CSSE 332 -- OPERATING SYSTEMS

Introduction to Condition Variables

SOLUTION KEY

Question	n 1 . Write down the API call that corresponds to each of the actions below.
(a)	(5 points) Create a condition variable c:
	<pre>pthread_cond_t c = PTHREAD_COND_INITIALIZER;</pre>
(b)	(5 points) Given a condition variable ${\tt c}$ and a mutex ${\tt m}$, wait on the condition variable:
	<pre>pthread_cond_wait(&c, &m);</pre>
(c)	(5 points) Given a condition variable c, signal exactly one waiting thread, if any.
	pthread_cond_signal(&c);
(d)	(5 points) Given a condition variable c, signal all waiting threads, if any.
	<pre>pthread_cond_broadcast(&c);</pre>

tion variable and a mutex lock, respectively.

Question 2. Consider a thread that calls pthread_cond_wait(&c, &m); where c and m are a condi-

(a) (5 points) Describe the steps performed by the thread as it is ready to wait on the condition variable.

Solution: First we assume that the thread *owns* the lock m. Then, in an atomic fashion, do the following:

• Release the lock m.

Name:

• Enter a sleep state awaiting for a signal or a broadcast.

Note that the behavior is undefined if the thread does not have the mutex m locked when it calls this function.

(b) (5 points) Assume now that another thread calls pthread_cond_signal(&c). Describe the steps taken by the waiting thread when it gets signaled.

Solution: The thread will enter the READY state awaiting for the scheduler to put into active running on the CPU. When it enters the RUNNING state, it will attempt to **grab** the lock m. Note that entering the READY state does not necessarily mean that the thread enters execution, it simply means it is ready for the scheduler to pick it up next.

If m is unlocked and ready, the thread will lock it and then continue with its execution. If m is not unlocked (i.e., locked by another thread), then the thread will enter the SLEEP state again waiting for the mutex.

Question 3. (5 points) In the boxes below, write down a possible implementation of pthread_join using condition variables.

First, list your state of the world (or concurrency state). These will essentially be your global variables.

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Solution:

int child_done = 0;
pthread_cond_t c = PTHREAD_COND_INITIALIZER;
pthread_mutex_t lk = PTHREAD_MUTEX_INITIALIZER;
```

Parent (main) thread:

Child thread:

```
Solution:

int child_done = 0;
pthread_cond_t c =
    PTHREAD_COND_INITIALIZER;

pthread_mutex_t lk =
    PTHREAD_MUTEX_INITIALIZER;
```