Midterm Exam I
CIS 341: Introduction to Logic and Automata — Spring 2004, day
Prof. Marvin K. Nakayama

Print Family (i.e., Last) Name: _____

Print Given (i.e., First) Name: _____

I have read and understand all of the instructions below, and I will obey the Academic Honor Code.

_____
Signature and Date

- This exam has 5 pages in total, numbered 1 to 5. Make sure your exam has all the pages.
- This exam will be 1 hour and 25 minutes in length.
- This is a closed-book, closed-note exam.
- For all problems, follow these instructions:
    1. Give only your answers in the spaces provided. I will only grade what you put in the answer space, and I will take off points for any scratch work in the answer space. Use the scratch-work area or the backs of the sheets to work out your answers before filling in the answer space.
    2. FA stands for finite automaton; TG stands for transition graph.
    3. For any proofs, be sure to provide a step-by-step argument, with justifications for every step.

Problem	1	2	3	4	Total
Points					

1. **[30 points]** For each of the following, circle TRUE if the statement is correct. Otherwise, circle FALSE

(a) TRUE FALSE — A finite automaton may crash when processing an input string.

(b) TRUE FALSE — The regular expressions $(\mathbf{a}+\mathbf{b})^*$ and $(\mathbf{a}^*\mathbf{b}^*)^*$ generate the same language.

(c) TRUE FALSE — If there is at least one way of processing a string w on a transition graph T such that T crashes on w, then w is not in the language of T.

(d) TRUE FALSE — If L is any language, then $L \subset L^*$.

(e) TRUE FALSE — Some finite automata are nondeterministic.

(f) TRUE FALSE — If L is any language, then $L^* = L^+ + \{\Lambda\}$.

(g) TRUE FALSE — If L has a regular expression, then L is finite.

(h) TRUE FALSE — $L^{*+} = L^*$ for any language L.

(i) TRUE FALSE — If $L = \emptyset$, then $\Lambda \in L$.

(j) TRUE FALSE — If the initial state in a finite automaton M is not also a final state, then M rejects Λ.

2. **[25 points]** For each of the following languages L over the alphabet $\Sigma = \{0, 1\}$, give a regular expression for L.

   (a) L exactly consists of all strings that have at least two 0's.

   Regular Expression: _____

   (b) L exactly consists of all strings that have an even number of 0's *or* an even number of 1's. (Note that this says *or*, not *and*.)

   Regular Expression: _____

Scratch-work area

3. **[25 points]** For each of the following languages L over the alphabet $\Sigma = \{a, b\}$, give a finite automaton that accepts exactly L.

   (a) L exactly consists of all strings that have at least one a.

   Draw finite automaton here:

   (b) L exactly consists of all strings that end in bab.

   Draw finite automaton here:

Scratch-work area

4. **[20 points]** Recall that Theorem 1 states that $S^{**} = S^*$ for any set of strings S. You may assume that this holds; i.e., you do not have to reprove it.

   (a) For any set of strings S, is $S^{***} = S^*$ always true? If this is always true, give a proof. If it is not true in general, give a counterexample. Be sure to explain your answer.

   (b) For any set of strings S, is $S^{***} = S$ always true? If this is always true, give a proof. If it is not true in general, give a counterexample. Be sure to explain your answer.