CS 273: Intro to Theory of Computation, Fall 2007
Quiz 3 (Thursday, November 15th)

NAME:

NETID:

This quiz has 3 pages containing 8 questions. None requires a long answer. Proofs and justifications are only required when the question explicitly asks for them. Please ensure your answers are legible. You have 20 minutes to finish.

1. (2 points) Is every context-free language Turing decidable? (Yes or No)

2. (2 points) Let $L = \{\langle M, w\rangle \mid M \text{ is a Turing machine and } M \text{ accepts } w\}$. Is L Turing recognizable, Turing decidable, or neither?

3. (3 points) Briefly explain the difference between a Turing recognizable language and a Turing decidable language.

4. (2 points) Suppose that a Turing machine M contains the transition $\delta(r, f) = (p, c, L)$ (r and p are states; f and c are tape symbols).
   If M is now in configuration $aadrfb$, what will its next configuration be?

5. (4 points) Draw the state diagram for a Turing machine with input alphabet $\{a, b\}$ which writes a # in the first tape position, shifting the input string one position rightwards, and then accepts leaving its head on first blank after the shifted input. You can assume that the input always contains at least one non-blank character (i.e. the TM will reject the empty input).

   Your diagram should not include the reject state or transitions to it. Hint: it can be done with only 4 non-reject states.

6. (4 points) Let L and K be two languages. Suppose that K reduces to L. I.e. if a decider for language L exists, this decider can be used to construct a decider for language K. Based on this information, state whether each of the following claims is true or false:

   (a) If L is undecidable, then K is undecidable.

   (b) If K is undecidable, then L is undecidable.

   (c) If K is TM-decidable, then L is TM-decidable.

   (d) If L is TM-decidable, then K is TM-decidable.

7. (4 points) Suppose that $M = (Q, \Sigma, \Gamma, \delta, q_0, q_{accept}, q_{reject})$ is a Turing machine. M is defined to accept a string w if there is a sequence of configurations of $C_1, C_2, \ldots, C_k$ which satisfy three conditions. The first condition is that C_1 is $q_0 w$. What are the other two conditions?

8. (4 points) Suppose that we are given an encoding of a DFA M. Sketch an algorithm for deciding whether $L(M)$ is empty.