NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CSPC41 – Formal Languages and Automata Theory
Assignment - 2

Class: II yr CSE 'B' **Deadline for Submission:** 10/04/23

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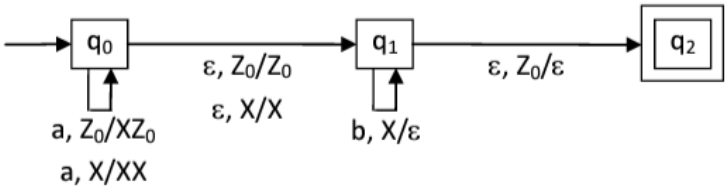
1. Give context-free grammars that generate the following languages. In all parts the alphabet is Σ is {0,1}.
   a) {w | w contains at least three 1s}
   b) {w | w starts and ends with the same symbol}
   c) {w | the length of w is odd}
   d) {$w\#x$ | w^R is a substring of x}
   e) {w | $w=w^R$, i.e., w is a palindrome (of either odd or even length)}
   f) {w | w contains more number of 0's than 1's}

2. Give a CFG that generates the language
   $A = \{a^i b^j c^k \mid i=j \text{ or } j=k \text{ where } i,j,k \geq 0\}$
   Is your grammar ambiguous? Why or why not?

3. Convert the following CFG into an equivalent CFG in Chomsky Normal Form and subsequently to Greibach Normal Form.
   $A \rightarrow BAB \mid B \mid \varepsilon$
   $B \rightarrow 00 \mid \varepsilon$

4. Convert the following grammar into an equivalent PDA.
   $R \rightarrow XRX \mid S$
   $S \rightarrow aTb \mid bTa$
   $T \rightarrow XTX \mid X \mid e$
   $X \rightarrow a \mid b$

5. Convert the following PDA into an equivalent CFG.



6. Design a PDA that accepts by empty stack for the following language:
   P = $\{a^n b^m c^{2(n+m)} \mid n>=0, m>=0\}$

7. Prove that the following language is not context-free using pumping lemma.
   L = $\{0^n\#0^{2n}\#0^{3n} \mid n>=0\}$