Object-Oriented Programming
August 2022

Notes or documents of any kind forbidden. Duration: 3 1/2h. Please answer the questions on separate sheets labeled with your name, section, and student ID.

1. The problem consists in programming in Java a class `Duration` suited for representing a duration, characterized by integer numbers h of *hours*, m of *minutes*, and s of *seconds*. The value of h must be non-negative. The values of m and s must belong to the interval $[0, 59]$.

   The class `Duration` should satisfy the following requirements:

   - It must be possible to instantiate a duration for given values of h, m and s.

   - It must be possible to print a duration on standard output (in the format of your choice).

   - It must be possible to add and to subtract two durations. For instance, adding 20h 40m 50s to 5h 35m 55s should result in 26h 16m 45s. The subtraction operation fails if the resulting duration is negative.

   - Instances of this class must be clonable, comparable to each other, and serializable. It must be possible to manipulate them simultaneously from separate threads.

   - In case of any error, a dedicated exception should be thrown.

   Note: You are free to implement any additional classes required by your solution.

2. (a) How would you define a subclass `PreciseDuration` of `Duration` suited for representing durations with millisecond precision? (You do not need to fully program `PreciseDuration`; it is sufficient to explain what you would do.)

   (b) Which application of inheritance did you use in your answer to (a)? Is the substitution principle satisfied? (Justify your answer.)

3. (a) A class C overrides a variable `x` inherited from its superclass D. How can the variable `x` defined in D be accessed from code in C without using the keyword `super`? (Give a concrete example.)

   (b) Explain the limited form of multiple inheritance allowed by the Java language.

(c) How does the Java compiler determine whether an exception defined by the programmer is a checked exception or a runtime exception?

(d) What is type erasure in Java? Give an example of a restriction imposed as a consequence of type erasure.

4. Write a complete Java program that creates two threads. The first thread must send a signal to the second one every 10 seconds. The second thread must repeatedly wait for a signal emitted by the first one, and display a message `"signal"` each time that such a signal is received.

   Note: The class method `sleep(t)` of the class `Thread` pauses the execution of the current thread by a duration equal to t milliseconds. This method throws the checked exception `InterruptedException`, that can be ignored.