1. A grammar $G$ is \textit{context-sensitive} if each rule is of the form $u \rightarrow v$, with $|u| \leq |v|$. A language is context-sensitive (CS) if it is generated by some context-sensitive grammar. (Note that a CS grammar is more general than a CF grammar.) Show that the CS languages are decidable. You may assume that there are no $\epsilon$ rules in the CS grammar.

2. Problem 5.4 in text.

3. Show that the following language is undecidable:
   \[ S_{TM} = \{ < M_1, M_2 > | M_1 \text{ and } M_2 \text{ are TM that halt on the same input strings} \} \]

4. Show that NP is closed under union and concatenation.

5. \textbf{Optional, extra credit}
   Show that P is closed under complement and intersection.

   \textit{Instructions for optional problem:} Please hand in on a separate, unattached sheet, with your name and student id. There will be no late optional problems accepted.