Name: _____ E-mail ID: _____@virginia.edu

Pledge: _____

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Signature: _____

This test is closed book, closed notes, and closed neighbor. There are 50 minutes for this exam and 100 points on the test; don't spend too long on any one question!

The 14 short answer questions require only a sentence or two for full credit (some can receive full credit with just a single word); the three long answer questions have their own page, and obviously require more. The reference sheet is on page 2.

All work must be on these exam pages. Good luck!

Page 3 (short answer)	_____ / 25
Page 4 (short answer)	_____ / 25
Page 5 (short answer)	_____ / 20
Page 6 (long answer)	_____ / 10
Page 7 (long answer)	_____ / 10
Page 8 (long answer)	_____ / 10
Total	_____ / 100

CS 202

Exam 1 Reference Sheet

Set and logical identities

Sets (Epp, page 272)	Name	Boolean logic (Epp page 14)
$A \cup \emptyset = A$ $A \cap U = A$	Identity laws	$p \wedge \mathbf{T} \equiv p$ $p \vee \mathbf{F} \equiv p$
$A \cup U = U$ $A \cap \emptyset = \emptyset$	Domination laws	$p \vee \mathbf{T} \equiv \mathbf{T}$ $p \wedge \mathbf{F} \equiv \mathbf{F}$
$A \cup A = A$ $A \cap A = A$	Idempotent laws	$p \vee p \equiv p$ $p \wedge p \equiv p$
$\overline{(\overline{A})} = A$	Complementation law	$\neg(\neg p) \equiv p$
$A \cup B = B \cup A$ $A \cap B = B \cap A$	Commutative laws	$p \vee q \equiv q \vee p$ $p \wedge q \equiv q \wedge p$
$A \cup (B \cup C) = (A \cup B) \cup C$ $A \cap (B \cap C) = (A \cap B) \cap C$	Associative laws	$(p \vee q) \vee r \equiv p \vee (q \vee r)$ $(p \wedge q) \wedge r \equiv p \wedge (q \wedge r)$
$A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$ $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$	Distributive laws	$p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$ $p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$
$\overline{A \cup B} = \overline{A} \cap \overline{B}$ $\overline{A \cap B} = \overline{A} \cup \overline{B}$	DeMorgan's laws	$\neg(p \wedge q) \equiv \neg p \vee \neg q$ $\neg(p \vee q) \equiv \neg p \wedge \neg q$
$A \cup (A \cap B) = A$ $A \cap (A \cup B) = A$	Absorption laws	$p \vee (p \wedge q) \equiv p$ $p \wedge (p \vee q) \equiv p$
$A \cup \overline{A} = U$ $A \cap \overline{A} = \emptyset$	Complement laws	$p \vee \neg p = \mathbf{T}$ $p \wedge \neg p = \mathbf{F}$

Rules of inference (Epp, p. 40)

Rule of Inference	Tautology	Name
$\underline{p}$ $\therefore p \vee q$	$p \rightarrow (p \vee q)$	Generalization
$\underline{p \wedge q}$ $\therefore p$	$(p \wedge q) \rightarrow p$	Specialization
p $\underline{q}$ $\therefore p \wedge q$	$\big((p) \wedge (q)\big) \rightarrow (p \wedge q)$	Conjunction
p $\underline{p \rightarrow q}$ $\therefore q$	$\big[p \wedge (p \rightarrow q)\big] \rightarrow q$	Modus ponens
$\neg q$ $\underline{p \rightarrow q}$ $\therefore \neg p$	$\big[\neg q \wedge (p \rightarrow q)\big] \rightarrow \neg p$	Modus tollens
$p \rightarrow q$ $\underline{q \rightarrow r}$ $\therefore p \rightarrow r$	$\big[(p \rightarrow q) \wedge (q \rightarrow r)\big] \rightarrow (p \rightarrow r)$	Transitivity
$p \vee q$ $\underline{\neg p}$ $\therefore q$	$\big[(p \vee q) \wedge \neg p\big] \rightarrow q$	Elimination
$p \vee q$ $\underline{\neg p \vee r}$ $\therefore q \vee r$	$\big[(p \vee q) \wedge (\neg p \vee r)\big] \rightarrow (q \vee r)$	Resolution

Part I: Short answer (5 points each)

Each of these questions is answerable in 10 words or less. Do not go over about 20 words!!!!

1. How are logic gates implemented in hardware, such as in a computer?

2. What is a trivial proof and a vacuous proof? If you mix them up, you'll still get credit on this problem

3. Give two applications of Prolog, the programming language that uses predicate logic. Solving sudoku doesn't count.

4. What is the halting problem?

5. Why was the halting problem's proof so important when it came out (and still so today)?

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