CBCS SCHEME

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17CS54

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

Time: 3 hrs. Max. Marks: 100

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. Define the following terms with examples:
(i) Alphabet (ii) Strings (iii) Kleene's closure
(iv) Languages (v) Concatenation **(05 Marks)**

b. Draw a DFA to accept the following languages.
(i) L = {w ∈ {a – z}*, all five vowels a, e, i, o and u occur in w in alphabetical order}
(ii) L = {w ∈ {a, b}*, set of all strings containing the substring "aab"} **(06 Marks)**

c. Convert the following ∈-NFA to its equivalent DFA. [Refer Fig.Q1(c)]

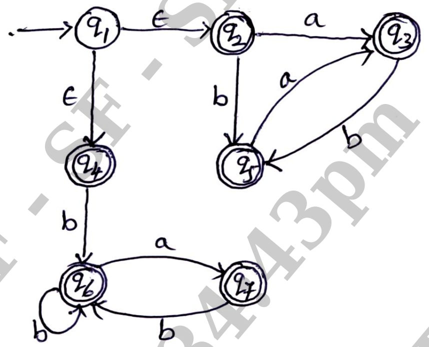

Fig.Q1(c) **(09 Marks)**

2 a. Obtain a DFA to accept the following language.
L = {w ∈ {a, b}*, $N_a(w)$ mod 5 = 0 and $N_b(w)$ mod 3 = 0} **(06 Marks)**

b. Give the differences between DFA, NFA and ∈-NFA. **(05 Marks)**

c. Minimize the following DFSM. [Refer Fig.Q2(c)]

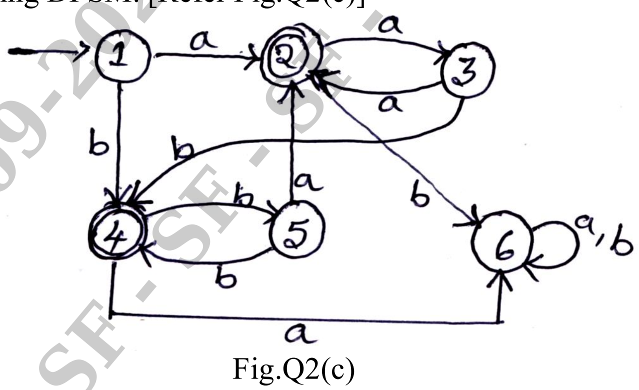

Fig.Q2(c) **(09 Marks)**

3 a. Obtain a regular expression for each of the following languages:
(i) L = {w|w∈{a, b}* with atleast three consecutive zero's} **(03 Marks)**
(ii) L = {w∈{a, b}* set of all strings starting with a and ending with b} **(03 Marks)**
(iii) L = {w|w∈{a, b}* whose second symbol from the right end is 'a'} **(04 Marks)**

b. Obtain the regular expression for the following FSM using Kleene's theorem.

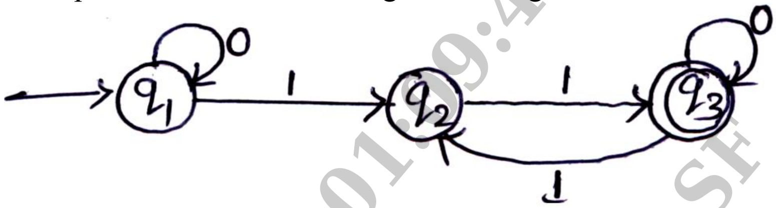

Fig.Q3(b) **(10 Marks)**

4 a. Show that the following languages are not regular:
(i) $L = \{a^n b^n \mid n \geq 0\}$ (ii) $L = \{1^p \mid p \text{ is prime}\}$ **(08 Marks)**

b. Simplify the following regular expression $((a^* \cup \phi)^* \cup aa)\ (b \cup bb)^*\ b^*\ ((a \cup b)^* b^* \cup ab)^*$ **(06 Marks)**

c. If L_1 and L_2 are regular languages, then prove that $L_1 \cup L_2$, $L_1 \cdot L_2$ and L_1^* are regular languages. **(06 Marks)**

