Automata Homework-3 (CFG)

Q1)

a) $S \rightarrow aSc \mid T$

$T \rightarrow \varepsilon \mid bTc$

b) $S \rightarrow AC$

$A \rightarrow \varepsilon \mid aAb$

$C \rightarrow \varepsilon \mid bCc$

c) $S \rightarrow BC$

$B \rightarrow AE$

$A \rightarrow a \mid aA$

$E \rightarrow \varepsilon \mid aEb$

$C \rightarrow FD$

$F \rightarrow \varepsilon \mid cFd$

$D \rightarrow d \mid dD$

d) t

$S \rightarrow \varepsilon \mid a^3 S b^2$

e) $S \rightarrow Ab$

$A \rightarrow a \mid aAb \mid aAa \mid bAa \mid bAb$

f) $S \rightarrow aSd \mid T \mid U$

$S \rightarrow T$ is chosen if $m \geq q$

$S \rightarrow U$ is chosen if $m \leq q$

$T \rightarrow W \mid aTc$

$U \rightarrow W \mid bUd$

$W \rightarrow \varepsilon \mid bWc$

g) $S' \rightarrow aB' \mid bA' \mid \varepsilon$

$A' \rightarrow aS' \mid bA'A'$

$B' \rightarrow bS' \mid aB'B'$

$S \rightarrow A' \mid SS$

S', A', B' have respectively $n_a = n_b, n_b+1, n_b-$
and S can be represented as a sequence of A's

h) $S \rightarrow \varepsilon \mid aB \mid bA$

$A \rightarrow aC \mid bAA$

$B \rightarrow aD \mid bC$

$C \rightarrow aS \mid bCA$

$D \rightarrow aDB \mid bS$

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Q2) $S \longrightarrow SS \mid PP \mid \epsilon$
$P \longrightarrow 0$

Chomsky Normal Form

Q3) Greibach normal free

$S \rightarrow 0 \mid 0SA \mid 1A$
$A \rightarrow 1 \mid 1AS \mid 0S$

Q4) $L = \{ ww \mid w \in (a+b)^* \}$

Consider strings of the form $a^n b^n a^n b^n$, there are type ww and PDA for L (if exists) should accept these languages. Now by pumping lemma for CFG, $a^n b^n a^n b^n = uvwxy$ where $|vwx| \leq n$. Now either uvw is in a^n, $a^n b^n$, b^n, $b^n a^n$, in each of these cases we can see that $uv^i w x^i y$ is not part of the language. Hence there is no PDA for L which proves L is not CFG.