



# United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

## Final Exam (Summer 2023)

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)	$S \rightarrow S + S \mid S * S \mid A \mid B$ $A \rightarrow aA \mid 1$ $B \rightarrow bB \mid 2$	With the help of <i>Top-Down Parse Trees</i> , find-out if the grammar is <i>Ambiguous</i> or not for the string " <b>bbb2 + aa1 + b2</b> "
b)	$S \rightarrow S + S \mid S - S \mid (S) \mid T$ $T \rightarrow X * X \mid X \% X \mid X$ $X \rightarrow x \mid y \mid z \mid Y$ $Y \rightarrow 0 \mid 1 \mid 2 \mid 3$	With the help of <i>Leftmost derivation</i> , derive the following string " <b>(x + 2*y) - (3*z + 1)</b> "

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

- a)  $L = \{ a^{m+n} c^{3n} d^{2m} \mid n, m \geq 2 \}$
- b)  $L = \{ w \text{ is considered of } \{0,1\} \mid w \text{ is of odd length \& } w \text{ starts and ends with same symbol} \}$
- c)  $L = \{ a^i b^j c^k \mid 2i + 3j \geq 6 \text{ and } 4i - 8j \geq -16 \text{ and } k \geq 1 \}$

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

a)  $S \rightarrow YXZ \mid Y$

$Y \rightarrow 0Y1 \mid 01$

$X \rightarrow aXb \mid \epsilon$

$Z \rightarrow Bz$

b)  $S \rightarrow ASB$

$$A \rightarrow aAS \mid a \mid \varepsilon$$

$$B \rightarrow SbS \mid A \mid bb$$

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

5 x 2

a)  $L = \{ w = w^R \mid w \in \{0, 1\}^* \}$

b)  $L = \{ a^m b^{2n} c^n d^{3m} \mid m \geq 0, n \geq 1 \}$

5. Draw *Turing Machine* for the following Languages and Show the *Tape Traversal* to *validate* the given input:

5+5

$$L = \{ x^a y^b z^c \mid \text{where } a=b-c \text{ and } a, b, c \geq 1 \} \quad | \quad \text{Input String: xxxyyyyyyyyzzzzzz}$$