# 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.***

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

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

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

**a)** $L = \{ a^{m+n} c^{3n} d^{2m} \mid n,m >= 2 \}$

**b)** L = { w is considered of {0,1} | w is of odd length & w starts and ends with same symbol }

**c)** $L = \{ a^i b^j c^k \mid 2i + 3j >= 6 \text{ and } 4i - 8j >= -16 \text{ and } k >= 1 \}$

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

**a)** $S \rightarrow YXZ \mid Y$

$Y \rightarrow 0Y1 \mid 01$

$X \rightarrow aXb \mid \varepsilon$

$Z \rightarrow Bz$

**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

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