: KB = 1024 bytes)

(b) (3 points) What is the main advantage of a multilevel page table over a single level one?

(c) (5 points) To implement a three-level page table system, a 32-bit virtual address is broken up into 4 fields, a, b, c, and d. The first three fields are used to implement the three-level page table system, and field d is the offset. Explain whether/how the number of pages depend on the sizes of all these four fields.

(d) (7 points) What is working set? What is the principle behind working set? What is thrashing? What is the cause of thrashing? What is the relationship between working set and thrashing?

C3. Operating Systems (25 points)

(a) (6 points) Describe three (3) disk scheduling algorithms.

(b) (5 points) Is the Shortest Seek Time First (SSTF) algorithm an appropriate choice if minimizing starvation is important? Why?

(c) (7 points) In general, the goal of RAID is to provide reliability via redundancy of data across multiple disks. Does RAID 0 achieve this goal? Why?

(d) (7 points) Describe RAID 1 + 0. Why is this configuration a popular choice for I/O intensive applications (e.g., databases, email and web servers, etc.)?

C4. Operating Systems (25 points)

(a) (7 points) What is an access control list (in the context of file systems)? What is it used for? What are the traditional UNIX access modes and user classes?

(b) (6 points) Describe synchronous and asynchronous I/O.

(c) (6 points) When should synchronous I/O be used and why?

(d) (6 points) When should asynchronous I/O be used and why?