United International **University** (**UIU**)
Dept. of Computer Science and Engineering (CSE)
Final Assessment   Year: **2021**   Semester: **Spring**
Course: **CSE 2233**   Title: **Theory of Computation (Section – A/B/C)**
Marks: **40**   Time: **1 Hour 30 minutes + 15 minutes(for uploading & downloading)**

[Any examinee found adopting unfair means will be expelled from the trimester/program as per UIU disciplinary rules.]

There are **4 (Four)** questions. Answer **all of them**. Figures in the right margin indicates full marks.

Q.1 Design context-free grammar (CFG) for the following languages over $\sum$={**a,b,c**}   **[3*3 = 9]**

    a) $\{ a^m b^n c^k \mid k = 3m+n, m >= 0, n > 0 \}$
    b) $\{ w a^m w^R \mid w \in \{a, b\}^* $ and w^R is the reverse string of w, $m > 2 \}$
    c) $\{ a\char`^n b\char`^t a\char`^(m+t) b\char`^(m+n) \mid n,t>0, m>=2 \}$?

Q.2 a) Consider the following context-free grammar (CFG) and answer the questions that follows:

        $S \rightarrow A \mid XP$
        $A \rightarrow 0A11 \mid Z$
        $Z \rightarrow 0Z2 \mid 02$
        $X \rightarrow 0X2 \mid Y$
        $Y \rightarrow 0Y \mid 0$
        $P \rightarrow 1P \mid 11$

    With the help of leftmost derivation decide whether the grammar is ambiguous or not for the string: ***0000221111***   **[5]**

b) Consider the following CFG,

        $S \rightarrow S1 \mid S2$
        $S1 \rightarrow S1b \mid Ab \mid \varepsilon$
        $A \rightarrow aAb \mid ab$
        $S2 \rightarrow S2a \mid Ba \mid \varepsilon$
        $B \rightarrow bBa \mid ba$

Covert the given grammar to Chomsky Normal Form.   **[5]**

Q3. a) Design a push down automata (PDA) for the following language L

    $L = \{w \mid$ w contains $\mathbf{p^i\ q^j\ r^k\ s^m} \mid \mathbf{i == k}$ **or** $\mathbf{j >= m + 2 , i > 0, j >= 3} \}$

Also give a formal definition of your designed PDA.   **[4+4]**

b) Design a push down automata for the language $L = \{w \mid w \in \{a, b\}^*$, w is a palindrome and $\mid w \mid >= 0$; here $\mid w \mid =$ number of characters in string w}   **[5]**

Q4.

a) Is it possible to design a push down automata for the language $L = \{ww \mid w \in \{0,1\}^*\}$. Why or why not? Explain your answer with reasons and example.   **[3]**

b) The Turing Machine given below recognizes the language $A = \{0^{2n}1^n \mid n \geq 0\}$.

$0 \to 0, R$
$1 \to 1, R$

$q_0 \xrightarrow{0 \to U, R} q_1 \xrightarrow{0 \to U, R} q_2 \xrightarrow{U \to U, L} q_3$

$U \to U, R$ (q0 → q4)

$U \to U, R$ (q5 → q1)

q_4 (accept)

$1 \to U, L$ (q3 → q5)

q_5 self-loop:
$0 \to 0, L$
$1 \to 1, L$
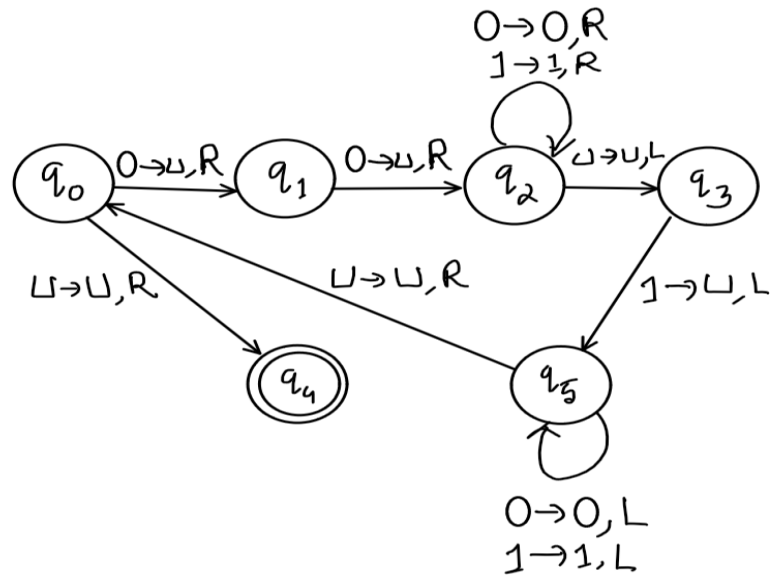
Show the sequence of configurations(instantaneous description) that the Turning Machine enters for the input string **000011**. Also, indicate whether the input string is finally accepted or rejected .

[5]

End of Paper – Thank You