



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

Final Exam Fall 2021

CSE 2233/CSI 233: Theory of Computation/Theory of Computing
Total Marks: **40** Duration: **2 Hours**

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

Answer all questions. Figures are in the right-hand margin indicates full marks.

1. Consider the following context-free grammars (CFG). With the help of leftmost derivation decide whether the grammars are ambiguous or not. [4x3]

a)	$E \rightarrow E + E \mid A \mid F$ $S \rightarrow 0E44 \mid 0A$ $A \rightarrow 5A7 \mid 2S3 \mid 0S4 \mid \varepsilon$ $F \rightarrow \varepsilon \mid 5 \mid (5)$	String: 2003+00444
b)	$B \rightarrow 11BS \mid 0S0B \mid \varepsilon$ $S \rightarrow AC01 \mid 0S \mid 1S \mid A1$ $A \rightarrow 1 \mid B \mid CA \mid C$ $C \rightarrow x \mid y \mid A$	String: 011010
c)	$B \rightarrow 1B3 \mid 1S3 \mid \varepsilon$ $S \rightarrow 2BA \mid 1S \mid 2A$ $A \rightarrow A11 \mid 12AS3 \mid B \mid \varepsilon$	String: 112113

2. Convert the following CFGs to Chomsky Normal Form (CNF). [4x4]

a) $E \rightarrow E + E \mid A \mid F$
 $S \rightarrow 0E44 \mid 0A$
 $A \rightarrow 5A7 \mid 2S3 \mid 0S4 \mid \varepsilon$
 $F \rightarrow \varepsilon \mid 5 \mid (5)$

b) $A \rightarrow 1 \mid B \mid CA \mid C$
 $B \rightarrow 1BS \mid 0S0B \mid \varepsilon$
 $C \rightarrow x \mid y \mid A$
 $S \rightarrow 1A1 \mid 0S \mid S \mid A1$

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

d) $S \rightarrow X \mid Y$
 $X \rightarrow Xb \mid Ab \mid \varepsilon$
 $A \rightarrow aAb \mid ab$
 $Y \rightarrow Ya \mid Ba \mid \varepsilon$
 $B \rightarrow bBa \mid ba$

3. Construct Push Down Automata (PDA) for the following languages [4x2]
- a)* $L = \{0^{3n}1^n2^{3n} \mid n \geq 1\}$
- b)* $L = \{a^m b^n c^k \mid n \geq 1, \text{ where } m=k \text{ and } n=m\}$
4. Construct a Turing Machine for the language $L = \{0^n 1^n 2^n \mid n \geq 1\}$ [4x1]