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

Final Exam Spring 2024

CSE 2233/CSI 233: Theory of Computation/Theory of Computing
Total Marks: **40**   Duration: 2 Hours
Answer all questions. Figures are 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: 4*2

    a) $S \rightarrow AB \mid C$

           $A \rightarrow aAb \mid ab$

           $B \rightarrow cBd \mid cd$

           $C \rightarrow aCd \mid aDd$

           $D \rightarrow bDc \mid bc$

      With the help of **Top-Down Parse Trees**, find out if the grammar is Ambiguous or not for the string " **aabbccdd** ".

    b) $E \rightarrow +E \mid -E \mid * E \mid X$

           $X \rightarrow pXq \mid pYq$

           $Y \rightarrow rYw \mid rw$

      With the help of **Leftmost derivation**, derive the following string " **+*-ppprrwwqqq** ".

2. Design **CFGs** that generate the following languages: 2*4

    a)   Design a CFG for a language of all strings over {1,0} that contains "**110**", "**010**" or "**011**".

    b)   Design a CFG for a language of all strings over {1,0} representing binary numbers divisible by 4.

    c)   Design a CFG for $L = \{ X^{2n} (Y^m Z^m)^n \} \mid m,n >= 0 \}$ over {X,Y,Z}
           (e.g. XX**XXYZ**YYZZ, XX**YYYZZZ**)

    d)   Design a CFG for $L = \{ a^n b^m c^p \mid$ where, (n,m > 1), (n≠m) and (p > 3) $\}$ over {a,b,c}

3. Convert the following grammars into Chomsky Normal Form (CNF):   4*3

    a) $E \rightarrow T \mid E + T$

           $T \rightarrow F \mid T * F$

           $F \rightarrow I \mid (E)$

           $I \rightarrow a \mid b \mid Ia \mid Ib \mid I0 \mid I1$

    b) $S \rightarrow ASB \mid \epsilon$

           $A \rightarrow aAS \mid a$

           $B \rightarrow SbS \mid A \mid bb$

    C) $A \rightarrow BAB \mid B \mid \epsilon$

           $B \rightarrow 00 \mid \epsilon$

4. Draw the Push Down Automata (PDA) for the following languages: 4*2

  a) $L = \{ a^m b^n c^n a^m \mid m,n > 0 \}$
  b) $L = \{w@w^r \mid w$ is a string over $\{a, b\}*$ and w^r is the reverse of $w\}$

5. Draw a Turing Machine for the following language. 4

  $L=\{a^i b^j c^k \mid i<j<k, i>=1\}$