Computational complexity

5. Consider 2-tape Turing machines with alphabet \{0, 1\}. Prove that there is a language \( L \) such that \( L \) can be decided in time \( O(n^5) \) but \( L \) cannot be decided in time \( 8n \).

6. (a, 5 points) State a polynomial-time algorithm to decide graph reachability. (b, 15 points) Prove that \text{NLOGSPACE} \subseteq \text{P}.

7. (a, 2 points) Give an example of an NP-complete language \( X \). (b, 10 points) Explain why every language \( L \in \text{NP} \) can be reduced to \( X \). You must construct a reduction for each \( L \); you do not need to prove that the reduction works. (c, 8 points) Prove that \( \text{P} = \text{NP} \) if and only if \( X \in \text{P} \).

8. Prove that there is an undecidable language that can be decided in non-uniform polynomial time.