

CONCORDIA UNIVERSITY
Dept. of Computer Science and Software Engineering
COMP 335 – Introduction to Theoretical Computer Science

Assignment 3

Electronic submission is due on ~~Friday June 5th~~ Thursday June 11th at 23:59

NOTE: The extended due date is to allow you provide a solution to ALL these problems.

Total mark is 40.

1. [5 Points] Show that context-free languages are closed under the reverse operation.
2. [5 Points] Given any CF grammar $G = (V, T, S, P)$, show that there is an equivalent CFG in which the productions are of the following two forms only, where $x \in T^*$:

$$A \rightarrow xBC \text{ or } A \rightarrow \lambda$$

3. [20 Points] For each of the following languages, give a CFG or show it is not CF.

(a). $L_1 = \{uvvw^R : u, v, w \in (a + b)^+ \text{ and } |u| = |w| = 2\}$.

(b). $L_2 = \{w \in (a + b)^* : w = w^R\}$.

(c). $L_3 = \{w \in (a + b + c)^* : n_a(w) > n_b(w) > n_c(w)\}$.

(d). $L_4 = \{a^i b^j a^i b^j : i \geq 0, j \geq 0\}$.

(e). ~~$L_5 = \{w_1 w_2 : w_1, w_2 \in (a + b)^*, |w_1| = |w_2|, w_1 \neq w_2\}$.~~

No need to submit a solution to (e) but still an interesting CFL to think about.

4. [10 Points] Give a "direct" design of a PDA for L_1 and L_2 in question 3. Your PDA cannot be obtained by "converting" a CFG for the language.