

CONCORDIA UNIVERSITY
Dept. of Computer Science and Software Engineering
COMP 335 – Introduction to Theoretical Computer Science
Fall 2023

Assignment 5

Submission through moodle is due by Sunday, November 19th at 23:59

1. [40 points] For each of the following languages, give a context-free grammar:
 - (a) $L_1 = \{ab^nab^na : n \geq 0\}$
 - (b) $L_2 = \{a^n b^m c^k : k = m + n\}$
 - (c) $L_3 = \{a^i b^j c^k : i = j \text{ or } i = k\}$
 - (d) $L_4 = \{ww : w \in L(0^*10^*)\}$
2. [10 points] Give a CFG for the complement of $L_5 = \{a^n b^{n+1} : n \geq 0\}$.
3. [30 points] For each of the following CFLs L , give a “direct” design of an NPDA. That is, it is not acceptable to first find a CFG and then convert it into an NPDA.
 - (a) $L_6 = \{a^n b^{3n} : n \geq 0\}$
 - (b) $L_7 = \{a^n b^m : 0 \leq n \leq m \leq 3n\}$
 - (c) $L_8 = \{w \in \{a, b\}^* : n_a(w) \leq 3n_b(w)\}$