

CNT 4419, Fall 2026, Test 1, 75 minutes **NAME:** _____

Instructions: All the instructions that are on the syllabus. For example, this test is closed everything, including phones, notes, AI, and other students. Do not talk to another student during the test. Do not look at another student's answers during the test. Do not ask a question during the test that gives away any part of any answer. If a response length is indicated, respond at that length and do not use bullet points or enumerated lists. Unless stated otherwise, use the same notations, definitions, and assumptions that we have been using in class. Respond at the level of detail discussed in class. This test is 5 pages.

1. [5 points] What are the tradeoffs discussed in class, between using statically and dynamically typed programming languages? [1-2 sentences]

2. [5 points] While we are on the subject, explain how and why static type checkers are normally not 100% static in practice. Hit all the main points discussed in class. [1-2 sentences]

3. [4 points] What does it mean, when we say “The Halting Problem is undecidable”? Hit all the main points discussed in class. [1-2 sentences]

4. [9 points] Suppose a mechanism is measured to exhibit T_P true positives, T_N true negatives, F_P false positives, and F_N false negatives. The mechanism's *accuracy* is defined as $(T_P + T_N) / (T_P + T_N + F_P + F_N)$, and its *recall* is $T_P / (T_P + F_N)$. In the context of our in-class discussions, briefly summarize what accuracy and recall are measuring. [1-2 sentences]

5. [2 points] As discussed in class, which value, or values, have unit type? [1 sentence]
6. [2 points] As discussed in class, what is the main feature of the lambda calculus (λ)? Hint: Don't mention types. [1 sentence]
7. [4 points] Explain what I meant in class, with the phrase "Safety is the dual of liveness." [1 sentence]
8. [5 points] Explain intuitively why all access-control policies are safety properties. [1-3 sentences]
9. [9 points] Briefly discuss how error handling may impact security, including with recommendations for secure coding. Hit all the main points discussed in class so far. [2-5 sentences]

10. [40 points] Let P_1 be the policy requiring that every **acq** action (to acquire a lock) must be immediately followed by a **rel** action (to release the lock). Let P_2 be the policy disallowing **read(0)** actions (note that we discussed this no-dereferencing-null policy in class). Let us also define, for all policies P , the complement of P , written P^C , to be the set of all programs not in P (note that P^C is also a policy).

For each of the two policies P_1 and P_2^C , do the following, always at the level of detail discussed in class.

- (a) Prove or disprove that the policy is a property.
- (b) If the policy is a property, prove or disprove that it is safety.
- (c) If the policy is a property, prove or disprove that it is liveness.
- (d) If the policy is a property, define properties G_S and G_L and prove that G_S is safety, G_L is liveness, and the intersection of G_S and G_L is the set of good traces for the policy.

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[The page provides optional additional space for Problem 10.]

11. [15 points] State as a theorem, and prove, the assertion from class, that Trivial is the only property that is both safety and liveness.