Deferred Exam for Software Engineering 4I03 Michael Soltys

DAY CLASS
DURATION OF EXAMINATION: 2 Hours
MCMASTER UNIVERSITY FINAL EXAMINATION April 2003

THIS EXAMINATION PAPER INCLUDES 1 PAGE AND 7 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. Define the following:
   (a) Regular language
   (b) Context-free language
   (c) Decidable language
2. Let $\mathcal{R}$ be a set of languages given by context-free grammars where all the rules are of the form:
   $$A \longrightarrow t_1 B | t_2$$
   where A, B are any variables, and t_1, t_2 are any terminals in Σ. Show that if $L \in \mathcal{R}$, that is, if L is a language in $\mathcal{R}$, then there exists a regular expression R such that $L = L(R)$.
3. A PDA is an ε-NFA with a stack. Define a DPDA to be a DFA with a stack (i.e., a DPDA is like a PDA except the machine is deterministic and it has no ε-transitions). Is there a DPDA that recognizes the language $\{0^n 1^n |\ n \text{ a positive integer }\}$? Explain. Are all the languages recognizable by DPDAs regular? Explain.
4. Define the language L to be the set of all those strings over $\Sigma = \{0, 1\}$ where the number of zeros is strictly less than the number of ones. For example, $0011101 \in L$ but $10 \notin L$. Is L regular? Explain.
5. Let $\Sigma = \{a, b, c, d, \ldots, z\}$, i.e., Σ contains all the lower case letters in the English alphabet. Let L be the set of strings of the form $\sigma_1 \mathbf{a} \sigma_2 \mathbf{r} \sigma_3 \mathbf{i} \sigma_4 \mathbf{z} \sigma_5 \mathbf{o} \sigma_6 \mathbf{n} \sigma_7 \mathbf{a} \sigma_8$, where $\sigma_i \in \Sigma^*$. That is, L contains the set of all those strings which contain the sequence of letters "arizona." Is L regular? Explain.
6. Is the language $\{1^p |\ p \text{ is prime }\} \subseteq \{1\}^*$ regular? Explain.
7. Let L be the set of all those strings which encode Turing machines that enter all their states when given themselves as input. That is, $\langle M \rangle \in L$, if $M(\langle M \rangle)$ enters every state during the computation. Is L recursive? Explain.

End of Exam