



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.

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 <i>Top-Down Parse Trees</i> , find-out if the grammar is <i>Ambiguous</i> 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 <i>Leftmost derivation</i> , find-out if the grammar is <i>Ambiguous</i> 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 $\Sigma = \{x, y, \#\}$
- b) $L = \{ w \mid w \text{ is considered of } \{0,1\} \mid w \text{ is of even length \& } w \text{ starts and ends with different symbol} \}$
- c) $L = \{ a^i b^j c^k \mid \text{where } i \neq j \text{ and } k \geq 1 \}$

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

- a) $S \rightarrow aSBcD \mid BC$
 $A \rightarrow AbCd \mid a$
 $B \rightarrow CBA \mid \epsilon$
 $C \rightarrow c \mid \epsilon$
 $D \rightarrow d$

$$\begin{aligned}
\text{b)} \quad S &\rightarrow xP \mid yQ \mid y \mid RRz \\
P &\rightarrow Qxx \mid xyR \mid \epsilon \\
Q &\rightarrow yPPy \mid xy \mid zR \\
R &\rightarrow x \mid y \mid PR \mid \epsilon
\end{aligned}$$

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

5 x 2

- a) $L = \{a^p b^q c^r \mid \text{Where } p = q - r \text{ and } p, q > 0 \text{ and } r \geq 0\}$
- b) $L = \{x^m \# y^n z^w \mid \text{Where } m = 2n \text{ or } w = 2m \text{ and } m, n, w > 0\}$

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

5 x 2

- a) $L = \{a^l b^m c^n d^k \mid \text{where } k = (m+n)*l \text{ and } l, m, n, k \geq 1\} \mid \text{Input String: aabccdddddd}$
- b) $L = \{W\#W \mid W \in \{0, 1\}^*\} \mid \text{Input String: 010\#010}$