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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

V Semester B. E. Examinations Nov/Dec-19

Information Science and Engineering

THEORY OF COMPUTATION

Time: 03 Hours *Maximum Marks: 100*

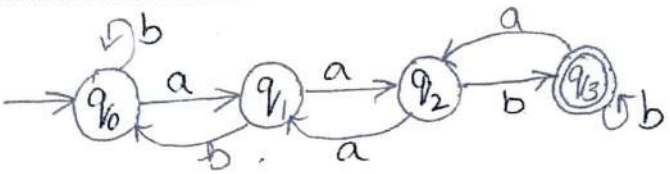
Instructions to candidates:

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	Identify the string of minimum length in $\{a,b\}^*$ NOT in the language $a^*b^*(ba)^*a^*$.	01
	1.2	Construct the regular expressions for the strings whose number of 0's are multiple of 3.	01
	1.3	State which of the following languages are not regular. $L_1 = \{WW \mid W \epsilon (a+b)^*\}$ $L_2 = \{WW^R \mid W \epsilon (a+b)^*\}$ $L_3 = \{a^n b^m \mid n \geq 0 \; and \; m > 5\}$ $L_4 = \{a^n b^m \mid m = n + 5\}$	01
	1.4	Construct an $\epsilon - NFA$ for the regular expression $0(0+1)^*1$	01
	1.5	State whether the following grammar is ambiguous or not. Justify your answer. $S \rightarrow AB \mid aaB$ $A \rightarrow a \mid Aa$ $B \rightarrow b$	02
	1.6	Construct $DPDA$ equivalent to the DFA whose transition table is as shown below. → A: A, B (B): C, A C: A, B	02
	1.7	Design a Turing machine to accept the language $L = \{(a+b)^n ab \mid n \geq 0\}$	02
	1.8	Transition function δ for Turing machine with stay option is _____.	01
	1.9	CFLs are closed under _____ and _____.	01
	1.10	Identify and remove the useless productions from the following grammar. Justify your answer. $S \rightarrow aA \mid a \mid B \mid C, A \rightarrow aB \mid \in, B \rightarrow Aa, C \rightarrow cCD, D \rightarrow dd$	02
	1.11	Define recursive and recursively enumerable languages.	02
	1.12	Define polynomial time reduction.	01
	1.13	Illustrate the language recognized by the following CFG. $S \rightarrow aSbS \mid bSaS \mid \in$	01
	1.14	Define $DPDA$.	02

PART-B

2	a	State and prove pumping lemma for regular languages.	06
	b	For each of the regular expression below, find an $\epsilon - NFA$ recognizing language corresponds to the regular expressions. i) $((ab)^*b + ab^*)^*$ ii) $(ab + (aab)^*)(aa + a)$.	05
	c	Convert the following finite automata in Fig 2c to Regular expression using state elimination method.  Fig 2c	05
3	a	Represent the following grammar in CNF. $S \rightarrow AaA\|CA\|BaB$ $A \rightarrow aaBa\|CDA\|aa\|DC$ $B \rightarrow bB\|bAB\|bb\|aS$ $C \rightarrow Ca\|bC\|D$ $D \rightarrow bD\|\in$	08
	b	Define left factoring. Left factor the following grammar. $S \rightarrow bSSaaS\|bSSaSb\|bSb\|a$	04
	c	Construct a CFG to generate the following languages. i) $L = \{uvwv^R : u, v, w \in \{a, b\}^+, \|u\| = \|w\| = 2\}$. ii) $L = \{a^n b^m : n \leq m + 3\}$	04
		OR	
4	a	Define left recursion. Eliminate the left recursion from the following grammar. $E \rightarrow E + T\|T$ $T \rightarrow T * F\|F$ $F \rightarrow (E)\|id.$	05
	b	Let G be the grammar $S \rightarrow aAS\|a\|SS, A \rightarrow SbA\|ba.$ For the string $aabbaa$, find a. i) Left most derivation ii) Right most derivation iii) Derivation trees.	06
	c	Discuss the applications of context free grammars with appropriate examples.	05
5	a	Construct PDA to accept the language $L = \{a^{2n} b^n \| n \geq 0\}$. Show the moves made by PDA for the string $aaaabb$.	05
	b	Show that the $CFLs$ are not closed under intersection.	05
	c	Find an equivalent CFG for the PDA below with q_0 as initial state and q_f as final state. $\delta(q_0, a, Z_0) = (q_0, AZ_0)$ $\delta(q_0, a, A) = (q_0, AA)$ $\delta(q_0, b, A) = (q_1, \in)$ $\delta(q_1, b, A) = (q_1, \in)$ $\delta(q_1, \in, Z_0) = (q_f, Z_0)$	06
		OR	

6	a	Discuss the languages accepted by PDA.	05
	b	Write an algorithm to convert CFG to PDA. Convert the following CFG to PDA. $S \rightarrow aABB \mid aAA$ $A \rightarrow aBB \mid a$ $B \rightarrow bBB \mid A$ $C \rightarrow a$	06
	c	Show that the language $L = \{a^n b^n c^n \mid n \geq 0\}$ is not a CFL.	05
7	a	Design a turing machine to compute the following function for x, a positive integer represented as : $f(x) = \begin{cases} \frac{x}{2} : x \text{ is even} \\ \frac{x+1}{2} : x \text{ is odd} \end{cases}$	05
	b	Discuss about Chomsky hierarchy.	05
	c	Prove that every language accepted by a multiple Turing machine is recursively enumerable.	06
8	a	Prove that the $3SAT$ problem is polynomial-time reducible to $CLIQUE$.	08
	b	Discuss and explain primitive recursive functions.	08