CSCI 338: Assignment 3 (6 points)

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This assignment is due on **Tuesday, March 10, 11:30pm**. It is strongly encouraged that you use Latex to generate a single pdf file and upload it under *Assignment 3* on D2L. But there will NOT be a penalty for not using Latex (to finish the assignment). This is **not** a group-assignment, so you must finish the assignment by yourself.

Problem 1

Design context-free grammars for the following languages

(1.1) $A = \{a^n b^m | n \neq 2m\}$.

- $S = aaSb|A|B$
- $A = aA|a$
- $B = bB|b$

(1.2) $B = \{a^i b^j c^k | i, j, k \geq 0 \text{ and either } i = j \text{ or } j = k\}$.

- $S = XC|AY$
- $A = aA|\epsilon$
- $C = cC|\epsilon$
- $X = aXb|\epsilon$
- $Y = bXc|\epsilon$

(1.3) $C = \{a^n b^m | n = 3m\}$.

- $S = aaaSb|\epsilon$

(1.4) $D = \{a^n b^m | n \leq m + 3\}$.

- $S = aSb|Sb|A$
- $A = aaa|aa|a|\epsilon$

Problem 2

Decide whether the following grammar is ambiguous.

$S \to AB|aaB$

$A \to a|Aa$

$B \to b$

S	S
AB	aaB
AaB	aaB
aaB	aaB
aab	aab

There are multiple ways to generate the string "aab" with this grammar, so **yes** the grammar is ambiguous.

Problem 3

Convert the following CFG G to an equivalent PDA.

$R \to XRX|S$

$S \to aTb|bTa$

$T \to XTX|X|\epsilon$

$X \to a|b$

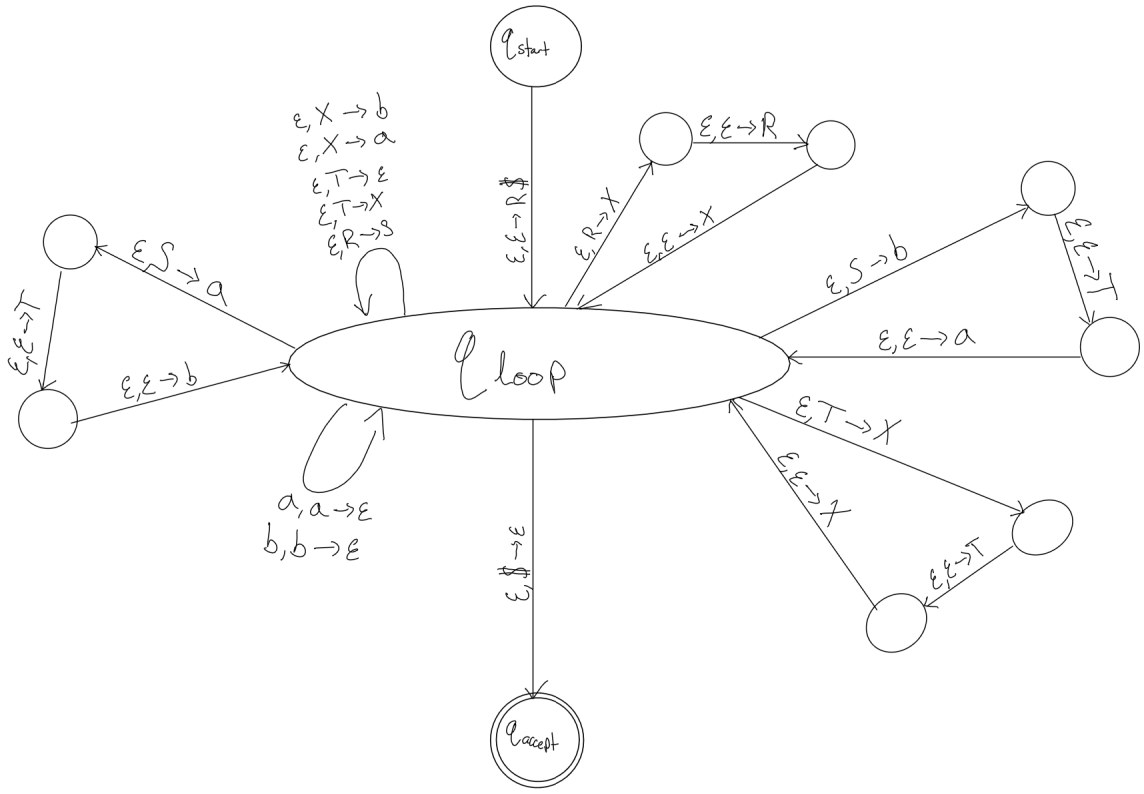

Figure 1: Solution to Problem 3

Problem 4

Let $G = (V, \Sigma, R, S)$ be the following grammar. $V = \{S, T, U\}$; $\Sigma = \{0, \#\}$; and R is the set of rules:

$S \to TT|U$

$T \to 0T|T0|\#$

$U \to 0U00|\#$

(4.1) Describe $L(G)$ in English.

$L(G)$ has two #'s within a list of an even number of zeros. Or L(G) a single # one third of the way through a list of zeros with a multiple of three length.

(4.2) Prove that $L(G)$ is not regular.

Problem 5

Convert the following CFG into an equivalent CFG in Chomsky Normal Form

$A \to BAB|B|\epsilon$

$B \to 00|\epsilon$

HEllo WOrld

$S_0 \to BD|AB|BA|CC$
$A \to BD|AB|BA|CC$
$B \to CC$
$C \to 0$
$D \to AB$

Problem 6

Using pumping lemma to prove that the following languages are not context-free.

(6.1) $L = \{a^n b^j c^k | k = nj\}$.

(6.2) $L = \{a^n b^j | n \geq (j-1)^3\}$.