Homework 2

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Problem 1

Uniprocessor Case

i) Under user-level thread management none of the states are possible. In user-level thread management if any of the threads in a process are blocked then the whole process becomes blocked. So all the processes that have one thread blocked would infact have all threads blocked.

ii) Under kernel level thread management all of the states are possible except s5 because it's a uniprocessor system and hence two threads can't run simultaneously. Furthermore the possible state transitions:

s1 $\rightarrow$ s4 is possible supposing the scheduler pre-empts s1. s4 would then replace s1 as the running thread because it's in the ready state. s4 $\rightarrow$ s1 is possible for similar reasons as above.

s2 $\rightarrow$ s3 is possible supposing Thread 2 blocks waiting for I/O. If that happens Thread 3 will then start running because it was ready.

iii) Under hybrid thread management s1, s3, and s4 are possible. s2 is impossible because Thread 1 being blocked would block both Thread 1 and Thread 2 and s5 is impossible because Thread 1 and Thread 2 can't run simultaneously on a uniprocessor system. Furthermore the possible state transitions:

s1 $\rightarrow$ s4 and s4 $\rightarrow$ s1 is possible supposing the scheduler pre-empts s1, or s4. s4 would then replace s1 as the running thread because it's in the ready state. Similarly for the inverse.

s1 $\rightarrow$ s3 is possible if Thread 2 blocks for I/O. Then the whole kernel thread associated with those 2 user threads blocks and Thread 3 unblocks and immediately runs because no other kernel level threads exist to pre-empt it. s3 $\rightarrow$ s1, the inverse of above, is possible if Thread 3 blocks for I/O. When that happens the kernel level thread associated with Threads 1 and 2 wakes and one of the user level threads runs and one becomes ready.

s3 $\leftarrow\rightarrow$ s4 is similar to the case for s1 $\leftarrow\rightarrow$ s3.

Multiprocessor case

i) Same as in the uniprocessor case. Because threads are user level managed none of the states are possible, even s5, because the kernel sees only one process.

ii) Same as in the uniprocessor case except that s5 is now possible because two threads can in fact run simultaneously. Possible **new** (in addition to the ones already listed for the uniprocessor case) transitions now include:

s4 $\rightarrow$ s5 if Thread 3 becomes unblocked and Thread 2 gets put on its own processor.

s1 $\rightarrow$ s5 if Thread 3 becomes unblocked and Thread 1 gets put on its own processor.

iii) Same as in the uniprocessor case. No new state transitions are allowed because Thread 1 and Thread 2 share one kernel level thread.

Problem 2

This scheme for mutual exclusion would fail and here is the counterexample. Imagine there are two threads being managed by the kernel. Without loss of generality suppose Thread 1 begins first. It continues onto the while loop conditional check and bypasses it, since OCCUPIED is set to **false**. Finally it is pre-empted and, immediately before setting OCCUPIED to **true**. Thread 2 then runs, proceeds through the while conditional check and also bypasses. It then continues onto the critical region and is pre-empted. Thread 1 wakes again and now both Thread 1 and Thread 2 are both inside the critical region.

Problem 3

a) Feasible.

Thread	mutex.count	mutex.waitingList
T1.1	0	0
T1.2	0	0
T2.1	0	1
T1.3	1	1
T2.2	0	0
T2.3	1	0

Between T1.3 and T2.2 Thread 2 leaves the waiting list and reduces the count simultaneously.

b) Infeasible.

Thread	mutex.count	mutex.waitingList
T2.1	0	0
T2.2	0	0
T1.1	0	1
T1.2	0	1

Thread 1 would not be able to proceed past executing the down operation on the mutex so this order of execution is not possible.

c) Feasible.

Thread	mutex.count	mutex.waitingList
T1.1	0	0
T2.1	0	1
T1.2	0	1
T1.3	1	1
T2.2	0	0
T2.3	1	0

d) Feasible.

Thread	mutex.count	mutex.waitingList
T1.1	0	0
T1.2	0	0
T1.3	1	0
T2.1	0	0
T2.2	0	0
T2.3	0	0

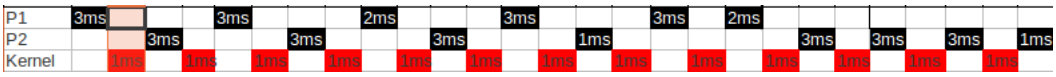
Problem 4

A blackshading indicates running time. A grey shading indicates blocking time.

Total time taken to run in scheduling scenario one for process one is 20 milliseconds. Total time taken to run in scheduling scenario one for process two is 26 milliseconds.

P1	8msec	4msec	8msec				
P2					10msec	6msec	10msec
Kernel				1msec			

Total time taken to run in scheduling scenario two for process one is 16 milliseconds. Total time taken to run in scheduling scenario two for process two is 20 milliseconds.



Total time taken to run in scheduling scenario three for process one is 20 milliseconds. Total time taken to run in scheduling scenario three for process two is 26 milliseconds.

Problem 5

This mechanism would not work on a system with priority scheduling. Here is a counterexample that creates **deadlock**:

Imagine 3 threads Thread 1 Thread 2 and Thread 3, with consecutively higher scheduling priorities. The process begins running and Thread 2 and Thread 3 block outside of the MUTEXLOCK. Thread 1 enters the MUTEXLOCK. LOCK = 0 because no one is in the MUTEXLOCK already so REGISTER is set to 0 and and LOCK is set to 1. Thread 1 then exits MUTEXLOCK, begins running critical code, and is finally pre-empted because Thread 2 unblocks. Thread 2 enters the MUTEXLOCK but LOCK is 1, because Thread 1 was pre-empted before MUTEUNLOCK, so Thread 2 sets register to 1 and busy waits because of the JNE instruction. Finally Thread 2 is pre-empted by Thread 3 when it becomes unblocked, not Thread 1 because it is of lower priority than Thread 3, and Thread 2 goes into a ready state. But the same thing that occurred with Thread 2 occurs with Thread 3. It busy waits until its quantum expires and then Thread 2 runs, because it is higher priority than Thread 1. And it again busy waits until its quantum expires. This process repeats because Thread 1 can never leave the critical region and set LOCK back to 0. Hence deadlock.