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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

V Semester B. E. Examinations Apr-2024

Computer Science and Engineering

FINITE AUTOMATA FORMAL LANGUAGES

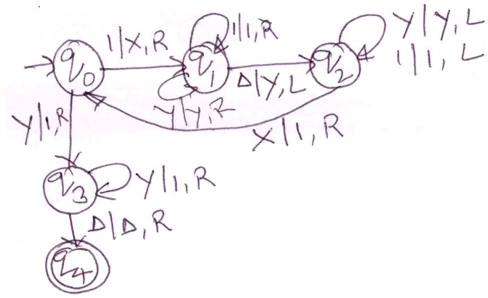
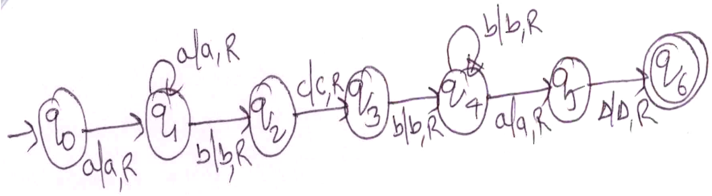
Time: 03 Hours ***Maximum Marks: 100***

Instructions to candidates:

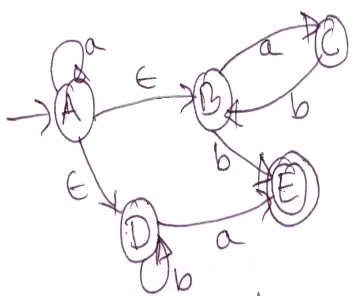
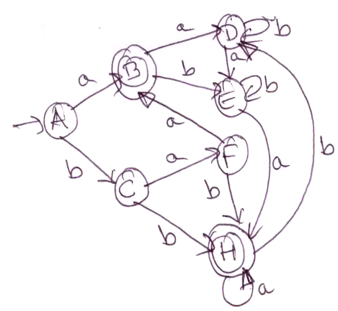
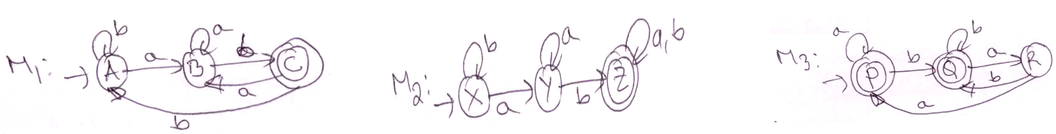
1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer FIVE full questions from Part B. In Part B question number 2, 7 and 8 are compulsory. Answer any one full question from 3 and 4 & one full question from 5 and 6

PART-A

			M	BT	CO
1	1.1	For the language $L = \{ab, bc, a\}$ over the alphabet $\Sigma = \{a, b, c\}$. Find L^3.	01	1	1
	1.2	Write the regular expression for the language $L = \{a^{2n}b^{2m}b \mid n, m \geq 0\}$ over the alphabet $\Sigma = \{a, b\}$.	01	1	1
	1.3	Consider two regular expressions $r = 0^* + 1^*$ and $s = 01^* + 10^* + 1^*0 + (0^*1^*)^*$. Find a string corresponds to r but not to s.	01	2	1
	1.4	For the regular expression $((ab)^*a + (ba)^*b)^*$ find an equivalent $\epsilon - NFA$ by applying Kleen's theorem part-1.	02	1	2
	1.5	Give DFA to accept the language over $\Sigma = \{0, 1\}$ the set of all strings that either begin or end or both with 01.	02	3	4
	1.6	Identify the language generated by the CFG with productions $S \rightarrow aSaSbS \mid aSbSaS \mid bSaSaS \mid \epsilon$	01	1	2
	1.7	Show that the CFG with productions $S \rightarrow aSb \mid aaSb \mid \epsilon$ is ambiguous.	01	1	1
	1.8	Let G be the CFG with productions: $S \rightarrow XA \mid YC \mid b$, $A \rightarrow XS \mid YB$, $B \rightarrow XC \mid YA \mid a$, $C \rightarrow XB \mid YS$ $X \rightarrow a$, $Y \rightarrow b$. How many steps are there to derive a string $aabbaba$?	01	1	2
	1.9	Let G be the CFG with productions $S \rightarrow S + S \mid S - S \mid S * S \mid S/S \mid (S) \mid a$. How many distinct left most derivations are there for the string $a + (a * a)/(a - a) + a$?	01	3	3
	1.10	For the grammar with productions $S \rightarrow AA \mid B$, $A \rightarrow AAA \mid Ab \mid bA \mid a$, $B \rightarrow bB \mid b$. Find the equivalent grammar which has no left recursion and no null productions.	01	2	2
	1.11	Identify the useless variables in the in the grammar with productions: $S \rightarrow ABC \mid aS$, $A \rightarrow aA \mid bB \mid \epsilon$, $B \rightarrow BB \mid bS \mid A$, $C \rightarrow AB \mid aaD \mid aDb$, $D \rightarrow aD \mid bD$, $E \rightarrow a \mid bS$.	01	1	2
	1.12	Construct the parser tree for the string $(a + a * a) * a$ by using the productions $S \rightarrow S + T \mid T$, $T \rightarrow T * F \mid F$, $F \rightarrow (S) \mid a$.	01	1	2

