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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

V Semester B. E. Examinations March / April-2023

Computer Science and Engineering

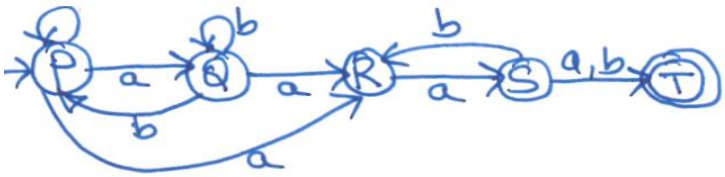
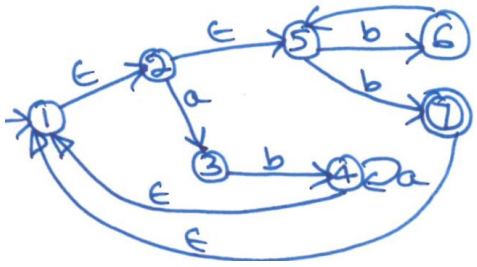
FINITE AUTOMATA FORMAL LANGUAGES

Time: 03 Hours ***Maximum Marks: 100***

Instructions to candidates:

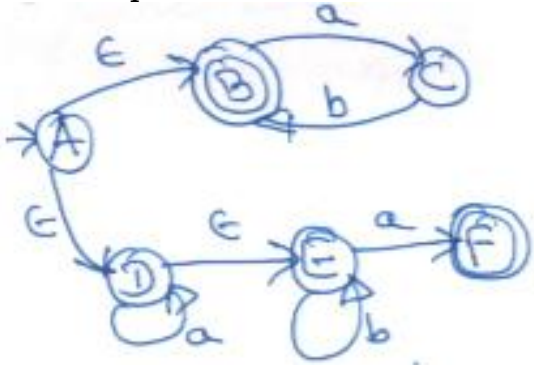
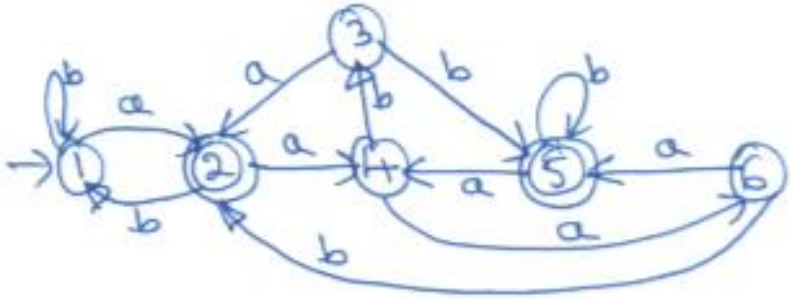
1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer FIVE full questions from Part B. In Part B question number 2, 7 and 8 are compulsory. Answer any one full question from 3 and 4 & one full question from 5 and 6

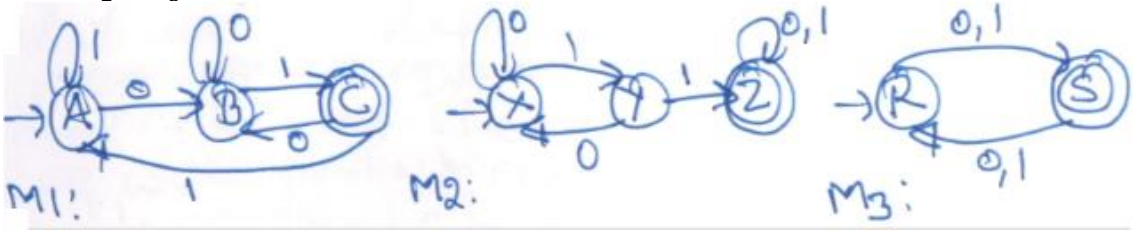
PART-A

1	1.1	Find $\delta^*(P, abab)$ in the NFA shown in Fig.1.1.  Fig.1.1	02
	1.2	Compute $\epsilon - closure$ $(\{3,4,5,6\})$ in the $\epsilon - NFA$ given in Fig. 1.2.  Fig. 1.2	02
	1.3	Give the regular expression which generates all the strings over $\{a, b\}$ and contains at least one 'a' and at least one 'b'.	01
	1.4	Let G be the CFG with productions $S \to S+S \mid S-S \mid S*S \mid S/S \mid (s) \mid a$. How many distinct left most derivations are there for the string $a+(a*a)/a-a$.	02
	1.5	Consider the grammar with productions $S \to SS \mid bTT \mid TbT \mid TTb \mid \epsilon$, $T \to aS \mid SaS \mid Sa \mid a$, what kind of strings are derived by this grammar with respect to number of a's and number of b's in the derived string.	02
	1.6	Let G be the CFG with productions set $\{S \to aB \mid bA, A \to a \mid aS \mid bAA, B \to b \mid bS \mid aBB\}$. Consider any derivation for the string ""$aababbaababb$" ". How many steps such a derivation contains?	02
	1.7	Which are the nullable variables in the CFG with the productions $\{S \to ABC \mid aS, A \to aA \mid bB \mid \epsilon, B \to BB \mid bS/A,\ C \to AB \mid aaD \mid aDb \mid a, D \to aD \mid bD\}$.	01
	1.8	Show that the CFG with productions $\{S \to o \mid o_1S_1 \mid oA_1, A \to IS \mid oAA_1\}$ is ambiguous.	02

