

# YSC4231: Parallel, Concurrent and Distributed Programming

## Theory Assignment 1

**Problem 1.** Give examples, not involving computers, of procedures that requires mutual exclusions and might lead to deadlocks. Use your imagination and real-life experience.

**Problem 2.** For each of the following, state whether it is a safety or liveness property. Identify the bad or good thing of interest (as in definitions of safety and liveness). Notice that “good things” from the definitions can be pretty bad in the statements.

**Example:** *Patrons are served in the order they arrive.* is a safety property. The “bad thing” — patrons being served *not in the order* they arrive. But this never happens according to this property.

1. Anything that can go wrong, will go wrong.
2. No one expects the Spanish Inquisition.
3. Two things are certain: death and taxes.
4. As soon as one is born, one starts dying.
5. If an interrupt occurs, then a message is printed within one second.
6. If an interrupt occurs, then a message is printed.
7. I will finish what Darth Vader has started.
8. The cost of living never decreases.
9. You can always tell a Harvard man.<sup>1</sup>

**Problem 3.** Running your application on two processors yields a speedup of  $S_2$ . Use Amdahl’s Law to derive a formula for  $S_n$ , the speedup on  $n$  processors, in terms of  $n$  and  $S_2$ .

**Problem 4.** You have a choice between buying one uniprocessor that executes five zillion instructions per second, or a ten-processor multiprocessor where each processor executes one zillion instructions per second. Using Amdahl’s Law, explain how you would decide which to buy for a particular application.

**Problem 5.** In the producer-consumer fable, we assumed that Bob can see whether the can on Alice’s windowsill is up or down. Design a producer-consumer protocol using cans and strings that works even if Bob cannot see the state of Alice’s can (this is how real-world interrupt bits work).

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<sup>1</sup>Note: This means you can always tell if someone’s a man who went to Harvard. The full saying, which is a play on words that dates back to the early 1900s when Harvard only admitted men, is “You can always tell a Harvard man when you see him, but you can’t tell him much.”