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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

V Semester B. E. Examinations Jan/Feb-21

Computer Science and Engineering

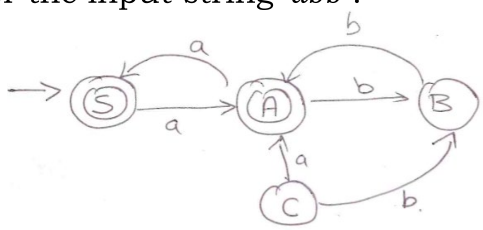
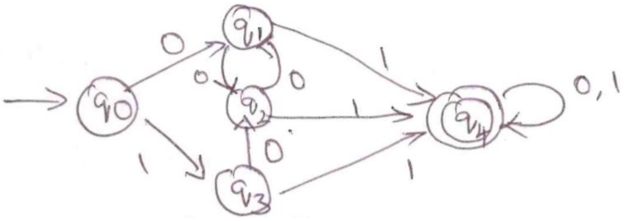
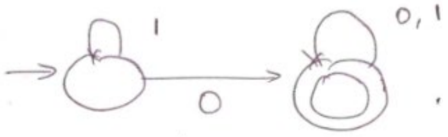
FINITE AUTOMATA AND FORMAL LANGUAGES

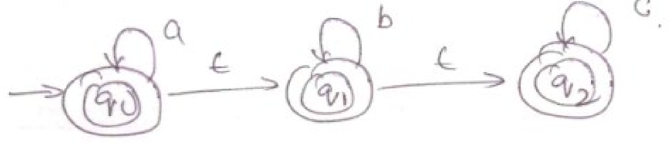
Time: 03 Hours ***Maximum Marks: 100***

Instructions to candidates:

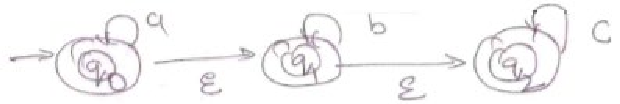
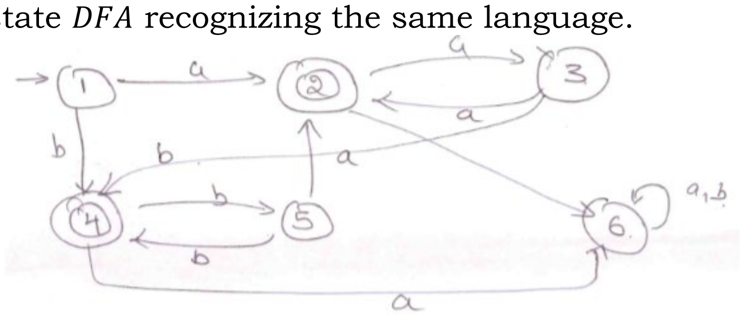
1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer FIVE full questions from Part B. In Part B question number 2, 7 and 8 are compulsory. Answer any one full question from 3 and 4 & one full question from 5 and 6

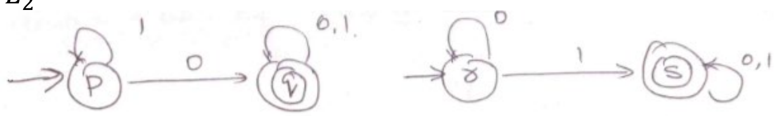
PART-A

1	1.1	Give DFA accepting the language over $\Sigma = \{a, b\}$. The set of all string that has even number of a's and b's.	01
	1.2	Consider the following automata given in Fig. 1.2. What is the set of reachable status for the input string 'abb'?  Fig. 1.2	01
	1.3	The minimum state automation equivalent to the FA shown in Fig 1.3 has how many number of states?  Fig 1.3	02
	1.4	Find the string of minimum length in $\Sigma = \{0, 1\}$. Not in the language corresponding to the regular expression $1^*(0\,1)^*\,0^*$	01
	1.5	Write a regular expression to describe each of the following languages: i) $\{w \in \{a, b\}^* :$ every a in w is immediately followed and preceded by $b\}$. ii) $\{w \in \{a, b\}^* : w$ does not end in $ba\}$	01
	1.6	Find $R_{12}^2 = ?$  Fig 1.6	01
	1.7	Define Non-deterministic push down automata	01

1.8		Define E- closure (q), where $q \in Q$ of an automata. And compute $eps(q)$ for each state in Q for the given NFA in Fig.1.8.  Fig 1.8	02
1.9		What is the language generated by the CFG with the productions $S \rightarrow aSa \vert bsb \vert \epsilon$	01
1.10		Define Right-most derivation. Give RMD for $aaabbabbba$ in the grammar with productions $S \rightarrow aB \vert Ba$ $A \rightarrow aS \vert bAA \vert a$ $B \rightarrow bS \vert aBB \vert b$	02
1.11		Identify the nullable variables in the grammar given below: $S \rightarrow aTa, T \rightarrow ABC, A \rightarrow Aa \vert C, B \rightarrow Bb \vert C, C \rightarrow c \vert \epsilon$	01
1.12		Define Deterministic push down automata.	01
1.13		Obtain turning machine over{1} which can compute a concatenation function.	02
1.14		Define right linear grammar Consider left linear grammar. $S \rightarrow Aa,\ A \rightarrow ab$. Find the right linear grammar which is equivalent to the above left grammar.	01
1.15		Recursively enumerable languages are also called as __________.	01
1.16		What is the solution to the instance of PCP given below x | y b | b^3 bab^3 | ba bab^3 | a	01

