



# 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 = 6

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 <u>00011111</u>
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 = 6

- a)  $L = \{ x^{2n} \# y^{3m} \mid n, m \geq 1 \}$ , Here  $\Sigma = \{x, y, \#\}$   
b)  $L = \{ w \text{ is considered of } \{0,1\} \mid w \text{ is of even length \& } w \text{ starts and ends with different symbol} \}$   
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 = 8

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

$$b) S \rightarrow xP \mid yQ \mid y \mid RRz$$

$$P \rightarrow Qxx \mid xyR \mid \epsilon$$

$$Q \rightarrow yPPy \mid xy \mid zR$$

$$R \rightarrow x \mid y \mid PR \mid \epsilon$$

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

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

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.

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

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

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