Homework #6 *due December 28 before recitation*

Question 1

Consider the CFG $\boldsymbol{G = (V,\Sigma, R,S)}$ *where* $\boldsymbol{V = \{S,A,B,C,D,E\}}$ *,* $\boldsymbol{\Sigma = \{a,b,c\}}$ *and* **R** *is as given below*

R *:*

$\boldsymbol{S \to AE \mid EB \mid C}$

$\boldsymbol{A \to aA \mid a}$

$\boldsymbol{B \to Bb \mid b}$

$\boldsymbol{C \to Cc}$

$\boldsymbol{D \to aCb \mid a \mid b \mid c}$

$\boldsymbol{E \to aEb \mid e}$

(a) *Remove all the null productions of* $\boldsymbol{G}$*, if any, and call the result* $\boldsymbol{G_1}$**.**

(b) *Remove all the unitary productions of* $\boldsymbol{G_1}$*, if any , call the result* $\boldsymbol{G_2}$

(c) *Remove all the non-generative and non-reachable symbols of this grammar, if any, and call the result* $\boldsymbol{G_3}$**.**

(d) *Compute the Chomsky Normal Form of* $\boldsymbol{G_3}$ *using your results above.*

(e) *State in the simplest possible way the language generated by* $\boldsymbol{G}$

Question 2

Show that the languages $\boldsymbol{L_1}$ **,** $\boldsymbol{L_2 \subseteq \{a,b,c,d\}^*}$ *given below are context-free languages (CFL) :*

$\boldsymbol{L_1 = \{a^n b^n c^m d^m;\ n,m \geq 0\}}$ **;** $\boldsymbol{L_2 = \{a^n b^m c^m d^n;\ n,m \geq 0\}}$

Is the language $\boldsymbol{L = (\omega \in \{a,b,c,d\}^* \mid}$ *in* $\boldsymbol{\omega}$ **:** *#**a**'s = #**b**'s* $\wedge$ *#**c**'s = #**d**'s* **)** *a CFL* **?** *If so find a CFG that generates* **L** *or a PDA that accepts* **L***; if not prove your claim using the pumping lemma for CFGs.*

Question 3

A CFG is called right linear if ***all*** *productions are of the form* $\boldsymbol{A \to a\, B}$ *or* $\boldsymbol{A \to e}$ *and called left linear if* ***all*** *productions are of the form* $\boldsymbol{A \to B\, a}$ *or* $\boldsymbol{A \to e}$ *where* $\boldsymbol{A, B} \in V$ *and* $\boldsymbol{a} \in \boldsymbol{T}$ *and* **e** *is the empty string. Show that both right linear and left linear grammars generate regular languages. Specify finite state machines corresponding respectively to right and left linear grammars.*

Main Text: Exercise 6.4.1 (a), (c); 6.4.2 , 7.1.3, 7.1.4, 7.2.1 (b), (c), 7.4.3(b), (c)