United International University
Department of Computer Science and Engineering

CSI 233: Theory of Computing Final Examination : Spring 2019

Total Marks: 40 Time: 2 hours

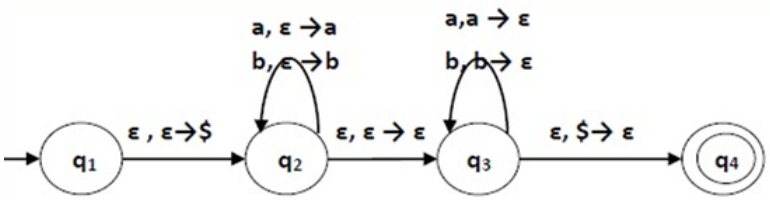
Answer all the 5 questions. Numbers to the right of the questions denote their marks.

1. Consider the following language: $L=\{a^p b^q c^r \mid p,\ q,\ r \geq 0 \text{ and } p=q \text{ or } p=r\}$

   (a) Design a *Pushdown Automaton (PDA)* for the above language. [6]

   (b) Write the seven components to represent the above *PDA*. [2]

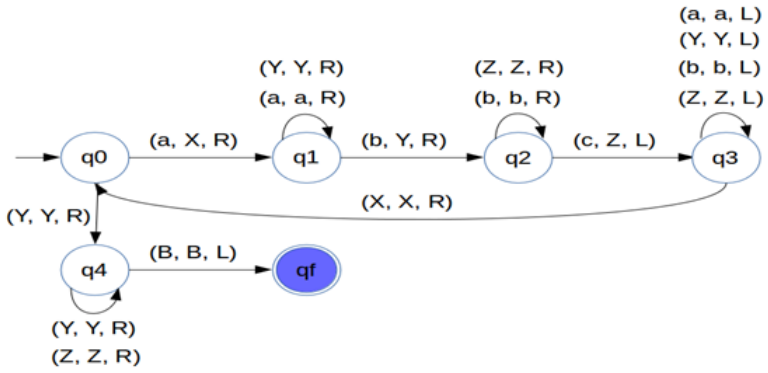
2. (a) Check whether the following strings are accepted by the *PDA*: i) *aaabaaa* ii) *babaabab* [2+2]



   (b) Convert the following CFG(V, Σ, R, S) into an equivalent CFG in Chomsky normal form and also show it's four components: [3+1]

$$
\begin{aligned}
V = &\ \{A, B\} \\
\Sigma = &\ \{0\} \\
R = &\ \{ \\
&\ A \to BAB \mid B \mid \varepsilon \\
&\ B \to 00 \mid \varepsilon \\
\} & \\
S = &\ A
\end{aligned}
$$

3. (a) Determine if the following *Turing Machine* accepts the following strings. The B symbol is mentioning blank tape cell. The strings are: i) *aabbccc* ii) *aaccbb* [3+3]



   (b) Design Context Free Grammar for the language: [2]

$$L = \{w \in \{0,1\}^* \mid w \textit{ starts and ends with the same symbol}\}$$

4. Consider the following language: $L=\{a^n b^n c^n \mid n \geq 1\}$

   (a) Design a *Turing machine* that accepts strings of the above language. [6]

   (b) Write down the seven components of the designed *Turing machine*. [2]

5. Consider the following context-free grammar, and answer to the question *(a)*: [2+4]

$$S \to S + S | S * S | A | B$$
$$A \to aA | 1$$
$$B \to bB | 2$$

(a) i. Show a leftmost derivation of the string: $aa1 + bb2 * a1$

ii. Show whether the string, $bbb2 + aa1 + b2$, makes the grammar ambiguous.

(b) Design Context Free Grammar for the language: [2]

$L = \left\{ w \in \{0,1\}^* \mid \#_0(w) = \#_1(w) \right\}, \#_0(w)$ *and* $\#_1(w)$ *represent the total number of* $0's$ *and* $1's$ *in* w, *respectively.*