Homework Assignment #5

Note

This assignment is due 2:10PM Wednesday, April 6, 2016. Please write or type your answers on A4 (or similar size) paper. Drop your homework by the due time in Yih-Kuen Tsay's mail box on the first floor of Management College Building II, or put it on the instructor's desk before the class on the due date starts. Late submission will be penalized by 20% for each working day overdue. You may discuss the problems with others, but copying answers is strictly forbidden.

Problems

(Note: problems marked with "Exercise X.XX" or "Problem X.XX" are taken from [Sipser 2006, 2013] with probable adaptation.)

1. (Exercise 2.1; 20 points) Consider the following CFG discussed in class, where for convenience the variables have been renamed with single letters.

$$\begin{array}{rcl} E & \rightarrow & E + T \mid T \\ T & \rightarrow & T \times F \mid F \\ F & \rightarrow & (E) \mid a \end{array}$$

   Give (leftmost) derivations and parse trees for the following strings.

   (a) $a + (a + a)$

   (b) $(a + (a))$

2. (Exercise 2.3; 10 points) Consider the following context-free grammar G.

$$\begin{array}{rcl} R & \rightarrow & XRX \mid S \\ S & \rightarrow & aTb \mid bTa \\ T & \rightarrow & XTX \mid X \mid \varepsilon \\ X & \rightarrow & a \mid b \end{array}$$

   Give a description of $L(G)$, explaining intuitively what its strings look like.

3. (Exercise 2.4; 20 points) Give context-free grammars that generate the following languages. In all parts the alphabet Σ is $\{0, 1\}$.

   (a) $\{w \mid \text{the length of } w \text{ is even}\}$

   (b) $\{w \mid w = w^R, \text{ that is, } w \text{ is a palindrome}\}$

4. (Exercise 2.6b; 10 points) Give a context-free grammar that generates the complement of the language $\{a^n b^n \mid n \geq 0\}$.

5. (Exercise 2.9; 20 points) Give a context-free grammar that generates the language

$$A = \{a^i b^j c^k \mid i = j \text{ or } j = k \text{ where } i, j, k \geq 0\}.$$

Is your grammar ambiguous? Why or why not?

6. (Exercise 2.14; 20 points) Convert the following CFG (where A is the start variable) into an equivalent CFG in Chomsky normal form, using the procedure given in Theorem 2.9.

$$\begin{array}{rcl} A & \rightarrow & BAB \mid B \mid \varepsilon \\ B & \rightarrow & 00 \mid \varepsilon \end{array}$$