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

1.	$E \rightarrow E + E \mid E - E \mid E = E$ $E \rightarrow MNV \mid MN$ $M \rightarrow - \mid \varepsilon$ $N \rightarrow 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9 \mid NN$ $V \rightarrow x \mid y \mid z$	
	a) With the help of **Top-Down Parse Trees**, figure out if the grammar is Ambiguous or not for the string "**x + y + z = 2**"	**[5]**
	b) Show the **Right Most Derivation** for the string "**-26x + 3y - 8z = -83**"	**[4]**

2.	Define a Context Free Grammar for the following languages:	**[3 x 3]**
	a) $L = \{x^i \, y^j z^{k+1} \mid k = 2j \text{ and } i \geq 0, j > 0\}$	
	b) $L = \{a^m \, b^n \, c^u \, d^v \mid m = \dfrac{n}{2}, v = \dfrac{u}{4}, m, n, u, v > 0\}$	
	c) $L = \{c^p \, \# \, d^q \, g^r h \mid q = 4p, p, q \geq 0 \text{ and } r > 2\}$	

3.	Convert the following Context Free Grammars to Chomsky Normal Form (CNF)	**[3 x 4]**
	a) $S \rightarrow ASA \mid aB$ $A \rightarrow B \mid S$ $B \rightarrow b \mid \varepsilon$	
	b) $S \rightarrow S + S \mid S - S \mid (S) \mid T$ $T \rightarrow x \mid y \mid z \mid X$ $X \rightarrow X * X \mid X \% X \mid Y$ $Y \rightarrow 0 \mid 1$	

	c)	$S \rightarrow ASB$ $A \rightarrow aAS \mid a \mid \varepsilon$ $B \rightarrow SbS \mid A \mid bb$	
4.		Draw PushDown Automata (PDA) for the following Languages	**[2 x 5]**
	a)	$L = \{a^p b^q c^{2r} \mid p \neq q \text{ and } p, q, r \geq 0\}$	
	b)	$L = \{0^i 1^j 2^k \mid (i = 3j \text{ or } j = k) \text{ and } i, j, k \geq 1\}$	