# United International University (UIU)

## Dept. of Computer Science & Engineering (CSE)

## Final Exam Spring 2022

**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.

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**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 → E + E \| E - E \| ( E ) \| F<br>F → x \| y \| z \| A<br>A → A * A \| A % A \| C<br>C → 0 \| 1 | String: (0%1*1) – z |
| ***b)*** | S→ AC01 \| 0S \| 1S \| A1<br>B→ 11BS \| 0S0B \| ε<br>A→ 1 \| B \| CA \| Є<br>C→ x\| y \|A | String: 0110111101 |
| ***c)*** | $S \rightarrow 2BA \mid 1S \mid 2A$<br>$B \rightarrow 1B3 \mid 1S3 \mid \varepsilon$<br>$A \rightarrow A11 \mid 12AS3 \mid B \mid \varepsilon$ | String: 211211313 |

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

***a)*** S → S + S | S - S | ( S ) | T
T → x | y | z | X
X → X * X | X % X | Y
Y → 0 | 1

***b)*** P→ ST01 | 0P | 1P | S1
Q→ 11QP | 0P0Q | ε
S→ 1 | Q | TS | Є
T→ x| y |S

***c)*** W → 2XY | 1W | 2Y
X → 1X3 | 1W3 | ε
Y → Y11 |12YW3 | X | ε

***d)*** S→ AC01 | 0S | 1S | A1
A→ B | CA | Є
C→ 0 | 1
B→ 11B | 00B | ε

**3.** Construct Push Down Automata (PDA) for the following languages **[4x2]**

***a)*** L = { $x^n y^{2n} z^{3m}$ | n>=1, m>=2 }

***b)*** L = { $0^m 1^{3m} 2^{2n}$ | m,n>=1, m>n}

**4.** Construct a Turing Machine for the language L = {$2^n 1^m 3^n$ where n≥1 and m≥2 } **[4x1]**