	1.9	Find them language corresponds to the right linear grammar with the productions $\{S \rightarrow aA\|bC\|b, B \rightarrow aC\|bA\|a, A \rightarrow aS\|bB, C \rightarrow aB\|bS\}.\|$	02
	1.10	Identify the language corresponds to the context sensitive grammar with the productions $\{S \rightarrow ABCS\|ABC, AB \rightarrow BA, AC \rightarrow CA, BC \rightarrow CB, BA \rightarrow AB, CA \rightarrow AC,$ $CB \rightarrow BC, A \rightarrow a, B \rightarrow b, C \rightarrow c\}\|$	02
	1.11	What is the solution to the instance of PCP give below: i | $List\ A$: X_i | $List\ B$: Y_i 1 | 1 | 010 2 | 0 | 10 3 | 10 | 101 4 | 01 | 100 5 | 100 | 0	02

PART-B

2	a	Define regular expression formally. For the following languages over $\sum\{a, b\}$, find the corresponding regular expression. i) Every string in the language contains minimum 3 a's. ii) Every string in the language contains atleast one pair of aa or bb.	04
	b	Prove that for every $\in$-NFA there exists an equivalent DFA accepting the same language. Find the equivalent DFA for the $\in$-NFA given in Fig.2b.  Fig.2b.	08
	c	For the DFA shown in Fig.2c, use the minimization algorithm to find a minimum state DFA recognizing the same language.  Fig.2c	04
3	a	State and prove the pumping lemma for regular languages. Apply this lemma to show the language $L = \{\{xy\|x, y\epsilon\{a, b\}^*\}$ where Y is either x or $x^R\}$ is not regular.	08

	b	Let M_1, M_2 and M_3 are the $DFA's$ shown in Fig.3b recognizes languages L_1, L_2 and L_3 respectively. Draw $DFAs$ recognizing the languages $L_1 \cup L_2$ and $L_2 \cap L_3$.  Fig.3b	04
	c	Describe the decision algorithm to answer the following questions: i) Given a regular expression γ and a $DFA\ M$, are the corresponding languages are same? ii) Given two $\in$-$NFAs$, do they accepts the same language?	04
		OR	
4	a	Give context free grammar which generates the following languages: i) $L_1 = \{a^i b^j c^k \mid i = j + k,\ i,j,k \geq 1\}$ ii) $L_2 = \{a^i b^j c^k \mid i = j \text{ or } j = k,\ i,j,k \geq 1\}$	04
	b	Define eNF grammar. List out the steps to be followed while converting the CFG into GNF form. For the CFG with the productions listed below, find the equivalent grammar in GNF which generated the same language. $S \to AB \mid AC, A \to aAb \mid bAa \mid a, B \to bbA \mid aaB \mid AB,\ C \to abCa \mid aDb,\ D \to bD \mid aC.$	08
	c	Describe the language generated by the left linear grammar with the productions $S \to Sb \mid Aa \mid \in, A \to Aa \mid Bb \mid b, B \to Sb.$ Find an equivalent right linear grammar to the given left Linear grammar.	04
5	a	Define PDA and the language of PDA. Construct PDA which accepts the following language L. You may accept either by final state or by empty stack. $L = \{WW^R \mid W \epsilon \{a,b\}^*\}$. Show by using IDs the string $abba$ is accepted.	08
	b	What are the steps to be followed while finding an equivalent PDA by empty stack for the given CFG. Find the equivalent PDA to the CFG with productions $S \to aSb \mid bSa \mid abS \mid Sab \mid baS \mid Sba \mid \epsilon\}$. Show that the string $abaabb$ is generated by the given CFG and it is also accepted by the equivalent PDA.	08
		OR	
6	a	State and prove the pumping lemma for context free languages. Apply this lemma to show $L = \{ww \mid w \epsilon \{a,b\}^*\} is$ not CFL.	06
	b	Let $L_1 = \{a^i b^j c^k \mid i < j\}$ and $L_2 = \{a^i b^j c^k \mid i < k\}$. Show that L_1 and L_2 are context free languages but L_3=$L_1 \cap L_2$ is not context free.	04
	c	Decide in each case whether the given language is a CFL, and prove your answer. i) $L_1 = \{a^i b^j a^j b^i \mid i.j \geq 0\}$ ii) $L_2 = \{XcX \mid X \epsilon \{a,b\}^*\}$	06

7	a	Define Turing Machine and the language acceptance by Turing Machine. Design Turing Machine which accepts $L = \{a^n b^{2n} \mid n > 0\}$. Using instantaneous descriptions show that the string $aabbbb$ is accepted by the constructed Turing Machine.	08
	b	Design Turing Machine to perform the string concatenation operation $f(x, y) = xy$ where $x, y \epsilon \{a, b\}^*$. Use instantaneous description to show the operation on $X = aba$ and $Y = bba$.	05
	c	Show that if the language is recursive then it is recursively enumerable also.	03
8	a	Construct Linear Bounded Automata to accept the language $L = \{wcw^R \mid w \epsilon \{a, b\}^*\}$. Using instantaneous descriptions show that the string $w = abbcbba$ is accepted.	06
	b	Define unrestricted grammar. Find the unrestricted grammar to generate the language $L = \{a^n \times b^n \mid n \geq 0, \mid x \mid = n \epsilon \{a, b\}^*\}$. Give the derivation for the string $w = aabbbb$.	06
	c	Write a note on Chomsky hierarchy.	04