



# United International University

## Department of Computer Science and Engineering

CSI 233: Theory of Computing

Final Examination : Spring 2019

Total Marks: 40

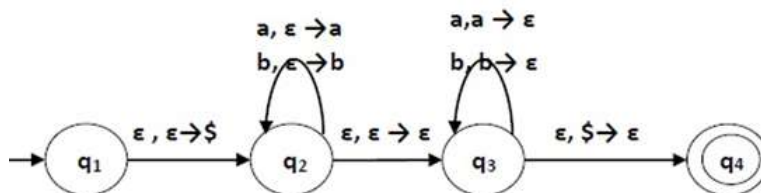
Time: 2 hours

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]

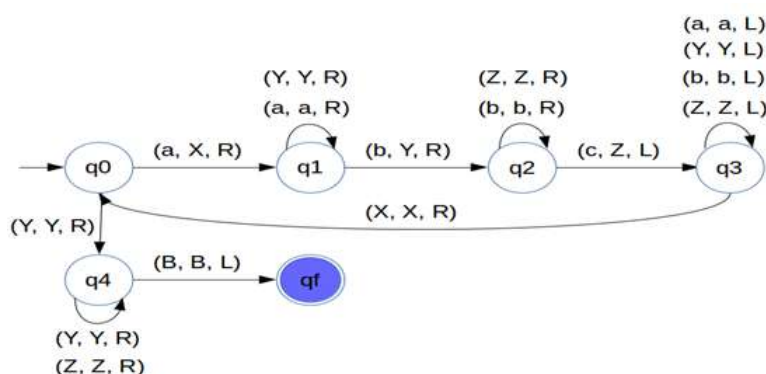
2. (a) Check whether the following strings are accepted by the *PDA*: i) *aaabaaa* ii) *babaabab* [2+2]



- (b) Convert the following CFG( $V, \Sigma, R, S$ ) into an equivalent CFG in Chomsky normal form and also show its four components: [3+1]

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

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]

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

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]

$$\begin{aligned}S &\rightarrow S + S | S * S | A | B \\A &\rightarrow aA | 1 \\B &\rightarrow bB | 2\end{aligned}$$

- (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]

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