United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

Final Exam (Fall 2022)

CSE 2233/CSI 233: Theory of Computation/Theory of Computing

Total Marks: **40**   Duration: 2 Hours

Answer all questions. Figures in the right-hand margin indicates full marks.

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

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1. Consider the following Context-free grammars (CFG) and answer according to it: 3 x 2

a)	$S \rightarrow AS \mid BAC$ $A \rightarrow A1 \mid 0A1 \mid 0B1 \mid B$ $B \rightarrow 0B \mid 0 \mid \epsilon$ $C \rightarrow 1 \mid \epsilon$	With the help of *Top-Down Parse Trees,* find-out if the grammar is *Ambiguous* or not for the string **00011111**
b)	$E \rightarrow E+E \mid E-E \mid (E) \mid V$ $V \rightarrow p \mid q \mid r \mid X$ $X \rightarrow X*X \mid X\%X \mid Y$ $Y \rightarrow 0 \mid 1$	With the help of *Leftmost derivation,* find-out if the grammar is *Ambiguous* or not for the string **p+(0*1%0)-r**

2. Find a *CFG that generates* the following languages.   2 x 3

   a) $L = \{ x^{2n} \# y^{3m} \mid n,m \geq 1 \}$, Here $\sum = \{x,y,\#\}$

   b) $L = \{ w$ is considered of $\{0,1\} \mid w$ is of even length & w starts and ends with different symbol $\}$

   c) $L = \{ a^i b^j c^k \mid$ where $i \neq j$ and $k \geq 1 \}$

3. Convert the following CFG's into equivalent *Chomsky Normal Form (CNF)* [Show all the Steps]   4 x 2

   a) $S \rightarrow aSBcD \mid BC$

   $A \rightarrow AbCd \mid a$

   $B \rightarrow CBA \mid \epsilon$

   $C \rightarrow c \mid \epsilon$

   $D \rightarrow d$

b)   S → xP | yQ | y | RRz

P → Qxx | xyR | €

Q → yPPy | xy | zR

R → x | y | PR | €

4. Draw ***Push Down Automata (PDA)*** for the following Languages   5 x 2

a) $L = \{a^p b^q c^r \mid Where\ p = q - r\ and\ p, q > 0\ and\ r \geq 0\}$

b) $L = \{x^m \# y^n z^w \mid Where\ m = 2n\ or\ w = 2m\ and\ m, n, w > 0\}$

5. Draw ***Turing Machine*** for the following Language and Show the ***Tape Traversal*** for the   5 x 2
Given input.

a) $L = \{a^l b^m c^n d^k \mid where\ k = (m+n)*l\ and\ l, m, n, k >= 1\}$ | **Input String: aabccdddddd**

b) $L = \{W \# W \mid W \in \{0, 1\}\}$| **Input String: 010#010**