1. (10 pts) Show that if SAT is poly-time reducible to $\overline{\text{SAT}}$, then PH = NP.

2. (15 pts) Prove that if $\text{NTIME}[n] \subseteq \text{TISP}[n^{1.2}, n^{0.2}]$, then $\text{NTIME}[n^{10}] \subseteq \text{TISP}[n^{12}, n^{2}]$.
   (Hint: use a padding argument.)

3. (10 pts, +5 bonus) The class DP is defined as the set of languages $A$ so that there are two languages $A_1 \in \text{NP}$ and $A_2 \in \text{coNP}$ so that $A = A_1 \cap A_2$. (Do not confuse DP with NP ∩ coNP, which may seem superficially similar!) Recall the language EXACT INDSET whose definition is

   $\text{EXACT INDSET} = \{ \langle G, k \rangle : G$ is a graph whose maximum-size independent set has size $k$ $\}$

   Show that
   (a) (5pts) EXACT INDSET ∈ $\Pi^p_2$.
   (b) (5pts) EXACT INDSET ∈ DP.
   (c) (+5 bonus) Every language in DP is polynomial-time reducible to EXACT INDSET.

4. (15 pts, 824 students only) Prove $\Sigma^p_i = \bigcup_{c \geq 1} \Sigma^c_i \text{TIME}[n^c]$. 