

# CS 311 Homework 5

October 26, 2013

1. (from 2.9 in Sipser) Give a context-free grammar that generates the language

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

Is your grammar ambiguous? Why or why not?

2. (from 2.11 in Sipser) Given the CFG

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

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

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

Convert this to an equivalent PDA using the procedure in Theorem 2.20

3. (from 2.14 of Sipser) Convert the following CFG into an equivalent CFG in Chomsky normal form, using the procedure given in Theorem 2.9

$$A \rightarrow BAB \mid B \mid \epsilon$$

$$B \rightarrow 00 \mid \epsilon$$

4. (from 2.26 in Sipser) Show that if  $G$  is a CFG in Chomsky normal form, then for any string  $w \in L(G)$  of length  $n \geq 1$  then exactly  $2n - 1$  steps are required for any derivation of  $w$ .