Software Engineering 4I03 Michael Soltys

DAY CLASS
DURATION OF EXAMINATION: 3 Hours
MCMASTER UNIVERSITY FINAL EXAMINATION December 17, 2001

THIS EXAMINATION PAPER INCLUDES 1 PAGE AND 10 QUESTIONS. YOU ARE RESPONSIBLE FOR ENSURING THAT YOUR COPY OF THE PAPER IS COMPLETE. BRING ANY DISCREPANCY TO THE ATTENTION OF YOUR INVIGILATOR.

No aids allowed.

1. What do we mean when we say that a language L is regular?
2. Give a Deterministic Finite Automaton (DFA) that accepts those strings over $\{0, 1\}$ which correspond to the binary encodings of positive numbers divisible by 4.
3. Could you design an ε-NFA (NFA = Non-deterministic Finite Automaton) N such that $L(N)$ = the set of strings over $\{a, b\}$ where the number of a's is twice the number of b's? Justify your answer.
4. Define what it means for two regular expressions to be equivalent. Is there an algorithm for deciding the equivalence of regular expressions? If you answer "yes", give the algorithm, if you answer "no", explain why.
5. If two states of an automaton are equivalent, can this automaton be minimal? Justify your answer.
6. Using the fact that $L = \{a^n b^n c^{2n} | n \geq 1\}$ is *not* a context-free language, prove that by adding one more stack to a Pushdown Automata, we can recognize a bigger class of languages.
7. Give an example of a language L that *can* be recognized by a Context-free Grammar (CFG), but that *cannot* be recognized by a regular expression. Give the CFG for this L, and prove that there is no regular expression R such that $L = L(R)$.
8. Define: (i) Turing Machines, (ii) decidable language, (iii) semi-decidable language, (iv) enumerable language. Show that a language L is semi-decidable iff it is enumerable.
9. Prove or disprove the following statement: If L is semi-decidable, then so is $L^c = \Sigma^* - L$.
10. Suppose that you work for a start-up company, and your boss gives you the following assignment: implement a new feature in a C++ debugger, which would allow you to tell if a given C++ program would halt on all possible inputs. Explain how would you go about this assignment.