

Name	Signature	Student Id Nr	Points

Operating Systems, miniexam 3, 9.2.2015 (6p)

Write your answer on this exam paper in the space given. Please notice, that the exam paper is 2-sided.

We have a 4-threaded program P, where all 4 threads increase the value of shared variable X (initialized to 0) with the following code:

```

Thread T1 (threads T2, T3, T4 similarly)
int a, b;    /* local variables in thread T1 */
...
i1:  b = a;
i2:  a = X;
i3:  a++;    /* a = a+1 */
i4:  X = a;
i5:  a = 3;
...

```

- a) [2 p] What is the critical section (CS) problem? Where in program P code is there a CS problem?
- b) [1 p] Give a scenario for P where final value of X is 2. (If you do not find the answer soon, move on!)
- c) [1 p] Show how the CS problem concerned with updating shared variable X is solved with hardware assistance using machine instruction *compare_and_swap(lock_variable, test_value, new_value)*. The instruction returns the original value of the lock variable. You may assume that lock variable L is defined with initial value 0 (unlocked). Instead of *compare_and_swap* instruction, you may use also some other similar instruction. Write the pseudocode for this solution by modifying the given program P.

- d) Editor, keyboard driver and semaphores. Text editor TE reads character buffer B one character at a time, and then makes the needed changes to the file being edited. Keyboard device driver DD reads the pressed keys (one at a time) and then writes the corresponding characters to the buffer B. Buffer B contains 200 characters.

Routines Put(buf, c) and c=Get(buf) are used to move data into the buffer and from it. They cannot be executed concurrently, if they access the same buffer.

Give the solution to this synchronization and communication problem for TE and DD using semaphores and buffer (B) in shared memory. Present the solution with pseudocode for TE and DD. Declare clearly all your semaphores and other data structures (needed for synchronization) with their initial values.