# CBCS SCHEME

USN

15CS/IS54

## Fifth Semester B.E. Degree Examination, July/August 2021
## Automata Theory and Computability

Time: 3 hrs. Max. Marks: 80

**Note:** ***Answer any FIVE full questions.***

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.

**1** a. Design a DFSM to accept $L = \{w \in \{0, 1\}^* : w$ contains even 0's and even 1's$\}$. Show that the string 101011 is accepted. **(05 Marks)**

b. Construct equivalent DFSM for the given NDFSM in Fig.Q.1(b). **(05 Marks)**

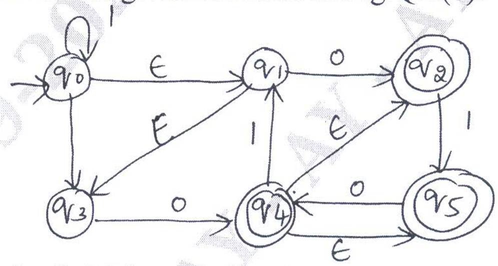


Fig.Q.1(b)

c. Obtain the minimal (minimized) DFSM for the given existing DFSM in Fig.Q.1(c). **(06 Marks)**

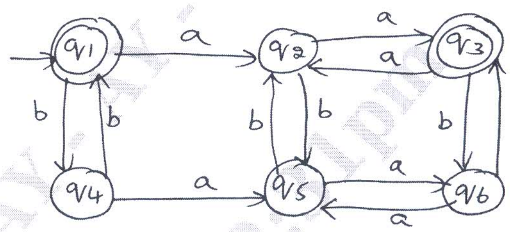


Fig.Q.1(c)

**2** a. Construct DFSM to accept $L = \{w \in \{a, b\}^* : w$ does not contain substring aab$\}$. **(05 Marks)**

b. Obtain the minimal DFSM from the existing DFSM in Fig.Q.2(b). **(08 Marks)**

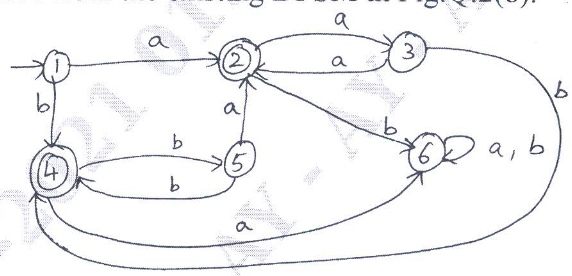

Fig.Q.2(b)

c. Let $L_1$ = {peach, apple, cherry} and $L_2$ = {pie, cobbler, $\in$). List all the elements of $L_1L_2$ in lexicographic order. **(03 Marks)**

**3** a. Define Regular Expression (RE) and write RE for $L = \{w \in \{0, 1\}^* : W$ contains odd number of 0's$\}$. **(04 Marks)**

b. Build a FSM for the RE $(a \cup b)^* \cdot abb$. **(03 Marks)**

c. Build a RE for the given FSM in Fig.Q.3(c). **(06 Marks)**

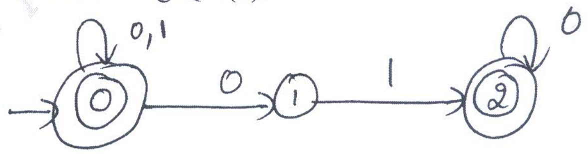

Fig.Q.3(c)

d. Show that regular languages are closed under intersection. **(03 Marks)**

4 a. State and prove pumping theorem for regular languages. (06 Marks)
b. Construct regular grammar G for $L = \{w \in \{a, b\}^* : w$ ends with the pattern aaaa$\}$. Also generate FSM M that accepts L(G). (05 Marks)
c. Show that $L = \{a^n b^n : n \geq 0\}$ is not regular. (05 Marks)

5 a. Define Context Free Grammar (CFG). Design CFG for $L = \{w \in \{a, b\}^* : \#_a(w) = \#_b(w)\}$ (04 Marks)
b. Is the balanced parenthesis grammar (BAL) $S \to SS|(S)|\in$ is ambiguous. If so, obtain unambiguous grammar. (07 Marks)
c. Design a PDA for $L = \{wCw^R : w \in \{0, 1\}^*\}$. (05 Marks)

6 a. Convert the grammar to Chomsky Normal Form (CNF).
$S \to aACa$
$A \to B|a$
$B \to C|c$
$C \to cC|\in$ (06 Marks)
b. Design PDA for $L = \{ww^R : w \in \{a, b\}^*\}$. (05 Marks)
c. Obtain LMD, RMD and parse tree for the string "+ * - xyxy" using the rules:
$E \to +EE|*EE|-EE|x|y$ (05 Marks)

7 a. Show that $L = \{0^n 1^n 2^n : n \geq 0\}$ is not context free. (05 Marks)
b. Design a Turing machine to accept $L = \{0^n 1^n : n \geq 1\}$ show moves for string 0011. (07 Marks)
c. Prove that context free languages are closed under union. (04 Marks)

8 a. State and prove pumping theorem for context free language. (05 Marks)
b. Design a Turing machine which can multiple two positive integers (m, n). (07 Marks)
c. Define deterministic context free language and show that deterministic CFL are not closed under intersection. (04 Marks)

9 a. Define Post Correspondence Problem (PCP). Does the PCP with two lists.
$X = \{b, bab^3, ba)$ and
$Y = (b^3, ba, a)$ have a solution. (06 Marks)
b. If L is recursive language over $\Sigma$, show that $\overline{L}$ is also recursive. (06 Marks)
c. Let $f(n) = 4n^3 + 5n^2 + 7n + 3$ prove that $f(n) = O(n^3)$. (04 Marks)

10 a. Prove that the Turing machine M that halts on input w is undecidable. (05 Marks)
b. Explain the model of Linear Bounded Automata (LBA), with a neat diagram. (05 Marks)
c. Write short notes on:
i) Quantum computers
ii) Church Turing thesis. (06 Marks)

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