Intro to Theory of Computing	**481 Prelim 2**
CS481 Fall 2005	**November 4**

This is an in-class examination.

1. Of the following languages state which are regular, context-free but not regular, not context free. Give 1/2 line informal arguments. No need to give the actual application of pumping lemma or detailed grammar/PDA. ($5 \times 5 = 25$)

   (a) $\{a^m b^n \mid 5m - 3n = 24, m, n \geq 0\}$.

   (b) $\{a^m b^n \mid 5m + 3n = 24, m, n \geq 0\}$.

   (c) $\{a^i b^j c^k d^l \mid j = k \wedge i = l\}$.

   (d) $L(G)$ where $G = \{S \rightarrow aS \mid Sb \mid bSa \mid \varepsilon\}$.

   (e) $\{a^i b^j c^k \mid i \neq j \wedge j \neq k \wedge k \neq i\}$.

2. Show that if L is regular then the following language is regular by constructing a NFA for the language. (25)

$$\text{cycle}(L) = \{w \mid \exists x, y \in \Sigma^*, w = xy \text{ such that } yx \in L\}.$$

3. If $L = \{ww^R \mid w \in \{a, b\}^*\}$, then is the language $\overline{L} = \Sigma^* - L$ context free ? If yes, give a grammar for it. Else prove that it is not context-free. (25)

4. Show that the following language is not context free using the pumping lemma. (25)

$$\{w\#x \mid w \text{ is a substring of } x \text{ where } w, x \in \{a, b\}^*\}.$$