CSE 322 Spring 2004

<u>Homework Assignment # 5</u>

Due Date: Friday, May 21 (at the *beginning* of class)

1. (10 points: 5 points each) Consider the CFG G_4 in Exercise 2.1 on page 119 in the textbook. Give <u>parse trees</u> and <u>leftmost derivations</u> for each of the following strings (see page 98 for a definition of leftmost derivation):
   a. $a \times (a + a)$
   b. $(a\ +\ (\,(\,a\,)\,)\,)$

2. (36 points: 6 points each) Let $\Sigma = \{0,1\}$. Give CFGs that generate the following languages over Σ:
   a. $\{w \mid w$ begins with 0 and ends in 1$\}$
   b. $\{w \mid w$ contains an even number of 0s <u>or</u> length of w is odd$\}$
   c. $\{w \mid w$ contains an even number of 0s <u>and</u> length of w is odd$\}$
   d. $\{w \mid w$ does not contain the substring 11$\}$
   e. $\{0^m10^n10^{m+n} \mid m, n \geq 1\}$
   f. $\{w \mid$ the number of 0s in w is two times the number of 1s in $w\}$

3. (20 points: 5, 5, 5, 5) Show that context-free languages are closed under the regular operations as well as the reversal operator, i.e., if L_1 and L_2 are any two context-free languages such that $L_1 = L(G_1)$ and $L_2 = L(G_2)$ for two CFGs G_1 and G_2, show that the following languages are also context-free:
   a. $L_1 \cup L_2$
   b. $L_1 \circ L_2$ ("$\circ$" denotes concatenation)
   c. $L_1{}^*$
   d. $L_1{}^R$ ("R" denotes string reversal)

4. (14 points) Construct a CFG for the language $L = \{0^i10^j10^k \mid i = j$ or $i = k$ for $i, j, k \geq 0\}$ over $\Sigma = \{0,1\}$. Is your grammar ambiguous? Explain why/why not.

5. (20 points) Give <u>informal descriptions</u> (as in Example 2.10 in the textbook) and <u>state diagrams</u> of pushdown automata (PDA) for the languages:
   a. $\{0^i10^j10^k \mid i < j$ or $i > k\}$
   b. $\{w\#x \mid w, x \in \{0,1\}^*$ and w^R is a substring of $x\}$