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R. V. COLLEGE OF ENGINEERING

Autonomous Institution affiliated to VTU

IV Semester B. E. Examinations April/May-16

Common to ISE / CSE

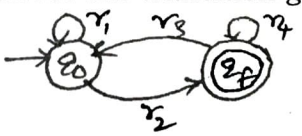
THEORY OF COMPUTATIONS

Time: 03 Hours *Maximum Marks: 100*

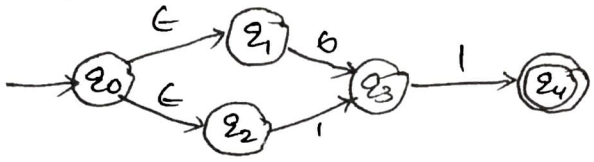
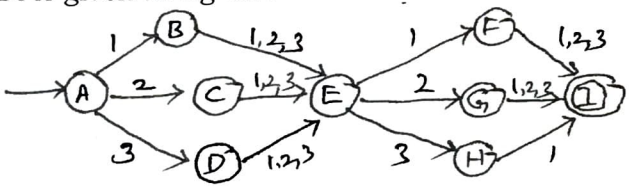
Instructions to candidates:

1. Answer all questions from Part A. Part A questions should be answered in the first three pages of the answer book only.
2. Answer FIVE full questions from Part B.

PART-A

1	1.1	For the language $L = \{ab, c\}$ over the set $A = \{a, b, c\}$, find L^3.	01
	1.2	Given $L_1 = \{a^i b^i c^j \mid i, j \geq 1\}$ and $L_2 = \{a^i b^j c^j \mid i, j \geq 1\}$, find $L_1 \cap L_2$.	01
	1.3	If $L = \{a, bba, aaa\}$ then $L^0 =$ _____.	01
	1.4	The relation between Σ^* and Σ^+ is _____.	01
	1.5	Write the primitive regular expressions.	01
	1.6	Write the regular expression for the language: $L = \{a^{2n} b^{2m} b : n, m \geq 0\}$ over $\Sigma = \{a, b\}$.	01
	1.7	Find the regular expression for the transition graph in Fig 1.7:  Fig 1.7	01
	1.8	Draw the plan for showing the equivalence of four different notations for regular languages.	01
	1.9	If $G = (V, T, P, S)$ is a CFG, then any string α in $(VUT)^*$ such that $S \overset{*}{\Rightarrow} \alpha$ is a _____.	01
	1.10	The transition function δ for the PDA is given by _____.	01
	1.11	_____ of a CFL and regular language is always CFL.	01
	1.12	CNF grammar has atmost _____ productions.	01
	1.13	Define instantaneous description (ID) of pushdown automata.	01
	1.14	A pushdown automaton is essentially _____ with a stack data structure.	01
	1.15	Draw the organization of constructions showing equivalence of three ways of defining the $CFLs$.	01
	1.16	Define deterministic pushdown automata.	01
	1.17	The languages accepted by TMs are called _____.	01
	1.18	Show the relationship between recursive RE and non-RE languages.	01
	1.19	The _____ symbol is in Γ but not in Σ of TM.	01
	1.20	Every language accepted by a multiple TM is _____.	01

PART-B

2	a	Design a *DFA* that accepts those words from $\Sigma = \{a, b\}$ where the number of *b's* is divisible by three. Sketch the state table diagram of finite automaton *M*.	05
	b	Convert the given $\varepsilon - NFA$ in fig 2b to its equivalent *DFA*. Also define the language accepted by it.  Fig 2b	08
	c	Write the differences between *NFA* and *DFA*.	03
		OR	
3	a	Minimize the *DFA* given in fig 3a .  Fig 3a	08
	b	Design an *NFA* to accept strings from $\Sigma = \{a, b\}$ ending with *ab* or *ba*.	04
	c	Construct a ε-*NFA* that accepts decimal numbers consisting of i) an optional + or - sign; ii) a string of digits; iii) a decimal point; iv) another string.	04
4	a	Obtain regular expression for the following: i) over $\Sigma = \{a, b\}$ and $L(r) = \{a, bb, aa, abb, ba, bbb, \ldots\}$; ii) over $\Sigma = \{0,1\}$ and $L(r) = \{$*all strings containing substring* 00$\}$; iii) over $\Sigma = \{0,1\}$ and without two consecutive zeroes.	08
	b	Consider the *DFA*: $\begin{array}{c\|cc} \delta & 0 & 1 \\ \hline \rightarrow q_1 & q_2 & q_1 \\ & q_2 & q_3 \\ & q_3 & q_2 \end{array}$ i) Give all the regular expressions $R_{ij}^{(o)}$; ii) Obtain the regular expression by eliminating q_2.	08
		OR	
5	a	State and prove pumping lemma for regular languages.	08
	b	Prove that $L = \{0^n 10^n \ / \ n \geq 1\}$ is not regular.	04
	c	Prove that class of regular languages is closed under union and concatenation.	04

6	a	Obtain a CFG to generate the following language: $L = \{W/W\varepsilon(a+b)^*$ *and all strings of even length*$\}$.	05
	b	Obtain the LMD, RMD and parse tree for the string $aabbabab$ where the grammar G is given by $S \rightarrow aB/bA, A \rightarrow a/as/bAA, B \rightarrow b/bS/aBB$.	07
	c	Show that the language of all non-null strings of a's defined by CFG $G = \{\{S\},\{a\},\{S \rightarrow aS/Sa/a\},S\}$ is ambiguous.	04
		OR	
7	a	Eliminate all ϵ −productions from the grammar: $S \rightarrow BAAB, A \rightarrow 0A2/2A0/\epsilon,\ B \rightarrow AB/1B/\epsilon$.	03
	b	Remove useless symbols and production from $G = (V,T,S,P)$, $V = \{S,A,B,C\}$, $T = \{a,b\}$ with productions $S \rightarrow aS/A/C,\ A \rightarrow a, B \rightarrow aa$, $C \rightarrow acb$.	03
	c	Remove all unit productions from: $S \rightarrow Aa/B, B \rightarrow A/bb, A \rightarrow a/bc/B$.	03
	d	Reduce the CFG G into Chomsky normal form given by following productions: $S \rightarrow aAc, A \rightarrow aB/bAB, B \rightarrow b, C \rightarrow c$.	07
8	a	Design a PDA to accept $L = \{WCW^R / W \in \{a,b\}^*\}$. Show the sequence of IDs to accept the string $abcba$.	10
	b	Convert the grammar $S \rightarrow aSa/bSb/\lambda$ to a PDA that accepts the same language by empty stack.	06
		OR	
9	a	Construct a PDA to accept balanced parenthesis and trace the PDA for the string (( )( )).	08
	b	Convert the following PDA to Grammar: $P = \{\{q_0\},\{b,c\},\{z_0,z_1\},\delta,\varepsilon_0,z_0\}$.	08
10	a	Design a Turing machine to accept palindrome over $\{a,b\}$. Give the sequence of IDs for the strings "$abaa$" and "aa".	10
	b	Prove that if L is recursive language, then so is complementation of L.	06
		OR	
11	a	Define Post's correspondence problem (PCP). Solve the following instance of PCP:	

	A	B
i	w_i	x_i
1	10	101
2	01	100
3	0	10
4	100	0
5	1	010

	b	Write short notes on: i) Multitape Turing machine; ii) Chomsky hierarchy.	08 08