Computer Science 456/656 Spring 2005 Second Examination, April 12, 2005

Name:_____

No books, notes, scratch paper, or calculators. Use pen or pencil, any color. Use the rest of this page and the backs of the pages for scratch paper. If you need more scratch paper, it will be provided.

The entire test is 150 points.

1. True or False. [5 points each] In each blank space, write "T" if the statement is known to be true, "F" is the statement is known to be false, and "N" if it is not known to science at this time whether the statement is true. Recall that $\mathcal{P}$ is the class of all polynomial-time languages (problems).

   (a) _____ Every subset of a regular language is regular.

   (b) _____ The complement of every decidable language is decidable.

   (c) _____ The set of all binary numerals for composite numbers is in the class $\mathcal{P}$.

   (d) _____ If a statement is true, it surely has a proof.

   (e) _____ Given a Turing machine M, let V_M be the set of all sequences of configurations of M which are computations of M. Then V_M is decidable.

   (f) _____ Every context-free language is $\mathcal{NP}$-complete.

   (g) _____ Every unambiguous context-free grammar has a deterministic top-down parser.

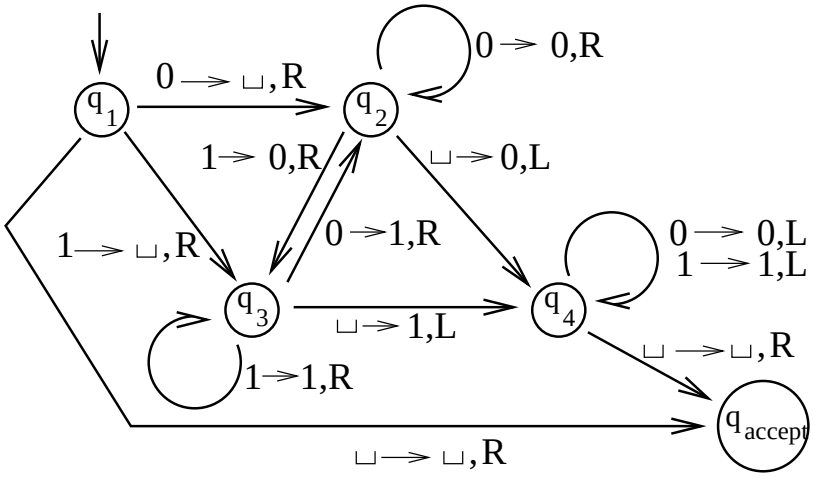
   (h) _____ If there is a recursive reduction of L_1 to L_2, and if $L_1 \notin \mathcal{P}$, then surely $L_2 \notin \mathcal{P}$.

2. Fill the blanks. [5 points each blank]

   (a) If a language is accepted by some Turing machine, we say it is _____ enumerable.

   (b) We say that a boolean expression is _____ if it is not a contradiction.

3. [20 points] Describe, in English, what the Turing machine diagrammed below does. Hint: It only takes a few words. If you cannot explain it in the space alloted below, you do not have the right anwswer.



4. [20 points] Give an exact definition of a polynomial time reduction of a language L_1 to a language L_2.

5. [20 points] Give an exact definition of the class $\mathcal{NP}$, in terms of NTMs.

6. [20 points] Prove that, if a language L is decidable, then L can be enumerated in canonical order by some machine.

7. [20 points] In class we outlined the proof that a 2-TM (*i.e.*, a 2-tape Turing machine) can be emulated by a Turing machine. Give a brief, informal, explanation of that emulation, using pictures if you wish.