CS3231
Tutorial 11

1. Show that the following problem is undecidable:

   Given two CFGs G_1 and G_2, is $L(G_1) \subseteq L(G_2)$?

2. Show that the following problem is undecidable

   Given two CFGs G_1 and G_2, is $L(G_1) = L(G_2)$.

3. Give unrestricted grammar for

   (a) $\{a^i b^j c^k \mid i \leq j \leq k\}$.

   (b) $\{w \mid w \in \{a, b, c\}^*$ and w contains equal number of a's, b's and c's$\}$.

   (c) $\{ww \mid w \in \{a, b\}^*\}$.

4. Is the class of context sensitive languages closed under union? Is it closed under concatenation?

5. Are context sensitive languages closed under intersection? For this question, you may assume without proof that context sensitive languages are exactly the languages which are in $NSPACE(O(n))$.

6. State whether the following are true or false, and give a short justification for your answer.

   (a) For every context free language A there exists a regular language B such that $A \leq_m B$.

   (b) Given a simple graph $G = (V, E)$, with n vertices, it is decidable in polynomial time whether G can be colored using $n - 1$ colors. That is, it is decidable in polynomial time, whether there is a mapping f from V to $\{1, , 2, \ldots, n - 1\}$ such that for all $(u, v) \in E$, $f(u) \neq f(v)$.