Intro to Theory of Computing	**481 Homework 10**
CS481 Fall 2005	**November 4**

Please write your name and net-id on the upper right corner of every page.

1. 8.4.4.

2. Describe a deterministic Turing machine that accepts the set $\{a^{3^n} \mid n \geq 0\}$. Describe the machine informally, in particular, describe the set of transitions and the states in English.

3. A context sensitive grammar is described as (N, Σ, P, S) where N is the set of nonterminals, Σ is the set of terminals, S is the start symbol and P are the production rules. The production rules are all of the form

$$\alpha \to \beta$$

where $\alpha, \beta \in (N \cup \Sigma)^*$, and $|\alpha| \leq |\beta|$. Give a context-sensitive grammar for the following languages

   (a) $\{a^n b^n c^n \mid n \geq 1\}$. This shows that the context sensitive grammars are strictly more general then context-free ones.

   (b) $\{a^{n^2} \mid n \geq 1\}$.

4. A linear bounded automaton (LBA) M is exactly like a one-tape Turing machine, except that the input string $x \in \Sigma^*$ is enclosed in a left and right endmarkers $\vdash$ and $\dashv$ which may not be overwritten, and the machine is constrained never to move to the left of $\vdash$ nor to the right of $\dashv$. It may read or write all it wants between the endmarkers. The LBA is formally described in terms of a 9-tuple $(Q, \Sigma, \Gamma, \dashv, \vdash, \delta, s, t, r)$ where s is the start state, t the final state, and r is a reject state. Σ is the input alphabet and Γ the tape alphabet. δ is the transition function.

   (a) If M be an LBA with $|Q| = k$ and $|\Gamma| = m$. How many configurations are there on input x, $|x| = n$.

   (b) Prove that for every CSG G, there is a non-deterministic LBA M such that $L(M) = L(G)$.

   (c) For every nondeterministic LBA M, there is context-sensitive grammar G such that $L(G) = L(M) - \{\varepsilon\}$.