Homework Assignment-1

King Saud University
CSC-339 Theory of Computation
Spring semester 2021

Name: .....
KSU ID: .....
Section number: .....

Due date: Wednesday March 31st, 2021 at 11pm

Instructions

1. The solution to this assignment should be your own work. Collaboration of any kind is prohibited.
2. After completing the assignment, submit your solution as a PDF file.
3. You may type (using a keyboard) or write (by hand) your answers. In case you choose to write your answer, please make sure your handwriting is clear.
4. Plagiarism of any kind will result in a zero mark for the whole assignment.
5. There are 5 questions. Make sure you answer them all.

Question-1 (20 points)

Design a **DFA** for each of the following sets.

a) The set of strings in {1,3,9} ending in 339. (e.g., 339, 9339, 1339)

b) the set of strings in {a} whose length is divisible by 5. (e.g., aaaaa, aaaaaaaaaa)

c) the set of {0,1} containing the substring 110 or 001. (e.g., 000110, 001001110)

d) the set of {a,b} starting with an *a* and ending with a *b*, or starting with a *b* and ending with an *a*. (e.g., ab, ba, abab, bbaba, aaab)

Question-2 (20 points)

Give regular expressions that generate each of the following languages. You may assume the alphabet is $\Sigma = \{a,b\}$.

1) $\{w \mid w$ contains at least 3 a's or 2 b's$\}$

2) $\{w \mid w$ ends in *aba* and $|w|$ is even$\}$

3) $\{w \mid w$ ends in two different letters$\}$. For instance, *abba* belongs to the language, whereas *baa* does not.

4) $\{w \mid w$ starts and ends with the same letter$\}$.

5) $\{w \mid w$ starts with a double letter$\}$. A double letter is the same letter appearing twice (*e.g.*, *aa* or *bb*).

Question-3 (20 points)

Answer the following questions about $L_1 = \{ww^Rw \mid w \in \Sigma^*\}$. You may assume the alphabet is $\Sigma = \{a,b\}$.

1) Informally describe L_1 (what kind of strings does it have?). Note: make sure your answer is complete.

2) Use the pumping lemma to prove that L_1 is not a regular language.

Question-4 (20 points)

Design a context-free grammar (CFG) that can generate strings for the following languages. You may assume that the alphabet $\Sigma = \{a,b,c\}$.

1) $\{w \mid w$ contains at least three c's$\}$ (e.g., ccc, acbcc, cacbc)

2) $\{w \mid$ the middle symbol is b and $|w|$ is odd$\}$ (e.g., abc, aba, bbb, b, acbab)

3) $\{w \mid w$ contains the substring $cab\}$ (e.g., cab, cabac, bcaba)

4) $\{w \mid w$ has an even number of a's$\}$ (e.g., aba, acabaa, aa)

Question-5 (20 points)

1) Construct a pushdown automaton (PDA) $\boldsymbol{P_1}$ that can recognize the following language

$L_1 = \{a^n b^{2n} \mid n > 0\}$.

2) Provide the formal definition for $\boldsymbol{P_1}$.