CSC 438F/2404F Test II Study Problems Fall 2019

Below are some suggested problems to help prepare for test II. Many of these we went over in tutorial or class, or were given as homework problems, but some are new. To get the most out of doing practice problems, I suggest that you first carefully read and understand the corresponding course notes/lectures, including the definitions and examples.

1. All problems from Homework 3
2. All problems from Homework 4
3. 2016 Final Exam (see link on webpage), problems 1,2,4,5,6,7,8,9,10
4. 2017 Final Exam (see link on course webpage), problems 1,2,4,6,7,8,9
5. Understand the proofs of completeness for Resolution, PK and LK and applications of completeness.
6. Practice giving LK-Γ proofs of sentences, where Γ is a given set of axioms (such as the axioms of RA, or PA).
7. Practice identifying relations as: (i) recursive, (ii) r.e. but not recursive, or (iii) not r.e. Practice proving such a result via reductions using a standard language (like HALT or K) – you may not use Rice's theorem on the test.
8. Practice proof method of diagonalization.
9. Know compactness theorem (3 forms) and applications.
10. Know all important definitions (what it means for a set of sentences to be a theory; the meaning of sound, complete, consistent; what it means for a formula to represent a predicate in TA/PA/RA, etc.)

NOTE: you will be given the following rules for PK (so you do not need to memorize them).

- Structural rules: Exchange, weakening
- OR right: From $\Gamma \to \Delta, A, B$ derive $\Gamma \to \Delta, A \vee B$.
- OR left: From $A, \Gamma \to \Delta$ and $B, \Gamma \to \Delta$, derive $A \vee B, \Gamma \to \Delta$.
- AND right: From $\Gamma \to \Delta, A$ and $\Gamma \to \Delta, B$ derive $\Gamma \to \Delta, A \wedge B$.
- AND left: From $A, B, \Gamma \to \Delta$ derive $A \wedge B, \Gamma \to \Delta$.

- NEG right: From $A, \Gamma \to \Delta$ derive $\Gamma \to \Delta, \neg A$
- NEG left: From $\Gamma \to \Delta, A$ derive $\neg A, \Gamma \to \Delta$.
- CUT: From $A, \Gamma \to \Delta$ and $\Gamma \to \Delta, A$ derive $\Gamma \to \Delta$.

The two addition LK rules are as follows.

- $\forall$ left: From $A(t), \Gamma \to \Delta$ derive $\forall x A(x), \Gamma \to \Delta$.
- $\forall$ right: From $\Gamma \to \Delta, A(b)$ derive $\Gamma \to \Delta, \forall x A(x)$.
- $\exists$ left: From $A(b), \Gamma \to \Delta$ derive $\exists x A(x), \Gamma \to \Delta$.
- $\exists$ right: From $\Gamma \to \Delta, A(t)$ derive $\Gamma \to \Delta, \exists x A(x)$.

The free variable b must not occur in the conclusion in $\forall$ right and $\exists$ left, and t is a proper term (free variables only).