CSCI 5105: Introduction to Distributed Systems
Homework Assignment 0

Note: This assignment will not be graded. However, you are **strongly** advised to solve this assignment to get an idea of the level of background expected in the course. If you struggle to solve any of the questions in this assignment or are unfamiliar with any of the concepts, you must talk to the instructor.

1. Answer the following questions briefly:

   (a) How does a system call work?

   (b) What kinds of information does a Process Control Block (PCB) contain?

   (c) What is a semaphore and what operations can be performed on it?

   (d) Describe one approach to avoid deadlocks when using locks for synchronization between multiple processes.

   (e) What is the LRU Page Replacement Algorithm?

   (f) What is thrashing and why does it occur?

   (g) Most OS's maintain a file buffer in main memory. What is the benefit?

   (h) What is an inode and what kind of information does it contain?

   (i) What is the difference between the linked and the indexed block allocation method for a file system.

   (j) In computer networking, what is packet-switching? How does a packet reach its destination IP address?

2. Consider the following set of processes, with the length of the CPU burst for each: P1 (10), P2 (1), P3 (2), P4 (1), and P5 (5). Assume that the processes arrive in the order P1, P2, P3, P4, P5, all at time 0.

   (a) What is the turnaround and waiting time for each process using FCFS?

   (b) What is the turnaround and waiting time for each process using Round Robin scheduling (quantum=1)?

3. A barbershop consists of a waiting room with n chairs and a barber room with one barber chair. If there are no customers to be served, the barber goes to sleep. If a customer enters the barbershop and all

chairs are occupied, then the customer leaves the shop. If the barber is busy but chairs are available, then the customer sits in one of the free chairs. If the barber is asleep, the customer wakes up the barber.

Write a program (pseudocode) to coordinate the barber and the customers using mutex locks and condition variables or semaphores.

4. A certain computer provides its users with a virtual memory space of 4GB. The computer has 1 MB of physical memory. The virtual memory is implemented by paging, and the page size is 4KB. How many physical frames are there, and how many virtual pages does a process see? If a process generates the virtual address 11123456, explain how the system maps this address to its corresponding physical location. For simplicity, you can assume 1K=1000, 1M=1000K, etc.

5. Consider a disk with 100 tracks numbered 1 to 100. Suppose the current disk head position is on track 49 and is moving towards track 100. Suppose it has pending disk I/O requests to the following tracks: 42 78 3 51 99. In what order will it visit the tracks using the following disk scheduling algorithms:

   (a) Shortest seek time first (SSTF)

   (b) SCAN (Elevator)

   (c) What is the total number of tracks seeked in each case?

   (d) If using SSTF, should more frequently accessed data be stored towards the middle tracks or the outermost/innermost tracks?

6. Briefly explain how TCP is able to achieve reliable, in-order data communication, although IP is unreliable (it can lose and re-order packets).