22C:131 Homework 1

Due: Monday, 2/20

Notes: (a) Solve all 5 problems listed below. The problem numbers refer to problems in the second edition of Sipser. (b) It is possible that solutions to some of these problems are available to you via other theory of computation books or on-line lecture notes, etc. If you use any such sources, please acknowledge these in your homework. You will benefit most from the homework, if you sincerely attempt each problem on your own first, before seeking other sources. (c) It is okay to discuss these problems with your classmates. Just make sure that you take no written material away from these discussions.

1. 3.13

2. Consider the nondeterministic Turing machine

$$M = (\{q_0, q_1, q_2, q_3, q_4\}, \{0, 1\}, \{0, 1, B\}, \delta, q_0, q_3, q_4).$$

   Informally, but clearly describe the language $L(M)$ if δ is the following:

$$\begin{aligned} \delta(q_0, 0) &= \{(q_0, 1, R), (q_1, 1, R)\} \\ \delta(q_1, 1) &= \{(q_2, 0, L)\} \\ \delta(q_2, 1) &= \{(q_0, 1, R)\} \\ \delta(q_1, B) &= \{(q_3, B, R)\}. \end{aligned}$$

   Here, B is the blank symbol, q_3 is the accepting state, and q_4 is the rejecting state. Assume that any transition that is not defined above (for example, $\delta(q_0, 1)$) takes the machine to q_4.

3. A *2-dimensional* Turing machine has the usual finite-state control, but a tape that is a 2-dimensional grid of cells, infinite in all directions. The input is placed on one row of the grid, with the head at the left end of the input and the control in the start state, as usual. Acceptance and rejection happen as usual, by entering an accepting state or a rejecting state, respectively. Prove that the languages recognized by a Turing machine are the same as those recognized by a 2-dimensional Turing machine.

4. 5.13

5. 5.14
