

CBCS SCHEME

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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:
 $L = \{\omega \in \{a, b\}^* : \text{no two consecutive characters are the same}\}$ (05 Marks)
- c. For the following NDFSM, use ndfsmtoDFSM to construct an equivalent DFSM. Begin by showing the value of $\text{eps}(q)$ for each state q .

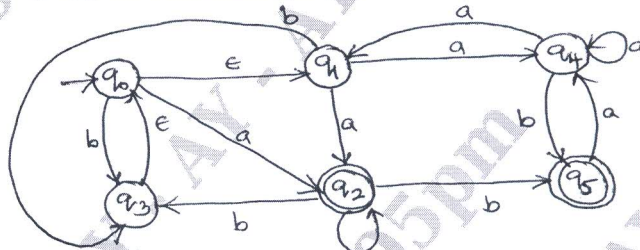


Fig.Q1(c)

(06 Marks)

OR

2. a. Explain the Machine-Based Hierarchy of Language classes. (05 Marks)
- b. Build a nondeterministic FSM for the language $L = \{\omega \in \{a, b\}^* : \omega = bab \text{ or } |\omega| \text{ is odd}\}$. (05 Marks)
- c. Minimize the DFSM.

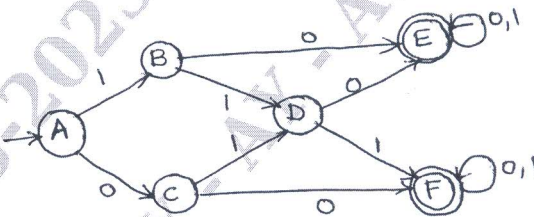


Fig.Q2(c)

(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) $L = \{\omega \in \{a, b\}^* : \omega \text{ has both } aa \text{ and } bb \text{ as substrings}\}$ (05 Marks)
- b. Show that Regular Languages are closed under complement. (05 Marks)
- c. Build a Regular Expression from the given FSM.

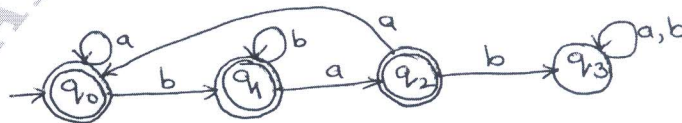


Fig.Q3(c)

(06 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
 2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

- 4 a. Show a regular grammar for the FSM.

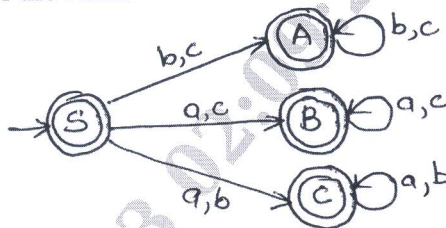


Fig.Q4(a)

- 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.
 $S \rightarrow aB \mid bA$
 $A \rightarrow aS \mid bAA \mid a$
 $B \rightarrow bS \mid aBB \mid b$ for the string aab . (05 Marks)
 b. Define Chomsky normal form. Apply the normalization algorithm to convert the grammar to CNF.
 $S \rightarrow ABC$
 $A \rightarrow aC \mid D$
 $B \rightarrow bB \mid \epsilon \mid A$
 $C \rightarrow Ac \mid \epsilon \mid Cc$
 $D \rightarrow aa$ (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)
