Aalto University, Department of Computer Science KH

CS-E4110 Concurrent Programming

Examination, December 14, 2017

Please note the following: To pass the course you need at least 50% of the home assignment points. Please contact the Lecturer after the exam if you've not completed the home assignments successfully.

Assignment 1 Please write a short essay (1/2 page max) on semaphores. What are semaphores, what do they consist of, how are they initialized, and what are the operations you can do on a semaphore? What are the guarantees given to the user of a semaphore, when they use these operations, i.e., how does a semaphore work and what does it guarantee? What are the differences between binary and general semaphores? How can semaphores be used to implement a critical section? (4p)

Assignment 2 Consider the Java Monitors notification mechanisms and answer using 2-4 sentences for each item:

a) What happens when a thread executes a `wait()` method on an object? (1p)

b) What are the three main reasons under which a Java `waiting` thread will continue execution? (1p)

c) What is the difference between `notify()` and `notifyAll()` methods? (1p)

d) What are spurious wakeups and how to defend against them in Java? (1p)

Assignment 3 Explain the following notions and terms using 2-4 sentences for each item:

a) Amdahl's law (1p)

b) Monitor (1p)

c) LCR (1p)

d) Mutex (1p)

e) Apache Spark (1p)

f) Livelock (1p)

g) C/C++ Low level atomics (1p)

h) Volatile variable (1p)

Assignment 4 Please write a short essay (1/2 page max) on race conditions. How are race conditions in Java defined? What kind problems can race conditions cause on concurrent programs? What kinds of tools and algorithms can be used to detect race conditions in concurrent programs? What kind of guarantees does Java memory model give to race condition free programs? How does the existence of race conditions in a Java program change the optimizations a compiler can or can not make, or is there any difference? (4p)

Assignment 5 Please write a short essay (1/2 page max) explaining how the x86-TSO abstract machine memory model works. Why is such a model needed? Please give an example of a program behavior allowed by x86-TSO memory model which is not allowed by sequential consistency. (4p)

The name of the course, the course code, the date, your name, your student id, and your signature must appear on every sheet of your answers. All calculators are allowed in this exam.