



United International University (UIU)
Dept. of Computer Science & Engineering (CSE)

‘I’ Grade Final Exam (Fall 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 indicate full marks.

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

3+3

1. a) Answer the following question based on the given CFG:

$$S \rightarrow 2BA \mid 1S \mid 2A$$

$$B \rightarrow 1B3 \mid 1S3 \mid \epsilon$$

$$A \rightarrow A11 \mid 12AS3 \mid B \mid \epsilon$$

With the help of **Parse Tree** show whether the given CFG is ambiguous for the string ‘211211313’.

- b) With the help of **Leftmost Derivation**, derive the string “bbb2 + aa1 + b2” from the following grammar:

$$S \rightarrow S + S \mid S * S \mid A \mid B$$

$$A \rightarrow aA \mid 1$$

$$B \rightarrow bB \mid 2$$

2. Design **CFGs** that generate the following languages:

2x3

- a) $L = \{ w \text{ is considered of } \{0,1\} \mid w \text{ is of odd length \& } w \text{ starts and ends with same symbol} \}$
- b) $L = \{ a^{x+y} c^{3x} d^{2y} \mid x, y \geq 1 \text{ and } \Sigma = \{a, c, d\} \}$
- c) $L = \{ x^i y^j z^k \mid \text{where } i=k \text{ or } j=k \text{ and } i, j, k \geq 0 \}$

3. Showing all necessary steps, convert the following CFGs into their equivalent **Chomsky Normal Form (CNF)**. **4x2**

a) $S \rightarrow DBC \mid Ba$
 $B \rightarrow 0B1 \mid 01 \mid \epsilon$
 $C \rightarrow aCb \mid aC \mid Bb$
 $D \rightarrow bD \mid D$

b) $S \rightarrow AC01 \mid 0S \mid 1S \mid A1$
 $A \rightarrow B \mid CA \mid \epsilon$
 $B \rightarrow 11B \mid 00B \mid \epsilon$
 $C \rightarrow 0 \mid 1$

4. Draw the **Push Down Automata (PDA)** for the following languages: **5x2**

a) $L = \{ a^p b^q c^{2r} \mid p \neq q \text{ and } p, q, r \geq 0 \}$

b) $L = \{ 0^i 1^j 2^k \mid (i = 3j \text{ or } j=k) \text{ and } i, j, k \geq 1 \}$

5. Draw a **Turing Machine** for the following language and show the **Tape Traversal** to validate the given input: **5+5**

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

Input String: aabccddddd