CSE 431: Introduction to Theory of Computation Spring 2005

Problem Set 1

Due Friday, April 8, 2005, in class

Reminder: If you haven't done so already, subscribe to CSE 431 mailing list ASAP by following the link off the course webpage (which is at `http://www.cs.washington.edu/431`).

Reading assignment: Sipser's book, Chapter 3.

Instructions: Information on the collaboration policy and honor code in solving problem sets can be found off the course webpage — **please be sure to read it carefully!**. In a nutshell, you are allowed to collaborate with fellow students taking the class to the extent of discussing solution ideas, *provided you think about each problem on your own for at least 30 minutes*. You must write down solutions on your own, and must clearly acknowledge each person with whom you discussed the solutions. You are expected to refrain from looking up solutions from web-sites, pre-existing sources from prior offerings of this or similar courses at UW or other schools, or other literature.

This problem set has **FOUR** questions. Each question is worth 10 points unless indicated otherwise. Please be as clear as possible in your arguments and answers. Poorly written solutions, even if more or less correct, will be penalized.

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1. Give an implementation level description of a Turing machine (i.e., use English prose to describe the way the Turing machine moves its head and the way that it stores data on its tape) that *decides* membership in the language $\{w \in \{0,1\}^* \mid w \text{ contains an equal number of 0s and 1s}\}$.

2. Problem 3.11, Sipser's book. (A Turing machine with doubly infinite tape is equivalent in power to Turing machines.) Give a formal description (tape alphabet, transition function, etc.) of your Turing machine that simulates the functionality of the TM with a two-way infinite tape.

3. Problem 3.13, Sipser's book (Turing machines with stay put instead of left)

4. Show that a language is decidable if and only if some enumerator enumerates the language in standard order.

   - Note that Sipser's book uses the terminology lexicographic order to mean the familiar dictionary order except that shorter strings precede longer strings. Thus, the lexicographic ordering of all strings over $\{0,1\}$ is $\{\varepsilon, 0, 1, 00, 01, 10, 11, 000, \ldots\}$. We refer to this ordering as the standard order.