1. (a) Suppose that $STCON \in DSPACE(S')$ for (say) some space constructible $S' = O(\log^a n)$. (We know this is true for $S' = \log^2 n$, so the interest in this result is for $a < 2$.) Show $NSPACE(S) \subseteq DSPACE(S^a)$ for any space constructible $S = \Omega(\log n)$.

(b) Show $NSPACE(S) = co-NSPACE(S)$ for any space constructible $S = \Omega(\log n)$.

2. We want to show that $2SAT$ is complete for $NL$. That is, we want to show:

- $2SAT \in NL$
- For all $L \in NL$, $L \leq_{log} 2SAT$.

Hint: Use $2SAT$ for the first part and $STCON$ for the second part and note that $u \lor v \equiv \neg u \rightarrow v \equiv \neg v \rightarrow u$.

3. Consider regular expressions with squaring as defined in the text and discussed in class.

(a) Show how to “succinctly” represent (i.e. within a small polynomial bound of $n$) the following languages:

- $L_1^n = \{w \in \Gamma^* : |w| = 2^n\}$
- $L_2^n = \{w \in \Gamma^* : |w| > 2^n\}$
- $L_3^n = \{w \in \Gamma^* : |w| < 2^n\}$

(b) We indicated (and the text shows) that $TSRE$ is complete for EXPSPACE. Using the first part of this question, deduce a specific lower bound on the space complexity of $TSRE$. 