Midterm Exam I
CIS 341: Introduction to Logic and Automata — Fall 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.

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Signature and Date

- This exam has 6 pages in total, numbered 1 to 6. 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 — All finite automata are deterministic.

(b) TRUE FALSE — All transition graphs are nondeterministic.

(c) TRUE FALSE — A finite automaton must have exactly one initial state.

(d) TRUE FALSE — The language $L = \{a^n b^n : n \geq 0\}$ has regular expression $\mathbf{a}^*\mathbf{b}^*$.

(e) TRUE FALSE — A transition graph $M = (K, \Sigma, \Pi, S, F)$ accepts a string $w \in \Sigma^*$ if and only if every possible way of processing w on M results in ending in a final state with no unread letters left and without crashing.

(f) TRUE FALSE — $\Lambda \in \{\Lambda\}$.

(g) TRUE FALSE — L has a regular expression only if L is finite.

(h) TRUE FALSE — If L has regular expression $\mathbf{a}^*$, then $\{a\} \in L$.

(i) TRUE FALSE — If two sets A and B satisfy $A = B$, then $A \subset B$.

(j) TRUE FALSE — A transition graph may have no final states.

2. **[20 points]** For each of the following languages L over the alphabet $\Sigma = \{0, 1\}$, give a regular expression for L.

   (a) $L = \{w \in \Sigma^* : w = s1 \text{ for some } s \in \Sigma^*\}$.

   Regular Expression: ______________________________

   (b) L consists of all strings over Σ that contain neither 00 nor 11 as a substring.

   Regular Expression: ______________________________

Scratch-work area

3. **[30 points]** For each of the following languages L over the alphabet $\Sigma = \{a, b\}$, give a finite automaton that accepts exactly L. **For each part below, give two representations of the finite automaton: first as a picture and then the formal definition of the finite automaton as** (K, Σ, π, s, F); i.e., specify each of K, Σ, π, s, and F for each of your finite automata.

   (a) $L = \{w \in \Sigma^* : |w| \leq 3\}$.

   Draw picture of finite automaton here:

   Give formal specification of finite automaton as (K, Σ, π, s, F) **here:**

Scratch-work area

(b) L exactly consists of all strings w with $|w| \geq 2$ and whose second-to-last letter is b.

Draw picture of finite automaton here:

Give formal specification of finite automaton as (K, Σ, π, s, F) here:

Scratch-work area

4. **[20 points]** Prove that $S^{++} = S^{+}$ for any set of strings S.