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MCA
(SEM II) THEORY EXAMINATION 2024-25
THEORY OF AUTOMATA & FORMAL LANGUAGES

TIME: 3 HRS

M.MARKS: 100

Note: Attempt all Sections. In case of any missing data; choose suitably.

SECTION A

1. Attempt all parts in brief.

2 x 10 = 20

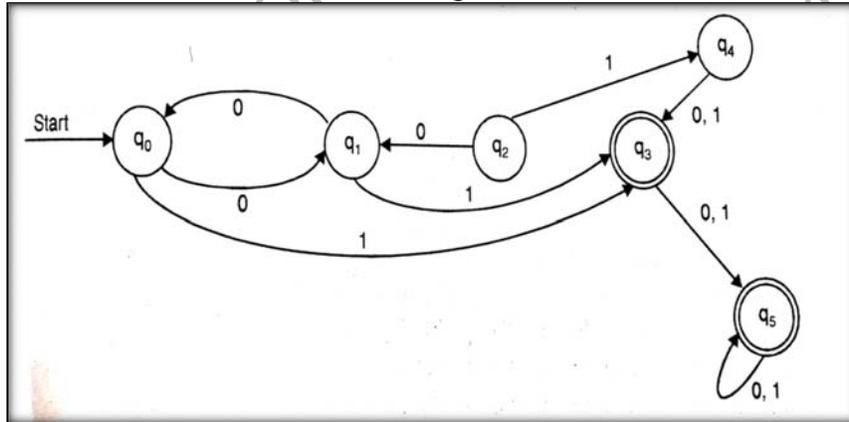
- a. Design a NFA for the language $L = \{ \text{All strings over } \{0,1\} \text{ that have at least two consecutive 0's or 1's.} \}$
- b. What is ϵ -closure of finite automata?
- c. Differentiate between Mealy and Moore machine.
- d. Let G be the given grammar :
 $S \rightarrow 0B \mid 1A \quad A \rightarrow 0 \mid 0S \mid 1AA \quad B \rightarrow 1 \mid 1S \mid 0BB$
 Produce left most derivation for string 00110101
- e. Explain Halting problem of Turing Machine.
- f. What are Type-0 and Type-1 languages according to Chomsky Hierarchy.
- g. Explain Universal TM.
- h. Design a FA to accept the string that always ends with 110.
- i. What is pumping lemma for regular languages?
- j. What are the differences between DFA and NFA?

SECTION B

2. Attempt any three parts of the following:

10 x 3 = 30

a. Construct a minimum state DFA from given FA



- b. (i) Design a DFA which accepts the strings over $\{0, 1\}^*$ in which every 00 is followed immediately by a 1.
- (ii) Consider the below given transition table for NFA:

Q / Σ	a	b	c	ϵ
Q ₀	{Q ₀ }	ϕ	ϕ	{Q ₁ }
Q ₁	ϕ	{Q ₂ }	ϕ	{Q ₂ }
Q ₂	ϕ	ϕ	{Q ₂ }	ϕ

Draw the transition diagram of NFA with null transition from above table.
Convert this NFA to DFA.



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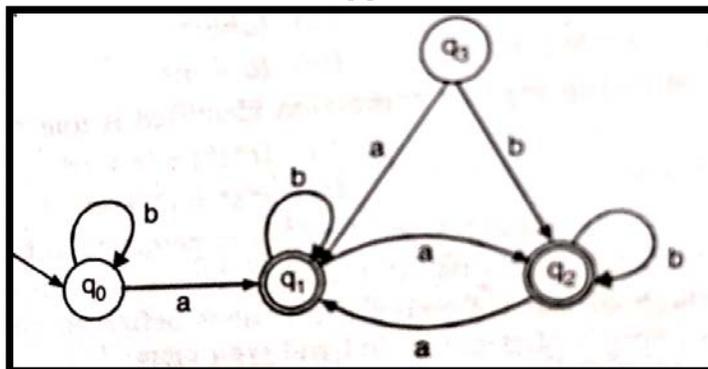
- c. Give the formal definition of Push Down Automata. Design a PDA for the following language: $L = \{wcw^R : w \text{ is set of all strings over a and b}\}$
- d. (i) Eliminate useless grammar symbols from the below given grammar :
 $S \rightarrow aC \mid SB \quad A \rightarrow bSCa \quad B \rightarrow aSB \mid BBC \quad C \rightarrow aBC \mid ad$
(ii) Reduce the below given grammar production rules into Chomsky Normal Form :
 $S \rightarrow bA \mid aB \quad A \rightarrow bAA \mid aS \mid a \quad B \rightarrow aBB \mid bS \mid b$
- e. Define Turing machine mathematically. Illustrate variants of Turing Machines.

SECTION C

3. Attempt any one part of the following:

10x 1 = 10

- a. Apply Arden's theorem to find the regular expression corresponding to the finite automata given below:



(b). (i) Construct a Moore machine that take set of all strings over Alphabet {0, 1} as input and produce 'A' as output if input end with (10) or produce 'B' as output if input end with (11) otherwise produce 'C'.

(ii) Write the regular expression for $L = \{a^n b^m : (n + m) \text{ is even}\}$

4. Attempt any one part of the following:

10 x 1 = 10

- (a) Using Pumping Lemma theorem, prove that the following language $L = \{a^n b a^n\}$ is not regular
- (b) Explain the Closure properties of regular languages.

5. Attempt any one part of the following:

10 x 1 = 10

- (a) (i) Design the CFG for the following languages
 $L = \{a^n b^{2n} c^m : n, m \geq 0\}$
(ii) What are ambiguous grammars? Identify whether the following grammar rules are ambiguous or not :

$S \rightarrow a \mid abSb \mid aAb$
 $A \rightarrow bS \mid aAAb$



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(b) Using Pumping Lemma theorem for context free languages , prove that the following language $L = \{a^n b^n c^n\}$ is not ContextFree.

6. Attempt any one part of the following: 10x 1 = 10

- (a) Design a two stack PDA for following language $L = \{a^n b^n c^n d^n : n \geq 1\}$
- (b) For the given CFG create equivalent PDA that accepts same language they generate.

$$\begin{aligned}
 S &\rightarrow XY \\
 X &\rightarrow aX \mid bX \mid a \\
 Y &\rightarrow Ya \mid Yb \mid a
 \end{aligned}$$

Give the steps of instantaneous description to show acceptance of string $w = baaab$ Using obtained PDA.

7. Attempt any one part of the following: 10 x 1 = 10

- (a) Design a TM for the following language $L = \{a^n b^n \mid n \geq 1\}$
- (OR)

Design a Turing machine which accepts the language $L = \{w \in (a, b)^* : w \text{ has equal number of } a\text{'s and } b\text{'s}\}$

- (b) (i) Let for $\Sigma = \{0, 1\}$, X and Y are lists of three strings each given as below :

$$X = \{1, 10111, 10\} \qquad Y = \{111, 10, 0\}$$

Show that **101111110** is a solution for Post Correspondence Problem.

(ii) Write short notes on the following:

- I. Recursive Language and Recursively Enumerable Language.
- II. Linear Bounded Automata

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