CS 154 - Introduction to Automata and Complexity Theory

Spring Quarter, 2000

INFORMATION ON MIDTERM EXAM

Midterm Exam

The midterm examination will be held from 3:15–4:30 pm on Wednesday, May 10.

> **Please note that the exam will be held in Terman Auditorium and Terman 156, and not in the regular lecture room.**

For the SITN students, we will send the midterm to you via the SITN courier or electronically. The exam will be open-book and open-notes, i.e., you will be allowed to consult any of the class handouts, your notes, and the text-book/reader. You are not permitted to refer to any other source during the exam. The exam will cover the material presented in class up to, but not including, the Pumping Lemma for Context-free Languages.

CS 154N Students

We expect to start discussing the topics from CS 154N, starting with Turing machines, around Monday, May 1. We suggest that you start attending the lectures starting now.

SAMPLE MIDTERM EXAM

Problem 1. [30 points] Decide if the following statements about languages over $\{0,1\}^*$ are TRUE or FALSE. *You must give a brief explanation of your answer to receive full credit.*

(a). Every subset of a regular language is regular.

(b). Every regular language has a *proper* subset that is also regular.

(c). If L_1 is a regular language, then so is $L_2 = \{xy \mid x \notin L_1 \text{ and } y \in L_1\}$.

(d). Given a regular language L, there exists a decision procedure to determine whether L is context-free or not.

(e). The language $L = \{w \mid w \neq w^R\}$ is regular.

(f). If L^* is regular, then L must be regular.

Problem 2. [20 points] Consider the following language over the alphabet $\Sigma = \{0, 1\}$.

$$L = \{w \in \Sigma^* \mid w \notin \{01, 10\}^*\}.$$

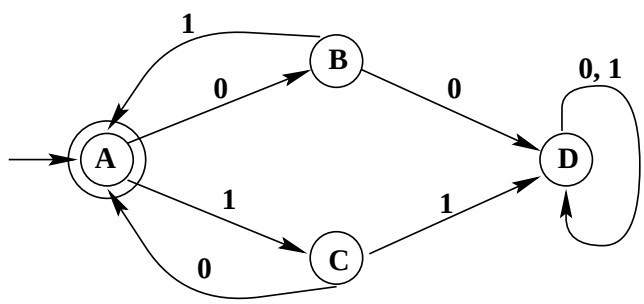
(a). [10 points] Use closure properties of regular languages to show that L is regular.
(b). [10 points] Give a regular expression for L.

Problem 3. [20 points] Consider the following language over the alphabet $\Sigma = \{0, 1\}$.

$$L = \{w \in \{a, b\}^* \mid w \text{ has twice as many } b\text{'s as } a\text{'s}\}.$$

Show that L is non-regular by using the pumping lemma.

Problem 4. [20 points] Define a *simple* DFA (henceforth, called *SFA*) as a DFA in which the start state, once left, cannot be re-entered. In other words, in an SFA there is no transition going *into* the initial state.
(a). [5 points] The following figure presents a DFA for the language of the regular expression $(10 + 01)^*$. Give an SFA for the same language.



(b). [10 points] Suppose you are given a DFA $M = (Q, \Sigma, \delta, q_0, F)$. Describe how you will construct an SFA M' such that $L(M') = L(M)$. (While you do not have to give a formal proof that your construction is correct, you must give a couple of lines of informal justification.)
(c). [5 points] Using part (b), characterize the class of languages that are accepted by SFAs.

Problem 5. [10 points] Consider the context-free grammar G over the alphabet $\Sigma = \{(,)\}$ with following production rules.

$$S \to \epsilon \mid SS \mid (S).$$

Clearly, $L(G)$ is the set of all balanced parenthesis sequences. Show that the grammar G is ambiguous.