

## THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

F.S. BE III(CSE)

Examination

Day: Monday Date: 06/12/2023 Year: 2023 Time: 3:00 pm to 6:00 pm

SUBJECT: Theory of Computation (CSE1504)

Note: (1) Answer both the sections in separate answer books

Max. Marks: 80

(2) Q1 and Q4 are compulsory.

(3) CO refers to Course Outcome and BT refers to Bloom's Taxonomy

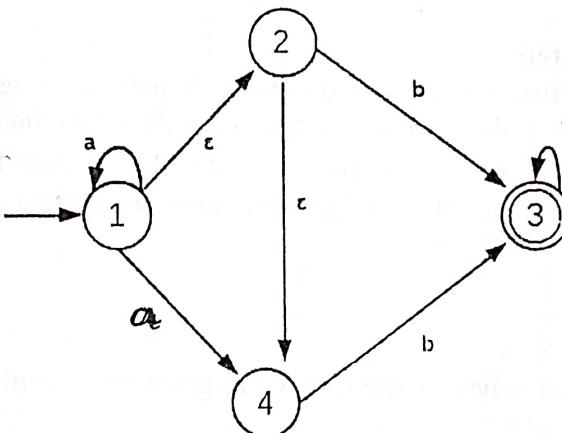
## Section - I

**Q.1 Answer the following questions:**

[12] CO1,2,

3BT-  
1,2,3

- 1) Explain the difference between a deterministic finite automaton (DFA) and a non-deterministic finite automaton (NFA). Provide an example of each.
- 2) State Pumping Lemma for Regular Language.
- 3) Define extended transition function for DFA.
- 4) What is the difference between an empty string and an empty language?
- 5) Write regular expression for the language having all strings not containing the substring 000.
- 6) What is the Chomsky hierarchy, and how does it categorize different types of languages and grammars?

**Q.2 a) What is NFA? Convert the following NFA-  $\epsilon$  into DFA by subset construction: [7]**CO2  
BT-  
3,4,6**b) Create DFA for the following language**[7] CO2  
BT-6 $L = \{ w \mid w \text{ is a binary string that has even number of 1's and odd number of 0's} \}$ 

OR

**Q.2 a) List the Closure property of Regular Languages. Consider the languages  $L_1$  and  $L_2$  as follows:**[7] CO1,2  
BT3,5 $L_1 = \{ x \in \{0,1\}^* \mid 00 \text{ is not a substring of } x \}$  $L_2 = \{ x \in \{0,1\}^* \mid x \text{ ends with } 01 \}$ Find  $L_1 \cup L_2$  and  $L_1 \cap L_2$ .**b) ii) Using the principle of mathematical induction, for all  $n > 0$ , prove that,**  
$$1 \times 2 + 3 \times 4 + 5 \times 6 + \dots + (2n-1) \times 2n = n(n+1)(4n-1)$$
[7] CO1  
BT2,3**Q.3 a) Apply the Kleen's theorem-I and construct an NFA for the regular expression  $(a|b)^*abb(a|b)^*$** [8] CO2,  
BT3,6**b) Design a DFA accepting Binary representation of integer Divisible by 3**[6] CO1,2  
BT2,6

(P.T.O.)

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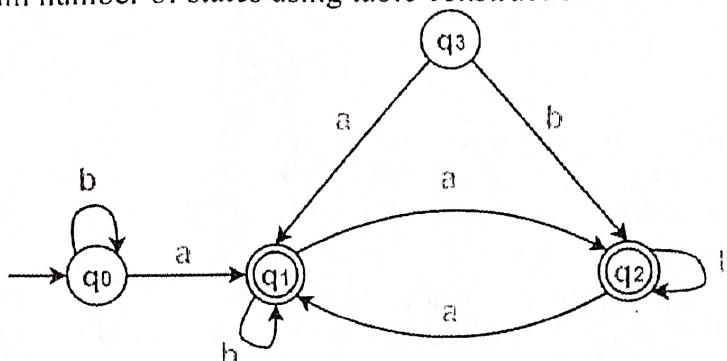
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- OR**
- Q.3 a)** Minimize the following DFA into an equivalent machine and minimum number of states using table construction method.

[8] CO2,  
BT5

- b)** Prove that Language  $L = \{ 0^{n!} / n \geq 1 \}$  is not regular.

[6] CO2,3  
BT4**Section – II**

- Q.4 Do as directed:**

[12] CO4,5,  
6BT1,2,  
3,5

- 1) Describe the key components of a Turing machine, including the tape, head, states, and transition function. How does a Turing machine operate?
- 2) Explain two closure properties of CFL with example.
- 3) Rewrite the following grammar after eliminating  $\epsilon$  productions.

$$\begin{aligned} S &\rightarrow ABBC \mid a \\ A &\rightarrow b \\ B &\rightarrow c \\ C &\rightarrow S \mid \epsilon \end{aligned}$$

- 4) Check whether the following grammar is ambiguous or not.

$$\begin{aligned} S &\rightarrow SAB \mid \epsilon \\ A &\rightarrow AaB \mid a \\ B &\rightarrow AS \mid b \end{aligned}$$

- Q.5 a)** Design a PDA to accept the language  $L = \{ ww^R \mid w \text{ is in } \{0,1\}^* \}$ .

[8] CO4  
BT6

- b)** State the pumping lemma for CFL's and prove that  $L = \{ a^n b^n c^n \mid n \geq 1 \}$  is not context free.

[7] CO1,4  
BT4,6**OR**

- Q.5 a)** Convert the following CFG to PDA

[8] CO1,4  
BT3,5

$$\begin{aligned} S &\rightarrow AS \mid \epsilon \\ A &\rightarrow 0A1 \mid A1 \mid 01 \end{aligned}$$

And simulate the string 000111 on the PDA.

- b)** Convert the following grammar into Chomsky normal form

[7] CO1,4  
BT3,5

$$\begin{aligned} S &\rightarrow ASB \mid \epsilon \\ A &\rightarrow aAS \mid a \\ B &\rightarrow SbS \mid A \mid bb \end{aligned}$$

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THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

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- Q.6 a) Desing Turing machine for the language, [8] CO5  
 $L = \{a^n b^n c^n : n \geq 1\}$  BT6  
b) Elaborate Universal Turing Machine and Halting Problem. [5] CO5,6  
BT1,2

OR

- a) Design a Turing Machine that accept a language  $L = \{ww \mid w \text{ is in } \{0,1\}^*\}$ . [8] CO5  
BT6  
b) Elaborate Enumerable, Recursively Enumerable and Recursive languages with example. [5] CO5,6  
BT1,2

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