

CSE 105: Introduction to the Theory of Computation, Fall 1999
HW2 Due Thursday, Nov. 4, at the beginning of class
Context-free Grammars and PDA's

1. For the following languages, give a CFG that generates it.
 - (a) $\{ w \text{ in } \{0,1\}^* \mid w \text{ contains twice as many 1's as 0's} \}$
 - (b) the set of regular expressions over $\{ \mathbf{a}, \mathbf{b} \}$, using the alphabet $\{ \mathbf{a}, \mathbf{b}, \cup, *, \circ, (,), \epsilon, \phi \}$. (Use Definition 1.26 on p. 64 of our text)
 - (c) the set of strings described by the regular expression $(01^*) \cup (10)^*$.
2. Describe a PDA that accepts $\{ a^n b^m c^q \mid n, m, q \geq 0 \text{ and } q \neq n + m \}$
3. Problem 2.2 in text.
4. Show the steps to putting the following grammar in Chomsky normal form: (Here, the terminals of the grammar are $\{ +, *, (,), a \}$)
$$\begin{aligned} E &\rightarrow E + T \mid T \\ T &\rightarrow T * F \mid F \\ F &\rightarrow (E) \mid a \end{aligned}$$
5. Consider the grammar over the alphabet $\{ \text{sub}, \text{sup}, c, (,) \}$
$$\begin{aligned} E &\rightarrow E\text{sub}E\text{sup}E \mid E\text{sub}E \mid E\text{sup}E \\ E &\rightarrow (E) \mid c \end{aligned}$$

Is the grammar ambiguous? Support your answer.
6. Show the following language is *not* context-free:
$$\{ www \mid w \text{ is in } \{ a, b \}^* \}$$