CBCS SCHEME

USN | | | | | | | | | | |

15CS54

Fifth Semester B.E. Degree Examination, June/July 2023

Automata Theory and Computability

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define the following terms with examples:
(i) Alphabet (ii) Length of string (iii) prefix **(05 Marks)**

b. Build a DFSM for the language:
L = {ω ∈ {a, b}* : no two consecutive characters are the same} **(05 Marks)**

c. For the following NDFSM, use ndfsmtodfsm to construct an equivalent DFSM. Begin by showing the value of eps(q) for each state q.

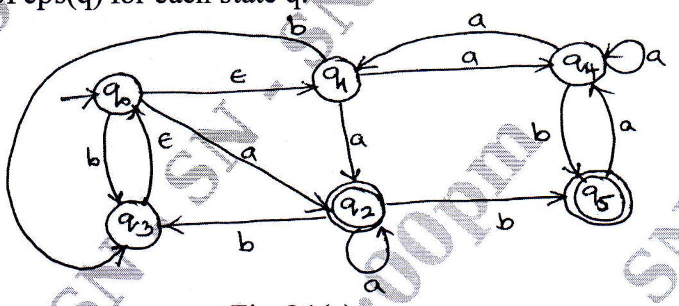

Fig.Q1(c) **(06 Marks)**

OR

2 a. Explain the Machine-Based Hierarchy of Language classes. **(05 Marks)**

b. Build a nondeterministic FSM for the language L = {ω ∈ {a, b}* : ω = bab or |ω| is odd}. **(05 Marks)**

c. Minimize the DFSM.

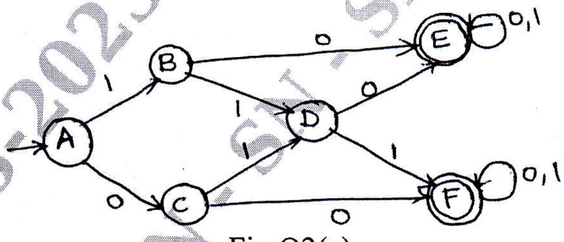

Fig.Q2(c) **(06 Marks)**

Module-2

3 a. Define Regular Expression and write a RE to describe each of the following language:
(i) $L = \{a^n b^m : n \geq 4, m \leq 3\}$
(ii) L = {ω ∈ {a, b}* : ω has both aa and bb as substrings} **(05 Marks)**

b. Show that Regular Languages are closed under complement. **(05 Marks)**

c. Build a Regular Expression from the given FSM.

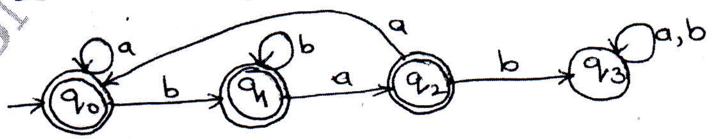

Fig.Q3(c) **(06 Marks)**

OR

4 a. Show a regular grammar for the FSM.

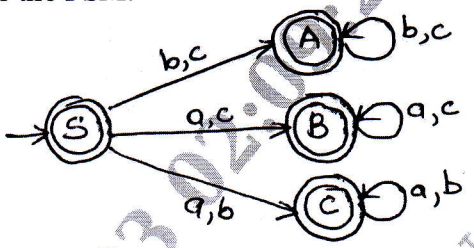

Fig.Q4(a) **(05 Marks)**

b. Build an FSM from the RE $(a^* \cup b^*c^*)^*$. **(05 Marks)**

c. State and prove the pumping lemma for Regular Languages. **(06 Marks)**

Module-3

5 a. Define context free grammar. Design a CFG for the language $L = \{a^n b^m c^m d^{2n} : n, m \geq 0\}$. **(05 Marks)**

b. Consider the CFG with productions

$E \rightarrow E + T \mid T$

$T \rightarrow T * F \mid F$

$F \rightarrow (E) \mid 0 \mid 1$

Write the leftmost derivation, rightmost derivation and a parse tree for the string $0 + 1 * 1$. **(05 Marks)**

c. Design a PDA for the language $L = \{a^n b^{2n} : n \geq 0\}$ **(06 Marks)**

OR

6 a. Prove whether the given grammar is ambiguous grammar or not.

$S \rightarrow aB|bA$

$A \rightarrow aS|bAA|a$

$B \rightarrow bS \mid aBB \mid b$ for the string aab. **(05 Marks)**

b. Define Chomsky normal form. Apply the normalization algorithm to convert the grammar to CNF.

$S \rightarrow ABC$

$A \rightarrow aC \mid D$

$B \rightarrow bB \mid \in \mid A$

$C \rightarrow Ac \mid \in \mid Cc$

$D \rightarrow aa$ **(05 Marks)**

c. Design a PDA for the language $L = \{a^i b^j c^k : i + j = k, i \geq 0, j \geq 0\}$. **(06 Marks)**

Module-4

7 a. Prove that the language $L = \{a^n b^n c^n : n \geq 1\}$ is not context free. **(05 Marks)**

b. Show that context free languages are closure under union, concatenation and kleene star. **(05 Marks)**

c. Design a Turing Machine to recognize all strings consisting of an even number of 1's. **(06 Marks)**

OR

8 a. Explain technique used for TM construction. **(05 Marks)**

b. What is the relationship between DCFL's and the L's that are not inherently ambiguous? Explain. **(05 Marks)**

c. Design a Turing Machine that accepts $L = \{a^n b^n : n \geq 1\}$. Obtain the instantaneous description for the string aabb. **(06 Marks)**

Module-5

9 a. Let $f(n) = 4n^3 + 5n^2 + 7n + 3$. Prove that $f(n) = O(n^3)$. **(05 Marks)**

b. Write a note on quantum computers. **(05 Marks)**

c. Find the running time for the Euclidean algorithm for evaluating gcd(a, b) where a and b are positive integers expressed in binary representation. **(06 Marks)**

OR

10 a. Explain the multi-tape TM. **(05 Marks)**

b. Explain the model of Linear Bounded Automata. **(05 Marks)**

c. Define PCP. Does the PCP with two lists $x = (b, bab^3, ba)$ and $y = (b^3, ba, a)$ have a solution. **(06 Marks)**

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