1.13	Identify the function computed by the Turing Machine shown in Fig 1.13.  Fig. 1.13	02	3	2
1.14	Give the last instantaneous description for the string *abcba* from the Turing Machine shown in Fig. 1.14  Fig. 1.14	02	3	4
1.15	Find the language generated by the context sensitive grammar with the productions: $S \rightarrow LaR$, $L \rightarrow LD \vert \epsilon$, $Da \rightarrow aaD$, $DR \rightarrow R$, $R \rightarrow \epsilon$	02	2	2

PART-B

2	a	Show that for a language L accepted by an $\epsilon - NFA$ there exists an equivalent DFA that recognizes the language L. Find the equivalent DFA for below $\epsilon - NFA$.  Fig. 2.a	10	3	4
	b	 Fig. 2.b For the DFA shown below use the minimization algorithm to find a minimum state DFA recognizing the same language.	06	2	2
3	a	State and Prove pumping lemma for regular languages. Using this lemma show that the language $L = \{ww \vert w \ \varepsilon \ \{a,b\}^*\}$ is not regular.	06	1	1
		Let M_1, M_2 and M_3 are the $DFA's$ as shown in Fig. 3.b recognizing languages L_1, L_2 *and* L_3 respectively. Draw $DFA's$ recognizing the following languages. i) $L_1 \cup L_2$ ii) $L_1 \cap L_3$ iii) $L_2 - L_3$  Fig. 3.b	06	3	4

c	Describe the decision algorithm to answer each of the following questions: i) Given a regular expression r and an $DFA\ M$, are the corresponding language are same? ii) Given two $NFA - \epsilon$, do they accept the same language?	04	2	3
	OR			
4 a	For the CFG with productions as below, find the equivalent GNF grammar. $S \to AA\|B$, $A \to AAA\|Ab\|bA\|\epsilon$, $B \to bB\|\epsilon$.	05	3	3
b	Find LLG for generating the languages corresponding to the language of the below regular expressions: i) $(a+b)^*(ab+ba)$ ii) $(a+b)^*aa(a+b)^*$	06	4	3
c	For the LLG with the productions as shown find the following: $A \to Ba\|Ab\|b$, $B \to Ca\|Db$, $C \to Aa\|Bb\|a$, $D \to Da\|Cb$ The language of the grammar i) The equivalent RLG ii) Give the derivation for $ababab$.	05	3	2
5 a	Define PDA and language accepted by PDA. Construct PDA to accept the language $L = \{a^i b^j c^k \| i,j,k \geq 0\ and\ j = i\ or\ j = k\}$. Show the string $aabbbccc$ is accepted by using the instantaneous description.	08	3	4
b	Define $DPDA$. Construct $DPDA$ to accept the language $L = \{w\|w\epsilon\{a,b\}^*\ and\ N_a(w) < N_b(w)\}$. Show that the string $baababb$ is accepted.	05	3	4
c	Show that if L is accepted by PDA in which no symbols are ecver removed from the stack, then L is regular.	03	2	1
	OR			
6 a	What are the steps to be followed while finding an equivalent CFG from the given PDA by empty stack. Construct empty stack PDA to accept the language $L = \{wcw^R\|w\epsilon\{a,b\}^*\}$ and find its equivalent CFG. Show that the string $abacaba$ is accepted the PDA and it is generated by the equivalent CFG.	08	4	4
b	Apply pumping lemma to show that the language $L = \{w\|w\epsilon\{a,b,c\}$ and $N_a(w) < N_b(w) < N_c(w)\}$ is not a context free language.	03	1	1
c	Prove the statement "if L_1 is CFL and L_2 is CFL then $L_1 \cap L_2$ is not CFL but if L_2 is regular then $L_1 \cap L_2$ is CFL.	05	3	2
7 a	Define Turing Machine and the language of Turing Machine. Construct Turing Machine to accept the language $L = \{w\|w\ \varepsilon\ \{a,b,c\}^*$ such that w is a palindrome$\}$. Show by using instantaneous descriptions the string $abccba$ is accepted.	08	4	4
b	Let x and y are two positive integers represented using unary notation. Design a Turing Machine that computes the function $f(x,y)$, where $x, y \in 1^+$ $f(x,y) = x - y$ if $x > y$ $f(x,y) = y - x$ if $y > x$ $f(x,y) = 0$ if $x = y$ Trace the operation of the constructed Turing machine for $x = 11111$ & $y = 111$.	08	4	4

8	a	Define Linear Bounded Automata (LBA) and the language accepted by linear bounded automata. Construct linear bounded automata to accept the language $L = \{\ \omega \mid \omega \in \{a, b, c\}^{*}$b such that w has equal number of $a's$, $b's$ and $c's\}$ show by using instantaneous description the string $bcacba$ is accepted.	08	4	4
	b	Define unrestricted grammar. Write the unrestricted grammar to generate the language $L = \{ww \mid w \epsilon \{a, b\}^{*}\}$. Give the derivation for the string $babbab$.	04	3	2
	c	Briefly explain the Chomsky hierarchy.	04	1	2