Computer Science Department, Kuwait University

Date:	21/ 4 /2022		**Due: 7/5/2022**
Course:	0418211/01	Homework 4	

Q1. Prove using pumping theorem for regular languages that L = { $a^n b^m$, $m \geq 3n$ }is not regular.

Q2. Find a rightmost derivation and a leftmost derivation for the string *aabbbb* using the grammar

$S \rightarrow AB|\lambda$
$A \rightarrow aB$
$B \rightarrow Sb$

Draw the parsing tree of each derivation.

Q3. Consider the grammar with productions

$S \rightarrow aaB$
$A \rightarrow bBb|\lambda$
$B \rightarrow Aa \mid bBb$

For each of the following strings decide whether or the string is in the language generated by this grammar. Justify your answer.

a) aabbabba
b) abbababa

Q4. Find an *s-grammar* for each of the following languages:

a- $L=\{a^n b^n : n \geq 2\}$
b- $L=\{a^n b^m : n \geq 1, m = 2n+1\}$

Q5. Show that the following grammar G is *ambiguous*

$S \rightarrow aSbS| aS|\lambda$

(Consider the string aab. Show that it has two:

a) Parse trees.
b) Leftmost derivations.

Q6. (*Grammar Simplification*) Begin with the grammar:

$S \rightarrow ASBb \mid aA$
$A \rightarrow aAS \mid a \mid \lambda$
$B \rightarrow SbS \mid A \mid bb \mid CD$
$C \rightarrow AC \mid CC$
$D \rightarrow DA \mid a \mid b$

a) Remove λ-productions.
b) Remove any unit-productions in the resulting grammar.
c) Remove any useless symbols in the resulting grammar.
d) Put the resulting grammar into Chomsky Normal Form.
e) Put the resulting grammar into Greibach Normal Form.

Q7. Prove using pumping theorem for CFL that L = { $a^n b^n c^m$, $n \geq 0$, $m > n$ }is not context free.

Q8. Design an NPDA for the language $L=\{ w \in \{a,b\}^+ , n_a(w) \neq n_b(w)\}$.
For example : aabb is not accepted . aabab is accepted.

Q9. Design a DPDA for the language $L=\{ w\, c\, w^R , w \in \{a,b\}^+\}$.

Q10. Design a *DPDA* that accepts the following language and trace its configuration changes given the input *aaabb$*: ($ is a marker for the end of input)

$$L = \{ a^n b^m \$, \; n \neq m \}$$