# Assignment 5 – CS 301 - Theory of Automata – Fall 2020

## Due: Thursday, December 3, 2020 (online – 8 AM)

**If any assignment is deemed to be copied from any other student or internet, you may be awarded an F in this course.**

1. [50 = 10 * 5]

   For the following grammars, determine whether the language is a CFL or non-CFL. If the language is CFL, you are required to give a CFG. Otherwise, use pumping lemma to show that the language is a non-CFL language.

   a. A = {$a^n ww^R a^n$ | n > 0 and w ∈ {a, b}* } Note that $w^R$ stands for reverse of word w
   b. B = {w | w ∈ {a, b}* and w is not a palindrome}
   c. C = {w | w ∈ {a, b, c}* where na(w) = 2nb(w) and n(w) = na(w) + nb(w)} Note: na(w) stands for number of a's in w.
   d. D = {$a^n b^m c^k$ | n >= m and k = n – m}
   e. E = { $a^{2n} b^{2m} c^n d^m$: n, m>=0}
   f. F = {$a^n b^n c^k$ | n <= k <= 2n }

Part a and b from http://www.cs.williams.edu/~tom/courses/361/notes/Lect17.pdf

Part c from final fall 2018

Part d from …


Part e from lums

Part f from lums HW8 SOL.pdf

2. [15] https://courses.engr.illinois.edu/cs373/fa2009/hws/hw_04.pdf
   In class we have seen that $a^n b^n c^n$ is not a CFL as we have just one stack and 2 comparisons cannot be done with one stack only. Assume that we have a special kind of PDA which has two stacks. Prove that a PDA with two stacks will be able to accept some non-CFL languages as well using $a^n b^n c^n$ as an example. Write down in steps how would the new PDA accept this language.

   List another example that can be accepted by 2-stack PDA but not by one-stack PDA

   How about PDAs with queue? Can it also accept our example language? Show complete working

3. [10]
   In class, we have seen CNF form of CFG, according to which all rules must be of the following form
   S → BC
   S → a

Assume new-CNF of the following format
S→ABC
S→a

All other CNF rules are still valid. For example, start variable symbol cannot appear on RHS of the rule.

Will it be possible to find grammar for every CFL?

**Counter example A->aa is a CFG but cannot be converted into the desired form. Infact any string with length two cannot be converted into the form given in question.**

4. Given two NPDA's, is it possible to verify whether both NPDA's accept the same language. If yes then how? If no then why?
Hint: consider how would someone check if two sets are equal or not. Also, consider the properties of CFL to do this question.