5 a. Obtain a grammar to generate each of the following languages:
(i) $L = \{a^n b^{2n} : n \geq 0\}$
(ii) $L = \{ww^R \text{ where } w \in \{a, b\}^*\}$ **(05 Marks)**

b. If the following grammar ambiguous?
$S \rightarrow aS|X$
$X \rightarrow aX|a$ **(05 Marks)**

c. Convert the following grammar to Chomsky Normal Form (CNF).
$S \rightarrow aACa$
$A \rightarrow B \mid a$
$B \rightarrow C \mid c$
$C \rightarrow cC \mid \in$ **(10 Marks)**

6 a. Define PDA and obtain a PDA to accept a string of balanced parenthesis. **(04 Marks)**

b. Construct a PDA to accept the language $L = \{wcw^R \mid w \in \{a, b\}^*\}$. Draw the graphical representation of this PDA. Show the moves made by this PDA for the string "abCba" **(10 Marks)**

c. Convert the following grammar into equivalent PDA.
$E \rightarrow E + T$
$E \rightarrow T$
$T \rightarrow T * F$
$T \rightarrow F$
$F \rightarrow (E)$
$F \rightarrow id$ **(06 Marks)**

7 a. If L_1 and L_2 are Context Free Languages (CFL's), then prove $L_1 \cup L_2$, $L_1 \cdot L_2$ and L_1^* are context free languages. **(05 Marks)**

b. State and prove pumping lemma for context free languages and show that $L = \{a^n b^n c^n \mid n \geq 0\}$ is not context free. **(10 Marks)**

c. Explain with neat diagram the working of turing machine model. **(05 Marks)**

8 a. Explain with neat diagram, the model of Linear Bounded Automata (LBA). **(06 Marks)**

b. Design a TM (Turing Machine) that accepts $L = \{0^n 1^n \mid n \geq 1\}$. **(06 Marks)**

c. Consider the turing description given in the following table. Draw the computation sequence of the input string "00". **(08 Marks)**

Present State	Tape symbols		
	b	0	1
$\rightarrow q_1$	1 L q_2	0 R q_1	
q_2	b R q_3	0 L q_2	1 L q_2
q_3	-	b R q_4	b R q_5
q_4	0 R q_5	0 R q_4	1 R q_4
q_5	0 L q_2		

9 a. M is a turing machine represented by the transition diagram. Obtain the computation sequence of M for processing the input string "0011". {Refer Fig.Q9(a)]

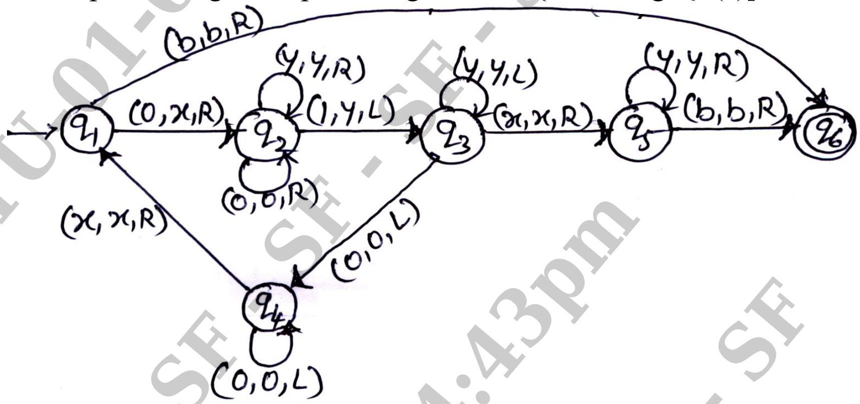

Fig.Q9(a) **(06 Marks)**

b. Design a Turing Machine (TM) to recognize all strings consisting of an even number of 1's. **(04 Marks)**

c. Design a Turing Machine (TM) to recognize the language. $L = \{1^n 2^n 3^n \mid n \geq 1\}$ **(10 Marks)**

10 Write short notes on:

a. Decidable and undecidable languages **(05 Marks)**

b. Halting problem of TM **(05 Marks)**

c. Post-correspondence problem **(05 Marks)**

d. Church-Turing thesis **(05 Marks)**

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