Mahindra University Hyderabad
École Centrale School of Engineering
Minor - 1

Program: B. Tech Branch: CSE/ARI/CAM/ECM Year: II Semester:2

Subject:- Theory of Computation (CS/AI 2204)

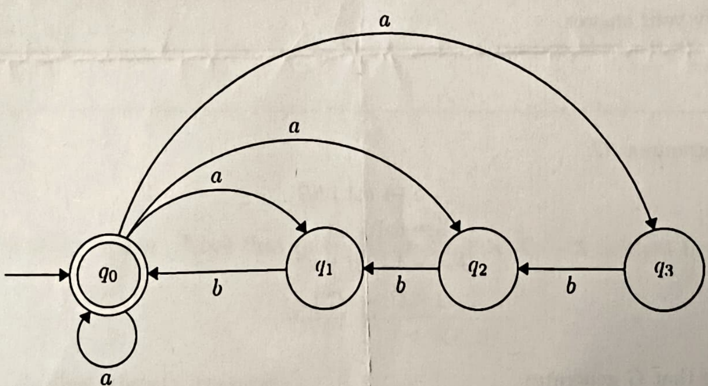
Date: 1/03/2024 Start Time: 02:00 PM
Time Duration: 1 h 30 m Max. Marks: 50

Instructions:

- Answer all the questions.
- All the sub-questions belonging to a question should be answered together and in the given order.
- Write less and write only that is needed.

Q1: (10 M)

Consider the following *Finite State Machine*:



Answer the following questions:

1. Is the given machine a DFA or an NFA? Explain why. (2)
2. Does the machine accept the string abbaa? - Yes / No (2)
3. Does the machine accept the string babaa? - Yes / No (2)
4. Give a string that starts with an a and is not accepted by the machine. (2)
5. Give a description of the regular language that is recognized by it. (2)

Q2: **(10 M)**

Let $G = (\Sigma, V, S, P)$ be a formal grammar, where

- The alphabet $\Sigma = \{a, b\}$
- The variables $V = \{S, A, B, C\}$
- The start variable $S = S$

and the production rules are given as follows:

$$S \rightarrow bA \mid aB$$
$$A \rightarrow aB \mid bA \mid \epsilon$$
$$B \rightarrow aC \mid bB$$
$$C \rightarrow aA \mid bC$$

1. Can this grammar generate the string $\mathsf{b}^{2030} = \underbrace{\mathsf{b}\ldots\mathsf{b}}_{2030 \text{ times}}$? Explain how. (5)

2. Can this grammar generate the string $(\mathsf{baa})^{2030} = \underbrace{\mathsf{baa}\ldots\mathsf{baa}}_{2030 \text{ times}}$? Explain how. (5)

Q3: **(10 M)**

Suppose L_1 and L_2 are two regular languages (over some alphabet Σ). Is it necessary that

$$L_1 - L_2 = \{x \in \Sigma^* | x \in L_1 \text{ and } x \notin L_2\}$$

is also regular? Justify your answer.

Q4: **(10 M)**

Consider the regular grammar G:

$$S \rightarrow aA \mid bB$$
$$A \rightarrow aA \mid bB \mid \epsilon$$
$$B \rightarrow aA \mid bB \mid cC$$
$$C \rightarrow cC \mid \epsilon$$

Let L be the language that G generates.

1. Give the grammar for the language $\bar{L} = \{x \in \Sigma^* | x \notin L\}$. (5)
2. Give the grammar for the language $\bar{L} = \{x^R \in \Sigma^* | x \in L\}$, where x^R is the reverse of x. (5)

Q5: **(10 M)**

Design a DFA over the alphabet $\Sigma = \{0, 1\}$ that accepts the language

$$L = \{x \in \Sigma^* | x \text{ is the binary representation of a number divisible by } 4\}$$

The machine has to have exactly 3 states. Give semantic meanings to each of them.