

# CSE 3321 - Problem Set 5

## Due beginning of lecture on October 20th

Collaboration is permitted; looking for solutions from external sources (books, the web, material from previous years, etc.) is prohibited.

1. Consider the following CFG:

$$E \rightarrow E + T \mid T$$

$$T \rightarrow T \times F \mid F$$

$$F \rightarrow (E) \mid a.$$

Give parse trees and derivations for each string.

(a)  $a + a + a$

(b)  $((a))$

2. Convert the following CFG to an equivalent PDA, using the equivalence shown in class (Theorem 2.20 in the 3rd edition of Sipser's book)

$$E \rightarrow E + T \mid T$$

$$T \rightarrow T \times F \mid F$$

$$F \rightarrow (E) \mid a$$

3. Convert the following CFG to an equivalent PDA, using the equivalence shown in class (Theorem 2.20 in the 3rd edition of Sipser's book)

$$R \rightarrow XRX \mid S$$

$$S \rightarrow aTb \mid bTa$$

$$T \rightarrow XTX \mid X \mid \epsilon$$

$$X \rightarrow a \mid b$$

4. Use the pumping lemma to show that the following languages are not context free.

(a)  $\{0^n 1^n 0^n 1^n : n \geq 0\}$

(b)  $\{t_1 \# t_2 \# \cdots \# t_k : k \geq 2, \text{ each } t_i \in \{a, b\}^*, \text{ and } t_i = t_j \text{ for some } i \neq j\}$

5. Let  $B$  be the language of all palindromes over  $\{0, 1\}$  containing equal number of 0s and 1s. Show that  $B$  is not context free. (A palindrome is a string that reads the same forward and backward.)