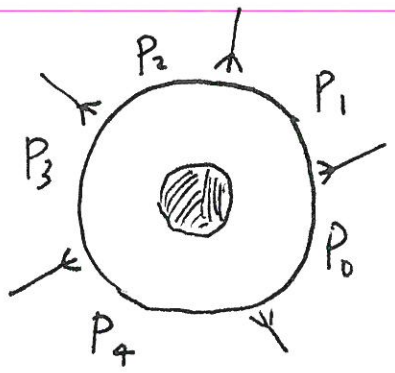
CSCI 460 Operating Systems

Practice Test 1

Instructions: Relax and attempt the problems below. This is NOT a quiz and you do NOT need to submit it. (Later, detailed solutions will be gone over and will be posted on the course webpage.)

This question is regarding the dining philosophers problem. In class we went over the algorithm where each hungry philosopher will pick up the fork on his left first:

```
void lefty_philosopher (int i)
{
    while (true) {
       think();
       wait (fork[i]);
       wait (fork[(i+1) mod 5]);
       eat();
       signal (fork[(i+1) mod 5]);
       signal (fork[i]);
    }
}
```



In some way, you can think all these 5 philosophers are 'lefty'. Now, define this symmetrically such that a hungry philosopher would pick the fork on his right first:

```
void righty_philosopher (int i)
{
    while (true) {
       think();
       wait (fork[(i+1) mod 5]);
       wait (fork[i]);
       eat();
       signal (fork[i]);
       signal (fork[(i+1) mod 5]);
    }
}
```

(1) If we have at least one lefty and one righty philosopher sitting on the dining table, would there ever be a deadlock? Why?

NO. We'll use a 'proof by contradiction'.
Assume that there is a deadlock, i.e., there is a set D of philosophers such that each $P_i \in D$ holds one fork and waits for another fork held by his neighbor. WLOG, assume $P_j \in D$ is a lefty. As P_j holds his left fork and cannot have his right fork, which must be held by his neighbor P_k (who never completes his dinner) and is also a lefty. Therefore, $P_k \in D$. Continue this we can show that all philosophers in D are lefty.

A contradiction.

(2) If we have at least one lefty and one righty philosopher sitting on the dining table, would there ever be a starvation? Why?

NO. Assume that lefty P_j starves, i.e., there is a pattern of dining in which P_j never eats. ① suppose P_j holds no fork. Then, P_j's left neighbor P_i must continually hold his right fork and never finishes eating. Thus, P_i is a righty and can never get his left fork, i.e., P_i also starves. Proceed this leftward shows that all philosophers are (starving) righties. But P_j is a lefty by assumption, a contradiction.
② If P_j always holds one fork and waits for his right fork, P_j's right neighbor P_k never sets his left fork down and never completes a meal, i.e., P_k is also a lefty who starves. (If P_k did not continually hold his left fork, P_j could eat; therefore P_k must hold his left fork.) Carrying this argument rightward, then all the philosophers are (starving) lefties, a contradiction to the assumption that there is always a righty.