Midterm Exam I
CIS 341: Foundations of Computer Science II — **Spring 2005, day section**
Prof. Marvin K. Nakayama

Print family (or last) name: _____

Print given (or 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 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. DFA stands for deterministic finite automaton; NFA stands for nondeterministic finite automaton.
    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. **[20 points]** For each of the following, circle TRUE if the statement is correct. Otherwise, circle FALSE

(a) TRUE FALSE — If A is a regular language, then $\overline{A}$ is a nonregular language.

(b) TRUE FALSE — If language A_1 is recognized by an NFA and language A_2 is defined by a regular expression, then $A_1 \cup A_2$ is recognized by some DFA.

(c) TRUE FALSE — A regular expression for the language $\{ a^n b^n \mid n \geq 0 \}$ is $\varepsilon \cup ab \cup aabb \cup aaabbb \cup \cdots$.

(d) TRUE FALSE — Every DFA is also an NFA.

(e) TRUE FALSE — Every NFA is also a DFA.

(f) TRUE FALSE — A DFA may have no accept states.

(g) TRUE FALSE — The language $\{a^{2n} : n \geq 0\}$ is a nonregular language.

(h) TRUE FALSE — If A is a nonregular language, then there is an NFA that recognizes A.

(i) TRUE FALSE — If A is a nonregular language and B is a language with $B \subseteq A$, then B must be nonregular.

(j) TRUE FALSE — An NFA accepts ε if and only if the start state is also an accept state.

2. **[20 points]** Give definitions or meanings of the following terms and phrases. Each answer should be at most two sentences. Be sure to define any notation that you use.

   (a) Regular language.

   (b) The transition function δ of an NFA.

   (c) The complement of a language A over an alphabet Σ.

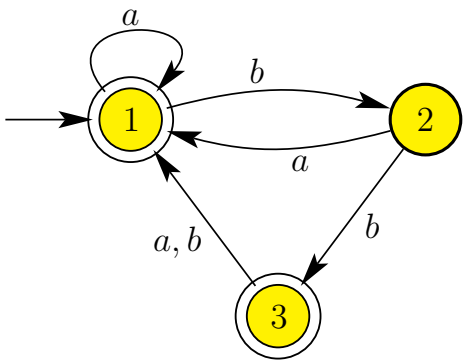
   (d) The class of regular languages is closed under Kleene-star.

3. **[20 points]** Let A be the language over the alphabet $\Sigma = \{a, b\}$ defined by regular expression $((aa)^*b \cup a)^*$. Give an NFA that recognizes A.

Give NFA for A here.

Scratch-work area

4. **[20 points]** Give a regular expression for the language recognized by the DFA below.



Regular expression: _____

Scratch-work area

5. **[20 points]** Recall the pumping lemma:

   Theorem: If A is a regular language, then $\exists$ number p (pumping length) where, if $s \in A$ with $|s| \geq p$, then $\exists$ strings x, y, z such that $s = xyz$ and

   (i) $xy^iz \in A$ for each $i \geq 0$,

   (ii) $|y| > 0$, and

   (iii) $|xy| \leq p$.

   Let $\Sigma = \{a, b\}$, and define language $B = \{\, w \in \Sigma^* \mid w = w^R \text{ and } |w| \text{ is even} \,\}$, where $w^{\mathcal{R}}$ denotes the reverse of the string w. Prove that B is a nonregular language.