



National University of Computer & Emerging Sciences, Karachi

Spring - 2022

Department of Computer Science

Assignment # 3

Due Date: 30/ April/ 2022



Course Code: CS3005	Course Name: Theory of Automata
Instructor Name / Names: Musawar Ali, Bakhtawer Abbasi	
Student Roll No:	Sections: A, B, C, D, E, F

Instructions

- Submit on time, solve by yourself.
- Follow the deadlines.
- Don't cheat and plagiarize.
- Submission method of assignment would be communicated by the course teacher.
- For any query you may contact your course teacher.

Question # 1 DFA Minimization

We discussed in class that DFA minimization is required usually after union, intersection, concatenation and closure. Your task to minimize at least two resultant DFAs of your choice from Question # 6 in assignment # 2.

Question # 2 Regular Grammar (RG) and Push Down Automata (PDA)

Design the RG and PDA for the following languages.

- $\{a^n b^m : (n + m) \text{ is even}\}$
- $\{a^n b^m, n \geq 4, m \leq 3\}$
- $\{a^n b^m, n < 4, m \leq 4\}$
- having exactly one pair of consecutive zeros.
- all strings that contain at least one occurrence of each symbol in alphabet.
- all string not ending in 0, 1.
- all string having at least two occurrences of substring 00.
- $\{w : n_a(w) \bmod 3 = 0\}$

Question # 3 Context Free Grammar (CFG), Push Down Automata (PDA) and Pumping Lemma (PL).

1. Design CFG and PDA for given languages.
 2. Using Pumping prove that any three of the given languages are not regular.
 3. Provide the stack operations for any words of your choice using any 3 of the PDAs you designed in this question.
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- a) The language of even length palindromes
 - b) The language of odd length palindromes
 - c) The languages of all palindromes.
 - d) $a^n b a^n$
 - e) $ww: w \in \{a, b\}^*$
 - f) $\{a^n b^m c^{n+m}\}$
 - g) $\{a^{n+m} b^n c^m\}$
 - h) $\{a^n b^{n+m} c^m\}$
 - i) $\{a^n b^{2m}\}$
 - j) $\{a^{2n} b^{3n}\}$

Question # 4 Simplification of CFG and CNF

Simplify the following CFG and convert the resultant CFG into CNF.

1) $S \rightarrow abS \mid abA \mid abB$

$A \rightarrow cd$

$B \rightarrow aB$

$C \rightarrow dc$

2) $S \rightarrow ABC \mid a$

$A \rightarrow b$

$B \rightarrow c$

$C \rightarrow d$

$E \rightarrow e$

$F \rightarrow f$

$G \rightarrow g$

$$3) S \rightarrow aB|bX$$

$$A \rightarrow Ba|bSX|a$$

$$B \rightarrow aSB|bBX$$

$$X \rightarrow SBD|aBX|ad$$

Question # 5 CFG to PDA

Convert the following CFGs to PDAs

$$a. S \rightarrow XS \mid \epsilon, A \rightarrow aXb \mid Ab \mid ab$$

$$b. S \rightarrow S+X \mid X, X \rightarrow X^*Y \mid Y, Y \rightarrow (S)$$

$$c. S \rightarrow 0S1 \mid 1S0 \mid \epsilon, S \rightarrow 0SX \mid 1SY \mid \epsilon, X \rightarrow 1, Y \rightarrow 0$$

Question # 6 Ambiguity in CFG

Check ambiguity in following CFGs

$$1) S \rightarrow ABC$$

$$A \rightarrow a$$

$$B \rightarrow b$$

$$C \rightarrow c$$

$$2) S \rightarrow aS \mid \epsilon$$

$$3) X \rightarrow X+X \mid X^*X \mid X \mid a$$

Best of Luck

Assignment may be lengthy but it would help you for exams.

Your queries and questions are always welcome