EECE.4810/EECE.5730: Operating Systems Spring 2018

Lecture 9: Key Questions February 28, 2018

1. Describe how monitors are used in a multithreaded program with shared data.

2. Describe semaphores, including the defined operations, the two general types, and how they can be used for both mutual exclusion and ordering.

EECE.4810/5730: Operating Systems Spring 2018

3. **Example:** Servers are often designed to limit the maximum number of connections, *N*, accepting up to that number and forcing other requests to wait if the maximum has been reached. How can semaphores be used to limit the number of simultaneous connections?

4. Show the basics of implementing a producer-consumer program using semaphores.

EECE.4810/5730: Operating Systems Spring 2018

5. Describe the readers-writers problem in general, and explain how the specific pseudo-code shown below uses semaphores to ensure (1) multiple reader threads may access shared data while locking out all writer threads, and (2) a single writer thread is allowed to access the shared data at any one time. The variables mutex and rw_mutex are binary semaphores initialized to 1.

```
Writer thread
                                    Reader thread
                                    do {
do {
                                       down(mutex);
   down(rw_mutex);
                                       read count++;
          . . .
                                       if (read count == 1)
   /* writing is performed */
                                           down(rw mutex);
          . . .
                                        up(mutex);
   up(rw mutex);
                                           . . .
} while (true);
                                        /* reading is performed */
                                           . . .
                                        down(mutex);
                                       read count--;
                                       if (read count == 0)
                                            up(rw mutex);
```

```
up(mutex);
```

```
} while (true);
```

6. Compare and contrast (a) locks vs. semaphores and (b) condition variables vs. semaphores.