Problems 1-2 will be graded by a different person than problems 3-5. Thus please hand these in on separate pieces of paper.

1. Show that alternating logspace machines that make at most one alternation yield only languages in NL.

2. Generalize this, to show that alternating logspace machines that make at most $O(1)$ alternations yield only languages in NL. This is the class that the text denotes as $\text{STA}((\log n, *, k))$ using the notation that is introduced on page 69.

Remember: These last three problems should be handed in separately from the first two.

3. Recall that the midterm gave a hierarchy theorem for ATIME. In a similar way, state and prove a hierarchy theorem for alternating space, using only the space and time hierarchy theorems (i.e., the separation results) given in Lecture 4, and the theorems in Lecture 7. That is, show that if the space bounds increase sufficiently, then the ASPACE classes get larger. Don’t bother to figure out how efficiently one ATM can simulate another one; just present the separation results that follow from the theorems that we’ve already proved. Be sure to mention what sort of “constructibility” you need to assume for the space and time bounds.

4. Miscellaneous exercise 34 in the text.

5. Miscellaneous exercise 35 in the text.