PART-B

2	a	Find the regular expressions corresponding to each of the following subsets of $\{a,b\}^*$ i) $L = \{ w \in \{a,b\}^* : \vert w \vert \text{ is even}\}$ ii) $L = \{ w \in \{a,b\}^* : w \text{ contains odd number of } a's \}$	04
	b	Consider the NFA shown in Fig 2.b, using the subset construction method draw the DFA accepting the language which is same as the language accepted by NFA.  Fig 2.b	06
	c	For the DFA in Fig 2.c use the minimization algorithm to find a minimum state DFA recognizing the same language.  Fig 2.c	06

3	a	State and prove pumping lemma for regular languages.	05
	b	Using pumping lemma show that the language $L = \{ ww^R : w \in \{a,b\}^* \}$ is not regular.	05
	c	Let M_1 and M_2 are the $DFA's$ as shown in Fig 3.c accepting languages L_1 and L_2 respectively. Draw $DFAs$ accepting the following languages: i) $L_1 \cap L_2$ ii) $L_1 - L_2$  Fig 3.c	06
		OR	
4	a	Define CFG. Construct CFG to generate the following languages: i) $L1 = \{ a^i \, b^j \, c^k \mid i = j + k \}$ ii) $L_2 = \{ a^i \, b^j \, c^k \mid j - i \; or \; j = k \}$	06
	b	Define ambiguity in CFG. Show that the CFG below is ambiguous. $S \rightarrow ABA$ $A \rightarrow Aa \mid \epsilon$ $B \rightarrow bB \mid \epsilon$	04
	c	Given below a CFG G, find a CFG G' in GNF generating $L(G) - \{\epsilon\}$ $S \rightarrow XA \mid BB$ $B \rightarrow b \mid SB$ $X \rightarrow b$ $A \rightarrow a$	06
5	a	Define PDA. Construct PDA to accept the language $L = \{ w \subset w^R : w \in \{a,b\}^* \}$. Show by IDs the string aabcbba is accepted.	06
	b	Obtain a CFG for the PDA below: $\delta(q_1, q, 2) = (q_0, AZ)$ $\delta(q_0, Aa) = (q_0, A)$ $\delta(q_0, b, A) = (q_1, \varepsilon)$ $\delta(q_1, \varepsilon, 2) = (q_2, \varepsilon)$	04
	c	List the steps to convert the given CFG to equivalent PDA by empty stack. Convert the CFG below to it's equivalent PDA. $R = \{ E \rightarrow E + T \mid T$ $T \rightarrow T * F \mid F$ $F \rightarrow E \mid id \}$	06
		OR	
6	a	State and prove pumping lemma for $CFLs$. Show that the language, $L = \{ w \subset w : w \in \{a,b\}^* \}$. is not context-free.	06
	b	Let $L_1 = \{ a^n \, b^n \, c^m : n, m \geq 0 \}$ and $L_2 = \{ a^m \, b^n \, c^n : n, m \geq 0 \}$. Show that L_1 and L_2 are context free but also $L_1 \cap L_2$ is not context free.	06
	c	If the PDA $L = \{ w : w \in \{a,b\}^* \}$ and $\#_a(w) = {}_b(w) \}$ is deterministic.	04
7	a	Design a tuning machine over{1} which can compute a concatenation function.	06
	b	Explain variants of tuning machine.	06
	c	If L and $\bar{L}$ are both recursively enumerable, show that W and $\bar{L}$ are recursive.	04

<table>
<tr><td>8</td><td>a</td><td>Define Linear Bounded Automata. Construct LBA to accept the language given in the transition table.
<table>
<tr><th>states</th><th>¢</th><th>$</th><th>0</th><th>1</th></tr>
<tr><td>$\rightarrow q_1$</td><td>¢Rq_1</td><td></td><td>$1Lq_2$</td><td>$0Rq_2$</td></tr>
<tr><td>q_2</td><td>¢Rq_4</td><td></td><td>$1Rq_3$</td><td>$1Lq_1$</td></tr>
<tr><td>q_3</td><td></td><td>$\$Lq_1$</td><td>$1Rq_3$</td><td>$1Rq_3$</td></tr>
<tr><td>q_4</td><td></td><td>Halt</td><td>$0Lq_4$</td><td>$0Rq_4$</td></tr>
</table>
</td><td>06</td></tr>
<tr><td></td><td>b</td><td>Define context sensitive grammar. Give context sensitive grammar to generate the language $= \{ a^n\, b^n\, c^n \mid n \geq 1\}$. Show that the string $aaabbbccc$ is generated.</td><td>06</td></tr>
<tr><td></td><td>c</td><td>Define unrestricted Grammar. Give unrestricted grammar to generate the Language $L = \{ a^n\, b^n\, c^n \mid n \geq 1\}$. Shwo that the string $aabbcc$ is generated by the grammar.</td><td>04</td></tr>
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