UNIVERSITY OF WESTERN ONTARIO

Computer Science 3331a, Fall 2011

Foundations of Computer Science

ASSIGNMENT 4

Due: Wednesday, Nov. 30, 2011

1. Give a CFG for each of the following languages:

   (1) $L_1 = \{a^i b^j \mid i \neq j, i, j \geq 0\}$

   (2) $L_2 = \{a^i b^j \mid i \leq j \leq 2i\}$

   (3) The set of all strings over alphabet $\{a, b, \cdot, +, *, (,), \varepsilon, \emptyset\}$ that are well-formed regular expressions over alphabet $\{a, b\}$. Note that here both ε and $\emptyset$ are symbols in regular expressions.

   (4) $L = \{a^{i+3} b^{2i+1} \mid i \geq 0\}$.

2. Place the following CFG into Chomsky normal form:

$$
\begin{aligned}
&S \to bE \mid aAC \\
&A \to aB \mid D \mid \varepsilon \\
&D \to bAB \\
&B \to b \mid \varepsilon \\
&C \to c \\
&E \to cE \\
&F \to ABC \mid \varepsilon
\end{aligned}
$$

3. Construct a deterministic pushdow automaton to accept the set of all words of balanced parentheses and square brackets.

4. Construct a pushdown automaton that accepts all words in $\{a, b\}^*$ that contain an equal number of a's and b's.