

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 pmSUBJECT: Theory of Computation (CSE1504)

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

Max. Marks:80

(2) Q1 and Q4 are compulsory.

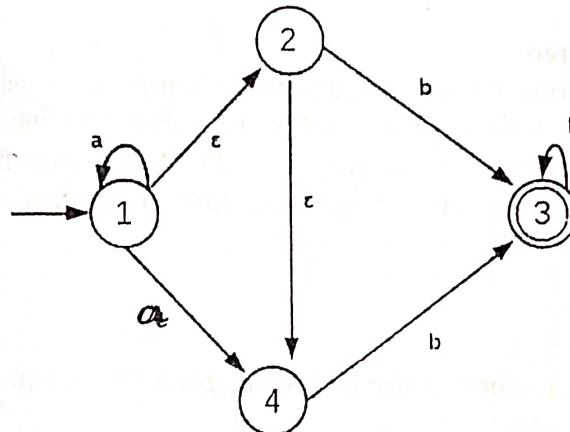
(3) CO refers to Course Outcome and BT refers to Bloom's Taxonomy

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- ϵ into DFA by subset construction: [7]CO2
BT-
3,4,6

- b) Create DFA for the following language
 $L = \{ w \mid w \text{ is a binary string that has even number of 1's and odd number of 0's} \}$

[7] CO2
BT-6

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,

[7] CO1
BT2,3

$$1 \times 2 + 3 \times 4 + 5 \times 6 + \dots + (2n-1) \times 2n = n(n+1)(4n-1) \quad \text{9/3}$$

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

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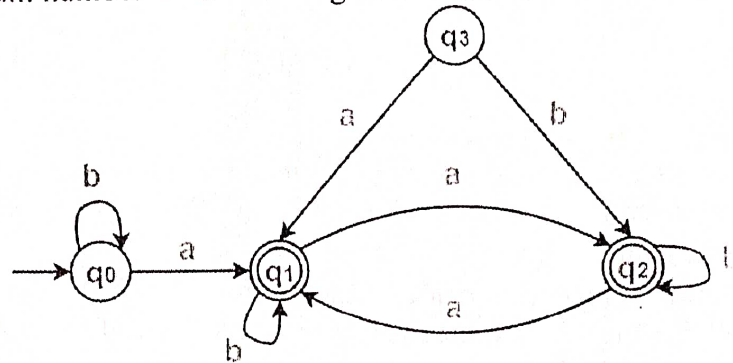
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OR

- 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

- Describe the key components of a Turing machine, including the tape, head, states, and transition function. How does a Turing machine operate?
- Explain two closure properties of CFL with example.
- Rewrite the following grammar after eliminating ϵ productions.
 $S \rightarrow ABBC \mid a$
 $A \rightarrow b$
 $B \rightarrow c$
 $C \rightarrow S \mid \epsilon$
- Check whether the following grammar is ambiguous or not.
 $S \rightarrow SAB \mid \epsilon$
 $A \rightarrow AaB \mid a$
 $B \rightarrow AS \mid b$

- 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

 $S \rightarrow AS \mid \epsilon$ $A \rightarrow 0A1 \mid A1 \mid 01$

And simulate the string 000111 on the PDA.

- b) Convert the following grammar into Chomsky normal form

[7] CO1,4 BT3,5

 $S \rightarrow ASB \mid \epsilon,$ $A \rightarrow aAS \mid a,$ $B \rightarrow SbS \mid A \mid bb$

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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 [5] CO5,6
languages with example. BT1,2
