CS 291 Exam 2
March 24, 2021

Name: _____

1. (15 points) Use equivalences to construct both prenex conjunctive normal form and prenex disjunctive normal form for the following wff:

   $A(x) \wedge \forall x(B(x) \rightarrow \exists y\ C(x, y) \vee \neg \exists y\ A(y))$

2. (15 points) Give a formal proof that the following wff is valid using natural deduction and the CP rule: $\forall x(p(x) \to q(x)) \to (\exists x\ p(x) \to \exists x\ q(x))$

3. (10 points) Use Robinson's unification algorithm to find a *most general unifier* for the following set of atoms. You must show your work for full credit:

   $S = \{p(f(x, g(y)), y), p(f(g(a), z), b)\}$

4. (20 points) Prove that the following statement is valid by using resolution to prove that its negation is unsatisfiable:

   $\forall x A(x) \vee \forall y B(y) \rightarrow \forall x (C(x) \vee D(x))$

5. (15 points) Do a proof of program correctness to prove that the following wff is correct:
   $\{x < y\} temp := x; x := y; y := temp \{y < x\}$

6. (15 points) In first-order logic we use the terms *valid, satisfiable,* and *unsatisfiable.* Define each term and give an example of a wff for each category.

7. (10 points) Over the domain of all people, let $C(x)$ mean that x is a computer science major. Let $T(x)$ mean that x owns a tablet device. Come up with a quantified logical sentence that means:

   Not all computer science majors own tablets.