Introduction to Theory of Computing	**Problem Set 8**
CS 481 Fall 2004	**Due Friday, November 5, 2004**

Reading. To review the material for this week read Sections E, and 24-25 of Kozen.

Please turn in Problems 1-2 and Problems 3-4 on separate papers with your name and cornell.edu email written on both.

(1) Solve Problem 1 on page 307.

(2) Let h be a homomorphism mapping alphabet Σ to Γ^*

(a) Show that if $A \subseteq \Sigma^*$ is a context free language then so is $h(A) \subseteq \Gamma^*$.

(b) Assume that $B \subset \Gamma^*$ is accepted by a PDA. Construct a PDA that accepts $h^{-1}(B)$.

(3) Solve Problem 3 on page 307. (You do need to prove that your answer is correct for both parts.)

(4) The CFL pumping lemma is a bit stronger than the version we proved in class. We took the Chomsky normal form grammar with k nonterminals defining a language L, and proved the following where $K = 2^k$.

For any word $z \in L$ with $|z| > K$, there is a way to write z as $z = uvwxy$ with at least one of v and x not empty, and so that $uv^iwx^iy \in L$ for all $i \geq 0$.

Note that by being a bit more careful in the proof we can require also that $|vwx| \leq K$. (See the proof in Lecture 22 of the book.) The book uses this stronger pumping lemma to prove that the language $\{a^nb^mc^nd^m | n, m \geq 0\}$ is not context free.

(a) Use this stronger pumping lemma to prove that

$$\{a^nb^mc^rd^k | n, m, r, k \geq 0 \text{ and } r = 2n, 2m = 3k\}$$

is not context free.

(b) Use homomorphism, and the fact that $\{a^nb^mc^nd^m | n, m \geq 0\}$ is not context free to show that the language in (a) is not context free.