# CSC465/2104 Test 2 2019 November 14

1 page, 3 questions, 42 marks, 50 minutes
Aids allowed: one letter-sized page, both sides

The value of each question is indicated in square brackets.
A blank answer is worth about one-third of the marks;
to that, marks will be added for readable and relevant and correct information,
and marks will be subtracted for unreadable or irrelevant or incorrect information.

0 Let $s$ and $n$ be *nat* variables. Here is a refinement.

$$s' = s + 2^n - 1 \quad \Longleftarrow \quad \textbf{if } n{=}0 \textbf{ then } ok \textbf{ else } n{:=}\, n{-}1.\ \ s{:=}\, s + 2^n.\ \ s' = s + 2^n - 1 \textbf{ fi}$$

(a)[12] Prove it.

(b)[3] Insert appropriate time increments according to the recursive measure, and write appropriate timing specifications.

(c)[6] Prove the timing refinement.

1[9] Let $S$ be a bunch of strings. Using construction and induction, define $T$ to be the bunch of all strings formed by joining together any number of any strings in $S$, in any order. (Do not use the $^*$ operator; in effect, you are defining the $^*$ operator.)





2[12] Let $i$ be an extended integer variable, and let $t$ be an extended natural time variable. Let $P$ be a specification such that

$$P \quad \Longleftarrow \quad \textbf{if } i{=}0 \textbf{ then } ok \textbf{ else } i{:=}\, i{-}1.\ \ t{:=}\, t{+}1.\ \ P \textbf{ fi}$$

What solution for $P$ does recursive construction give when we start with $P_0 \ = \ t{:=}\, \infty$ ? (Find it, but you do not need to prove that it is a solution.)



end of test