Problem Set 7—Due Friday, November 17

Problem 30. Page 151, Exercise 6.

Problem 31. Page 151, Problem 4.

Problem 32. Page 152, Problem 8.

Problem 33. Consider a *black-box-L Turing machine* M^L. Such a machine is just like an ordinary Turing machine, except that it has an "oracle" for the language L. That means that the Turing machine has a special *query tape* and, if the TM writes on that tape a string x and goes into a special *query state*, q_{query}, then the next state will be either q_{yes} or q_{no}, depending on whether or not x is in L.

Part A. Show that $M^{A_{\mathrm{TM}}}$ can decide any enumerable language.

Part B. Prove that there is a a language L that the black-box Turing machine $M^{A_{\mathrm{TM}}}$ can *not* decide. *Hint:* Consider the "halting problem for black-box-A_{TM} Turing machines.

Problem 34. Classify the following languages as **decidable**, **enumerable** (but not decidable), **co-enumerable** (but not decidable), or **neither**. Prove all your answers.

Part A. $L_a = \{\langle M \rangle : M$ is a TM that accepts an even-length string$\}$.

Part B. $L_b = \{\langle M \rangle : M$ is a TM that accepts a decidable language$\}$.

Part C. $L_c = \{\langle M \rangle : M$ on blank tape *eventually* writes a non-blank symbol$\}$.